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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 14

LIGHTING *TO* MAXIMILIAN

ENCYCLOPÆDIA BRITANNICA, INC.

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LIGHTING *TO* MAXIMILIAN

LIGHTING. Man has been engaged in continuous effort to utilize the hours of darkness through the application of artificial illumination. Methods of producing light remained primitive over long periods of time, and, when improved methods were introduced, the use of the earlier forms continued, so that at no time has one method completely replaced another. More than half of the world's inhabitants still have only flame sources for artificial light.

Artificial illumination is obtained as a result of combustion, incandescence or electric discharge with or without fluorescence. Sources of light may be divided into three classes: (1) vegetable and animal fatty substances; (2) carbonaceous matters, gases and oils; and (3) electrical.

Light as a physical phenomenon is discussed in the article LIGHT, while its perception is dealt with in VISION.

This article is divided into the following sections:

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I. HISTORICAL DEVELOPMENT

The earliest form of artificial illumination was the fire used by primitive man for warmth and for protection against wild beasts, and flaming faggots from the campfire were the first torches. From this beginning, thousands of centuries before written history, the torch in various forms has continued as a source of illumination throughout the world.

The flambeau of the middle ages, carried by pedestrians at night, was a torch consisting of twisted fibre coated with some inflammable substance. These torches provided the earliest form of street lighting, being fastened in metal holders to the outside walls of houses. Pieces of resinous wood, stuck between the stones of the fireplace, gave forth bright but smoky flames for lighting the homes of early New England.

Unusual sources of artificial illumination are the glowworms, beetles and fireflies supposedly confined in lanterns in the West Indies or stuck in wax in shallow saucers in Java. Oily carcasses of various animals with wicks drawn through them have been used; the penguin has been most frequently used in this manner.

1. Oil Lamps.—The earliest prehistoric lamp dates to the Mousterian Age. This was a hollowed piece of stone, very crude, found at Le Moustier, France, in 1928. Terra-cotta lamps of 7000–8000 B.C. have been found on the Mesopotamian plains, and Egyptian and Persian copper and bronze lamps of about 2700 B.C. have been discovered at various times.

By 1000 B.C. an advancement in lighting efficiency was provided by a wick of vegetable fibre burning in a saucer-type vessel holding olive or nut oil, and by 500–400 B.C. oil lamps had come

into general domestic use. Roman lamps of unglazed and glazed terra cotta had two or more spouts, and later bronze and iron lamps were introduced, with designs becoming more elaborate. About 100 B.C. the Romans developed the first true lantern of horn, cylindrical in form with a perforated top. Vegetable-oil lamps were in general use among the early Jews, Greeks and Romans.

The first record of mineral-oil lamps was made about A.D. 50 when Pliny the Elder mentioned this use of oil found on the Adriatic shores. Japanese history in A.D. 615 mentions "burning water," and Marco Polo wrote in the 13th century of Baku oil springs furnishing oil satisfactory for lighting purposes.

Early attempts were made to improve the efficiency of oil lamps. About the latter half of the 1st century A.D., Hero of Alexandria devised a lamp in which pressure of brine acting through a column of air raised the oil to the wick. In 1490 Leonardo da Vinci added a cylindrical glass chimney fitted into a glass globe filled with water. The light burned steadily, and through lens action the work surface was brightly lighted for night study. Da Vinci also devised water lenses for correcting near vision, the first recorded analysis of the fact that seeing is a combination of light and vision.

Various types of oil lamps were used through the 14th to 17th centuries, but with little improvement of efficiency. The Betty lamp of the Pilgrims (1620), a metal receptacle with a wick lying in a slot and protruding from one side, was equipped for hanging from mantelpieces or shelves. Fish oil was the chief illuminant.

In 1784 the Swiss physicist Aimé Argand patented a lamp with round burner and tubular wick and a chimney for directing and regulating the flow of air to the flame. An accident led to the discovery that a round glass chimney reduced flickering, and the Argand lamp marked the greatest advancement in artificial illumination to that date. In 1800 Bertrand G. Carcel added a clockwork pump for raising and feeding oil to the wick and, because of the steadiness of the light produced, the Argand lamp in this form became a photometric standard. Benjamin Franklin discovered that two wicks side by side a small distance apart gave more light than two single-wick lamps.

Distilled coal oil produced by James Young in 1850–51 was an improvement, but the discovery of petroleum by Edwin L. Drake in 1859 provided an inexpensive illuminant of high lighting efficiency, and the crude-oil lamp was practically superseded. In the following 20 years an average of 80 patents per year were granted for various types of improved oil lamps. One of the most important was the duplex burner lamp introduced in 1865 by Joseph Hinks. In 1868 the Wells light combined an oil spray with vaporized oil through the use of pressure, giving a highly luminous flame, the principle used in modern flare lamps. The Kitson lamp of 1885 was a pressure-type lamp using platinum mantles, replaced later by Welsbach mantles.

During the latter half of the 19th century oil lamps underwent many changes and improvements intended to make them more attractive for domestic use and more efficient for industrial purposes. They were mounted on elaborate bases and the oil reservoirs were decorated; some were designed for suspension from ceilings and others were portable. The latter designs carried over into the 20th century, and the kerosene lamp with a flat wick in a perforated metallic holder and a plain glass chimney came into extensive use in rural districts.

2. Candles.—The use of candles dates as far back as the beginning of the Christian era, and candlemaking is probably one of the oldest industries of mankind. Among aboriginal races in Africa oily nuts were burned in clay saucers; later they were strung on twigs, thereby providing continuous illumination.

In A.D. 100 Greek and Roman true candles were made of flax threads coated with pitch or wax, although the Phoenicians are credited with the first use of wax candles about A.D. 400. The candle was not in as common use as the oil lamp for several centuries, but returned during the middle ages. Throughout the 16th to 18th centuries and until the discovery of petroleum, candles provided the only method of artificial illumination available to people of average means. Their use has been closely related to religious ceremonies and customs throughout Christian history. The earliest candles were rush piths dipped in tallow. Later, splinters of wood, also dipped in tallow or beeswax and called kindle lights, were used. Homemade candles of Pilgrim days were of tallow. The whaling industry in the 18th century brought spermaceti into use. The spermaceti candle, because of its clear, steady flame, was used as a standard measure for artificial light, the term "one candle power" being based on the light given by a pure spermaceti candle weighing one-sixth of a pound and burning at the rate of 120 gr. an hour. The isolation of stearine in 1823 and the development of paraffin in the 1850s furnished improved materials for candles.

Candleholders have assumed various forms. The Prickett chandelier introduced in Italy in 1492 was a multiple-spiked holder mounted in groups around a decorative figure on the wall, with mutton-fat candles forced on the spikes. In the 15th century crystal chandeliers with small cups for holding wax candles lighted homes, ballrooms and public gathering places. Of these candles, 120 would have been required to equal the light of one 100-w. electric lamp, and the number required to illuminate a large room produced considerable heat. Candles in elaborate chandeliers were used for illumination of the house of commons in England as late as 1834, and their replacement by gas was strongly opposed by members. With the advent of gas as an illuminant, the use of candles was gradually confined to church ceremonies, decorative domestic purposes and festive occasions.

3. Gas.—Ancient records of Egypt and Persia provide numerous instances of spontaneous discharge of combustible gases from fissures in the earth. Natural gas was employed as an illuminant by the Chinese centuries before the Christian era. The gas was brought to the surface from beds of rock salt 1,500 to 1,600 ft. deep, conveyed through bamboo pipes and used for lighting salt mines and homes in Szechwan province.

In 1664 near Wigan, Lancashire, Eng., John Clayton discovered a pool of natural gas near a coal mine, and later described satisfactory experiments in extracting coal gas by distillation. In 1726 Stephen Hales reported that 158 g. of Newcastle coal would yield 180 cu.in. of "inflammable air," and in 1733 Sir James Lowther sent specimens of distilled coal gas to the Royal society for experimentation.

In 1784 Jean Pierre Minckelers first used gas for lighting. Contemporaneously, in Paris, Philippe Lebon experimented with distillation of gas from various materials for domestic use, and in 1799 Lebon patented a "thermo-lampe," using gas distilled from wood.

The first extensive use of illuminating gas is ascribed to William Murdock, who, in 1792, lighted his home in Redruth, Cornwall, Eng. The gas was produced in large iron retorts and conveyed 70 ft. through metal pipes. In 1798 Murdock installed gaslighting in a factory near Birmingham, Eng., and soon was providing gas commercially for several shops in the vicinity.

The new illuminant was denounced as dangerous and impractical, slowing its adoption. Through the efforts of F. A. Winsor, a German, the first public installation of gaslights was made in London in 1807. For dispelling the public prejudice against illuminating gas, Winsor is referred to as the father of gaslighting. Westminster bridge, London, was illuminated by gas in 1813; Paris adopted gas for street lighting in 1818; and most cities in England and Europe soon had gaslighting systems. The first domestic use of gas in the United States was in 1806, when David Melville, of Newport, R.I., lighted his home and the street directly in front. The first interior commercial use was in the New theatre, Philadelphia, Pa., where gaslights were installed in 1816.

Between 1820 and 1880 many improved burners were developed, the batwing or fishtail type being most commonly used. The Bunsen burner was invented by Robert Wilhelm Bunsen in 1855, and in 1858 William Sugg invented a burner with an incorrodible steatite orifice. Carl Auer von Welsbach experimented for ten years on the Welsbach mantle, and his system of lighting was first exhibited in London in Feb. 1887. By 1900 incandescent gaslighting was firmly established.

The Welsbach mantle consisted of a cylinder woven of sea-island and Egyptian cotton soaked in a solution of 99% thoria and

1% ceria. After various manufacturing processes, the mantle was altered so that it consisted of a metallic-oxide skeleton. In use the mantle was suspended over a Bunsen burner so that the metallic oxides composing the mantle were heated to incandescence, emitting a brilliant greenish light. By using varying combinations of rare earths in solution for impregnating the mantles, different colours of light could be obtained. Welsbach mantles have continued in use with various types of lamps.

4. Acetylene Gas.—Although the existence of this gas had been known since 1836, its manufacture and use as an illuminant was first described by Henri Moissan in 1892. Simultaneously, in the U.S., Thomas L. Willson demonstrated that acetylene gas obtained by immersion of calcium carbide in water produced an intense white light. By 1909, 290 towns in the U.S. were lighted by acetylene gas. Later its use was confined to emergency lighting in remote areas.

5. Pintsch Gas.—Originally developed for lighting railroad cars by Julius Pintsch of Germany, this gas was used in Europe for many years, and was introduced into the U.S. in 1866. By 1910 there were 93 Pintsch gas works in the U.S., Canada and Mexico. It was used extensively on steamships and for lighthouses. Similar to Pintsch gas were the numerous bottled gases developed in subsequent years to provide illumination with Welsbach-type mantles in areas where electricity was not available.

By 1911 conversion of gas fixtures for use with electricity had begun, and soon electricity was rapidly replacing gas for general illuminating purposes. In England and Europe, however, gas enjoyed wide use for a number of years longer.

6. Electric Lamps.—In 1650 Otto von Guericke of Magdeburg, Ger., discovered that light was produced by electricity or by electrical excitation. He demonstrated that when a globe of sulfur was rotated rapidly and friction was produced by pressure of the hand during rotation, a luminous glow could be observed. About 1706 the Englishman Francis Hauksbee (Hawksbee) used this discovery, together with a glass globe exhausted by means of a vacuum pump also invented by Guericke, to produce the first electric light. When the globe was rotated at high speed, then rubbed with the hand, it emitted a faint glow of light. In 1802 Sir Humphry Davy demonstrated that strips of platinum or other metals could be heated to incandescence electrically and would give off light for some time. In 1809 he used a battery of 2,000 cells to pass a current through two charcoal sticks four inches apart, producing a brilliant arch-shaped flame, thereafter called the arc lamp.

Throughout the 19th century, development of the arc lamp and the incandescent lamp were parallel. The earliest recorded attempt to make an incandescent lamp was in 1820, when De la Rue enclosed a platinum coil in a piece of evacuated glass tubing. In 1840 Sir William Robert Grove of England lighted an auditorium with feeble, impractical lamps using platinum coils heated to incandescence and covered by inverted tumblers in glass dishes partly filled with water. The cost of the current consumed by the installation was estimated at several hundred pounds a kilowatt-hour.

In 1841 Frederick de Moleyns of Cheltenham, Eng., obtained the first patent granted for an incandescent lamp. His lamp was unique, consisting of an evacuated glass sphere containing powdered charcoal which bridged the gap between two platinum wires or filaments. Light was produced by passage of current through the filaments, heating the charcoal to incandescence. However, the globe blackened quickly and the lamp was short-lived.

In 1845 Thomas Wright of London obtained the first patent for an arc lamp, and in the same year a young Ohio inventor, J. W. Starr, obtained a British patent for two incandescent electric lamps. Edward G. Shepard in 1850 constructed a lamp using incandescent charcoal. The same year Sir Joseph Wilson Swan, English physicist, devised carbon filaments of paper.

During the latter part of the 19th century many scientists tried to produce electrical illumination on a practical commercial basis, and there are records of occasional use of electric lamps throughout the period. In 1856 the French engineer C. de Chagny patented a novel platinum-filament lamp for mines, and in 1857 the first commercial installation of an electric arc lamp was made in the lighthouse at Dungeness, Eng.

In 1872 Alexandre de Lodyguine, a Russian physician, made a lamp having a V-shaped piece of graphite for a filament, operating in a glass globe filled with nitrogen gas. Two hundred of these lamps were installed about the Admiralty dock in St. Petersburg, but unreliability of operation and cost made them impractical for general use. A contemporary, S. A. Kosloff, used multiple rods of graphite operated in nitrogen. None of the foregoing lamps was practical.

In 1876 Paul Jablochkov, a Russian electrical engineer, introduced the Jablochkov candle, marking an epoch in artificial illumination. The Jablochkov candle was an arc lamp having parallel carbon rods separated by porcelain clay, which vaporized during burning of the arc. Alternating current was used to ensure equal rates of consumption of the two points of the rods. This lamp was widely used commercially. First installation of arc lamps for public lighting in the U.S. was in 1879 when the public square in Cleveland, O., was lighted by a system of 12 Brush carbon arc lamps developed by Charles F. Brush.

Before the Edison incandescent carbon-filament lamp was patented in 1880, numerous scientists directed their efforts toward production of a satisfactory incandescent lighting system, outstanding among them being Sir Joseph Wilson Swan. In 1850 Swan had devised carbon filaments of paper; later he used cotton thread treated with sulfuric acid and mounted in glass vacuum bulbs (only possible after 1875). Utilizing this type of lamp, called the electric glow lamp, he gave a large-scale public exhibition of electric lighting at Newcastle, Eng., in Dec. 1878.

Final development of the incandescent lamp was the result of concurrent work by Swan and Thomas A. Edison, using the vacuum pump of Hermann Sprengel and Sir William Crookes. The invention of a completely practical lamp ordinarily is credited to Edison, who began studying the problem in 1877 and within a year and a half had made more than 1,200 experiments. Concurrently, recognizing that the series wiring systems then used for arc lights would not be satisfactory for incandescent lamps, Edison directed much effort toward development of dynamos and other necessary equipment for multiple circuits.

On Oct. 21, 1879, Edison lighted a lamp containing a carbonized thread for the filament. The lamp burned steadily for two days. Later he learned that filaments of carbonized visiting card paper (Bristol board) would give several hundred hours' life. Soon carbonized bamboo was found acceptable and was used as the filament material. Extruded cellulose filaments were introduced by Swan in 1883. The first complete incandescent lighting system was publicly demonstrated at Edison's laboratory in Menlo Park, N.J., on Dec. 21, 1879.

The first commercial installation of Edison's lamp was made in May 1880 on the steamship "Columbia." This installation, consisting of 115 lamps, was operated successfully for 15 years. In 1881 a New York city factory was lighted with Edison's system, and the commercial success of the incandescent lamp was quickly established. More than 150 other installations were made in the following two years. In 1882 the Pearl street generating station in New York city was put into service, and is considered the forerunner of the great central stations subsequently developed. In England an exhibition of electric lighting was held in 1882 at the Crystal palace, and by this time incandescent lamps had been installed in numerous public buildings.

When the incandescent lamp was introduced as a public illuminant, fear was expressed that it might be injurious to the eyesight, particularly when used for long periods by indoor workers. In 1898 the oculists of London petitioned parliament to pass laws against the use of unshaded lights, and consequently research was instituted on various types of shades and reflectors. One of the earliest reflectors used commercially was the one-piece silvered glass reflector developed by E. L. Haines and installed in show windows in Chicago and other cities in the U.S.

Closely related to the incandescent gas mantle, and suggested by it, was the Nernst glower, unique among illuminants of its time as the first practical attempt to substitute some other in-

candescent substance for carbon filaments. Patented in 1901 by W. H. Nernst of Germany, it utilized a filament composed of oxides of rare-earth elements heated to incandescence by passage of electrical current. Mixtures of two or more oxides were found to be most satisfactory, and in 1905 the commercial Nernst glower consisted of 85% zirconia and 15% yttria. The Nernst lamp did not achieve wide use, but investigations carried out to improve it had considerable effect on the development of the incandescent lamp.

Welsbach invented the first commercial metal-filament lamp, but the osmium employed was extremely rare and expensive. The first applications were in Berlin and Vienna in 1899, but manufacture was discontinued in 1907 when the tungsten lamp appeared. Werner von Bolton, a Russian chemist, discovered the possibility of using tantalum for lamp filaments about 1902, and in 1906 the tantalum lamp was put on the market in the U.S., but it disappeared from use about 1913.

In 1904 Willis R. Whitney of Schenectady, N.Y., produced the heat-treated or metalized carbon-filament lamp, with a higher degree of efficiency than any previous incandescent lamp. But scientists were concerned with the most efficient conversion of electrical energy into light, and the discovery of tungsten as a material for filaments seemed to achieve this goal. The tungsten-filament lamp represented the greatest advance ever made in the quality and efficiency of incandescent lighting, and quickly replaced carbon, tantalum and metalized carbon filaments for commercial use.

The first tungsten-filament lamps, introduced in the U.S. in 1907, made use of pressed tungsten, manufactured by a process perfected by Alexander Just and Franz Hanaman of Vienna. By 1910 William D. Coolidge of Schenectady, N.Y., discovered a process (patented in 1913) for producing drawn tungsten filaments, greatly improving the durability of tungsten lamps.

In 1913 Irving Langmuir of Schenectady, N.Y., developed the use of inert gases inside the incandescent lamp bulb which retard filament evaporation, giving increased efficiency. Nitrogen alone was first used, but later lamps used argon and nitrogen in varying proportions, depending on the wattage. Low first cost, ease of maintenance and adaptability gave the gas-filled lamp such importance in the lighting field that other incandescent lamps practically disappeared. Other significant milestones included dumet seal wire (an iron-nickel alloy) developed in 1913; tipless lamps in 1919; inside-frosted bulbs in 1925; photoflash lamps and the copper-to-glass seal in 1930; and vaporized-aluminum reflector lamps in 1936. A further improvement introduced in 1937 was the coiled-coil type of filament for general service lamps.

Tungsten-filament lamps were developed in a variety of sizes and shapes, for domestic and commercial use and for some highly specialized purposes. By 1935 they were available in shapes varying from the common pear-shaped or round bulb type to tubular forms several feet long. A very small lamp, known as the grain o' wheat lamp, having a bulb only 2 mm. in diameter and 8.7 mm. long, became valuable to the medical profession, providing a light source for internal investigation and surgical work. A lamp smaller than the grain o' wheat lamp was being regularly supplied, and lamps with built-in reflectors were in wide use. Inside silica coatings had improved the diffusing qualities without loss in lamp efficiency.

7. Electric Discharge Lamps.—The observations of Jean Picard in 1675 and Johann Bernoulli about 1700 indicated that light could be produced by agitated mercury. Early research in the field was done about 1850 by Heinrich Geissler, German physicist who invented the Geissler tube, by means of which was demonstrated the phenomenon of luminosity accompanying the discharge of electricity through rarefied gases. An Englishman, John T. Way, demonstrated the first mercury arc in 1860; and John Rapieff of London and the French scientist M. Jamin made further contributions in 1879 and 1882 respectively.

In 1887 Geissler tubes were used largely for laboratory demonstrations, but in 1897 tubes of various colours were used successfully for a display commemorating the diamond jubilee of Queen Victoria of England.

The Moore tube, developed by Daniel McFarlan Moore between 1891 and 1904 along the principle of the Geissler tube, made use of nitrogen to produce a yellow light and of carbon dioxide for a pinkish-white colour approximating daylight. Moore tube lights were most widely used for colour matching, and the first commercial installation was made in a Newark, N.J., store in 1904. The Moore tube was difficult to install and repair, and a complicated valve mechanism was required to maintain the gas at the correct pressure.

The mercury-vapour lamp, originated by L. Arons of Germany in 1892, was not manufactured on a commercial basis. Peter Cooper-Hewitt marketed the mercury-arc lamp in 1901, its efficiency proving to be two or three times that of the contemporary incandescent lamp. Its chief limitation was its peculiar colour quality, with light rays concentrated in three restricted spectral regions and with a complete absence of red. Introduction of other gases failed to produce satisfactory results until Cooper-Hewitt devised a fluorescent screen which converted some of the excess blue and green light and a little of the yellow into red, thereby materially improving the colour. The first practical installation of the Cooper-Hewitt lamp was in the composing room of the *New York Evening Post* in 1903. Creating a nearly shadow-free light and less glare, the lamp immediately found wide use for industrial lighting in the U.S.

Cooper-Hewitt also developed the quartz tube mercury lamp, used extensively in biological research. A later form of the quartz tube lamp, based on research carried on by C. Bol and others in the laboratories of the Philips company in Eindhoven, Neth., led to exploitation in Europe of a small water-cooled or capillary type of mercury-arc lamp, developed in 1935. Subsequently the U.S. type of this lamp was used primarily for photographic work and for searchlights.

Research in the use of noble gases for illumination purposes was continuous. In 1910 Georges Claude in France experimented with electric discharge tubes containing neon, argon, helium, krypton and xenon, and within a decade the neon sign industry had developed. The novel effects obtainable with neon tubes gave them wide use for advertising purposes, their extreme adaptability, high luminosity and brilliant colours making them particularly suitable in this field. Efficiency of light production by use of neon tubes was too low for general illumination, and none of the colours was satisfactory for interior lighting.

A promising electric discharge lamp developed in Europe by 1931 was the high-intensity sodium-vapour lamp, although it was not satisfactory for commercial or domestic use because of its characteristic yellow colour. Major applications were for highway lighting and general outdoor lighting where colour rendition was not important; and by mid-20th century sodium-vapour lamps were being used for highway lighting and illumination of bridges and vehicular tunnels all over the world.

Fluorescent phenomena had long been known, while fluorescent lamp coatings were investigated in France and Germany in the 1930s. By 1934 the low-voltage fluorescent lamp was under development in the U.S. Offering a highly efficient low-power source in various colours, the fluorescent lamp afforded the nearest approach to "cold" light ever devised in practical form. Fluorescent lamps produce light not by heating a filament to incandescence but by fluorescence of certain chemicals when excited by ultraviolet energy.

The early fluorescent lamp consisted of a low-pressure mercury arc of about 15 w. in a cylindrical glass tube coated inside with mineral salts having fluorescent qualities (phosphors). The efficiency and colour of the light were determined by the vapour pressure and the particular chemicals used. Fluorescent lamps were introduced commercially in 1938, and their rapid application on a large scale marked a major development in the field of artificial illumination. In the following year numerous permanent installations were made, and general lighting by these lamps was completed in two large factories in the U.S. Fluorescent lighting was an integral part of the decorative scheme of the New York and San Francisco world's fairs in 1938 and 1939.

During the ensuing years research designed to improve fluores-

cent sources was carried on extensively, and low- and high-voltage fluorescent lighting found many new applications in interior lighting and luminous decorative design. The adoption of fluorescent lighting was relatively rapid for industrial plants, stores and offices, but not until 1942 was it used to any extent for home lighting, although many specialized applications had been made. In 1944 experimental installations of fluorescent lamps for street lighting were made, and many installations were made in subsequent years. Other developments included rapid-start lamps, which eliminated the disturbing initial flicker; dimming and flashing circuits for special applications; and high-frequency systems which eliminated the need for expensive lamp ballast units. Intensive efforts also were devoted toward increasing lamp efficiency and light output so that the number of lamps needed in a given installation could be reduced.

II. MODERN ELECTRICAL LIGHT SOURCES

A. Arc Lamps

By mid-20th century the atmospheric arc lamp was used chiefly in large-wattage units for searchlights, for projectors calling for a high intensity and concentrated source, and for other special applications requiring small but powerful sources of blue and ultraviolet energy. The colour of the arc light may be controlled to some extent by use of various materials in the electrodes.

Arc lamps may be classified as: (1) low-intensity arcs, using solid carbon or neutral-cored electrodes and producing light by the incandescence of the electrode; (2) flame arcs, using mineralized carbon electrodes and producing the light from a luminous arc with some incandescence at the electrode ends; and (3) high-intensity arcs, where much of the light comes from the gaseous region immediately in front of the carbon.

When arc lamps operating at atmospheric pressure are operated in parallel, it is necessary to control the flow of current by a ballast or series inductance. Arcs have a negative volt-ampere characteristic and operate at voltages lower than the starting value. Arc lamps must be equipped with automatic mechanisms for starting the arc and adjusting the electrodes. The maximum brightness obtained depends upon the size of the carbons and operation of the arc, and brightnesses exceeding 1,300,000 candles per square inch have been recorded with high-intensity arcs. The carbon-arc lamp operates at an efficiency of from 40 to 65 lumens per watt (l.p.w.). The objectionable noise and unsteady operation of the earlier types were overcome. Special arc electrodes and construction are used for wave-length standard measurements, and the line at the red end of the cadmium arc (6432.5696 Å) has been so accurately measured that the standard of length could be reproduced by using this wave length as a base.

Low-intensity arcs are used for motion-picture projection, photoengraving illumination and other photochemical effects, therapy, ultraviolet irradiation, black-light effects, etc. Uses for the flame arc are related to the spectral characteristics which result from the electrode material used; for example, carbons cored with cerium compounds produce light closely approaching natural sunlight.

High-intensity arcs are widely used for searchlights and large area floodlights and for coloured motion-picture photography and projection. Properly positioned with respect to a large parabolic mirror, the high-intensity arc makes possible searchlights of very narrow beam spreads and intensities exceeding 1,000,000,000 cp.

B. Incandescent Lamps

Edison developed a 100-w. carbon-filament lamp having an efficiency of 1.6 l.p.w. and a life of 600 hours. This efficiency was sufficient for the early lamp to compete with existing flame sources, but within 50 years manufacturers were offering 100-w. lamps with an efficiency of 16.4 l.p.w. and a life of 750 hours.

1. Losses.—Losses in the incandescent lamp are caused by: (1) heat conduction by lead-in wires and filament supports; (2) heat conducted and convected to the gas of gas-filled lamps; (3) voltage loss in the leads; and (4) light absorption by the glass and the base. After lamps have been in service, the lamp produces less light because of (1) decreased power consumption as the filament becomes thinner because of tungsten evaporation and (2) bulb blackening. Higher-temperature filaments produce whiter light as well as increased efficiency, and progress has been marked by increased filament temperatures. Drawn tungsten wire, because of its favourable radiating characteristics, low rate of evaporation, high melting point, high tensile strength and ductility, became the preferred material for lamp filaments. This metal is available in sufficient quantity for all lighting needs; filaments for 75,000 40-w. or 1,000 500-w., 115-v. lamps can be made from one pound. No readily available substance exists with the efficiency of tungsten for converting electrical energy into light with no reservations as to cost, manufacturing difficulties or other considerations. The introduction of automatic machines into the manufacture of incandescent lamps aided in the production of a superior, uniform lamp at a nominal cost; and the high quality of the lamp is maintained by rigid specifications and tests.

2. Gas-Filled and Vacuum Incandescent Lamps.—Air is exhausted from the lamps to eliminate oxygen, thereby preventing filament oxidation and vaporization. Air seepage into an incandescent lamp causes rapid deterioration of the filament.

Attempts to introduce inert gases into the carbon lamp for increasing filament temperatures failed because the resultant losses by conduction neutralized filament temperature gains.

The first major improvement of the tungsten lamp was the introduction of an inert gas into the bulb. Nitrogen was first used because the rarer gases were too expensive to obtain; however, by improved processes enough argon became available so that the atmosphere surrounding the filament is composed of 88% argon and 12% nitrogen. Krypton has lower heat conductivity than either nitrogen or argon, but it is too scarce and expensive to be used generally. Because the gas used must be very pure and free from moisture, special care must be taken during lamp manufacture to remove unwanted gases and water vapour.

Higher lamp efficiency can be obtained by increasing the size of the filament because the protective sheath of hot gas is of nearly constant thickness. Coiling the filament made gas-filled lamps practical, and the next step in reducing filament loss was an apparent increase in filament size produced in 1935 by winding the coiled filament around a mandrel. The coiled-coil filament thus formed had an additional 10% to 15% increase in efficiency.

Materials used for lead-ins and supports were improved and the number of supports reduced until end losses from these sources had been reduced to about 2%. Elimination of a support increased the efficiency approximately 0.5%. In the 40-w. lamp, supports were reduced from 11 in the vacuum tungsten lamp to 3 in the gas-filled lamp.

3. Mechanical Features.—The incandescent lamp is an assemblage of a mount, a glass bulb and a base. Standard-voltage lamps of 40 w. or larger contain gas which permits higher filament temperature and thus improved efficiency. The complete mount for a standard large lamp consists of: (1) the stem which carries the molybdenum support wires held in a glass button at the end of the stem; (2) the exhaust tube; (3) the tungsten filament; and (4) lead-in wires. In the press (the sealing point at which the wires pass through the glass) the lead-in wires are made of a nickel-iron core clad in copper, this combination having the same coefficient of expansion as glass; nickel lead-ins are used from the press to the filament, and copper from the press to the base. In some of the larger sizes a mica disk on the stem protects the stem press, stem and socket from the excessive temperature by retarding the circulation of hot gases from the filament when the lamp is burned base up. The base is used for the connection to the electrical circuit. To open the circuit and protect line fuses when the filament arcs, many sizes of lamps have a small fuse just outside the stem press on the mount.

The filaments are supported in many ways for various types of duty. The filament form determines the position in which the lamp may be burned and its resistance to vibration. The filament form also controls the incandescent plane important in projection service. The base of the lamp adapts it to the holder of the equipment, and is cemented except where greater strength and

higher base temperatures require a mechanical base without cement. When the screw lacks carrying capacity in large lamps, it can be replaced by the bipost base which forms a pin-type positive connection and accurate location of the light source. In other cases when precise filament positioning is essential, prefocus bases are used so that lamps may be interchanged in an optical system (*e.g.*, in a film projector) with the filament remaining in the same place. Bayonet, disk and pin bases are used on smaller types and tubular lamps.

Many shapes and sizes of glass bulbs are employed, depending on the wattage and service intended. The bulbs may be clear, coloured, inside-frosted or coated with diffusing or reflecting materials.

4. Spectral Quality of the Incandescent Lamp.—The light emitted from the incandescent lamp is deficient in blue radiation and strong in the red, the exact distribution depending on filament temperature. If additional radiation is desired in the blue region, lamps are operated at voltages higher than normal, resulting in shorter lamp life. The enclosing bulb influences the spectral distribution, the daylight lamp using coloured glass for correcting this region (blue-green glass); this lowers lamp efficiency about 35% because of the light absorbed by the glass.

5. Other Factors Affecting Light Output.—The electrical frequency of the system supplying the incandescent lamp will influence its output. The light from a lamp filament varies as the current decreases from maximum to zero. This is noticeable at the lower frequencies but invisible to the unaided eye for 60-cycle systems. The larger the lamp, the more carry-over there will be. A 40-w. lamp has 13% variation at 60 cycles, while a 500-w. lamp has only 2%, and the same sizes range from 29% to 6% with 25 cycles. Flicker in lighting will be noticed if a 3% change of voltage is applied for a two-cycle duration.

Lamps should be operated at the voltage for which they were designed, though at ordinary rates for electric energy the cost of producing light is often less if lamps are burned at increased voltage. A 10% increase of voltage gives the following results: watts 116%, lumen output 135% and considerably reduced lamp life. A 10% decrease of voltage causes an 85% wattage consumption, gives 71% of lumens and increased lamp life. The selection of rated life for a lamp is determined by a balance between lamp cost, power cost and cost of maintenance and overhead.

As the temperature of the filament was increased, lamp brightness was also increased, so the bulb of the lamp was given special treatment. Early enameling processes were inefficient and increased the collection of dirt. Inside frosting provided reasonable diffusing and reduced the light output less than 1%, compared with 5% to 20% for outside coatings. Later, silica coatings gave excellent diffusion with virtually the same light output as with inside frosting.

A certain amount of blackening inside the bulb is inevitable and is removed in some of the high-intensity short-life lamps by sealing coarse tungsten powder inside the bulb. By shaking the lamp at intervals, the inside of the bulb can be scoured by the tungsten particles, increasing both the light output and useful life of the lamp. In some lamps the vaporized tungsten is removed by passing the hot gases, carrying the vapour from the filament, through a screen above the filament.

C. Gaseous Vapour Lamps

1. Low-Pressure Mercury-Vapour Lamps.—The Cooper-Hewitt source was the first of the commercial low-pressure lamps. These were built in 200-w. to 1,600-w. sizes using mercury vapour at 1 to 2 mm. pressure and a mercury cathode. The tubes had a rated life of 4,000 hours, but poor colour characteristics. The tube operated on either A.C. or D.C., but auxiliary equipment was required for starting and operating. Few low-pressure Cooper-Hewitt lamps are still in service. An 85-w. Cooper-Hewitt fluorescent lamp which was introduced around 1938 used phosphors on the inner surface of the tubular bulb. Called the R.F. fluorescent lamp, it operated as a full-wave rectifier, giving no stroboscopic effect. R.F. lamps are still being made, but largely for replacement purposes.

Much experimental work has been done in an effort to correct the poor colour quality of the mercury arc. The combination of Cooper-Hewitt tubes with incandescent lamps was an additive method of colour correction. Although this correction did not produce a colour-matching light, it did produce a soft white light which for a time found favour in commercial and industrial fields. For adaption to desired luminaire design, tubes were produced in straight, round and square forms. Pleasing results were obtained with a ratio of 2 w. of incandescent to 1 w. of mercury-vapour light. The development of the fluorescent lamp with its excellent colour and light control possibilities superseded this more complex and expensive means of producing a pleasing colour quality in lighting.

2. High-Pressure Mercury-Vapour Lamps.—The radiation from a mercury arc changes with pressure, and ranges of pressure up to about 280 atm. have been investigated. At high pressures the spectral lines of mercury radiation are no longer sharp but are broadened, giving a background radiation. This broadening is greater toward the red end of the spectrum, which improves colour quality, although it still does not give a balanced spectrum.

One disadvantage of this source is that it requires a starting time ranging from a few seconds for one special 1,000-w. unit to approximately 7 min. for the 400-w. A-H1 type. Any interruption requires a repetition of the starting cycle. Although efficient in itself, mercury lighting is often used in combination with incandescent lighting to ensure continuity of light and to correct the colour of the light source by additive means. The combination should be made on an equal-lumen basis between the high-pressure mercury and incandescent lamps.

3. Other Gaseous-Vapour Discharge Lamps.—In addition to the principal types of discharge lamps there is a subsidiary group of special lamps which includes photochemical, ozone, germicidal, black-light, glow and sunlight lamps, flash tubes and high-voltage neon lamps. The first four are not light sources, strictly speaking, although they do emit some visible light; however, they are produced by light-source manufacturers and are customarily installed by lighting engineers.

Photochemical Lamps.—The characteristic ultraviolet radiation of mercury-vapour discharges is useful for many photochemical processes, such as testing the fastness of dyes and the weathering of paints, water disinfection, photographic reproduction and ultraviolet therapy. Cylindrical mercury-vapour lamps, with walls of quartz or of glass especially compounded to transmit ultraviolet, are manufactured in sizes from 250 to 3,000 w. The quartz types emit energy below 2,800 Å, and the lamps must be shielded from the eyes. Photochemical lamps operate with ballasts similar to those employed with standard mercury-vapour types.

Ozone-Producing Lamps.—These are mercury-vapour lamps that consume 4 w. and operate at 10.5 v. The bulb of the lamp transmits radiation at 1,849 Å, producing ozone which eliminates odours by combining chemically with odorous constituents in the air.

Germicidal Lamps.—The radiation at 2,537 Å produced by this type of low-pressure mercury-vapour lamp is the most effective in producing germicidal action.

Black-Light Lamps.—These emit radiation from 3,200 Å to 4,000 Å, beyond the visible range, that produces fluorescence in certain chemicals (*see* Luminescence). The lamps have been used in such divergent applications as advertising displays, theatrical productions, the identification of minerals, crime detection, medical and chemical research, and industrial inspection for quality control. Black-light lamps are available in all sizes in which mercury-vapour lamps radiating ultraviolet are made; however, the radiation from any mercury-vapour lamp can be used if a proper filter eliminates the visible light.

Glow Lamps.—Electrodes sealed in a small bulb filled with neon or argon gas produce lamps that will work on voltages as low as 60 D.C. or 42 A.C. The lamps are used as signal, pilot, indicator and night lights. They have a low current consumption and a life ranging from 3,000 to 25,000 hr.

Sunlight Lamps.—Mercury lamps equipped with special glass bulbs to transmit the middle ultraviolet energy generated by the

TABLE I.—*Comparative Data on Light Sources*

Source	Candles per sq.in.	Lumens per watt	Luminous efficiency (%)
Sun	923×10^9		16
Candle	3.5	0.1	
Kerosene flame	9.0	0.3	
Gas flame	2.7		
Acetylene flame	40	0.7	
Welsbach mantle	31		
Carbon arc	92×10^4	7	1.1
Flaming arc	5×10^3	17	2.7
Magnetite arc	4×10^3	90	14.5
Mercury arc	8×10^2	12.7	2.0
Cooper-Hewitt	20		
Cold-cathode			
Red	0.5		
Green	0.16		
Blue	0.1		
Hot-cathode, 40-w.			
Warm white	4.2	63	9.7
Daylight	3.5	53	
Soft white	2.9	44	
Carbon filament	340	2.6	0.42
Gem filament	615	4	
Nernst glower	1,660		
Tantalum filament	750		
Tungsten filament (vacuum)	1,328	10	1.6
Tungsten filament (gas), 500-w.	7,500	19.8	3.2
Tungsten filament, coated lamp, 25-w.	11		
Tungsten filament, inside frost, 25-w.	22	10.5	1.69

vapour discharge are used to produce sun tan. Various types of mercury sun lamps are available; the most popular for home use is a 275-w. lamp with built-in reflector and self-contained filament ballast for operation on standard 110- to 125-v. A.C. circuits. More powerful sources of erythema-producing ultraviolet are employed for solaria and other specialized applications. Fluorescent sun lamps use phosphors which convert the resonant 2,537-Å energy generated in the arc to longer ultraviolet wave lengths.

Flash Tubes.—Straight or coiled sections of glass or quartz tubing, filled with a rare gas and discharged across capacitors, produce a brief flash of white light for high-speed photography. Xenon is the gas most frequently used. Voltages from 800 to several thousand are accumulated on the capacitors by a D.C. rectifier, and a high-voltage pulse initiates the brilliant flash which produces up to 90,000,000 peak lumens and lasts from $\frac{1}{1000}$ to $\frac{1}{1,000,000}$ sec. For ordinary operation a tube lasts thousands of flashes. The power supply depends on the size of the flash tube; several hundred pounds of equipment are necessary for the larger models, while portable lightweight power packs are available for the smaller flash tubes. With special auxiliary equipment, flash tubes can be flashed repeatedly, some at frequencies up to 30,000 per second. (*See* STROBOSCOPE.)

High-Voltage Neon Lamps.—The neon lamp is associated with the cold-cathode group, with the luminescence produced by an electrical discharge through gases. These lamps are efficient when of considerable length and contain a high percentage of neon gas, giving the characteristic orange-red colour. To obtain other colours, mercury, argon, carbon dioxide and xenon are used, and coloured glass tubes are used in conjunction with the gases. The voltages range from 8,000 to 12,000 v. The operation of the high-voltage cold-cathode and the high-voltage hot-cathode fluorescent lamp is the same except at the cathodes, where the cold-cathode lamp has the higher voltage loss.

Prior to the introduction of the fluorescent coating, sign tubing had little application for illumination purposes, its low lumen output being used for signs and to create luminous patterns. With mercury vapour and fluorescent coating, and depending on diameter, current rating and length, efficiencies approaching those of standard hot-cathode fluorescent lamps are obtainable. The units are from four to ten feet long and are connected in series to operate from 1,000- to 15,000-v. transformers.

D. Fluorescent Lamps

The fluorescent lamp is a glass tube coated on the inside with a phosphor (fluorescent chemical) and filled with mercury vapour, with a small amount of argon to facilitate starting. After starting the current is carried essentially by the mercury vapour. The design adjustment is such that the desired resonant radiation of mercury at 2,537 Å is produced. Small coils of tungsten wire (electrodes) are sealed into each end and these filament cathodes are coated with an active electron-emissive material.

The ultraviolet radiated from the conducting mercury gas excites the phosphor, which radiates light in the visible region. Different mixtures of the powders forming the phosphors control the colour of the emitted light. Most lamps are white when unlighted; the gold and red lamps have a pigment coating on the bulb interior to give the desired colours. In the 40-w. fluorescent lamp approximately 1% of the light is delivered directly by the mercury vapour. Of the input wattage 20.5% is converted into visible radiation, nearly three times that from the 40-w. incandescent lamp, which delivers only 7.4% of its wattage in the visible region.

1. Operation.—The operation of the preheat-start fluorescent lamp requires two switches, one for normal on-off switching of the primary power as in the incandescent lamp; and the other for closing the circuit on the cathodes for an instant, allowing the cathodes to preheat, then opening, producing an inductive voltage which causes the arc to strike.

In the typical circuit shown in fig. 1(A), the sockets hold the lamp; the ballast (a coil of wire wound on an iron core) furnishes the inductive "kick" to start the arc and limits the flow of current through the arc; and the filter reduces feedback into the electric supply circuit which may cause radio interference. The starter, wired across the lamp sockets (terminals T_1 and T_2), may be any of three types. The glow switch (fig. 1[B]) consists of a bulb containing neon or argon gas and a bimetallic switch element. When power is applied, the voltage is high across the terminals, and the glowing gas heats the bimetallic switch, closing it; this places the lamp cathodes into the circuit, heating them and reducing the voltage across the glow switch; the switch opens, and the inductive "kick" from the ballast strikes an arc through the lamp. The glow switch remains open while the lamp is in

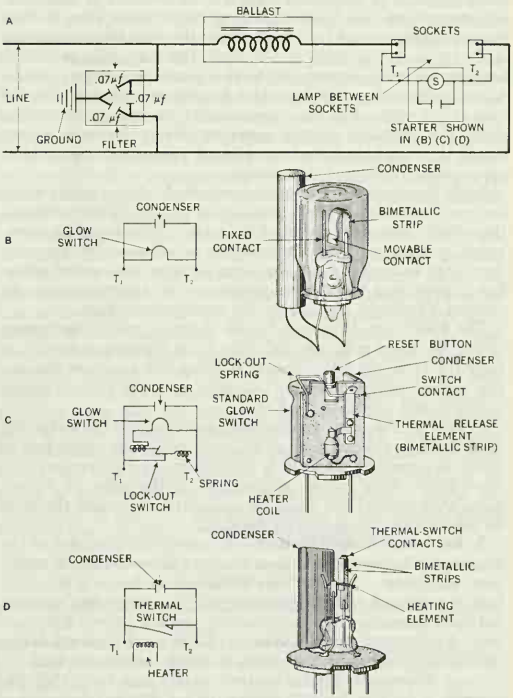

FIG. 1.—(A) DIAGRAM OF TYPICAL LAMP CIRCUIT; (B) GLOW-SWITCH STARTER; (C) NON-BLINK STARTER; (D) THERMAL-SWITCH STARTER (*see* TEXT)

operation because the voltage across its terminals is too low to cause a glow.

The non-blink starter (fig. 1[C]) functions in much the same manner as the glow-switch starter except that an additional locking switch is provided; this removes the lamp from the circuit if it fails to function properly after a few attempts at starting. When the lamp is replaced, the starter may be returned to service by pressing the reset button, which protrudes through the end of its case.

The thermal-switch starter (fig. 1[D]) consists of a bimetallic switch, normally closed when power is off. In starting, a small heating element opens this switch after a brief period during which the lamp cathodes heat; the inductive "kick" from the ballast starts the lamp, and the operating current holds the switch open.

Circuits have been designed for the elimination of starter switches, which are always a source of operating trouble. Several standard sizes of hot-cathode fluorescent lamps are available for instant-start service without starters.

The fluorescent lamp has high efficiency, up to 73 l.p.w., but introduces several operating characteristics which necessitate a lighting installation less simple in theory and function than that needed for the incandescent lamp.

2. Characteristics.—Diameter and length of the fluorescent lamp depend upon several factors. Design has been centred about $\frac{5}{8}$-in., 1-in., $1\frac{1}{2}$-in. and $2\frac{1}{8}$-in. tubes for the lower voltages; and $\frac{3}{4}$-in., 1-in. and $1\frac{1}{2}$-in. tubes for instant starting at higher voltages. Long lamps are more efficient than short ones, other conditions being equal. The fluorescent lamp is more sensitive to surrounding temperature than the incandescent lamp; many sizes of fluorescent lamps generate light most efficiently when the surrounding air is 21° to 27° C. (70° to 80° F.). The lamp voltage divides between the electrode drop (12 to 18 v.) and the voltage gradient, which is the voltage per inch of tube required to neutralize the ions at the walls, plus the conversion of the energy into radiation. For preheated-cathode operation, the open-circuit voltage should be at least twice the lamp voltage. Somewhat higher ratios are required for instant-start lamps.

Early fluorescent lamps, when used singly, often produced an annoying stroboscopic effect because the vapour discharge was extinguished twice during each A.C. cycle. This could be eliminated by using two lamps in the same or adjacent fixtures, with the circuit so arranged that the lamp currents were out of phase. Later, phosphors with longer persistence or afterglow were developed, effectively eliminating the stroboscopic effect.

The fluorescent lamp can be the cause of radio interference caused by direct radiation, radiation from the electric supply or feedback from the line. Proper filtering will minimize the last two causes, while removal of the radio from the field or proper screening will eliminate the first.

Failure of the lamp to function properly may lie within the lamp itself, in the auxiliary or in the starter. The safest rule to follow in correcting the fault is to eliminate by replacement with spare parts which should be available, in the order of starter, lamp, then ballast; but under no circumstances should the lamp be left in operation if trouble develops.

3. Economic Consideration.—Economic consideration of the fluorescent lamp requires a close study of the cost of both equipment and power. The first cost of fluorescent lamps is relatively high as compared with incandescent lamps of equivalent wattage, but their operating costs are relatively low for a given light output. Replacement of incandescent lamps by fluorescent lamps ordinarily gives two to four times as many lumens per watt.

Since fluorescent lighting systems create less heat they are valuable in conjunction with modern air-conditioning systems and they are also of great usefulness where colour matching or coloured lighting is required.

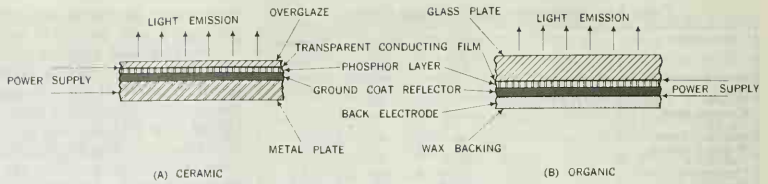

FIG. 2.—ELECTROLUMINESCENT PANELS

Because of the various ways in which efficiencies may be stated, many claims have been made concerning fluorescent lamps, but it is necessary to include all the losses in the auxiliary with the lamp wattage to arrive at a correct evaluation. Brightness of the fluorescent lamp is much less than that of the incandescent lamp, but it is still so bright that neither the eye nor the work should be directly exposed to it.

E. Electroluminescence

When fluorescent materials are embedded in the dielectric of a capacitor, one plate of which is transparent, light can be produced by the electrostatic field between the plates. Such sources are called electroluminescent (EL) plates or panels.

The phenomenon was first reported by G. Destriau of France in 1936, but no practical applications appeared until 1950. The fluorescent materials or phosphors are either embedded in an organic dielectric coated on glass or held in a vitreous enamel, ceramic or plastic dielectric coated on a metal plate. The two types of EL devices are shown schematically in fig. 2.

While EL devices are not lamps in the usual sense of the word, they provide means for producing lighted surfaces that are useful in many applications. Surface brightnesses of as much as 10 foot-lamberts (ft.-L.) can be obtained in panels using 600-v., 60-c.p.s. power, and the brightness can be increased to more than 200 ft.-L. with a 3,000-c.p.s. power source. Efficiencies of 10–12 l.p.w. were achieved in early EL panels, but it was thought that efficiencies of the order of 150 l.p.w. ultimately might be obtained.

Electroluminescent panels are used where lighted surfaces of fairly low brightness are required; typical examples are the faces of electric clocks and cover panels for electric switches and outlets. In the case of the organic-type (fig. 2[B]), the rear electrode can be shaped into a desired pattern without visible indication of the electrical connections. Panels of this type have been used for such things as aircraft signs (*e.g.*, "Fasten Seat Belts"), the legends of which are invisible until power is switched on.

In 1959 a new sulfide phosphor was developed which, in a ceramic plate excited by a D.C. power source, emits light only if other energy (light, X-rays or electrons) falls on the plate. The visible image then produced is retained as long as the D.C. field is maintained. Devices using this principle were called image-retaining panels and were used in industrial X-ray testing.

III. ILLUMINATING ENGINEERING

Illuminating engineering is the profession concerned with the application of artificial and natural light. Advancement of the art and science of lighting has been fostered by professional associations, the first of which was founded in the United States (1906), followed by similar organizations in Great Britain (1909), Germany (1913), Japan (1915), Austria and Hungary (1925) and the Netherlands (1926). These organizations and similar groups subsequently formed in other countries embrace all activities connected with the production of artificial light and the design, installation and servicing of lighting systems.

1. International Organizations.—The International Commission on Photometry, founded in 1900, was succeeded by the International Commission on Illumination (I.C.I.) in 1913. World War I halted this reorganization, and the first international meeting of the I.C.I. was not held until 1921 in Paris. The organization's constitution calls for international meetings every three years. Work started by the International Commission on

Photometry, which brought forward the international candlepower standard and solved important problems involving gas lighting, was continued and many other matters of standardization and interchanges of information were implemented by committees representing the leading countries. In 1948 the central bureau of the commission was transferred from Teddington, Eng., to New York city.

2. Measurement of Light.—Light is measured by its capacity to produce a sensation. The eye interprets this sensation in that region of the electromagnetic spectrum which extends from 7,600 Å to 3,800 Å. The eye does not respond equally to the radiant energy in this octave, responding more efficiently to the greens and yellows than to the reds, blues and violets.

There are three units of special importance in the application of lighting in practice: the lumen (unit of luminous flux), the foot-candle (ft.-c.; one lumen incident per square foot) and brightness. Brightness is measured by foot-lamberts for surfaces of low intensity and by candles per square inch for sources of high intensity. In the metric system the corresponding units are the lux (one lumen incident per square metre), and the lambert (one lumen per square centimetre) for brightness. The lumen is used in lighting calculations, while field measurements are made of illumination (ft.-c.) and brightness (ft.-L. or candles per square inch).

Illumination is measured by means of a light meter (foot-candle meter), usually of the photoelectric type.

Measurements of brightness are made with some form of brightness meter which the observer is required to adjust for photometric balance. In the past, average illumination was relied upon to a great extent, but the modern tendency is to give serious consideration to brightness, and future design will continue in this direction.

3. Lighting Environment.—The act of seeing depends upon visual acuity, the size of the object and its brightness, the contrast between object and background, and the length of time the object is exposed for viewing. The first essential to proper vision is that the eyesight be normal or corrected to normal; the second essential is that the proper amount and quality of light be provided.

Period of Exposure.—If the object is large and long periods of time are allowed for exposure, the task can be adequately lighted with little illumination, but for small objects and short exposure periods, the illumination must be correspondingly increased. If the amount of illumination varies, the retina will still retain an image with no consciousness on the part of the observer that the lighting is not continuous if the flicker is rapid. Motion-picture projection bears witness to this fact. However, sudden changes of light at long intervals will cause blurring of moving objects, which becomes more pronounced at low foot-candle levels of illumination. The stroboscopic effect from fluorescent lamps and the flicker noticeable in incandescent lamps connected to 25-cycle sources exemplify the effects of lack of continuity in lighting.

Size of Object.—The size of an object establishes the lighting requirements. By size is meant visual size, which is a combination of dimensions of the smallest detail which must be observed and the distance of the object from the eye. More foot-candles are needed for smaller objects, all other factors being equal. The normal eye can distinguish any object which subtends an angle of one minute of arc. This is an important factor in the design of signs that are to be seen from some distance.

Contrast.—An object is seen more clearly if background and object are of different colours. A white object against a black background can be more readily seen than a black object against a black background. This fact is utilized in industry to obtain contrast between the machine and its moving parts, the material being worked and the surround (visual field).

Brightness.—Brightness contributes directly to the visibility of the object. A very dark object requires more foot-candles for illumination than one with a high reflection factor. For many years foot-candles of illumination were the index to lighting design and specifications, and failure to recognize the importance of the reflection factor led to faulty lighting. More attention is being paid to the brightness of the task and its surroundings in design.

Glare.—When brightness becomes irritating it is recognized as glare. Glare contributes more to the poor quality of a lighting system than any other factor. Glare may depend upon several conditions present in the lighting system: (1) high brightness of the source; (2) high brightness contrast between the source and the background; (3) location of the source in the field of view; (4) the total volume of the light entering the eye; and (5) the time of exposure to the brightness source. The correction of any one of these contributing factors becomes simple when it is considered individually.

Investigation and experience have established principles for studying the installation in order to control glare. These are not recommended as precise, but are suggestive of order of evaluation: (1) the light output of a source cannot be increased as fast as its area, but it is safe to increase the output as fast as the diameter; (2) increasing the foot-candles ten times in a room permits only doubling the brightness of the light source; (3) doubling the mounting height of a unit allows a lumen output of approximately three times that used previously; (4) brightness ratio of adjacent areas should be within limits of ten to one; (5) there should be more light on the work than at the eye; and (6) each light in a row makes the same contribution to glare. All these specifications are based on equal comfort from the lighting system.

Proper Amount of Lighting.—The severity of the task is the first index to the amount of light required. Lighting may be specified as: (1) For severe and prolonged tasks with details small, contrast low and speed of operation high, 100 ft.-c. or more should be used, best obtained by supplementary lighting. (2) For installations in which speed is not a factor and the object is small, 50 to 100 ft.-c. should be used, and again should be obtained by supplementary lighting. (3) For normal industrial and commercial tasks, 20 to 50 ft.-c. will suffice and may be supplied by a well-designed general lighting system; where economy is a factor supplementary lighting should be used. (4) For most recreational needs and ordinary tasks which are not prolonged throughout the working day, 10 to 20 ft.-c. from a general lighting system is satisfactory. (5) Where seeing is important but not prolonged, the contrast good, the object fairly large and the speed of movement slow, 5 to 10 ft.-c. from a general lighting system is specified. (6) Levels of less than 5 ft.-c. should be specified only for casual and nonhazardous passageways; this is obtainable with a relatively cheap general lighting installation, since for this use the quality of the lighting is of minor importance.

Considering the high foot-candle level to which the eye is accustomed out-of-doors, it is logical to believe that the eye will function best under high foot-candle levels of properly controlled light; that is, light in which quality of distribution approaches that of the out-of-doors. Control of the surround requires a reduction in the foot-candles. The spectral quality of the light source has no influence on seeing, although it does affect the psychological atmosphere; and modern light sources do not emit enough of the harmful wave lengths so that repeated exposures are injurious (this does not hold true, of course, for special lamps such as those emitting ultraviolet). As was the case with the incandescent lamp, the fluorescent lamp when first introduced drew accusations that its light injured the eyes, but any instances of injury or discomfort have been traceable directly to poorly designed lighting systems. Table II compares recommended lighting levels of five countries for various installations.

TABLE II.—*Recommended Levels of Illumination for Various Visual Tasks in Different Countries*
(in lumens per square foot)

Task or area	France	Great Britain	Sweden	United States	U.S.S.R.	
					Fluorescent	Incandescent
Assembly shop						
Rough work	20	15	30	50	10–15	3–5
Extra fine work	150	150	400	1,000	30–75	15–30
General offices	60	30	30–100	100–150	20–30	7.5–15
School classrooms	50	30	30	70	30	15
Corridors	20	10	8	20	10	3

Colour and Shadow.—Colour and shadow are not necessarily factors in seeing but are of importance in recognition of objects. Colour must be treated carefully when used in conjunction with light. If coloured light is used, white or neutral gray makes the best surround. With the incandescent lamp, usually considered as white light, the spectral distribution of the output must be considered when colours are to be intensified or are to appear in their natural intensity.

Shadows may be either detrimental or helpful, depending upon the task to be performed. For decoration the shadow removes the monotony of a uniform lighting system and adds atmosphere to areas of relaxation, as in the home. In industry the shadow facilitates inspection tasks, emphasizes surfaces in relief and thereby improves visual conditions. Where there is moving machinery or the work lies within a single plane, shadow is detrimental both to safety and visibility. Small concentrated sources will produce harsh, severe shadows, while large area sources of low brightness will produce, for practical purposes, a shadowless surface. Between these two extremes are gradations adaptable to specific types of tasks. Shadow control on stair treads, at corners and on moving machine parts is an important contribution of light to safety.

Surround.—The surfaces surrounding a task area should be properly prepared and illuminated both for light reflection and for psychological effect. Brightness of the surround should be at least 10% of the brightness of the task, although research has shown that, if it is feasible, the task and the surround should be equally bright.

Ceilings should have a reflection factor of 75% or more, and side walls of from 50% to 70%. Any trim occurring higher than 30 in. above the floor may be as dark as desired, provided its area does not constitute more than a small percentage of the total wall surface. The use of warm and cool colours in shades or tints makes little difference if the reflection factors are correct.

Factors Controlling Effectiveness of a Lighting System.—These factors should be considered carefully when analyzing a lighting system: (1) The quantity of light should be such as to produce a desired brightness for the severity of the task. (2) There should be no direct glare from the light source, and the reflected glare should be reduced to a minimum. This can be aided by selection of equipment and work surfaces producing no specular images. (3) Uniformity of the lighting should be controlled. For tasks in one plane, such as writing, drawing and reading, a shadow-free light is desirable. For tasks in three dimensions, such as relief work and inspection, a nonuniform light may be better. (4) Illumination of the surround is essential for the relief of eye strain by providing the proper atmosphere for eye relaxation.

The amount of illumination has been so strongly stressed that frequently quality of lighting is sacrificed by lack of consideration of the elements other than the brightness of the light falling on the task. A lower foot-candle level with proper control is better than a high foot-candle level improperly controlled.

4. Light Control.—Primitive light sources required no shielding, and there was no attempt to control artificial lighting until the 13th century, when mirrors were placed behind the Venetian stand lamp, the *lucerna*. In 1490 Leonardo da Vinci introduced control by refraction, and in 1745 polished metal reflectors were used in the *reverbere*. For the most part, however, control of light belongs to the 20th century.

Classes of Substances.—Transparent materials are not effective with modern light sources because the bare source has a brightness which must be controlled. Transparent material can be used with lighting equipment having very low candle power; however, this class of equipment is more for decorative effect than for lighting, and when used for lighting as well as decoration the quality of light is very poor.

Translucent materials are more widely used than any other light-control substance, and the introduction of plastics into this field in 1933 marked a new stage of light-control development. Translucent glasses of the denser types (opal and alabaster) are used for light backgrounds, while the configurated, decorated, structural and architectural glasses are used for decoration where atmosphere rather than illumination of a task is important. The flashed opal, cased, enameled and light opal glasses have a relatively high transmission and good diffusing qualities. These latter two classes of glass have been widely used in the better grade of lighting glassware and luminous elements.

Opaque materials are used primarily as reflectors and shields. Reflectors for beam control should have a high reflection factor, and usually some form of protected metal film or treated metal is used, silver and aluminum ranking high for this application. For industrial equipment, white enamel and paints on opaque surfaces give high reflection with reasonable maintenance and replacement.

Light-Beam Control.—There are three ways in which the light beam may be controlled: (1) reflection, (2) transmission and (3) refraction. The opaque materials are of the reflection type, and the translucent of the transmission type. Refraction is redirection of light caused by surface shape of the transmitting material. One of the most efficient means of control is by use of prisms, but control in one direction may cause bright spots in others if the arrangement of the prisms is not properly designed.

Nature of the Surface.—Light may be diffused by transmission or reflection from a surface, and diffused light is very acceptable for lighting purposes. Redirected light or even scattered light has its merits in the instance of the special reflector, but may cause specular images or highlights producing objectionable reflected glare. It is recommended that all lighted surfaces within the line of vision (walls and equipment) be of the diffusing type.

Optical Control.—Where accurate control of the light is desired, as in projectors or searchlights, optical reflectors or lenses may be used and for fine control these devices must be accurate. For floodlights and searchlights the control lenses and the reflectors may be made by molding the glass and drawing or spinning the metal. "Sealed-beam" automotive headlights consist of two glass "dishes" sealed together, the rear one silvered to act as a reflector, the front one molded with refracting prisms to concentrate the light in the desired pattern.

Luminaire and Installation.—The design of the lighting equipment and the character of the room are controlling factors in lighting efficiency and light distribution. Lighting equipment is classified into five groups, as shown in Table III.

TABLE III.—*Lighting Equipment*

Classification	Approximate light distribution	
	% Upward	% Downward
Direct	0–10	90–100
Semidirect	10–40	60–90
General diffusing	40–60	40–60
Semi-indirect	60–90	10–40
Indirect	90–100	0–10

The dimensions of the room and the colour of the ceiling and side walls, as well as the efficiency, depreciation and candle-power distribution of the equipment, control the output. In design the equipment is classified by a coefficient of performance (utilization factor), designating the control in the room of the light from the luminaire, and by the coefficient of utilization, which includes the luminaire efficiency and therefore designates control from the lamp to the work surface. These coefficients may be determined accurately for specific equipment or may be grouped into classes for practical use.

Classification of Outdoor Equipment.—Lighting units for outdoor service are classified as floodlights when the area is not restricted in pattern, and may have broad, medium or narrow beams. The broad-beam equipment is used where the surface to be illuminated is in the immediate area; narrow-beam equipment is used for more distant areas. For a controlled beam the projector or searchlight is used, the first lacking the optical accuracy of the latter. Rotating or fixed equipment used for signal systems is classified as a beacon.

5. Design of Lighting Installation.—There are two methods of lighting design, the point-by-point and the lumen. Each has its specific use, and the accuracy attained with each is satisfactory for practical purposes. The point-by-point method is

used to determine the illumination at a point from a specific lighting equipment for which the distribution curve is known. Where there is no interreflection, the point-by-point method gives the total illumination on the surface at the point; but in an enclosure interreflections will increase the illumination. The point-by-point method is accurate for outdoor lighting, for calculation and design of supplementary lighting and for down lights in interiors. The lumen method is satisfactory for determining the illumination within enclosures and is the procedure accepted in the designing of interior illumination. This is a method of determining average illumination and not specific illumination at a point. Although the method is relatively simple, it considers room proportions, coloration of the room, efficiency of the equipment, type of equipment to be installed and conditions contributing to the depreciation of the lighting system, such as operation and the presence of dirt. The method is based upon empirical data obtained by careful research into the actual performance of lighting systems in controlled installations.

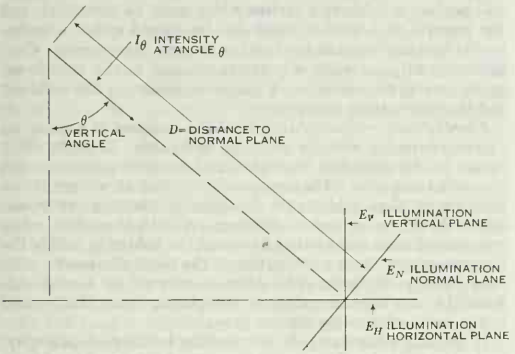

FIG. 3.—POINT-SOURCE ILLUMINATION CALCULATIONS

Point-by-Point Method.—This method assumes that for actual conditions the source of light may be considered a point source when the illumination is to be determined on a surface that is at least five diameters from the light source.

The illumination on a point at a distance d from a source (fig. 3) is directly proportional to the intensity of the source and inversely to the square of the distance. This is the illumination on a surface normal to the incident beam of light. When the horizontal or the vertical illumination is desired, the illumination on the normal is corrected by the cosine of the vertical angle for the horizontal and by the sine of the vertical angle for the vertical illumination. Determination of the normal illumination in fig. 3 is given by the formula

$$E_N = \frac{I\theta}{d^2} \tag{1}$$

and the horizontal illumination therefore is

$$E_H = E_N \cos\theta \tag{2}$$

while the vertical illumination is

$$E_V = E_N \sin\theta \tag{3}$$

Lumen Method.—The general expression for the determination of the necessary lamp size is:

$$\text{lumens per outlet} = \frac{\text{area per outlet} \times \text{foot-candles}}{\text{efficiency} \times \text{utilization factor} \times \text{maintenance factor}} \tag{4}$$

The following steps are necessary in the logical solution of a specific determination:

1. Have a simple but complete sketch of the room to be lighted, with information as to its use, location and dimensions and any special information as to the placing of work surfaces and machines, with the bay dimensions of the ceiling pattern and the nature of any beam structures at the ceiling.

2. Determine the number of units and the spacing of the units. It is good practice to arrange the units symmetrically and to space the units at the corners of squares dividing the room into a symmetrical pattern. Where beams or other obstructions are present the pattern of outlet arrangement should conform to the general ceiling pattern. Outlet spacing should not exceed 1.5 times the mounting height above the work surface for units of the direct, semidirect and general diffusing type; and not more than twice the height of the ceiling above the work surface for the semi-indirect and indirect units. The spacing to the side wall should be approximately one-half the spacing between units. From the layout, with the location of the lamps marked, it is possible to determine the area per outlet.

3. The amount of illumination must be determined for the specific task to be performed. The general requirements previously given will determine in general the foot-candles. To determine the best practice for an installation, reference should be made to the recommendations of engineering societies.

4. Equipment must be chosen for the particular task to be performed. In industrial installations the equipment must usually be relatively inexpensive and easy to clean, and should be of the direct or semidirect type, as the ceiling and walls cannot be expected to reflect much of the light. For commercial installations diffusing types are preferable. In either instance the more successful lighting is obtained where the light source is large and of low brightness. In the indirect system of lighting the ceiling acts as a reflector. Use of luminous elements and cove lighting attains lighting conditions similar to that of indirect lighting. The introduction of the fluorescent lamp, requiring many tubes to obtain the desired foot-candles, gives a light distribution comparable with an indirect lighting installation. The practice of using bare fluorescent lamps without proper light control will produce lighting with distressing glare while indirect lighting will not.

5. The efficiency and the utilization factor (or their product, the coefficient of utilization) must be determined for the type of equipment chosen. The room proportion, room coloration and type of equipment enter into this coefficient. The manufacturer of the equipment can supply this information for the specific equipment chosen, or values may be chosen for the general type, given in widely published tables. Considering a very light ceiling and a fairly light side wall colouring, the utilization factors average approximately 0.5 for direct equipment, 0.3 for semi-indirect equipment and 0.25 for indirect equipment. High coefficients are associated with large and light rooms, and the lower coefficients with small and dark rooms. The over-all efficiency utilization factor of a lighting system is relatively poor.

6. The maintenance factor (one minus depreciation factor) is an estimate of the cleanliness of the location and the maintenance of the lighting system. This factor ranges from 60% in relatively poor conditions to as high as 75% under favourable conditions. Direct equipment will maintain better lighting under the adverse conditions of normal industrial usage than will the semi-indirect or indirect lighting systems, which are generally used for commercial purposes.

Having determined the quantities to substitute, the result given is the number of lumens required per outlet (equation 4). From manufacturer or laboratory data a lamp or a number of lamps may be selected which will most nearly approximate the required lumens. These lamps are rated in watts and should be so specified. Since the lumen output is constantly being changed in the manufacture of lamps, it is desirable to refer to the latest tables of lumen output.

The foregoing is applicable to the design for incandescent installations in which lamps in the larger sizes emit approximately 18 to 20 l.p.w.

Lumen Method and Fluorescent Lighting Design.—The only difference in applying equation (4) to fluorescent lamp installations is that the total area is used instead of the area per outlet, thereby determining the total number of lumens required in the lamp output. After the lamp has been selected, the number required is determined from the output of the individual lamps. Equip-

ment to house the lamps and the arrangement of the lamps is then guided by the number of lamps needed. This design method is not as direct as for the incandescent system, and usually more trials will have to be made to get a satisfactory arrangement.

Design of Luminous Ceilings.—An important development of the 1950s was the introduction of glass and plastic luminous ceilings, either solid or louvered, with lighting sources above them. These simulate artificial skylights and, when properly designed and installed with correct baffling so as not to expose the eye to too large an expanse of lighted surface, represent the best in artificial lighting so far attained.

If a room is large and high, the illumination will be equivalent in value to the brightness of the lighting unit in foot-lamberts. Design of the lighting system embodies design of the light unit as well. The illumination obtained is expressed by:

$$\text{foot-candles} = \frac{\text{total lumens} \times \text{utilization factor} \times \text{maintenance factor}}{\text{total room area}} \quad (5)$$

The efficiency and the utilization factor are determined for a specific design, and the manufacturer has this information available. Spacing does not enter into the problem since the units are placed in the room either from wall to wall or with a border around the unit which is very narrow with respect to the total ceiling dimensions.

Either incandescent or fluorescent lamps may be used as a source to illuminate the ceiling. If the space above the ceiling is deep enough, the largest types of lighting units may be used, even industrial equipment with very large incandescent or fluorescent lamps.

Cove Lighting.—Where the lighting equipment is concealed by coves, with the ceiling and upper wall used as a luminous surface, the system may be designed by the lumen method. Good reflecting equipment will have an efficiency of approximately 70% while the cove itself may show efficiencies ranging from 25% to 40%. Recessed coves and coves close to the ceiling will have utilization factors of 0.35.

Coves placed too close to the ceiling will give an uneven illumination, a ratio of one foot from the ceiling to every five feet of lighted surface being the minimum that should be used. Plaster coves, finished with the wall and ceiling surface, are very inefficient and will give spotty lighting. The use of reflectors increases cove efficiency, and with the correct design the coves can be moved closer to the ceiling. Where control is obtained by use of some form of prismatic lens it is possible to mount the light source against the ceiling. Relief decorations must be crosslighted to eliminate undesirable shadows and produce uniform lighting.

Luminous Architectural Elements.—Luminous elements are applicable both to the exterior and interior of buildings. The term is applied to large, low-brightness lighting sources under which it is correct to consider all forms of indirect lighting as well as architectural elements. The correct application of this type of lighting demands close study, with consideration of the design of the structure as a whole. Luminous elements may take the form of panels, recesses, cavities, niches, pylons, columns, pilasters, parapets, spandrels, soffits, beams, coves, coffers or moldings, or may be incorporated into any architectural design. The light may be controlled by diffusing glass, reflectors, louvers or grillwork or by design of the element shape.

The lumen method is used in the design of the luminous element. Projecting elements have utilization factors of 0.5 and maintenance factors of 0.75, while the flush types have utilization factors of 0.7. Efficiency varies from 10% to 90% depending on the reflection material, the shape and the transmission mediums. In brightness the element should be so proportioned that when it is in direct exposure to the eye it does not exceed 75 ft.-L. If the element is on the ceiling and at such an angle as not to be directly exposed to the eye, a brightness of 500 ft.-L. is allowable. For exteriors the brightness depends upon the illumination of the surroundings and ranges from 30 to 400 ft.-L. on buildings to as high as 600 ft.-L. in letter strokes for signs, on which luminous elements are used extensively.

Glass Blocks.—Used in structures for decorative purposes and lighting, glass blocks may be considered as luminous elements and must be so designed. The blocks will have transmission values ranging from 10% to 85%. Their obscuring value varies inversely as their efficiency. The transmission of an individual block cannot be considered, as the transmission value of a wall or surface built of glass blocks is largely controlled by the construction. These surfaces may be constructed for both daytime and night use. The lighting equipment must not interfere with light transmission during the day and must be so placed that the rudiments of good lighting are not violated.

It is commonly accepted by the lighting specialist that the providing of illumination is the least successful function performed by windows. Glass blocks allow light to enter but eliminate the normal view from the window. Sunlight falling upon glass blocks will produce a brightness surface which must be controlled, and the removal of a window which can be opened makes it necessary to heat and ventilate the building by some other means. Consideration of glass walls or surfaces exposed to the outside requires careful co-ordination of functional design by the architect and the illuminating engineer.

Floodlighting.—Floodlighting should be designed to produce an effective harmony with the object to be lighted. Daylight effect cannot be reproduced by floodlights, and the effect produced must be studied carefully. The simple straight lines of modern structures are excellent subjects for floodlighting. Statues and monuments should be lighted in collaboration with the artist, while recreational areas and sports fields should be lighted to satisfy the requirements of those participating in the particular sport. Uniform lighting of playing fields often is achieved by aiming each floodlight at a specific point on the playing area, the overlap of the lights eliminating shadow zones.

In locating equipment, the surrounding buildings, topography, area to be lighted and economical aspects of the installation must be considered. If not located directly on the building to be illuminated, the equipment may be located on adjacent buildings, electric service poles, street lighting standards (for buildings not higher than three floors), in shrubbery or trees or on poles installed for the purpose. On the building itself, ledges, cornices and parapets will provide concealment. When sports areas, construction projects and airport loading ramps are lighted it is usually necessary to supply towers, poles or special mounting elements.

For illumination at a distance, narrow-beam equipment is used, ranging from searchlights with optical control to standard narrow-beam (15° or less) equipment. For near areas, broad-beam (30° and over) equipment is used. Intermediate ranges and surface areas may use medium-beam (16° to 29°) equipment. The lumen method of design is used for determination of the average illumination with a standard maintenance factor of 0.7 and the output is determined from the beam lumens of the equipment. Since little if any light can be obtained by interreflection, such light as does not strike the specific area to be illuminated is lost. There must be provision for control of the "spill light" which may become objectionable, and there must be about 10% overlapping of beam pattern so as to attain some degree of uniformity. Tables of recommended foot-candles should be used, and buildings with reflection factors of 20% or less will prove uneconomical to illuminate.

6. Operation and Maintenance of Lighting Systems.—The success of a lighting system depends upon selection of the proper installation and lighting source and upon maintenance. The lighting source should be the most economical, determined from first cost of the equipment, its installation and the power and labour costs in the community where the installation is to be made. Frequently there may be a choice of several schemes and systems which will be adequate and satisfactory as to lighting quality; and no general rule can be applied which definitely determines any combination as superior.

For "seeing," even the monochromatic lights seem to prove equally efficient and comfortable to users. Research has not been able to determine any one source quality which is superior to another for the usual seeing tasks. When colour matching is involved in production, daylight sources of artificial light have proved more satisfactory than natural daylight. No artificial source for ordinary lighting, either incandescent or fluorescent,

radiates wave lengths which under continued usage are harmful to the eyes; neither has it been found that any of these, including daylight sources, has superior qualities for seeing.

Lamp Selection.—The general service lamp, in the voltage rating of the electric system, satisfies the usual conditions. For severe tasks under conditions of vibration, heat, extremes of weather, and unusual position, the type of lamp designed for the particular service should be selected. Special usage lamps vary in their base construction, cementing and filament suspension.

Proper Voltage.—To be efficient, lamps should be operated at their rated voltage. To maintain the voltage at the lamp it is necessary to install adequate wiring systems. The voltage at the lamp, when the system is fully loaded, should not deviate more than 2%. Wiring systems that are inadequate are expensive for reasons of output loss and extra losses in the wiring system. A 120-v. incandescent lamp burned at 115 v. gives only 86.4% of the normal lumen output and will be operating at 92.3% efficiency. The fluorescent lamp is even more critical to voltage change than the incandescent lamp, to the extent of becoming inoperative at incorrect voltages.

Maintenance.—From the first hour that a lighting system begins to operate it deteriorates through darkening of the lamp, dirt accumulation on the lighting equipment and general depreciation of the reflecting surfaces. When this depreciation of the system reduces the initial illumination about 30% it is necessary to consider some form of maintenance. The loss can be partially restored by renewing the darkened lamps, cleaning the equipment and, if these fail, by either washing or painting the reflecting surfaces. A schedule of washing equipment monthly and walls every two years is satisfactory in the average commercial installation. The installation must be designed so that maintenance is possible at low unit costs.

The "smashing point" of lamps, at which it is economical to replace the lamp even though it is still operative, is reached when the lumen output of the lamp has been reduced to the point at which the cost of energy consumed per 1,000,000 lumen-hours exceeds the average cost of light produced up to that time, including initial cost of lamp and energy.

Study has shown that the renovated lighting system could gain 12% by repainting of reflecting surfaces, 20% by cleaning and 19% by using new lamps with proper voltage ratings, a total of 51%. (J. O. K.; C. L. A.)

IV. SPECIFIC LIGHTING APPLICATIONS

World-wide interest in artificial illumination gathered momentum with the beginning of the 20th century. Great expositions held in many parts of the world featured spectacular lighting, using the latest developments. Festivals of light were held in many cities. Widespread interest was shown in the psychological and physiological aspects of higher levels of illumination as related to human welfare, one evidence of this being the adoption in 1937 of a factories act in England containing provisions for compulsory adoption of standards of lighting in all factories and workshops.

Artificial illumination has been accepted as an architectural medium, and lighting is no longer a thing of utility alone, but an intrinsic part of the architectural design of buildings. Specialized types of lighting for various industrial, agricultural and domestic fields have been investigated and adopted.

1. Residential Lighting.—Domestic lighting should be both utilitarian and atmospheric. Light adequate in quantity and quality should be provided for reading, sewing, cooking and cleaning, while its decorative effect enhances the appearance of the rooms.

Most home lighting is inadequate, especially in older buildings. Usually, when an electricity supply first became available, a central ceiling fixture in each room was wired and fitted with a low-wattage lamp. Later, this might be replaced by a more powerful lamp, with some sort of shade added, but progress too often stopped at this point, even in countries where industrial and commercial lighting reached high standards. Many reasons for this have been suggested, including the public's failure to appreciate the relative cheapness of electric light and the fact that fixtures too often are selected on the basis of their appearance rather than their lighting effectiveness. In addition, inadequate wiring often is an obstacle, for spreading the sources of light about a room is usually better than increasing the wattage at existing outlets.

The various national lighting codes make some illumination recommendations for the home (*e.g.*, from the British code: kitchens, 20 lumens per square foot; casual reading, 15; study and sustained reading, 30), but few householders have either the equipment or the experience to make such measurements. In spite of the dangers of rules of thumb, a recommendation in terms of the electrical loading required to give adequate utilitarian lighting may be more practical: 2 w. per square foot or 20 w. per square metre of floor area (this excludes any lighting for decorative purposes). More light than this is desirable, but it is difficult to achieve adequate illumination with less. For example, a living room measuring 16 by 12 ft. has an area of 192 sq.ft. and thus needs about 400 w.; this could be four 100-w. lamps, two in ceiling or wall fixtures and two in the larger type of table lamp.

In any room the lighting arrangement should take account of the visual tasks to be performed there; a dining room needs direct light on the table, the kitchen requires a good distribution of light sources to avoid shadows on work surfaces, and in the bathroom a light at the mirror is important. In halls, stairways and entries good lighting is essential for safety.

2. Retail-Shop Lighting.—The increasing research on consumer buying habits emphasized the importance of visual impact. An item must be seen if it is to be sold, but seeing is itself a matter of degree, of the intensity of the impression created. The aim of retail-shop lighting is to enhance the appeal of the merchandise.

Display Windows.—The first principle is that the lighting should focus attention on the merchandise, not call attention to itself. This means that the brightness of the light sources must be concealed, and ideally the equipment should be out of sight. The light falling on the display should be considered in terms of quantity, colour, direction and the balance between diffuse illumination and direct beams.

Colour rendering usually is considered to be not so critical in display windows as it is inside the shop. Colour-corrected mercury lamps, usually in combination with an approximately equal wattage of incandescent lamps, have proved acceptable for a wide range of merchandise, and, in high or shallow windows, the better

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SHOP INTERIOR: INDIRECT LIGHTING FROM 100-W. TUNGSTEN LAMPS AND 40-W. FLUORESCENT TUBES SET BEHIND PANELS ABOVE WALLS; COUNTERS ILLUMINED BY SUSPENDED 150-W. GLASS REFLECTOR LAMPS; SHOWCASES ILLUMINED BY CONCEALED 20-W. FLUORESCENT LAMPS

optical control provided by this relatively small source makes it preferable to the fluorescent tube. More commonly, the fluorescent tube is the choice for general illumination.

Beams of light from different directions differ in their effect. Light from the front, originating as close as possible to the line of view, is the most important in display terms since it illuminates the surfaces facing the onlooker; it is revealing and emphatic. Light from above is normally the easiest to provide, is natural in effect and has the most point when the display presents surfaces at a relatively small angle to the horizontal; beams from the side reveal modeling and texture, but light from below ordinarily gives an unnatural effect. Although screening the source presents problems, light from behind the display can give a sense of depth and three-dimensional reality.

Shop Interiors.—The improved colour-rendering of de luxe fluorescent lamps is more than worth the small sacrifice in efficiency. Lamps with outputs close in spectral distribution to those of incandescent sources are widely used for the display of food, furniture, evening clothes and wherever a luxurious atmosphere is appropriate. De luxe cool white lamps produce a clean, stimulating atmosphere for men's wear, sportswear, white goods, furs, toys, fresh produce, meats and flowers.

In modern merchandising the attempt is made to control the customer's reactions throughout the shop, not merely in the windows; it is light that turns stock into display. Built-in lamps in counters and shelving enhance attention values, while spot-lighting permits controlled emphasis.

3. Office Lighting.—As the pattern of employment in modern society has changed to put the office worker in the majority, the industrial worker in the minority, the office has thus come to represent the typical working environment of the time, and office conditions have increasingly preoccupied those concerned with productivity.

Many factors, such as simplification of building services, have combined to favour large rooms with many occupants. The basic situation facing the lighting engineer is that of a rectangular room with windows along one of the longer sides. Thus, desks are arranged to give a direction of view parallel to the window wall, with the occupants sitting with the source of daylight on their left, since the majority will be right-handed. Fluorescent fixtures in rows parallel to the window wall will produce a light distribution that complements the natural light. Recessed luminaires are often preferred by architects for their contribution to a "clean" interior; many are based on a module common to the standard suspended-ceiling systems.

In private offices, specifications ordinarily call for the same illumination as for the larger general room. However, considerations of prestige are important, and an atmosphere approaching the domestic is often sought.

4. Industrial Lighting.—Experience in the more industrialized countries has shown that modern levels of illumination have proved a good economic investment by increasing productivity, improving quality and reducing accidents. The generally accepted conclusion is that lighting is primarily an environmental factor, with many effects that are beyond analysis. As in the commercial field, management is realizing the overwhelming importance of morale, and the question of how much light workers need is being superseded by another: How much do they want? In those countries where legislation on lighting exists, it is concerned with minimum standards; it is therefore irrelevant to this discussion, for the legally specified levels are far below those of general practice.

For general lighting of industrial interiors the choice of light source is almost always between two types: the fluorescent tube and the colour-corrected mercury lamp. The former has some advantage in terms of efficiency and gives a choice of colour; mercury lamps, on the other hand, provide a powerful light source in a compact fitting, thus simplifying installation and maintenance. Mercury lamps also prove useful as point-by-point replacements for incandescent lamps in the modernization of older installations.

In all but the smallest factories, the penetration of daylight from side windows is inadequate for illumination over most of the floor area, and the electric lighting system is used throughout the working day. Some processes demand a completely controlled environment, with daylight excluded. The increased efficiency of artificial-light sources has focused attention on the real cost of daylight, which is affected by such factors as the design (and therefore the cost) of the building, heating and maintenance costs, and efficient utilization of interior space. Detailed consideration of these and other economic factors has led to the erection, particularly in the United States, of "no-daylight" factories with flat, opaque roofs; windows, if installed at all, serve a purely psychological purpose.

5. School Lighting.—In England contemporary school architecture puts great stress on generous daylighting. Where buildings are used in the evening as well as during the day, the more extended use of the lighting system is accepted as justifying fluorescent systems for classrooms, but otherwise the assumption may be that the electric lighting will be little used and an incandescent system will be more economical. In practice, artificial lighting is turned on more than calculations based on daylight factors would suggest. As this becomes recognized, fluorescent lighting is increasingly favoured.

In the United States there has been a growing awareness of the role that modern lighting levels and balanced brightnesses can play in producing an efficient and comfortable visual environment. In some localities natural daylight is abundant enough for school illumination.

Lighting in school workshops, laboratories and other rooms for practical or vocational instruction tends to be imitative of the appropriate industrial or commercial environment.

6. Street Lighting.—Safe and fast movement along traffic routes after dark is of major economic importance. Street lighting is a field where some degree of international standardization must be a long-term aim, even though road surfaces—a vital factor—may vary, depending on the locally available materials. However, even national codes have been slow in developing; and where such codes have been published, progress toward applying them fully has often been hampered because public lighting systems are administered by local authorities with limited jurisdiction.

At the levels of illumination usually employed, and from the driver's viewpoint, good colour rendering is unimportant, so the most efficient practicable light source is indicated. At least in

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CITY CENTRE LIGHTING AT STATION SQUARE IN STUTTGART, GER.: POST-TOP LANTERNS MOUNTED AT 14 M. HEIGHT EACH WITH FOUR 250-W. AND FOUR 400-W. HIGH PRESSURE MERCURY LAMPS

BRITISH LIGHTING COUNCIL

ROTTERDAM, NETH., CENTRAL STATION: GENERAL ILLUMINATION OF PLATFORM IS DERIVED FROM LIGHT REFLECTED FROM CURVED CONCRETE CANOPY

Europe, therefore, the integral sodium lamp has been increasingly used for traffic routes; its size and shape are appropriate for the kind of optical control needed. In the U.S. the colour-improved mercury source has come into favour for many street-lighting services.

On an uncrowded road the driver's perception of vehicles, pedestrians and other objects depends on silhouette vision—on seeing objects dark against the brighter background of the road. Therefore, the lighting engineer's aim is to produce a uniformly bright road surface. When this theory was developed in the 1930s, roads usually had polished surfaces; the most economical solution thus was lights that produced their main beams at angles of only 5° to 10° below the horizontal, and British engineers developed "non-cut-off" lanterns with this characteristic. The opposing view, generally adopted in continental Europe, was that the glare this produced was unacceptable. "Cut-off" lanterns, usually simple metal reflectors, were therefore used at somewhat closer spacings and with the sacrifice of some degree of uniformity in road brightness. However, dramatically increased traffic densities, nonskid road surfaces that require a lower beam angle, and economic progress in general tended toward a compromise between the two views. The trend is to closer spacing and greater mounting heights, and in these conditions semi-cut-off and cut-off designs can produce an acceptably uniform light pattern.

7. Floodlighting.—Almost any type of illumination that permits outdoor work to continue after nightfall can be regarded as floodlighting. In railway yards, quarries and construction sites, high-wattage incandescent or mercury lamps are used in open reflectors or enclosed floodlighting fixtures. However, the decorative lighting of statues, fountains and particularly buildings naturally requires more careful attention.

The classic floodlighting problem is that of achieving an apparently nearly uniform brightness on an extensive vertical surface, using light sources close to its base. Thus luminaires mounted at ground level close to a façade must produce a very high intensity in the direction of the top of the building, for not only is the lighted surface there at a greater distance but the angle of incidence of the light is extreme. Conventional floodlights are designed with paraboloidal reflectors housing projector lamps to produce beams of great concentration. Where necessary, a wider spread can be achieved by using a faceted reflector or an ordinary incandescent lamp, or both. Integral-reflector lamps are sometimes used, especially if the scale is small.

Son et Lumière spectacles are a form of dynamic floodlighting presented to the accompaniment of a recorded sound track of the spoken word and music. The original productions were at the châteaux of the Loire valley in France; others have since been mounted at the Pyramids, the Acropolis and the Tower of London.

See also references under "Lighting" in the Index.

BIBLIOGRAPHY.—For information concerning past practice and later illumination techniques, consult the publications and periodicals of the American and British Illuminating Engineering societies. Illumination practice in the U.S. is summarized in the *IES Lighting Handbook*. Detailed information can be found in W. T. O'Dea, *The Social History of Lighting* (1958); H. Cotton, *Principles of Illumination* (1960); W. B. Boast, *Illumination Engineering*, 2nd ed. (1953); R. G. Hopkinson, *Architectural Physics: Lighting* (1963); C. L. Amick, *Fluorescent Lighting Manual*, 3rd ed. (1961); H. Hewitt, *Modern Lighting Technique* (1952); M. Fahsbender, *Residential Lighting* (1947); J. M. Waldram, *Street Lighting* (1952). (J. K. Bo.; C. L. A.)

LIGHTNING, any of the various forms of visible discharge of atmospheric electricity. For lightning to occur, there must first be a production of electricity, and a separation in space into centres carrying positive and negative charges, respectively. As the charging proceeds, the electrical field between the charge centres or between the ground and a charge centre increases until a field strength is reached at which the air breaks down electrically. A lightning flash, a large electrical spark in the atmosphere, then follows. Charging processes are usually associated with thunderstorms, sometimes also called electric, or electrical, storms, but somewhat similar though less intense effects are present in blizzards, dust storms and even waterfalls; discharges have been observed accompanying all these phenomena. Much electricity is generated within the clouds produced by volcanic eruptions and nuclear explosions, and copious lightning activity often ensues. (*See* also THUNDERSTORM.)

The main divisions of this article are as follows:

I. Lightning and Thunder in Folklore
II. Forms of Lightning
III. Methods of Study
IV. Propagation of Lightning
V. Effects of Lightning
VI. Lightning Protection

I. LIGHTNING AND THUNDER IN FOLKLORE

As one of nature's most awesome spectacles lightning has long challenged man's myth-making ingenuity. Speculations about the great power and destructiveness of lightning have not been limited to primitive man, nor are these notions confined to the great mythologies of the world; they live on in the folklore of every land, with ancient heathen beliefs often persisting side by side with folkloric ideas that emerge mainly from the Judeo-Christian tradition.

Throughout the world, gods have been held to manifest themselves through lightning or thunder. These deities include: Baiame and Daramulum (Australian aborigines); Iko (Maori, New Zealand); Indra and Parjanya (India); Kari (Semang Negritos, Malaya); Kvum (Pygmies, tropical Africa); Wakan (Dakota Indians, North America). In China and southeast Asia dragons are believed to have sacred control of thunderbolts, rain and fertility.

Likewise, the thunderbolt, the mythical bolt or dart that explained the damage done by lightning before the nature of electricity was discovered, was considered the weapon of the etymologically identical gods Zeus and Jupiter in Greek and Roman antiquity, and areas struck by lightning were hedged off as sacred precincts. Persons killed by lightning were not accorded usual funerary rites, but were buried at the spot of the divine fulmination. Thor is the Teutonic counterpart of Zeus, Jupiter and other storm gods of Indo-European mythology (*e.g.*, Perkunas, Baltic; Perun, Slavic; Taranis, Celtic).

In Old Testament times lightning struck fear in the hearts of the people, and was regarded as evidence of the divine will of Yahweh (Jehovah). The idea persists in the classification of death and destruction by lightning as acts of God. That these ideas of divine will extend to primitive peoples is seen among Negroes of the African gold coast, where fires started by lightning are not extinguished, nor aid given a person struck down.

In the Christian community various kinds of sinful and blasphemous acts are said to be punished by lightning. These include perjury, mockery of things holy, desecration of sacred places and utensils, and profanation of the Sabbath and other church holidays.

The hawthorn, laurel, aspen, beech, elder and bay trees, among others, are thought to repel lightning, as are several kinds of bushes, including holly. On the other hand, the poplar, locust and walnut are believed to attract it; likewise the oak and ash as the familiar verse indicates: "Beware of an oak: it draws the stroke; avoid an ash: it courts the flash . . ." German folk verses caution against the oak and fir, and bid one seek safety under the beech during a thunderstorm.

The widespread folk belief in the U.S. that fires started by lightning can be extinguished only by milk is also known in France and Germany. Even though the wood from trees felled by lightning is tabu as a fuel it is nevertheless widely used for curative and magical purposes. Cats and dogs are said to attract lightning, also mules and horses; while pregnant women are considered immune to it, as are sleeping persons and babies in the innocent state before they learn to talk. Such sacred objects as the Bible, candles, bells and salt are held to avert lightning or abate it; for safety the occupants of houses are cautioned to stay away from windows, avoid mirrors and keep well back from the chimney; featherbeds are supposed to offer the surest haven. Quite general is the proverbial and erroneous notion that lightning never strikes twice in the same place.

Various notions have been advanced among the folk of all nations to account for the crash of thunder, such as Thor's hurling his mighty hammer at giants; God's chasing the devil, overtaking and dashing him down; or, among American Indians, the flapping of the wings of great thunderbirds. In more homely U.S. folk idiom, thunder is explained as the "'tater" (potato) wagon trundling down the cellar steps, the angry voice of a displeased God or the noise of his water barrels as they roll across the floor of heaven. Any speaking or other noise made during a peal of thunder is considered a mockery, and is held unfailingly to invite a lightning bolt. (W. D. Ha.)

II. FORMS OF LIGHTNING

The term lightning flash or discharge refers to all the phenomena associated with a single lightning incident. A lightning stroke is a special feature of the flash to earth.

Forked lightning is familiar in a ground discharge; the bright main channel then has less luminous branches directed downwards. Branching results from the inhomogeneity of the electric field encountered by a pilot lightning column, termed a leader, moving from the cloud toward the earth. The leader branches in the directions where the electric field is greatest, thus endeavouring to reach the ground by several paths. One branch usually strikes earth first; the other branches then progress no farther, and the successful branch becomes the main discharge channel. Occasionally branching is slight; this is streak lightning. The accompanying photograph of lightning over Brisbane, Austr., shows examples of both forked and streak lightning. Discharges to earth normally contain several high current surges or return strokes of brilliant luminosity along the same channel. The intervals between strokes vary considerably but 50 milliseconds (1/20 sec.) is typical. This time allows the eye to discriminate between the successive luminous pulses; the effect is seen as the flickering characteristic of many flashes to ground.

BY COURTESY OF S. A. PRENTICE, UNIVERSITY OF QUEENSLAND, BRISBANE, AUSTR.

FORKED AND STREAK LIGHTNING OVER BRISBANE, AUSTR.

Sheet lightning is common. The flash occurs within the thundercloud; the channel cannot be distinguished, only a diffuse illumination over a considerable area is observed. The luminosity fluctuates during the discharge because the distribution of charge in the cloud is not uniform. Sheet lightning usually results from a discharge confined to a single cloud. True cloud-to-cloud flashes are rare.

Many other forms of lightning exist. Heat lightning is the illumination, generally diffuse, observed when flashes are too distant for thunder to be heard. Warm summer evenings favour both the occurrence of thunderstorms and the presence of observers outdoors; the term heat lightning is an understandable consequence of these facts. Air discharges are not uncommon. They often emerge from a cloud and run along the base without reaching the earth. The evidence for flashes upwardly directed from thunderclouds is inconclusive; although currents undoubtedly flow above thunderheads, it is uncertain whether they are spread over a wide area or are confined, as in a true discharge, to a discrete channel. Ribbon and bead lightning are rare forms of the discharge to earth. Ribbon lightning occurs when a lateral wind displaces the successive illuminations of the channel by return strokes; the resulting parallel streaks present a ribbonlike appearance. In bead (or pearl) lightning some parts of the channel appear appreciably brighter than others. This can be because these segments are sections of a zigzag channel viewed end on, but even with a straight channel the luminosity sometimes seems to persist longer in certain parts than in others.

Bead lightning and the most mysterious kind of lightning—ball lightning—may be allied phenomena. Some scientists dispute the reality of ball lightning although there is a core of consistent reports confirming its existence. Very infrequently, under thundery conditions and especially following a nearby flash to ground, a globular luminous mass about 20 cm. in diameter is seen floating in the air. The ball moves irregularly; it usually lasts for a few seconds, and may disappear quietly or with an explosion. Standing electromagnetic waves, ring currents, quantum mechanical exchange forces, and gaseous combustion have all been invoked as causative mechanisms for ball lightning, but there is no entirely satisfactory explanation.

In a ground discharge the channel below the cloud is 1 or 2 km. long and is seldom much inclined to the vertical; within the cloud, the channel is more horizontal than below and the path length increases with the number of strokes in the discharge, perhaps within the limits of 2 to 10 km. Cloud flashes have orientations ranging from predominantly horizontal to predominantly vertical; a typical channel length would be 4 km. Air discharges can be as long as 15 km. There is radar evidence for flashes along a squall line of thunderclouds apparently approaching 100 km. in extent; these discharges may not represent a continuous channel but may rather be a sequence of separated flashes occurring in rapid succession along the squall line. *See* also Squall and Squall Line.

III. METHODS OF STUDY

Although lightning produces many observable effects it is not an easy phenomenon to examine experimentally. There are two main difficulties: exactly when or where a flash will occur is unpredictable, and the range of magnitudes to be covered is immense. A single discharge may last a second, but the detailed study of certain stages demands a time resolution of at least one microsecond (μ sec.; 1/1,000,000 sec.); at times the current approaches 100,000 amp., while in other phases of the flash it is less than 100 amp.

Experimental investigations of lightning were initiated by Benjamin Franklin in 1749. Many facts had been established previously by intelligent observations but it remained for Franklin to demonstrate how instructive carefully designed experiments can be. Many of Franklin's deductions remained the best information for more than 150 years, a tribute to the quality of his work (*see* FRANKLIN, BENJAMIN: *Electrical Science*).

Two techniques of studying lightning have been especially valuable. Photographs of changes in luminosity using cameras that record the variations as a detailed function of time were first obtained by Sir Basil Schonland in South Africa in 1933. This work provided the initial clues to the manner in which a discharge propagates. The second important technique, largely developed by Scottish physicist C. T. R. Wilson (*q.v.*) from 1916 onward, consists in measuring the changes in electric field produced by the flash. From the measurements, the charges and currents involved can be deduced. Close to a discharge, the change in electric field is mainly electrostatic, semipermanent and controlled by the positions of the charges and their magnitudes. Farther away, the field change is dominated by a transient electromagnetic term dependent upon the rate at which the currents change.

Other supplementary techniques are valuable. Current surges in objects struck can be monitored by means of elaborate instruments giving detailed information, installed at points struck frequently, such as the tops of high structures. There are, for example, more than 100 flashes per year to a television mast 300 m. tall located at Champaign, Ill. Unfortunately, however, a discharge to a tall structure differs in character from a flash to open ground. For economic reasons, instruments placed at points struck relatively rarely must be cheap; the resulting information is inevitably limited. Radar reflections from lightning give information on conditions in the channel, while deductions regarding electric charges and currents can be made from the damage to objects that have been struck. Some clues to lightning behaviour emerge from studying long sparks artificially generated in the laboratory. In 1962 this triggering technique was extended to the initiation of natural lightning by firing a rocket trailing a grounded wire toward a thundercloud. An experiment of similar intention was attempted, without proper precautions, by Franklin. Fortunately he failed, but his Russian contemporary G. Richmann was successful both in the experiment and in killing himself.

IV. PROPAGATION OF LIGHTNING

Thunderstorm Electrification.—Thunderstorms normally contain several cells each of which represents a separate electric entity. Individual cells have lifetimes of about 45 min.; they seldom develop simultaneously, one cell generally becomes active as another wanes.

The mechanisms responsible for thunderstorm electricity are complicated. Impact of ice particles and supercooled water droplets upon pellets of soft hail (graupel) can produce considerable electrification, especially if, as is usual, temperature differences exist between the impinging bodies. Coalescence of droplets; mass movement of charge by air flow; preferential attachment of ions—air molecules that have either gained or lost an electron and are therefore charged—to precipitation elements: all these are factors contributing to thunderstorm electrification.

In an active thundercloud the larger particles usually possess a negative charge while the smaller carriers are positively charged. The electrical structure can be very complex, but a simple model applies to perhaps half the clouds. In the upper portions the net charge is positive, some 30 coulombs in magnitude, and spread over a diffuse volume centred at a height of about 8 km. (one coulomb = the quantity of electricity produced by a current of one ampere in one second). The body of the thundercloud is electrically neutral, containing a mixture of positive and negative charge carriers, representing roughly 1,000 coulombs aggregate charge of each sign. Toward the cloud base the net charge is negative, again about 30 coulombs in size, centred at a height of 4 km. and occupying a more concentrated volume than the upper positive charge. The electric moment of a cloud is twice the algebraic sum of the products of the individual charge magnitudes and their respective heights; it is +240 coulomb-km. for the above model. If the moment is destroyed, as by a cloud discharge, it can be regenerated within a few seconds. Large particles fall faster than the small carriers by as much as 8 m. per second (m./sec.). Thus within the body of the cloud re-creation of the moment can proceed at 16 coulomb-km. per second—twice the product of the charge concerned (1,000 coulombs) and the relative fall velocity (8 m./sec.). The potential with respect to earth at the negative charge centre is about −100,000,000 v.; at the positive centre it is +100,000,000 v.; while the conducting upper atmosphere is at +300,000 v. Below the cloud the electric field is therefore negative (the sense to drive an electron toward earth); within the cloud it is positive; above the cloud it is again negative.

Flashing in a single thunderstorm cell starts at one or two per minute, then rises abruptly to a peak of perhaps five discharges a minute; this rate is maintained for only a few minutes. The proportion of flashes going to earth is highly variable among individual storms; the rather obvious association applies that if the storm develops at high levels there are few ground discharges. The proportion of discharges to earth increases with geographic latitude; near the equator less than 10% of all flashes reach the ground, but at latitudes of 55° the figure is 40%. Well over 90% of ground discharges transport negative electricity from the cloud to earth. A record of thunder heard upon a particular day defines a "thunderstorm-day." This statistic is related to lightning incidence since the total number of discharges occurring per square kilometer per thunderstorm-day per annum is approximately 0.25. Some parts of the world have more than 200 thunderstorm-days annually; at other places, thunder is unknown. Since it is believed that 1,800 thunderstorms are active over the world at any one time, the plausible flashing rate of 5 per minute leads to a global estimate of 150 discharges a second.

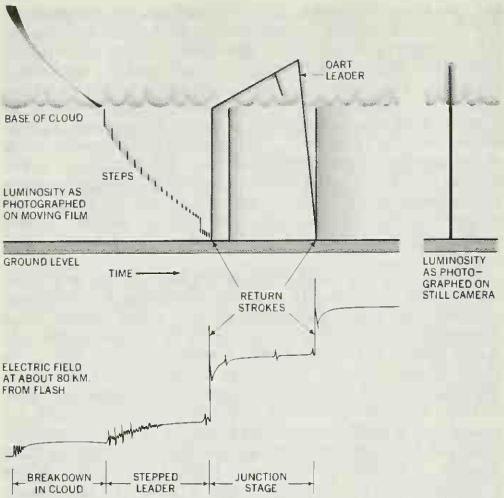
Initiation of a Discharge.—The field strength for electrical breakdown of air at atmospheric pressure is 10,000 volts per centimetre (v./cm.) when water droplets are present. The average pre-discharge field over the path to be bridged by a flash is much smaller, 250 v./cm., for example, between the negative charge centre and the ground. Even within a thundercloud, fields of 1,000 v./cm. are exceeded only over limited areas.

Thus the flash does not take place because the breakdown field strength is simultaneously reached over the whole path. Rather, there is a progression of the breakdown across the gap. In large electric fields water drops distort and show elongated tips. Electrical corona discharge occurs from these tips: a drop disrupts to give a positive streamer spray of ions and droplets, and to leave a residue carrying a negative charge. The residual particles, being larger, fall relative to the positive carriers. A column of negative charge is thus formed; the electric field due to this negative charge exceeds the breakdown value locally at the top of the column; the air at the tip consequently becomes ionized, and therefore electrically conducting, so that the negative column develops into a leader channel—the infant discharge.

Discharge initiation is very localized. It is most likely at the fringes of the negative charge centre. Once a leader channel is a few metres long its further progress becomes easier. The voltage gradient along the channel is less than that in the adjacent air. Therefore the farther the leader travels the greater the potential discontinuity between its tip and the ambient atmosphere; the larger, consequently, the electric field and the easier the production of the ionization to further advance the leader.

Leader channels contain a core a few centimetres in diameter, within which conditions approximate those in an electric arc, the electrical conductivity being large. The core carries a current approaching 100 amp. and is surrounded with space charge generated by lateral corona.

Leaders can develop whenever a sufficient potential discontinuity exists; during thunderstorms, therefore, they frequently originate and travel upward from tall buildings. The field below a thunderstorm is typically 100 v./cm.; the potential discontinuity at a building 300 m. high is therefore 3,000,000 v., more than enough for leader initiation. Tall structures such as the Empire



TYPICAL FLASH TO EARTH: VARIATION WITH TIME OF LUMINOSITY AND ELECTRIC FIELD

State building in New York city are struck more commonly than would be expected; by generating upward leaders they provoke discharges that otherwise would not have occurred so readily.

The Flash to Earth.—The variations with time of the luminosity and electric field associated with a typical ground discharge are represented in the figure. All the phenomena occur within a single channel drawn vertically for simplicity. A still photograph would show only a vertical streak. If, however, a moving film is used, channel development can be followed, and the fact that various sections become bright in turn can be established. The upper part of the figure shows the luminosity changes, and the lower portion the accompanying variations in vertical field at the earth's surface. The field changes are for 80 km. from the flash; at this distance the semipermanent electrostatic field component and the superimposed transient electromagnetic radiations are of comparable size.

Breakdown as a leader process in the cloud is often facilitated by the presence of a small subsidiary positive charge at the cloud base; this charge is generated by corona at the ground and transported upward. The leader, originating and fed from the main negative charge centre, may have to pause in its motion toward earth until the subsidiary positive charge is neutralized. After emerging from the cloud, the leader moves downward at a vertical speed typically of 10^7 cm./sec. Often there is a momentary brightening for about 1 μ sec. of perhaps the forward 50 m. of the leader channel. This brightening is repeated at intervals of some 50 μ sec., so that the advance of the leader is apparently by steps. In reality, the advance is steady; only the brightening is intermittent. During a step the channel current may increase momentarily to 1,000 amp. In the leader stage the channel, even when the steps are occurring, is never very bright.

The leader reaches the ground about 50 milliseconds after the initial breakdown. As it progresses, negative charge is deposited on and around the channel. This negative charge induces a corresponding positive charge on the earth's surface, and as the leader approaches the ground the fields between the charges increase so that a positive upward leader develops from the earth. Over open terrain, the two leaders unite a few metres above the ground. Following the union, a massive surge of current, representing the mutual charge neutralization, moves up the channel at very great velocity (10^{10} cm./sec.). This spectacular effect is the return stroke. The upward velocity decreases as the return stroke travels higher, because the portions of the channel now being reached have had time to decrease in conductivity since their original formation. Typically, the current in the return stroke crests to 20,000 amp. in 10 μ sec., and causes intense heating and luminosity. Spectroscopic observations show that the temperature reaches 25,000° K.; at this temperature the air molecules are dissociated into their constituent atoms, many of which become ionized. Relaxation from the various excited atomic and molecular states causes the brilliant light emission. The diameter of the return stroke channel is only a few millimetres. In the channel the air density is momentarily reduced to perhaps a hundredth of that in the ambient atmosphere; there are approximately 4×10^{17} atoms per cubic centimetre while the electron concentration is 10^{17} per cubic centimetre. Thus the channel is a 25% ionized plasma.

After the return stroke, the current and the associated luminosity in the channel can decrease abruptly or can continue for some time. The channel is now positively charged and positive streamers, known as junction leaders, probe into the cloud in search of untapped concentrations of negative charge. If a concentration is encountered, and the continuing current is still appreciable, a surge of renewed current passes along the whole channel to ground. If, however, the continuing current drops below about 50 amp., the channel decreases appreciably in conductivity; an encounter with a minor centre of negative charge then usually produces a current surge, and an associated recoil streamer of luminosity reaching only part way to the ground. These partial surges produce characteristic variations in electric fields known as K changes.

Sometimes a junction leader taps a negative charge sufficiently intense to cause re-energizing of the entire channel to earth; the recoil streamer is then termed a dart leader. The velocity (2×10^8 cm./sec.) of the dart mechanism is much greater than that for the stepped leader; this is because the channel is still carrying residual ionization and is therefore more conductive than the virgin air first penetrated by the stepped leader process. As with the stepped leader, the dart leader deposits negative charge along the channel, so that when the dart reaches the earth conditions are suitable for a second return stroke to occur. This, and any subsequent stroke, differs from the first in that the upward velocity is constant and the current reaches its peak in less than 1 μ sec.

Following a return stroke, the cloud may discharge steadily by a continuous current, intermittently by further strokes, or, as usually happens, by a combination of both mechanisms. About 80% of flashes to earth include more than one stroke, while the average number of strokes in a ground discharge is four. The total change of moment is some 150 coulomb-km., with about 25 coulombs of negative charge flowing to earth, mostly in long continuing currents of low magnitude. The power output in a return stroke exceeds 1,000,000 Mw. (10^{12} watts) for a few microseconds, but the average over the whole duration (typically 300 milliseconds) of a flash is about 4,000,000 kw. (4×10^9 watts). The total energy of the flash is about 350 kw.hr.

Cloud Discharges.—The first lightning in a thunderstorm is within the cloud. As with the ground discharge, the flash originates as a leader; this develops between the two main centres of charge, thereby producing a lightning spark and neutralizing the electrification. A leader in a cloud never encounters a medium, such as the earth, of good electrical conductivity, through which charge can pass very readily. Consequently, the peak current in a cloud discharge rarely exceeds 10,000 amp. Currents of over 1,000 amp. are, however, not infrequent. They occur when the advancing leader, which may be carrying either positive or negative charge, encounters a charge centre of the opposite sign. A readjustment of conditions within the channel follows, and a luminous recoil streamer represents the progress of this readjustment backward from the leader tip. The associated field change and the K change previously discussed are much alike. Indeed there are considerable similarities in the development of a cloud flash and in the processes between the return strokes of a ground discharge. Cloud discharges typically produce a change in electric moment of 100 coulomb-km.

V. EFFECTS OF LIGHTNING

Radio Noise.—The electric field-change far from a discharge is dominated by the transient electromagnetic radiation familiar as the "atmospherics" (atmospheric interference, sferics or noise) that interfere with radio communication. Radio noise extends over a wide range of radio frequencies; it is intense when the current in the discharge changes rapidly. The shorter the path covered by the current, the higher the frequencies radiated. Thus the long channels energized by return strokes radiate predominantly at very low frequencies (3 to 30 kc. per second), while the short sparks that effectively advance a leader give their peak output at perhaps 1,000 kc. per second. In a complete ground discharge the maximum noise signal is at 5 kc. per second; for higher frequencies noise is inversely proportional to frequency. At very low frequencies the noise occurs in pulses and discrimination is easy between cloud and ground discharges; as frequency increases, noise becomes more continuous and it is harder to distinguish cloud from ground flashes. Radio noise propagates in the same manner as conventional radio transmissions.

The "whistler" is an interesting phenomenon. Radio energy emitted by the flash is guided by the earth's magnetic field and may travel far into space. The high frequencies move faster than the low, so the signal after the return to earth can be heard in a loudspeaker as a whistle of descending pitch. Research on whistlers reveals much about the earth's environment in space.

Thunder.—The current surge in a lightning channel produces sudden heating and expansion; this is communicated to the surrounding air as an impulsive compression which, the air being essentially elastic, sets it into oscillation longitudinally, thus generating the sound wave known as thunder. The most abrupt current change, giving the strongest thunder crack, is in the return stroke of the ground discharge. During leader processes currents of hundreds of amperes can flow with little associated light or sound; the current rise is too slow for thunder to occur. At the source, thunder contains a range of sound frequencies extending from about 100 cycles (.1 kc.) per second downward. The higher frequencies are more attenuated during travel, hence the low-pitched rumble of distant thunder. Most of the energy lies in the subaudible frequency range; it often makes houses vibrate and windows and dishes rattle. The thunder wave starts at supersonic velocities but soon slows to 330 m./sec., the speed of sound in air. Since light travels approximately 1,000,000 times faster than sound, the distance of a discharge can be estimated by allowing 330 m. for each second (or roughly 5 sec. per mile) between seeing the flash and hearing the thunder. The lightning channel is of considerable length; thus, the arrival of the sound from the more distant portions occurs appreciably after that for the closest parts and thunder is, consequently, of long duration. Thunder is rarely heard at distances exceeding 15 km. (about 9 mi.).

Lightning-Strikes.—When lightning strikes, several phenomena occur, caused mainly by the current surge of the return stroke. Forces associated with the pinching action of the strong magnetic fields can crush hollow conductors. If the object struck is of high electrical resistance, then large voltages, given by the product of resistance and current (Ohm's law), develop; flashover to nearby surfaces may result. Voltage differences can be transferred great distances if strokes touch metallic conductors such as wire fences. A lightning current surge ending suddenly is described as "cold" lightning; if there is continuing current, the lightning produces heating and ignition and is therefore "hot." Lightning often builds up local pressures by converting water to vapour; destruction of objects sometimes follows.

Lightning tends to strike the highest points. Ships and isolated trees are therefore especially vulnerable. Cold lightning merely damages a tree but the continuing current of hot lightning causes fires. In the United States about one sizable fire results from lightning per 40 sq.km. of forest per annum. Lightning follows the best conducting path; in a tree this is the moist layer below the bark, and bark stripping is consequently a common lightning effect. Traditionally, oaks are struck more often than other trees; this may be correct, but the truly significant factors are height, habit of growth (in isolation or not) and the proneness to damage, this being dependent on the moisture distribution within the trunk.

Immediate damage to buildings by lightning is small. Heavy currents may pass along wires, and such accessories of civilization as telephones and electrical equipment are therefore particularly vulnerable. The chief dangers are, however, indirect; for example, the starting of fires by quite minor sparks.

Persons struck by lightning are either killed or recover completely, especially if mouth-to-mouth artificial respiration is quickly applied. The lethal current is small and the bodies of many of the victims show no markings; burns are only present for close strokes. Over 70% of casualties occur outdoors, and as countries become more urbanized fatalities due to lightning decrease.

Aircraft in thunderstorms develop a self-charge by colliding with precipitation elements; they also distort existing electrical fields. The fields at the extremities of aircraft can become very high, causing local breakdown of the air visible as a glow discharge (St. Elmo's fire; *q.v.*). Glow discharges generate radio interference that is best minimized by the suitable placing on the aircraft of special discharging points or wicks. Aircraft can provoke lightning strikes by field distortion and also, perhaps, through the exhaust. The current, generally of the continuing type, passes along the fuselage or between wingtips; it follows the longest path in the airplane, this being a better conductor than the surrounding air. Damage is generally slight; minor holes may be burned in the plane's skin, radio antennas may be fused, bearings can be overheated, while radomes covering radar antenna assemblies, being plastic and therefore resistive to current, are especially affected.

VI. LIGHTNING PROTECTION

Statistical information on lightning incidence is essential when considering protection against lightning. It is economically foolish to install a system costing more than the probable losses, but elaborate installations may be justifiable in some situations, for instance in explosives factories.

The principles of protection against direct strokes are simple. A lightning rod, usually of copper, intercepts the stroke before it reaches the threatened structure and passes the current harmlessly to ground. A 45° cone of protection is normally assumed for the rod; this means that it shields over a cone whose radius at the ground is equal to the height of the rod. Upward leaders increase the effective shielding by the rod. The rod is connected to ground through a cable of low electrical resistance (less than 10 ohms); this avoids the development of voltages that may cause side flashover. The lightning current can be adequately carried by a cable only a few millimetres in diameter, but the cable is usually thicker for mechanical strength. All joints must be mechanically and electrically sound, and a good ground connection is often ensured by a counterpoise of buried wires.

The principles of the shielding cone and low resistance path to ground apply to the protection of buildings, trees, ships and power lines. The lightning rod should be mounted as high as possible; for houses this usually means on the mast carrying the television antenna; for ships, the mast is again the appropriate support, and if the hull is nonmetallic, and therefore nonconducting, the ground connection is made to a plate immersed in the water. Power transmission lines usually have one or more grounded overhead wires; each transmission tower has a low footing resistance, the ground connection being improved by buried conductors. With all installations the dangers of flashover, as from adjacent trees, must be considered.

In rural areas voltage transfer can occur along wire fences; these should be grounded at 50 m. intervals and their electrical continuity broken every 200 m. by insulators. Radomes in aircraft are protected by strips of aluminum foil, and bearings are bypassed by metallic "jumpers," thus preventing overheating. Modern aircraft, however, usually avoid storms by flying high and using radar; even within thunderclouds turbulence is a much greater hazard than lightning.

Personal lightning danger is readily minimized. It is best to

be indoors; to avoid contact with the telephone, electrical equipment and water systems; and to sit away from a fireplace. If one is caught outdoors, sheltering in a forest is fairly safe, but isolated trees should be shunned; flashover from the tree can occur and currents can radiate from the trunk along the ground. At the sea or lake, swimmers should leave the water and yachtsmen stay below deck. Proximity to long metallic conductors, such as wire fences, ski lifts and railway lines, is dangerous because of voltage transfer and induced surges. However, during a thunderstorm it is exceptionally safe inside motor cars and railway trains; the metal bodies act as so-called Faraday cages, screening the occupants from the electrical effects. Indeed elaborate protective installations are often essentially Faraday cages made up of interconnected wires.

Even if all direct strokes are avoided, surges induced in long wires, perhaps by flashes to nearby lightning rods, can cause damage. Sometimes, as with the accidental detonation of explosives, this can be catastrophic. Many direct and induced effects can be minimized by using simple lightning arresters in combination with fuses; such devices are often attached to telephone lines, overhead power cables and lead-ins from television antennas before they enter buildings. More elaborate arresters are used on power lines; these consist essentially of a spark gap in series with a nonlinear resistor, and are connected between the power line and ground. A lightning surge in the line breaks down the gap and therefore passes to ground without continuing its potentially destructive course. The nonlinear resistor, by limiting the following current, enables the arrester to reset automatically without the need for circuit breakers. (*See* ELECTRIC POWER: *Transmission: Transmission Line Design and Construction.*) Electric motors and generators are often protected by suitably connected capacitors; these reduce the rate of voltage rise.

See also ELECTRICITY; ELECTRICITY, ATMOSPHERIC; ELECTRICITY, CONDUCTION OF; METEOROLOGY. (E. T. PI.)

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LIGHTNING BUG, the name often given in the United States to the firefly (*q.v.*).

LIGHT VERSE can be defined tautologically as verse written on any light theme. Excluding burlesque and parody, also epigram, limerick, clerihew and macaronics (*qq.v.*), there remains a body of verse in all the western languages almost as great as that devoted to more serious subjects, from which it is divided by no rigid frontier. Light verse is essentially that which celebrates the pleasures of the moment, untroubled by the wingbeat of time the destroyer. It invites to the pleasures of love or of wine; it mocks without malice; or piles up cacophonous mountains of words to deride those who use them for overserious purposes.

Classical.—There are light poems in the *Greek Anthology* (*see* ANTHOLOGY), and both Catullus and Horace wrote light poems which were taken as models by their successors up to the end of the 19th century. Catullus wrote, in *Carmina* ii, of his young mistress's sparrow, in playing with which he hoped to lighten his own cares:

> tecum ludere sicut ipsa possem
> et tristis animi levare curas.
>
> (Ah, sparrow, could I but play,
> Like her, with you
> And banish far away
> My heart-ache too!)

(trans. by A. S. Way, *Catullus and Tibullus,* Macmillan and Co., Ltd., 1936)

Catullus, however, is never entirely free from these cares. Horace, in *Odes,* i, 20, on the other hand, invites his friends to drink without a thought of the cares they may be drowning at the bottom of the cup:

> Vile potabis modicis Sabinum
> cantharis, Graeca quod ego ipse testa
> conditum levi, datus in theatro
> cum tibi plausus,
>
> (There's Sabine for you, when you come this way,
> In sober country tankards—nothing grand,
> But sealed with my own hand
> In a Greek pitcher, on that famous day,
> Dear knight Maecenas, when the playhouse rose
> To greet you . . .)

(trans. by E. Marsh, *Odes of Horace,* Macmillan and Co., Ltd., 1941)

Sabine, Caecuban and Calenian he can offer, and it is without excuses or self-reproach that he confesses there is neither Falernian nor Formian in his cellar. Seldom could the Romans celebrate the passing minute so cheerfully, since in a world of unbelief nothing could truly comfort a man for the coming of gray hairs and the falling of rose petals.

Medieval.—In medieval Christendom, belief in eternity allowed the poet to watch with less perturbation the fading of that beauty which was his principal theme. The Latin songs of the wandering scholars or goliards (*q.v.*), which attained popularity about the end of the 12th century; the often indecent fabliaux (*q.v.*), rhymed stories chiefly in French, which became current at about the same time; and the mock-epic cycle of the *Roman de Renart* (*see* REYNARD THE FOX), together formed the first great body of light poetry that Europe had known. The goliards may owe something to Horace and the Roman past, though their invitations to drink are coarser and the choice of their wines or beers was no doubt less critical. But the fabliaux and *Renart* are a modern literature, the product of the new middle class. Anti-feudal and anticourtly in tone, they come from that area on the borders of France and Flanders where the wool trade was enriching the new towns. Here for the first time we meet the fox and the crow whose argument over a cheese was told in a more polished way by La Fontaine, some three centuries later. In the 13th-century collection, the *Isopet de Paris*—the title refers to Aesop—the fox lays on his flattery rather thicker; but "Dan Corbel" is as delighted as his more cultivated descendant to hear that he has the finest voice of all the creatures in the district:

> Dist Renart: "Par ma foy,
> En tout le mont ne say
> Nul si helle heste
> Comme vous, Dan Corbel!
> Car fuisse je si bel
> Et de cors et de teste!
>
> Il n'est oisel volant
> Plus de vous soit plaisant,
> Qui vous verroit estendre.
> Trop grosse vois avés
> Quant haut chanter volés:
> Plus n'i a que reprendre."

Side by side with this poetry grew a repertory of vernacular songs, typical of which is the French "Pourquoi me bat mon mari?," which no sooner asks this question than it proposes the remedy:

> Or sai bien que je ferai
> Et comment m'an vengerai:
> Avec mon amin geirai
> Nuette.
>
> ("I know how to take my vengeance," she says,
> "I'll spend a night with my lover.")

The descendants of such songs are still sung in Parisian revues. The English "Little Pretty Mopsy" is equally frank and commonsensical, and just as up-to-date. The lover knows that kisses are hard to buy, so he asks for them free:

> now I se well that kyssys ar dere,
> and, yf I shold labvr all the hole yere,
> I thynke I shold be neuer the nere;
> wherefore, I pray yow, cum kyss me.

One of the finest collections of light verse of many kinds in any language is the *Libro de buen amor* (1343) of the Spanish archpriest of Hita, Juan Ruiz, which contains the whole repertory of a strolling entertainer, loosely strung together on a thread of pre-

tended autobiography. Here are fables, love songs, serious and burlesque, a battle between Carnival and Lent, satires against the clerics, a song in praise of small women, and several in praise of the Virgin, also other stock religious items. This masterpiece of 13th-century literature contains, in addition, one of the first major literary comic characters, the pander Trotaconventos, who is the mother of the title character of *La Celestina* (*q.v.*), and the ancestress of Shakespeare's Falstaff, Mistress Quickly and Juliet's nurse. The *Libro de buen amor* derives its material from the goliards, from the fabliaux, from Arabic writing and from popular poetry, and upon all this is impressed the cheerful cast of mind of a worldly, scabrous, curiously learned priest, who could celebrate the pleasures of the world without fear or foreboding since his ultimate trust was in a faith that must redeem him if he believed. Hence his frank rejoicing in the charms of little women, whom he found cold without, yet ardent when in love; comfortable, jolly, cheerful and gay in bed; sensible, pleasing, peaceful and virtuous in the home; and endowed with many other virtues which his hearers would soon discover if they attended to the task. Like the archpriest, Chaucer too takes over the legacy of the *Isopet* in the *Nun's Priest's Tale* and of the fabliaux in the *Reeve's Tale* and the *Miller's Tale*.

Renaissance.—The medieval contribution to light verse was mainly in the realm of the story, satirical, bawdy and irreverent, yet fundamentally sensible and moral. The light verse of the Renaissance tends to revive the pagan conventions of Catullus and Horace. John Skelton in his *Book of Philip Sparrow* takes up Catullus' own theme, in his lighthearted mourning for the death of the girl Joanna's sparrow. Skelton's mock-heroics, however, are still medieval in form, and his *Tunning of Elinor Rumming*, a splendid piece of barroom bawdry, is the greatest fabliau in English. He is a Renaissance figure only in his use and comic misuse of learning, in which he is the English counterpart of François Rabelais. He is perhaps happiest in the fantastic invention of Philip Sparrow's funeral service:

> The owl, that is so foul,
> Must help us to howl;
> The heron so gaunt,
> And the cormorant,
> With the pheasant,
> And the gaggling gant,
> And the churlish chough;
> The knot and the ruff;
> The barnacle, the buzzard,
> With the mild mallard;
> The divendop to sleep;
> The waterhen to weep;

and so on through a long catalogue of birds, each with a part to play in the procession. A similar love of lists and strange learning informs the two *Testaments* of François Villon.

French light poetry of the 14th and 15th centuries was written largely in ballades and rondeaux (*qq.v.*), strict forms which challenged the poets to displays of great virtuosity but which limited originality of thought. The prevailing mood was a light melancholy. With Clément Marot a little Horatian wit was injected into these moribund forms. His epigrams, in particular, are pointed in a classical manner that was to prevail for more than two centuries. "De l'Abbé et de son valet" (lxxiv), indeed, well translated, might easily pass as written by the 18th-century poet Matthew Prior:

> Monsieur l'abbé et monsieur son valet
> Sont faits égaux, tous doux comme de cire;
> L'un est grand fou, l'autre petit follet;
> L'un veut railler, l'autre gaudir et rire;
> L'un boit du bon; l'autre ne boit du pire.
> Mais un débat au soir entr'eux s'émeut:
> Car maitre abbé toute la nuit ne veut
> Être sans vin, que sans secours ne meure,
> Et son valet jamais dormir ne peut
> Tandis qu'au pot une goutte en demeure.

("The abbé and his servant are alike in every way. One's a big fool, the other is a little one, and if one has to drink all night, the other will not go to bed while there is a drop left in the house.")

Ronsard also wrote lightly at times, though his prevailing concern with the passing of beauty cast a shadow even on his gayest lines. He can cry for wine as persuasively as Horace in the verses to his lackey; and he is more particular than Marot in his demands that his bottle be cooled, that he may sit under an arbour, and lie on a bed of flowers when he has finished drinking.

> Corydon, marche devant,
> Sçache où le bon vin se vend:
> Fais refreschir ma bouteille,
> Cherche une fueilleuse treille
> Et des fleurs pour me coucher.

But he ends his poem with the fear that one day sickness will tell him, in words that carry an echo of Anacreon: "Die, my lad, you've lived too long." (*Meurs, galland, c'est trop vescu.*)

A similar vein runs through the poetry of the English Renaissance from Sir Thomas Wyat to such Jacobeans as Richard Lovelace and Sir John Suckling. Few except Robert Herrick and Ben Jonson were capable of a lightness unmixed with melancholy or sorrow, and these few compensated themselves by writing many heavyhearted poems for each one that was gay. Nevertheless Jonson, in "Inviting a Friend to Supper," promises that

> No simple word
> That shall be utter'd at our mirthful board
> Shall make us sad next morning: or affright
> The liberty, that we'll enjoy to-night.

And Herrick tempts his friend, Sir Clipsebie Crew, the recipient of his ode of invitation, with a description of a parson's life in Devonshire that is every bit as carefree and classical:

> Then cause we *Horace* to be read,
> Which sung, or seyd,
> A Goblet to the brim
> Of Lyrick wine, both swell'd and crown'd
> A Round
> We quaffe to him.

When Herrick is gay he celebrates food, flowers and pretty girls in the cheerful assurance that his "Larres," or household gods, will save from the passage of time anything that he can enshrine in a poem. Suckling, too, in his "Ballad Upon a Wedding," can write of a girl as if she will never grow old:

> Her lips were red, and one was thin,
> Compar'd to that was next her chin:
> (Some bee had stung it newly.)
> But (Dick) her eyes so guard her face;
> I durst no more upon them gaze
> Than on the Sun in July.

Late 17th and 18th Centuries.—As the 17th century progressed, light poetry became more intellectual. Nonsense and other forms of wordplay, the counterpart of the metaphysical conceit, often gave a sinister undertone to words that appear at first to have been chosen out of pure fantasy. Théophile de Viau's nonsense ode, "Un corbeau devant moi croasse," seems to offer a crazy premonition of the end of the world; and even "A Non-Sequitur," probably by Richard Corbett, is not entirely jovial.

> The putrid skies
> Eat mulsacke pies
> Backed up in logick breeches

is crazy enough. But the lines that follow become increasingly baleful:

> Munday trenchers make good hay,
> The lobster wears no dagger;
> Meal-mouth'd shee-peacocks powle the starres,
> And make the lowbell stagger.

Samuel Butler's *Hudibras* (1663) is light and digressive in the manner of the fabliaux, and La Fontaine's *Contes* look back in their choice of language and broad anecdote to Marot and Rabelais, but the light form is used to greatest effect in La Fontaine's *Fables* (1668, 1678). Here, without apparent seriousness, a whole picture of society is created, and the behaviour of men anatomized under cover of a delicate fable based on Aesop or drawn from India. Similarly, in the greatest light poem of the 18th century, *The Rape of the Lock* (1714), Alexander Pope builds the most trivial anecdote into a mock epic in which the polite society of

his day is shown by innuendo to be a mere shadow of the heroic days of old. It is in the vein of parody that he asks his initial question:

> Say what strange motive, Goddess! could compel
> A well-bred lord t'assault a gentle belle?
> Oh, say what stranger cause, yet unexplored,
> Could make a gentle belle reject a lord?

Among English 18th-century poets Matthew Prior makes fresh use of the broad anecdote, Oliver Goldsmith writes with something of Pope's wit and William Cowper, in his *Diverting History of John Gilpin* (1782), invents the punning narrative that was to be the stock in trade of Thomas Hood.

19th and 20th Centuries.—The greatest English light poem of the 19th century is undoubtedly Byron's *Don Juan* (1819–24), the first important novel in verse, which marked a return to the colloquialism of medieval light poetry. Before him George Crabbe, and after him W. M. Praed, Arthur Clough and, at times, Robert Browning, wrote light poetry that was conversational and digressive in tone. For a while the novel seemed to be leading and the poem following, as it did also in the Russia of Aleksandr Pushkin and his successors. Byron's lightness is sardonic and casual. He throws away a romantic situation with nonchalance:

> Alas! for Juan and Haidée! they were
> So loving and so lovely—till then never,
> Excepting our first parents, such a pair
> Had run the risk of being damn'd for ever;
> And Haidée, being devout as well as fair
> Had, doubtless, heard about the Stygian river,
> And hell and purgatory—but forgot
> Just in the very crisis she should not.

Clough in the same way, in *Amours de Voyage* (1862), though with rather more show of conscience, writes off Rome and the battle for Italian independence with a colloquial shrug:

> *Dulce* it is, and *decorum*, no doubt, for the country to fall,—to
> Offer one's blood an oblation to Freedom, and die for the Cause; yet
> Still, individual culture is also something, and no man
> Finds quite distinct the assurance that he of all others is called on. . . .

The 19th century was prolific of light poetry. The nonsense of Edward Lear, the parodies and nonsense of Lewis Carroll, the parodies and occasional verse of C. S. Calverley and the *Bab Ballads* (1869) of W. S. Gilbert are the principal English collections, for which there is little parallel abroad, except for the sardonic doggerel of the German Wilhelm Busch. The cause of this flowering lies in a certain matter-of-fact revulsion from the romanticism of the serious poets, and in the proliferation of humorous periodicals in which such verse could appear.

Light poetry of the 20th century has been sparser and on the whole more literary in its allusions than the punning or the colloquial output of the Victorians. A revival of the 14th-century ballade by Hilaire Belloc, G. K. Chesterton and Sir John Squire, the vogue of the limerick (*q.v.*) and the invention of the clerihew (*q.v.*) were the chief landmarks up to 1925.

American light verse of the 19th century had a parodic character which comes out to perfection in *Hans Breitmann's Ballads* (1871) by Charles G. Leland. These gave a new twist to the macaronic joke, which was particularly apposite to a country so many of whose inhabitants had learned the language in middle life. Earlier American practitioners had exploited the humour of Negro dialect and backwoods jargon. The *New Yorker* school marks the beginnings of sophisticated and urban light verse. T. S. Eliot, in such mock-romantic parodies as "Burbank with a Baedeker: Bleistein With a Cigar," was a forerunner, but the naïve *sotto voce* of *archy and mehitabel* (1927) by Don Marquis strikes a more typically American note. The inventor of this offbeat *vers de société* was Ogden Nash, a master both of the short quatrain and of the longer poem of resigned self-depreciation of the type of "Ask Daddy, he won't know." Nash was the most original and best known of the *New Yorker* poets. Phyllis McGinley, however, produced feminine and more sentimental variants on Nash's self-ironic theme of adult helplessness, and Morris Bishop applied to similar subjects a more traditional talent which at times recalls that of Thomas Hood.

In England the new grotesques of Robert Graves and the neo-Victorian topical verse of John Betjeman were the principal light poetry of the later '50s and early '60s. In France some nonsense of a surrealistic kind and in the German-speaking countries the whimsical and punning wit of Christian Morgenstern and the light satires of Erich Kästner stand out among the far thinner output of 20th-century Europe.

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LIGHT-YEAR, an astronomical unit of length, the distance traveled by light in the course of one year, being equivalent to about six million million (6×10^{12}) miles. The distance of stars may be measured in terms of this unit or in terms of the parsec (*q.v.*), which is about 3.26 light-years.

LIGNE, CHARLES JOSEPH, PRINCE DE (1735–1814), officer in the Austrian army, man of the world and, in Belgian literature, the outstanding representative of the elegant sensibility of the *ancien régime*, was born in Brussels, capital of the Austrian Netherlands, on May 23, 1735, the son of Claude Lamoral, prince de Ligne, head of a family long established in Hainaut and ranking as princes of the Holy Roman empire from 1601. Charles Joseph had a passion for soldiering from his earliest years and fought for Austria during the Seven Years' War. When he was chosen to announce the victory of Maxen (1759) to Louis XV of France, his handsome figure and wit won instant favour at Versailles. Having succeeded to immense wealth on his father's death (1766), he could pass his life between Vienna, Versailles and his château of Beloeil, near Mons, one of the great houses of Europe, where he laid out gardens and staged prodigious fetes. His marriage (1755) to Franziska of Liechtenstein had never deterred him from lighthearted amours; he was a favourite of Marie Antoinette; he was welcomed in the Parisian salons; and he visited Voltaire and corresponded with Jean Jacques Rousseau. Throughout these years, however, he remained a trusted adviser of the emperor Joseph II. Sent by Joseph to Catherine II the Great of Russia in 1780, he won her friendship and returned loaded with honours and presents. In 1786 he was once more sent to St. Petersburg, whence Catherine took him in 1787 on her tour of the Crimea. On the outbreak of the Russo-Turkish War he served at the siege of Ochakov (1788) before rejoining the Austrians for the siege of Belgrade (1789).

The Belgian troubles of 1789, the death of Joseph II (1790) and the outbreak of the French Revolutionary Wars (1792) put an end to the happy era of the prince's life. A refugee in Vienna or a guest in other people's houses, he could only write his memoirs and watch, with a soldier's eye, the campaigns of Napoleon I and the mistakes of the allies. His Austrian rank of field marshal (1808) had no practical effect. Yet when the congress of Vienna opened in Oct. 1814, its members crowded about the aged prince to do him honour; and his death, on Dec. 13, was followed by a military funeral which all the congress attended.

The prince de Ligne's *Mélanges militaires, littéraires et sentimentaires* fill 34 volumes (1795–1811), but his personality is best expressed in his letters (collections published in 1809 and in 1812) and in the *Fragments de l'histoire de ma vie* (first printed in 1927). The letters have the easy formality of an 18th-century prince and provide vivid descriptions of incidents in his life; and the *Fragments* are written in a vigorous conversational style anticipating that of Stendhal. There are editions by F. Leuridant of *Oeuvres du prince de Ligne* (1914) and of *Oeuvres inédites* (1914–22), as well as selections in English by K. P. Wormeley (1899) and by L. Ashton (1927).

See F. Leuridant (ed.), *Annales Prince de Ligne*, 19 vol. (1920–38).

LIGNITE. In North America, coals having a moist mineral-matter-free heat content of less than 8,300 B.T.U. per pound are called lignite. Moisture content (as received) varies from 20% up to 60%. The classifications of other countries are overlapping. Some European lignite would be classified "subbituminous" in the U.S. Most brown coals in Europe would be classified as lignite.

Lignite is generally younger geologically than higher-rank coal.

Approximately 4,000,000 tons of lignite are mined annually in the United States, largely by open-pit methods. North Dakota and Texas are the largest producers. Assured U.S. reserves total more than 463,000,000,000 tons, about 15% of the nation's total solid fuels reserves on a B.T.U. basis. About 95% of total tonnage is located in North Dakota, South Dakota and Montana.

The fuel is used by local utility, industrial and domestic consumers fairly close to the mine site. It is adaptable to firing in stokers of the overfeed type, in pulverizers and in cyclone furnaces. It can be shipped and stored in the same manner as higher-rank coals. Because of its greater liability to oxidation and to spontaneous combustion, it requires more careful compaction in stockpiles than coals of higher rank. Crushed lignite can be stored for periods of two or three months without compaction when treated with small quantities of oil.

Lignite (brown coal) resources are a major factor in the development of eastern and southeastern Europe. About one-third of the output is briquetted for domestic and industrial heating. Another one-third is used for power generation. The remainder is used by chemical and carbonization processes. *See* also COAL AND COAL MINING. (W. A. McC.)

LIGONIER, JOHN (JEAN LOUIS) **LIGONIER,** 1ST EARL (1680–1770), British soldier who was military adviser to the elder Pitt during the Seven Years' War. He was born at Castres in Languedoc, France, on Nov. 7 (new style; Oct. 28, old style), 1680, and came from a French Huguenot family that sought refuge in England in 1698. He joined the British army, took part in all Marlborough's campaigns and battles between 1702 and 1711, and spent the last years of the War of the Spanish Succession as lieutenant governor of Fort St. Philip, Minorca. Later he distinguished himself at the capture of Vigo (1719). In 1720 he was appointed colonel of the Black Horse (7th Dragoon guards). During the War of the Austrian Succession Ligonier acted first as staff officer to George II. He was second-in-command of the cavalry at the battle of Dettingen and was given the Order of the Bath on the field by the king in person. After the battle of Fontenoy (1745) he became commander of the British contingent in Flanders. He led the British forces at Roucoux (1746) and also at Lauffeld (1747), where he saved the allied army from destruction by a brilliant charge of the British cavalry. Soon after the opening (1756) of the Seven Years' War he was appointed commander in chief and acted as military adviser to Pitt; the brilliant successes attending British arms throughout the war worthily crowned Ligonier's lifework. He became a field marshal and was created earl in 1766. He died in Surrey on April 28, 1770, and was buried in Westminster Abbey.

See R. Whitworth, *Field Marshal Lord Ligonier* (1958).

(E. W. SH.)

LIGUORI, SAINT ALFONSO MARIA DE' (1696–1787), Italian moral theologian and founder of the Redemptorists, a doctor of the church, was born at Marianella, near Naples, on Sept. 27, 1696, the son of Giuseppe de' Liguori. He studied law, passed his examination for the doctor's degree at the age of 16 and practised law for eight years. Giving up the bar, he was ordained priest in 1726. In 1732 he founded the Congregation of the Most Holy Redeemer, commonly called the Redemptorists (*see* REDEMPTORISTS). In 1762 he became bishop of Sant' Agata de' Goti, about 30 mi. from Naples. He resigned this bishopric in 1775 and died on Aug. 1, 1787. He was canonized in 1839 and declared a doctor of the church by Pius IX in 1871. In 1950 he was named patron of moralists and confessors by Pope Pius XII. His feast is celebrated on Aug. 2.

Liguori wrote extensively. By 1953 his works had gone through about 18,000 editions and had been translated into 60 languages. They fall into three classes. (1) The first, in the field of moral theology, is headed by his *Theologia moralis*. This first appeared in 1748 and went through nine editions in his lifetime and more than 60 subsequently. He summarized it in *Praxis confessarii*. Another work in this class is *Homo apostolicus*. (2) The second class embraces his ascetical and devotional writings for priests, religious and lay persons. This includes *Visits to the Blessed Sacrament, The True Spouse of Christ* (for nuns) and *Selva* (for priests) and *The Glories of Mary*. The last is one of the most influential and widely used manuals of Marian devotion, and it helped to shape the Marian doctrine. (3) The third class contains his dogmatic writings, such as *The History of Heresies,* his works on the infallibility of the pope and those on the power of prayer. This last theme he stressed so constantly that he is sometimes called the "doctor of prayer."

Liguori was also a celebrated preacher, a musician and a poet. He composed and put to music many hymns which are still favourites among the Italian people. His Christmas hymn "Tu Scendi dalle Stelle" is as closely associated with Christmas in Italy as are "Adeste Fideles" and "Silent Night" in other countries.

In theology Liguori is known as the principal exponent of equiprobabilism, a system of principles designed to guide the conscience when one doubts whether he is free from, or bound by, a given law. The system is based on the legal axiom "in doubt the presumption favours the possessor." Applying it to doubts of conscience, Liguori laid down these three principles: (1) In a doubt with equally probable reasons pro and con, a person is free from the obligation of the law if he has been free from it hitherto, for freedom is in possession and the presumption favours the possessor. (2) In a doubt with equally probable reasons pro and con, a person is bound to keep the law if he has been bound to it hitherto, for the law is in possession. (3) In a doubt when the reasons for the obligation of the law are considerably more probable than those for liberty, the law must be kept.

Collected editions of St. Alfonso Liguori's works have been published in Italian, French, German, Dutch and English. For bibliographies, *see* M. de Meulemeester, *Bibliographie générale des écrivains Rédemptoristes,* three volumes (1933–39) and *Histoire sommaire de la Congrégation du Très-Saint-Rédempteur* (1950); as well as A. Sampers, "Bibliographia Alphonsiana," *Spicilegium Historicum C. SS. R.*, pp. 248–271 (1953).

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(RA. J. M.; F. J. C.)

LIGURIA, the smallest of the regions of Italy, is composed of the provinces of Genova, Imperia, La Spezia and Savona. Area 5,410 sq.km. (2,089 sq.mi.). Pop. (1961) 1,735,349. Liguria is shaped like a semicircle, reaching from the mouth of the Roia river to that of the Magra and from the French-Italian frontier to Tuscany. It is dominated by the Maritime Alps as far as the Cadibona pass and by the Ligurian Apennines east of that point. The narrow, picturesquely indented coastal fringe, the Italian Riviera, is customarily divided into a western section, the Riviera di Ponente, and an eastern section, the Riviera di Levante, the point of division being the apex of the Ligurian arc at Voltri. Most of the population is concentrated within this coastal area.

Because of the shelter from the winter winds afforded by the Alps and the Apennines, Liguria is particularly favoured in the production of early vegetables, flowers (especially in the westernmost section), olives and wine. Industries are concentrated in and around the city of Genoa, around Savona and along the shores of the Gulf of La Spezia. Genoa and La Spezia (*qq.v.*) contain the leading shipyards of Italy, and La Spezia is Italy's major naval base. Iron and steel and machinery are produced in Savona, Imperia (*qq.v.*) and Genoa; chemicals and petrochemicals at Genoa and at Vado outside Savona. Textiles and food industries are located in nearly all the major cities. Not least among the region's sources of income is the tourist trade, and there are numerous resorts scattered all along the coast.

The main railroad lines connect Genoa with Nice and Marseilles in France to the west, with Pisa and Rome to the southeast and with Milan, Turin and Switzerland to the north. An automobile toll road runs from Genoa to the Po valley. Genoa leads all Italian ports in volume of passenger and freight traffic.

Liguria, which derived its name from its pre-Roman inhabitants, came under the domination of Rome in the 1st century B.C. After short periods of Lombard and Frankish rule during the middle

ages, Genoa began to emerge as a leading power as early as the 11th century. By 1400 Genoa had not only gained control of the entire region but had become one of the principal maritime powers of Europe. Its commerce extended throughout the seas surrounding Europe, and it maintained permanent outposts as far east as the Crimea.

Throughout this period Genoa was involved in numerous conflicts with its competitors, especially Venice. It fell under foreign rule during the late 15th century but was restored to independence by Andrea Doria in 1528. Among its many outstanding seamen, Christopher Columbus was perhaps the most famous. Genoese independence came to an end under Napoleon I, and the congress of Vienna, in 1815, gave Liguria to Piedmont. During the Risorgimento, Liguria played a leading part in Italian affairs and, with Piedmont, contributed significantly to the union of Italy in 1860.

See also LIGURIANS; ITALY; and references under "Liguria" in the Index. (G. KH.)

LIGURIANS. The Liguri of ancient times, mentioned by Hesiod, are said in other classical sources to have made up the indigenous population of the northwestern Mediterranean coast from the mouth of the Ebro river in Spain to the mouth of the Arno river in Italy. It is a very difficult problem to decide who the Liguri were and also to differentiate them on the Spanish side from indigenous Iberians (*q.v.*). Much that has been written about them is based upon the evidence of place names, especially the distribution of roots ending in *-asc, -esc, -osc* which are common in the west of Liguria but also occur outside the true Ligurian area; *e.g.,* in the Basque provinces of northern Spain.

In the earliest historical period, "Liguria" referred to an area where in the Early Iron Age Hallstatt culture there was great similarity in the Urnfield pottery and metal types (including a peculiar razor type) between Catalonia, Languedoc, Roussillon, southern Switzerland and northern Italy, through all of which burial in flat graves was prevalent. It has been argued that it was to this Early Iron Age cultural unity that the Greeks applied the ethnic name "Liguri" although the objection can be raised that this identity in Urnfield types no longer applied at the period of the first Greek settlements.

The affinities which exist between the peoples stretching from the Pyrenees to the Arno in prehistoric times are Neolithic rather than Iron Age, and it is probable that the Urnfield elements of the Early Iron Age left the indigenous ethnic stratum undisturbed. This stratum was basically a Neolithic one, and it is to this or rather to types of Neolithic culture in this area that archaeologists are now apt to apply the ethnic term "Ligurian." This Neolithic mode of life continued in village settlements in remote places despite intrusive Celtic elements of later Urnfield invasion, and it was probably to loose political groupings of these people that classical authors attach the name. Rough handmade pottery with finger-impressed decoration of basically Neolithic type has been found in the lowest levels of the Greek city of Ampurias in Spain and of the southern French Celtic fortresses of Ensérune and Cayla de Mailhac, at both of which Iberian influence was strong from the 5th century B.C. onward.

No texts speak of Ligurians (or of Iberians for that matter) in southern Gaul as nations, or attribute definite racial characteristics to them. Ancient authors (Strabo, iv, 6, 2 ff.; Diodorus Siculus, v, 39) describe them as a rough and strong people whose piracy the Romans deplored. These, however, are late texts and refer to the celticized Ligurians (Celtoligures) between the Rhône and the Arno rivers. Strabo tells us distinctly that they were of a different race from the Gauls or Celts, and Diodorus mentions that they lived in villages and made a difficult living from the rocky mountainous soil.

Their boldness caused them to be in great demand as mercenaries. They served Hamilcar in 480 B.C. and the Sicilian Greek colonies in the time of Agathocles and openly sided with Carthage in the Second Punic War. Not until 180 B.C. were steps taken for their final reduction by Rome, when under the proconsuls P. Cornelius Cethegus and M. Baebius 40,000 Ligurians were deported to Samnium and settled near Beneventum (Benevento).

Stretching from Gaul to Etruria, Liguria was made the ninth division of Italy by Augustus and contained the following tribes: the Friniates on the northern slopes of the Apennines, the Briniates and the Apuani in the Vara and Magra valleys respectively, the Genuates around Genoa, and the Veturii to the west of these, the Vediantiti around modern Vence, the Intemelii whose capital was Albium Intemelium (modern Ventimiglia) and the Ingauni whose capital was Albium Ingaunum (modern Albenga). North of the Apennines there were lesser tribes, the Vagienni around Augusta Vagiennorum (modern Bene), the Statielli around Aquae Statiellae (modern Acqui). The Taurini near modern Turin and many other tribes listed by Pliny and Livy were also considered Ligurians.

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LI HUNG-CHANG (1823–1901), Chinese statesman who symbolized Confucian China's inability to adjust to the modern western-dominated world. For 25 years after 1870, he was governor-general of the northern metropolitan province of Chihli but even this long and able tenure of the highest provincial post in the Ch'ing (Manchu) system did not prevent increasingly damaging military defeats which hastened the final collapse of the dynastic system (1911).

Born in Ho-fei, Anhwei, on Feb. 15, 1823, Li received the prescribed Confucian education, and first won recognition for his part in the suppression of the T'ai p'ing rebellion (1850–64). But the dynasty had other enemies and after Li became Chihli governor-general he was continuously engaged in diplomacy, trying to parry the demands of Great Britain, France, Russia and particularly Japan, whose modernization, like China's, had started only in the 1860s. Yet he had to see or report defeats by the French (war of 1884–85), the Japanese (war of 1894–95), and the western powers and Japan (after the antiforeign Boxer uprising of 1900).

In this quarter-century Li laboured to enhance China's strength. He modernized his army with products of his new arsenal at Tientsin and equipped his northern fleet with purchased late-model European warships, showing a respectable force by the 1890s. Yet Li was an official in a decentralized system, under Manchu domination, and the complex politics of dynastic decline encouraged him to treat these forces almost as personal possessions. Thus he managed not to send in his fleet when France attacked South China in 1884–85. Conversely, he was not able to unify the other new provincial fleets and arsenals into a single force, and so in turn had to send his demoralized northern fleet into unsupported action against Japan in the 1890s. His commercial ventures, which included shipping and mining, were similarly vitiated by a mixture of personal and official concerns. In a word, China's late 19th-century modernization, designed to save the dynasty and the traditional life, was disastrously hampered by institutional contradictions, which are nowhere better illustrated than in Li's unprecedented career. He died on Nov. 7, 1901.

See the entry for Li Hung-chang in A. W. Hummel (ed.), *Eminent Chinese of the Ch'ing Period,* 2 vol. (1943–44). (J. L. RN.)

LILAC, any shrub of the genus *Syringa,* family Oleaceae. The genus contains more than 25 species of ornamental hardy deciduous shrubs and trees, native in eastern Europe and temperate Asia. They have opposite, generally entire leaves and large panicles of small regular flowers, with a bell-shaped calyx and a four-lobed cylindrical corolla, with the two stamens characteristic of the family attached at the mouth of the tube.

The lilacs are among the commonest and most beautiful of fragrant, spring-flowering shrubs. Scores of fine varieties, some with double flowers, have been developed, mostly in France, and are preferred by many to the common lilac.

The common lilac (*S. vulgaris*) is said to have come from Persia in the 16th century, but is doubtfully indigenous to Hungary, the borders of Moldavia, etc. Two kinds of *Syringa,* viz., *alba* and *caerulea,* are figured and described by John Gerard (*Herball,* 1597); these he calls the white and the blue pipe privets. The

white is the common privet, *Ligustrum vulgare,* which, with the ash tree, *Fraxinus excelsior,* is the only member of the family found wild in Great Britain. The blue pipe privet is the lilac, as both figure and description agree accurately with it. It was carried by the European colonists to northeast America and is widely grown in gardens of Canada and the northern and central United States.

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LILAC (SYRINGA VULGARIS)

The Persian lilac of gardens (*S. persica*), also known as the Chinese or Rouen lilac, a small shrub four to six feet high with intense violet flowers appearing in May and June, is much cultivated for ornament. Of other species, *S. josikaea,* from Transylvania, has scentless bluish-purple flowers; *S. emodi,* a native of the Himalayas, is a handsome shrub with large ovate leaves and dense panicles of purple or white strongly scented flowers.

Lilacs grow freely and flower profusely in almost any soil and situation, but when neglected are apt to become choked with suckers, which shoot up in great numbers from the base. These should be removed to promote better growth, and the suckers used for propagation. Vigorous growth and flowering depend on adequate feeding and proper pruning. Well-rotted cow manure, applied as a four-inch deep dressing about every two years in early spring, is preferred to prepared chemical fertilizers, which tend to induce woody vegetative growth at the expense of flowering shoots. Flower buds set in the autumn. Flower clusters produced in the spring should be removed when they fade. Powdery mildew, a common disease of lilacs, produces a grayish to whitish powder on the leaves; fungicidal sprays, applied during early spring growth, afford control.

Notable collections of lilacs are found at Rochester, N.Y., at the Arnold arboretum, Jamaica Plain, Mass., and at Swarthmore college, Swarthmore, Pa. In 1953 the U.S. Lilac Survey committee issued *Lilacs for America,* which lists all the varieties of *S. vulgaris*.

Syringa is also a common name for the mock orange, which are unrelated shrubs of the genus *Philadelphus* (*q.v.*). (N. Tr.)

LILBURNE, JOHN (1614–1657), English republican and leader of the extremists known as the Levellers (*q.v.*), was born at Greenwich in 1614. After an early apprenticeship to a London cloth merchant he soon joined the subversive opposition to the church policy of Charles I's personal rule (1629–40), helping to smuggle in and circulate pamphlets printed in the Netherlands. For this he was tried by the Star Chamber in 1638, fined £500, whipped, pilloried and imprisoned until he submitted. He even used the pillory as a pulpit until he was firmly gagged. Lilburne remained in prison until the Long parliament liberated him in Nov. 1640, when Oliver Cromwell spoke for him. On the outbreak of the Civil War Lilburne was commissioned as a captain in the parliamentarian forces. Taken prisoner at Brentford his life was saved when parliament threatened reprisals if he were not spared and exchanged. When he resigned in April 1645 rather than take the Covenant, Lilburne had risen to the rank of lieutenant colonel.

Thereafter his career was fused with the history of the Levellers. He wrote quantities of pamphlets but his special contribution was his vindication of the legal rights of Englishmen, for which he gained the nickname "Free-born John." He quoted Sir Edward Coke almost as often as the Bible and was even criticized by his fellow Levellers William Walwyn and Richard Overton for attaching exaggerated importance to Magna Carta. Finally Lilburne took the view that the existing law and constitution were inadequate to defend the birthright of Englishmen. He proposed manhood suffrage and extensive reform of the law; past laws were justified only if they harmonized with reason. Thus he rejected the common-law appeal to precedent and custom.

Lilburne was fierce in his criticism first of the Presbyterian parliament and then of the army's Independent leaders for failing to meet the Levellers' demands. Often arrested, his popularity ensured his acquittal by juries. He even insisted, when on trial in Oct. 1649, that juries were judges of law as well as fact, while the judges were a Norman innovation. Banished by parliament in 1652, Lilburne returned in 1653 after the dissolution of the Rump. He was put on trial and his acquittal by a London jury led to a great popular demonstration which affected the army and alarmed the government. He was therefore kept in prison until 1655 by which time he had become a Quaker and was prepared to offer security for his good behaviour.

Lilburne died at Eltham in Kent on Aug. 29, 1657.

See M. A. Gibb, *John Lilburne the Leveller* (1947).

LILIACEAE, the lily family of plants, containing about 240 genera and 4,000 species, many of economic importance. The family includes plants of highly diverse appearance but of basically similar flower structure. Most Liliaceae are perennials that grow from bulbs (tulip, hyacinth, onion) or rhizomes (asparagus, lily of the valley); some are shrubs (butcher's-broom); some are vines, either herbaceous (glory lily) or woody (cat brier); and a few are treelike (Joshua tree).

The lily family is cosmopolitan. The majority of species is found in temperate and subtropical regions, although some representatives occur as far north as northern Greenland (*Tofieldia coccinea*) and as far south as Tierra del Fuego (*Luzuriaga marginata*). Liliaceae are especially plentiful in South Africa, which has 60 genera and approximately 1,000 species. About 60 genera occur in North America north of Mexico. California alone has about 25 genera and 120 species. Twenty genera and almost 40 species are found in the British Isles.

Some Liliaceae are well-known garden ornamentals, including the true lily (*Lilium*); crown imperial (*Fritillaria imperialis*); Mariposa lily (*Calochortus*); glory-of-the-snow (*Chionodoxa*); day lily (*Hemerocallis*); plantain lily (*Hosta*); hyacinth (*Hyacinthus*); grape hyacinth (*Muscari*); lily of the valley (*Convallaria majalis*); star-of-Bethlehem (*Ornithogalum umbellatum*); scilla (*Scilla*); tulip (*Tulipa*); and foxtail lily (*Eremurus*). Some Liliaceae are chiefly greenhouse subjects, such as the African lily (*Agapanthus africanus*); St. Bernard's lily (*Anthericum liliago*); gasteria (*Gasteria*); ti (*Cordyline terminalis*); and butcher's-broom (*Ruscus aculeatus*). Bowstring hemp or snake plant (*Sansevieria*) and cast-iron plant (*Aspidistra elatior*) are popular house plants.

Food plants that are members of the Liliaceae are asparagus (*Asparagus officinalis*), onion (*Allium cepa*), chives (*Allium schoenoprasum*), leek (*Allium porrum*) and garlic (*Allium sativum*). Of the several fibre plants in the family the most important are New Zealand hemp (*Phormium tenax*) and bowstring hemp. Some of the drugs obtained from liliaceous plants include aloes, the dried juice from various species of *Aloe,* used mainly as a purgative; colchicum, the dried corm of the meadow saffron or autumn crocus (*Colchicum autumnale*), used in the treatment of rheumatism and gout; and red squill, the dried inner bulb scales of the sea squill (*Urginea maritima*), used as an expectorant and stimulant and also as a rat poison. Colchicine, an alkaloid derived from *Colchicum,* is used by plant breeders in the production of new varieties of plants. Sarsaparilla, a flavouring in certain beverages and medicines, is extracted from the roots

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PLANTAIN LILY (HOSTA ELATA), ONE OF THE MANY SPECIES OF LILIACEAE

of several tropical American species of *Smilax*. Acaroid resin or "gum accroides," used in varnishes, sizing and inks, is obtained from several species of grass trees (*Xanthorrhoea*) of Australia. Socotra dragon's blood, another resin, comes from the dragon tree (*Dracaena cinnabari*) of Socotra and is used mainly as a pigment.

A few Liliaceae are weedy plants. In localities where wild onions and leeks are common, cattle may graze upon them and yield milk with an off-flavour. Cat brier (*Smilax rotundifolia*) and saw brier (*Smilax glauca*), which are prickly woody vines, may form impenetrable thickets in woods, clearings and abandoned fields. Some Liliaceae are poisonous. In western United States, species of death camas (*Zygadenus*) may cause serious losses among stock that graze upon them. Also poisonous to stock are bunchflower (*Melanthium virginicum*), fly poison or stagger grass (*Amianthium muscaetoxicum*), false hellebore (*Veratrum viride*), meadow saffron, grass trees and several south African species of *Ornithogalum*. Hyacinth bulbs caused acute purgation and eventual death in cattle when used as feed during World War II in Holland. All parts of lily of the valley are poisonous if eaten.

Most genera of Liliaceae have a limited distribution. Many are confined to Australia, South Africa, southern and western United States, Mexico and western Asia. In contrast, some genera (*e.g., Smilax, Tofieldia* and *Allium*) have a wide distribution and are found in both the old and new worlds. Among the larger genera of the family are *Allium, Smilax, Aloe, Asparagus, Scilla* and *Lilium*. Liliaceae are dominant plants only in some desert regions, as in southwestern United States, where species of *Yucca* are characteristic; southern Africa, where large aloes may be abundant locally; and Socotra, where dragon-tree "forests" occur.

Familiar native Liliaceae in the United States are: Turk's-cap lily (*Lilium superbum*); dog's-tooth violet, adder's-tongue or trout lily (*Erythronium*); ramp or wild leek (*Allium tricoccum*); wild onion (*Allium cernuum* and other species of *Allium*); soapweed (*Yucca glauca*), Spanish bayonet (*Yucca aloifolia*); Joshua tree (*Yucca brevifolia*); Solomon's-seal (*Polygonatum*); false Solomon's-seal or false spikenard (*Smilacina racemosa*); wild lily of the valley (*Maianthemum canadense*); trillium or wake-robin (*Trillium*); red-berried bamboo (*Smilax walteri*); cat brier; ookow (*Brodiaea congesta*); death camas; and bear grass (*Xerophyllum tenax*). Some British Liliaceae are bog asphodel (*Narthecium ossifragum*); lily of the valley; Bath asparagus (*Ornithogalum pyrenaicum*); bluebell or wild hyacinth (*Scilla nonscripta*); crow or field garlic (*Allium vineale*); and meadow saffron.

For the most part, flowers of Liliaceae, which may be borne singly or in clusters, are easily recognized by their six similar petal-like perianth segments (three sepals and three petals), which in some species are united into a tube; by their six stamens; and by their three-chambered ovary, which is superior (*i.e.*, it is situated above the point of attachment of the perianth segments). Well-known members of the family whose flowers differ from this pattern include trilliums, in which the sepals and petals are distinctly unlike, and wild lily of the valley (*Maianthemum*), which has four perianth segments, four stamens and a four-chambered ovary. Liliaceous flowers are generally bisexual, containing both pistil and stamens. Among the few exceptions are *Smilax* and *Chamaelirium* (fairy wand), in which the flowers are unisexual, male and female occurring on separate plants. The fruit of Liliaceae is typically a three-chambered capsule, as in tulip and day lily; or a berry, as in Solomon's-seal and asparagus.

Leaves of Liliaceae may be clustered at the base of the plant or may be scattered along the stem alternately or in whorls. The leaves are generally parallel-veined and leaflike, although in some species they are scalelike. In certain Liliaceae the smaller branches are much flattened and are leaflike in appearance and function, as in butcher's-broom and some species of *Asparagus*. Such leaflike branches are called cladodes and can be distinguished from true leaves because each is subtended by a scale (the true leaf) and each may bear one to several flowers. The "leaves" of garden asparagus are needlelike cladodes borne in tufts.

Flowers of Liliaceae are, for the most part, insect pollinated. Insects visit some species for nectar (scilla, Solomon's-seal, onion, hyacinth, meadow saffron), others for pollen (tulip, lily of the valley, yucca). In carrion flowers (*Smilax*), herb Paris (*Paris*) and some trilliums, the flowers produce a fetid odour, like that of decaying meat, which attracts carrion-loving flies. Many Liliaceae produce rather heavy seeds that have no special adaptation for dispersal far from the parent plant. Some (*e.g.*, certain *Lilium*) have light, flat, winged seeds that are spread by wind, as are the minute seeds of *Tofieldia* and *Narthecium*. Liliaceae whose fruit is a berry are bird distributed.

Certain anatomical and morphological data indicate that the Liliaceae include a number of genera that either are not closely enough related to be placed in the same family or seem to be more closely related to families other than the Liliaceae. By some students of the problem, notably J. Hutchinson (1934), the Liliaceae are divided into several families. The segregate families recognized by Hutchinson appear, for the most part, to represent natural groups; however, they have not been accepted universally by botanists. United States and British genera transferred by Hutchinson from the Liliaceae include *Smilax*, to the smilax family (Smilacaceae); *Ruscus*, to the ruscus family (Ruscaceae); *Trillium, Paris* and *Medeola*, to the trillium family (Trilliaceae); *Allium*, to the amaryllis family (Amaryllidaceae); and *Yucca*, to the agave family (Agavaceae).

See J. Hutchinson, *The Families of Flowering Plants*, vol. 2, "Monocotyledons" (1934); K. Krause, "Liliaceae" in A. Engler and K. Prantl, *Die Natürlichen Pflanzenfamilien*, Bd. 15a:227–386 (1935).

(J. W. Tr.)

LILIENCRON, (FRIEDRICH ADOLF AXEL) DETLEV, Freiherr von (1844–1909), German writer of novels and poems largely concerned with the glory and violence of war, was born at Kiel on June 3, 1844. He served as a regular officer in the campaigns of 1866 and 1870–71, left the army because of debts in 1875 and, after spending some time in America, became a civil servant, finally being in charge of the administration in Kellinghusen in Holstein, where he remained till 1887. He had begun writing in the early 1880s and his first volume of poems (*Adjutantenritte und andere Gedichte*, 1883) attracted some attention. He lived subsequently in Munich, Berlin and Altona and finally settled in Alt-Rahlstedt near Hamburg, where he died on July 22, 1909.

Liliencron published several plays (*Die Rantzow und die Pogwisch*, 1886) and a novel (*Breide Himmelsbüttel*, 1887), but, apart from his poetry, it was on short stories that he concentrated. In several collections (*Krieg und Frieden*, 1891; *Kriegsnovellen*, 1895) he painted realistic and arresting pictures of war. His lyrical poetry exploited a new manner of conveying broad impressions without sacrificing accuracy of detail, making much use of the acoustic and nervous energy of the words in poems written on a variety of subjects—nature, battle, the life of the soldier or of the Prussian *Junker*. His feeling for the emotional tone of isolated moments of experience gives his poetry great immediacy and vividness, but it lacks any profound sense of large coherence. He achieved some success also in humorous pieces, particularly the mock-epic *Poggfred* (1896, extended 1908). His reputation stood very high for a time but later declined considerably.

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(W. D. Wl.)

LILIENTHAL, OTTO (1848–1896), German aeronautical pioneer, on whose work later, more successful engineers such as Octave Chanute and the Wright brothers drew heavily, was born at Anklam, in Prussian Pomerania, on May 23, 1848. As boys, he and his brother Gustav studied the flight of birds. Later, after graduation from the trade school at Potsdam and the Berlin Trade academy, Otto Lilienthal experimented with flying models with flapping wings and with gliders. His book on bird flight (*Der Vogelflug als Grundlage der Fliegekunst*, 1889) and his essays on flying machines (1894) were recognized as the basic works in aeronautics. Lilienthal made several hundred flights in gliders of

his design. from an artificial hill near Lichterfelde. On Aug. 9, 1896, attempting to glide from a hill in the Stollerier mountains near Rhinow, he was killed when his glider turned over in flight. *See* GLIDING: *History of Gliding Experiments.* (S. P. J.)

LILITH, a female demon of Jewish folklore, equivalent to the English vampire. The personality and name ("night monster") are derived from a Babylonian-Assyrian demon Lilit or Lilu. Lilith was believed to have a special power for evil over children. The superstition was extended to a cult surviving among some Jews even as late as the 7th century A.D. In the rabbinical literature Lilith becomes the first wife of Adam, but flies away from him and becomes a demon.

LILLE (formerly spelled L'ILE or LISLE; Flemish RYSSEL or RIJSSEL), an industrial city of northern France, capital of the *département* of Nord and of French Flanders, 160 mi. (258 km.) N.E. of Paris by rail. Pop. (1962) 199,033. Lille lies in a rich agricultural and industrial plain on the right bank of the canalized Deûle. With Roubaix and Tourcoing (*qq.v.*) it forms one of the largest urban agglomerations in France, a continuously built-up and expanding area with a population of about 750,000.

Lille is the headquarters of the I army corps and has an *enceinte* and a pentagonal citadel, one of Vauban's finest works (the "queen of citadels," he said), west of the city, across the Deûle. With its barracks and arsenal, the citadel is surrounded by a park. Before 1858 the town, fortified by Vauban about 1668, occupied an elliptical area of about 2,500 by 1,300 yd., with the church of Notre Dame de la Treille in the centre. At that time, however, the southern ramparts and ditches were replaced by the Boulevard de la Liberté, a straight line from the freight railway station to the citadel. The area of the town was thus more than doubled. Eventually, as the city expanded toward Roubaix and Tourcoing, the three became one great conurbation.

At the demolition of the southern fortifications, the Paris gate, erected in 1682 to the design of Simon Vollant in honour of Louis XIV and at his expense, after the conquest of Flanders, was preserved. On the east are the Ghent (1617) and Roubaix (1622) gates, in Renaissance style, in bricks of different colours. The city's churches possess valuable pictures (including an important Rubens in the church of St. Catherine), and the modern cathedral of Notre Dame de la Treille has a statue of the Virgin which is an object of pilgrimage. Lille was made a bishopric in 1913. The Vieille Bourse (17th century) separates the Place du Théâtre and the present Place du Général de Gaulle (who was born at Lille). The Hôtel d'Aigremont, the Hôtel Gentil and other houses are in the Flemish style. The Palais des Beaux-Arts contains a museum and an art gallery, the latter among the richest in France. During World War I, damp (caused by lack of heating) and deterioration of the glass casings resulted in damage to some of the canvases. Throughout World War II great precautions were taken to safeguard the museum's treasures, and there was almost no damage. The large military hospital was once a Jesuit college.

Lille is the seat of a prefect and has tribunals of first instance and of commerce, a commercial arbitration council, a chamber of commerce and a branch of the Bank of France. It is the seat of an *académie* and has a university (established 1887) with faculties of laws, letters, science and medicine and pharmacy, and a number of affiliated institutes. There are also the Catholic University of Lille, a national technical school, schools of music and fine arts, and the industrial and Pasteur institutes.

Lille, with Roubaix-Tourcoing and Armentières, is one of the world's great textile centres. The spinning of flax thread for sewing and lacemaking is specially connected with Lille, and the city has flax, hemp, jute, cotton and woolen mills. There are important iron and steel works and manufactures of locomotives and textile machinery; chemical industries, breweries, distilleries and beet-sugar refineries are also significant.

Lille is an important railway junction, and the canalized Deûle affords communication with neighbouring ports and with Belgium. Trade is chiefly in the raw material and machinery for the city's industries, in its industrial products and in the wheat and other agricultural products of the surrounding district. An international commercial fair is held annually.

In 1030 Count Baldwin IV of Flanders surrounded with walls a little town which had arisen around the castle of Buc. In the first half of the 13th century, the town obtained communal privileges. Destroyed by Philip Augustus in 1214, it was rebuilt by Joan of Constantinople, countess of Flanders; it was besieged and retaken by Philip the Fair in 1297. After having taken part with the Flemings against the king of France, it was ceded to the latter in 1312. In 1369 Charles V, king of France, gave it to Louis de Mâle, who transmitted his rights to his daughter Margaret, wife of Philip the Bold, duke of Burgundy. Under Burgundian rule Lille prospered and its merchants were at the head of the London Hansa. Philip the Good made it his residence. With Flanders it passed from the dukes of Burgundy to Austria, and then to Spain. After the death of Philip IV of Spain, Louis XIV reclaimed the territory and besieged Lille in 1667. He forced it to capitulate, but preserved its liberties. In 1708, after heroic resistance, it surrendered to Prince Eugene and the duke of Marlborough. The treaty of Utrecht restored it to France.

In World War I, after several days' bombardment, the Germans entered the city on Oct. 12, 1914; it was occupied till Oct. 1918, when the Germans were outflanked by the Allied capture of neighbouring towns. The deportation of a large number of citizens in 1916 was the culminating point of tyranny suffered by the people of Lille under war conditions. The city was not shelled by the Allies, though it lay within range of the guns. In World War II, on the other hand, it was severely damaged by Allied air raids.

LILLEBONNE, a town of France in the Seine-Maritime *département*, 3½ mi. N. of the Seine and 24 mi. E. of Le Havre by the Western railway. Pop. (1962) 7,672. It lies in the valley of the Bolbec at the foot of wooded hills. Lillebonne—under the Romans, *Iuliobona*—was the capital of the Caletes and became an important focus of Roman roads. The remains of ancient baths and of a great theatre have been brought to light. The medieval fortifications were built of materials from the theatre. Tradition has it that William the Conqueror in 1066 decided upon the invasion of England at his château in Lillebonne. The church of Notre-Dame has a 16th-century tower and portal; the donjon of a 13th-century castle stands in the park. In the town hall is a museum of archaeology, local history, folklore and natural history. The principal industry was the spinning of wool and cotton. Between Lillebonne and the Seine river is an important petrochemical centre. (M. Yv.)

LILLIBURLERO (LILLIBULLERO), a 17th-century English political song that played an important part in driving James II from the throne in 1688. Among the many verses, two run as follows:

Dare was an old prophesy found in a bog,
Lilli burlero, bullen a-la
"Ireland shall be ruled by an ass and a dog."
Lilli burlero, bullen a-la
Lero, lero, lilli burlero, lero, lero, bullen a-la,
Lero, lero, lilli burlero, lero, lero, bullen a-la.

And now dis prophesy is come to pass,
Lilli burlero, etc.
For Talbot's de dog and Ja. .s is de ass.
Lilli burlero, etc.

Written in 1687 by Thomas (1648–1715), (afterward marquess of) Wharton, the verses were intended to discredit the administration in Ireland of Richard Talbot (1630–91), earl of Tyrconnel, after his appointment as viceroy in 1687. According to Gilbert Burnet, bishop of Salisbury, in his *History of His Own Time* (1724), "The whole army, and at last the people, both in city and country, were singing it perpetually. And perhaps never had so slight a thing so great an effect." The earliest known printed version of the tune now associated with the words appeared in Robert Carr's *The Delightful Companion* (1686), for recorder or flute. In *Musick's Hand-Maid* (1689: originally published by John Playford in 1663) it is called "A New Irish Tune" and Henry Purcell's name is subscribed, whether as composer or merely as arranger of the version for harpsichord is not clear. The words, with the tune printed above, were issued on a single sheet

in 1688; it was reprinted in a number of different collections during the next 100 years. (D. Po.)

LILLIE, FRANK RATTRAY (1870–1947), U.S. zoologist, specializing in embryology, who demonstrated that fertilization involves the interaction of specific substances borne by the egg and sperm (fertilizin theory), and that embryonic sex differentiation is controlled by sex hormones circulating in the blood between fetal cattle twins (freemartin theory). Born in Toronto, Ont., on June 27, 1870, he was educated at the University of Toronto and The University of Chicago (Ph.D., 1894). Returning to The University of Chicago in 1900, he became professor of embryology in 1906 and distinguished service professor in 1931. He served as chairman of the department of zoology (1910–31) and dean of the division of biological sciences (1931–35). Through his leadership (1908–42) the Marine Biological laboratory (Woods Hole, Mass.) was built into a research institution of international distinction.

Lillie was founder and first president of the Woods Hole Oceanographic institution. He served as president of the National Academy of Sciences (1935–39) and was awarded its Agassiz medal in 1940. His books include *Development of the Chick* (1908, 1919), *Problems of Fertilization* (1919) and *The Woods Hole Marine Biological Laboratory* (1944). He died in Chicago on Nov. 5, 1947.

For a full account of Lillie's career see *Biological Memoirs*, National Academy of Sciences, vol. 30 (1957). (B. H. W.)

LILLO, GEORGE (1693–1739), English dramatist whose tragedy *The London Merchant, or the History of George Barnwell* (1731) revived an interest in domestic themes and influenced the sentimental drama of France and Germany, was born in London, Feb. 4, 1693, the son of a Dutch jeweler. He was for many years a partner in his father's business. His first piece *Silvia, or the Country Burial* (1730), a ballad opera, was produced at Lincoln's Inn Fields. *The London Merchant*, produced by Colley Cibber at Drury Lane, is founded on "an excellent ballad of George Barnwell, an apprentice of London who . . . thrice robbed his master, and murdered his uncle in Ludlow." Lillo had gone back to the Elizabethan domestic drama of passion of which the anonymous *Yorkshire Tragedy* is a type. Scoffing critics called it, with reason, a "Newgate tragedy" but it was regularly acted for many years at holiday seasons for the moral benefit of the apprentices. The last act contained a scene generally omitted on the London stage, in which the gallows actually figured. In 1734 Lillo celebrated the marriage of the Princess Anne with William IV of Orange in *Britannia and Batavia*, a masque. His other dramas were *The Christian Hero* (1735); *Fatal Curiosity* (1736); an adaptation of *Pericles, Prince of Tyre* entitled *Marina* (1738); and *Elmerick, or Justice Triumphant* (1740).

Lillo died in London, Sept. 3, 1739. His unfinished version of the anonymous Elizabethan tragedy *Arden of Feversham* was completed by Dr. J. Hoadly and produced in 1759. His *Dramatic Works, with Memoirs of the Author by Thomas Davies* were published in two volumes, 2nd ed. (1810).

See E. Bernbaum, *The Drama of Sensibility* (1915).

LILLY, WILLIAM (1602–1681), English astrologer immortalized as Sidrophel in Samuel Butler's *Hudibras*, was born on May 1, 1602, at Diseworth in Leicestershire, and was educated at the school of Ashby-de-la-Zouch. In April 1644, he began publishing his astrological almanacs, which received serious attention from some of the most prominent members of the Long Parliament. Like all successful astrologers, he tempered the indications given by the aspects of the heavens with his knowledge of current events, with the result that his predictions often showed a sympathy with the parliament. For this reason, and because he misjudged the scientific revolution that spread so rapidly in England during the 17th century, Lilly fell into disrepute after the Restoration.

He died at Hersham, Surrey, on June 9, 1681. (O. J. E.)

LILY, WILLIAM (1468?–1522), English Renaissance scholar and classical grammarian, was born at Odiham, Hampshire, about 1468. After graduating at Oxford university he traveled in the south and east of Europe, during which time he studied Greek. He became the personal friend of William Grocyn, Thomas Linacre and Sir Thomas More. After teaching privately in London he was appointed high master of Dean Colet's refoundation of St. Paul's school (1512–22). He died in 1522.

Lily was a pioneer of Greek learning in England and one of the authors of the Latin grammar which bears his name. In 1540 Henry VIII ordered it to be used in all English grammar schools. In the Anglican canons of 1604 the bishop, when visiting a school, was directed to ask if the "Royal Grammar" was used.

Lily's Grammar was severely criticized by schoolmasters, and numerous revisions were made which corrected errors, eliminated needless complications and contributed useful additions. The most important criticism concerned the Latin syntax "by which children have been usually put upon learning the construction of a language, they were unacquainted with, from rules given them in that very language." Thus English translations of the rules and the syntax were made by William Haine of Merchant Taylors' school (1637), Richard Busby (1659) and many others. Charles Hoole published an edition in 1651 with an English translation on the left-hand pages.

Editions incorporating recognized emendations were also published at Cambridge (1634 and 1640) and at Oxford (1636 and 1687). John Ward's edition (1732) was commonly used in 18th-century English schools. Revised in 1758 and appropriated by Eton college as the *Eton Latin Grammar*, it was finally superseded ten years later by the *Public School Latin Grammar*.

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LILY, the common name applied to herbaceous flowering plants belonging to *Lilium*, the typical genus of the family Liliaceae, embracing about 80 species, all confined to the northern hemisphere and widely distributed throughout the north temperate zone. However, the word "lily" is loosely used in connection with many plants which are not really members of the genus *Lilium*, but belong to genera which are quite distinct botanically. The earliest in cultivation were described in 1597 by John Gerard, who figured eight kinds of true lilies, including *L. candidum* and a variety, *bizantinum;* two umbellate forms of the type *L. bulbiferum*, named *L. aureum* and *L. cruentum latifolium;* and three with pendulous flowers, apparently forms of the martagon lily. Parkinson, in his *Paradisus* (1629), described five varieties of martagon, six of umbellate kinds, together with one American, *L. canadense*.

The Madonna lily, *L. candidum*, was one of the commonest garden flowers of antiquity, appearing in the poets from Homer on, sharing popularity with the rose and the violet. Roses and lilies are thought to have entered Greece from the east by way of Phrygia, Thrace and Macedonia. Mythologically the white lily *Rosa junonis* (called Madonna in the late 19th century) was fabled to have sprung from the milk of Hera. As the plant of purity it was contrasted with the rose of Aphrodite.

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MADONNA LILY (LILIUM CANDIDUM), KNOWN FROM ANTIQUITY

The Greek word *krinon* (lily), on the other hand, included red and purple lilies. The red lily was that best known in Syria and Judaea, and the lily of the Old Testament may be conjectured to be a red lily from the metaphor used in Song of Solomon v, 13 ("His lips are lilies") unless the allusion is to the fragrance rather than to the colour. The "lilies of the field" (Matt. vi, 28) are quite certainly *Anemone coronaria*, the poppy anemone, which is common in Palestine where lilies are not.

True Lilies.—In North America about 20 native species of lily occur. In the eastern half of the continent the best-known are the wood lily (*L. philadelphicum*), the meadow lily (*L. canadense*), the Turk's-cap lily (*L. superbum*) and the bell lily (*L. grayi*). Noteworthy among the ten native lilies found in the Pacific states are the Washington lily (*L. washingtonianum*), the Columbia lily (*L. columbianum*) and the Humboldt lily (*L. humboldtii*). None of these American lilies compares with those from the Himalayas, Korea, China and Japan as garden plants. But many magnificent hybrid lilies were developed after 1930 on the Pacific coast by such outstanding plant breeders as E. F. Palmer and Jan de Graaff. No true lily is found native in Great Britain.

The structure of the flower represents the simple type of monocotyledons, consisting of two whorls of petallike perianth lobes, of three free parts each; six free stamens; and a consolidated pistil of three carpels, ripening into a three-valved capsule containing many winged seeds. In form, the flower assumes three types: trumpet-shaped, with a more or less elongated tube (*e.g., L. longiflorum*, the white trumpet lily, and *L. candidum*, the Madonna lily); an open form with spreading perianth leaves (*e.g., L. auratum*); or assuming a pendulous habit, with the tips strongly reflexed (*e.g.*, the martagon type). All have scaly bulbs which, in three western American species such as *L. humboldtii*, are remarkable for being somewhat intermediate between a bulb and a creeping rhizome. *L. bulbiferum* and its allies produce aerial reproductive bulbils in the axils of the leaves.

The bulbs of several species are eaten in some areas of the world. Medicinal uses were once ascribed to the species, but none appears to have any marked properties in this respect. From *L. longiflorum* was developed in Oregon the Croft lily, the commonest Easter lily in the United States.

The noble *L. auratum*, with its large white flowers, having a yellow band and numerous red or purple spots, is a magnificent plant when grown to perfection; and so are the varieties called *rubrovittatum* and Crimson Queen, which have the central band crimson instead of yellow, and the broad-petaled *platyphyllum* and its almost pure white subvariety called *virginale*. Of *L. speciosum*, the Japanese lily (well known to most gardeners as *lancifolium*), the true typical form and the red-spotted and white varieties are impressive plants for late summer blooming.

The tiger lily, *L. tigrinum*, and its varieties *fortunei, splendens* and *plenescens* are among the best species for the flower garden.

The pretty *L. leichtlinii* and *L. monadelphum*, with drooping yellow flowers, and the scarlet droop-flowered *L. tenuifolium* comprise, with those already mentioned, a series of the finest hardy flowers of the summer garden. The Indian *L. giganteum* is distinct in character, having broad heart-shaped leaves and a noble stem 10 to 14 ft. high and bearing a dozen or more large, deflexed, funnel-shaped, purple-stained white flowers; *L. cordatum* (China and Japan) is similar in character, but shorter stemmed.

The cultivation of lilies is not difficult if the gardener keeps in mind a few essentials. Nearly all of them tend to die out in a few years and should therefore be replaced by fresh plantings. They are rich feeders and should only be planted in rich garden loam, with a layer of well-rotted manure well below the bulb but never touching it. Many species, notably *L. hansonii* and *L. henryi*, prefer partial shade to full sun. Drainage must be perfect because they will not stand stagnant water over the winter. If rodents (which eat the bulbs) are a pest, bulbs should be planted in underground wire cages.

In planting (except for *L. candidum*, which should be planted shallowly) the bulbs should be planted at least three times their height below the surface, so that stem roots which develop above the bulb will be in the soil. If a bulb is 3 in. high, its base, when planted, should be 9 in. below the surface. All lilies respond to a winter mulch of manure about 1½ in. thick. Tall sorts must be staked if the site is windy.

Other Lilies.—The Lent lily is a *Narcissus;* the African lily is *Agapanthus africanus*, the belladonna lily is *Amaryllis belladonna* (*see* AMARYLLIS); the Jacobean lily is *Sprekelia formosissima;* the mariposa lily is *Calochortus;* the Peruvian lily is *Alstroemeria;* St. Bernard's lily is *Anthericum liliago;* St. Bruno's lily is *Paradisea liliastrum;* the water lily is *Nymphaea;* the giant water lily of the Amazon is *Victoria regia* (*q.v.*); the arum lily is *Zantedeschia aethiopica;* and there are many others, among them the day lilies (*Hemerocallis*).

See also references under "Lily" in the Index.

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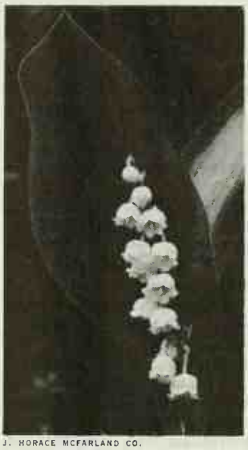
LILY OF THE VALLEY



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LILY OF THE VALLEY (CONVALLARIA MAJALIS)

(*Convallaria majalis*), a beautiful plant of the lily family (Liliaceae), native to woods in some parts of England, Europe, northern Asia and possibly in the higher Allegheny mountains from Virginia to Tennessee, although the American plant is thought by some to be *C. montana*, an endemic species.

It is widely cultivated for its dainty, white, nodding, fragrant flowers, borne in spring on slender stalks, which, like the two oblong basal leaves, rise from an underground creeping stem, or rootstock. On these underground stems arise small detachable buds, commonly called pips. These, if planted about 1½ in. deep, preferably in the shade, represent the easiest way to start a planting and may also be forced for indoor blooms in winter. Variegated-leaved, double-flowered and pink horticultural varieties are available. (N. TR.)

LIMA, a department in central Peru bounded on the southwest by the Pacific ocean, on the northwest by Ancash, on the northeast by Huánuco, Pasco, Junín and Huancavelica and on the southeast by Ica. The northeastern border of the department is drawn along the westernmost range of the Andes, which forms the continental divide. Area 13,087 sq.mi. Pop. (1961) 2,319,231. The capital is the city of Lima, pop. (1961) 1,715,971.

Along the coast there is seldom any rain at all. At Lima the average annual rainfall is 1.8 in., yet many years pass with no recorded rainfall. Temperatures along the coast are mild, averaging between 16° C. (61° F.) in August and 23° C. (74° F.) in February. Only where rivers descend from the Andes can there be irrigation. The five chief rivers—the Chancay, Huaura, Mala, Rímac and Cañete—are all short and only the last two, which rise in snow fields among the highest peaks, have a year-round flow of water to the ocean.

The coast is peculiar in that a thick cloud rests over it, especially from June to October. This cloud is in contact with the mountain slopes from about 2,500 ft. to 4,000 ft. above sea level and there, in the fog zone, is a lush growth of herbaceous annuals known as *loma*, on which cattle can be fed. Above the zone of lomas there is a regular rainy season from October to April.

Outside the great urban concentration of Lima and Callao (*qq.v.*) most of the people work as farmers and herders. Cattle destined for the market in Lima are driven up and down the mountain slopes to feed on the vegetation as it turns green with the rainy season or the fog season. The lomas provide pasture from June to October and the high mountain grasslands are green from October to April. From April to June cattle are fed on hay grown under irrigation. Other crops of the irrigated lowlands include

sugar cane, cotton and a variety of vegetables.

There is some fishing off Callao and Huacho, but not nearly so much as the wealth of fish life would support. Salt is produced from the evaporation of sea water at Huacho and Chilca. In the mountains there are copper mines at Casapalca, and coal mines at Oyón. The department is crossed from northwest to southeast by the Inter-American highway and is connected with the highland centres by both rail and highway.

(P. E. J.)

LIMA (a corruption of RÍMAC), capital and largest city of Peru and of the department of Lima, is situated on the Rímac river adjacent to its seaport Callao (*q.v.*). In the desert coastal zone, nearly 500 ft. above sea level, Lima is surrounded by an irrigated plain, out of which rise, here and there, rugged crystalline hills, among them San Cristóbal (1,343 ft.) just east of the city. Pop. (1961) 1,715,971.

Lima has grown enormously in area and in population in the 20th century and now covers more than 30 sq.mi. in a great triangle 8 mi. east and southeast of Callao and overlooking the Pacific. Most of the city lies south of the Rímac, the hilly terrain restricting growth on the north. This expansion has taken place on the great cone of alluvial deposition, the gentle slopes of which are truncated by the Pacific. In the pink cliffs so formed, the sand, clays and pebbles are evidence both of the plain's formation and of the fertility of the lands within and surrounding the city.

The climate is equable, the cool Humboldt current considerably reducing temperatures usually experienced in Lima's latitude. Winter temperatures rarely fall below 12° C. (54° F.) and those of summer seldom rise above 27° C. (80° F.). Rainfall averages between one and two inches annually, occurring in the form of sea mists from May to November. The long periods of overcast sky retard both insolation and radiation and prevent the extremes usually associated with desert climates.

History.—Lima was founded as the "City of the Kings" by Francisco Pizarro on Jan. 18, 1535, on the south bank of the Rímac. He traced the outlines of the chief plaza (Plaza de Armas) and the rectilinear plan of streets with built-up blocks and open plazas at intervals, a pattern which still survives. On the same day, he laid the cornerstone of the cathedral, consecrated in 1625, where his remains are preserved. The first archbishop was appointed in 1545. Lima became the luxurious capital of the Spanish viceroys, the first of whom arrived in 1544. By a grant from Charles V, the University of San Marcos, the first university in South America, was founded in 1551.

Lima thus became the focus of Spanish colonization in South America, the heart of Spanish power in the New World and the headquarters of the mercantile control system on the Pacific coast. As vast wealth from the mines accumulated, the city was embellished with elaborate balconies and carved stone portals, while churches and monasteries glittered with gold and silver. Stone bridges were built across the Rímac; one constructed in 1610 is still standing. Meanwhile, for protection against attacks by foreign pirates, the Duke of La Palata (viceroy 1681–89) built the city walls which stood until 1870, when they were razed and replaced by the present boulevards. Much of Lima was destroyed by an earthquake on Oct. 28, 1746, and little in the present city antedates that catastrophe.

During Latin America's struggle for independence Lima was the centre of Spanish resistance, and even after Peru's independence was declared (1821), the city remained rigidly conservative. The period of reconstruction was followed by a great influx of money from exploitation of the guano deposits on the coastal islands. This resulted in some public improvements, such as the railway to Callao (1851), a lighting system, and a water supply from the Andes. Following Peru's defeat by Chile in the War of the Pacific, Lima was occupied by a Chilean army from Jan. 17, 1881, to Oct. 22, 1883, and many public buildings and scientific, literary and artistic collections were pillaged.

FOTO BOCZ FROM "ANDEAN AIR MAIL AND PERUVIAN TIMES"

MINISTRY OF EDUCATION BUILDING
One of the tallest structures in Lima

The spectacular modern growth of the city, whereby it has spread over an area 15 times that of the old colonial town, is based on the rise of industry; the growth of its administrative, commercial and transportation functions; and a very large natural increase of its population. In addition it is estimated that 25,000 people immigrate into the capital annually from other parts of Peru. In the process of Lima's expansion south and west of its colonial nucleus, several settlements, such as Magdalena, Miraflores, Barranco and Chorrillos, have been absorbed, and Callao has become a part of Greater Lima.

Urban Regions and Principal Buildings.—The core of the old city, south of the Rímac, still remains the functional centre of the capital. Planned around the Plaza de Armas it includes the government palace, the national library, the city hall, the archbishop's palace, the cathedral and four of Lima's finest churches: La Merced, Santo Domingo, San Francisco and San Pedro. Within this part of the city are preserved many of the narrow streets of the original checkerboard plan, arcaded shops, shady parks and colonial houses with inner patios. Now, however, they share the heart of Lima with skyscrapers, modern banks, hotels, government office buildings and commercial offices. The 20-story skyscraper housing the ministry of education, immediately adjacent to the old University of San Marcos, dramatically symbolizes this curious blend of old and new. It also vividly emphasizes the fact that the advent of reinforced concrete has overcome the building restrictions formerly handicapping a city in an earthquake zone. The Torre Tagle mansion, now the Foreign office, with its fine wood carving and wrought ironwork, is the best remaining example of secular colonial architecture. Many of the churches also contain interesting relics of Peru's historic past. The church of San Pedro, for example, has the tombs of several viceroys, and its 16th-century bell was rung on the day that Peru's independence was declared. The old city nucleus, bounded by the Abancay, Tacna and Colmena avenues and the Rímac on the north, is also the communications centre of Lima; streetcar and bus lines radiate from it, and it is also the site of the Desemparados station of the Central railway, which adjoins the river. Each street in this section, several blocks long and known as a *jirón,* is named after one of the departments of Peru.

North of the Rímac there survives another part of old Lima, which was predominantly an area of aristocratic residences in the 18th and 19th centuries; many plaster-covered adobe houses with barred outer windows and flower-decorated balconies now line the streets. The Alameda de los Descalzos, at the foot of Cerro Cristóbal, a tree-shaded avenue laid out in 1610 and leading to the monastery of discalced friars, is a favourite promenade for the humbler citizens who now reside in this area north of the river.

At the southern limit of the old city is Plaza San Martín and, a short distance beyond, the circular Plaza Bolognesi, each containing a statue of the national hero for whom it was named. From these plazas radiate many wide concrete-paved avenues to the west and south, lined by delightful promenades. One of these, the Paseo Colón, 1 mi. long and 150 ft. wide, with a statue of Columbus, is bordered by trees, flowers and beautiful residences. At one end of this avenue is Exhibition park, 30 ac. of gardens, walks, artificial lakes, the national museum and a zoological garden.

The great arterial roads to the south spread out in a fanlike manner and reach the residential suburbs of San Isidro and Miraflores, with their modern villas, irrigated gardens and open spaces. Still other zones of residential expansion stretch toward the airport at Limatambo on the eastern fringe of the urban area and adjacent to the foothills of the sierra and the maize and cotton fields of the Lima plain.

The coastal districts of Magdalena, Barranco and Chorrillos at

the southern and southwestern extremities of the Lima urban area are examples of the "neighbourhood units" set up by the National Housing corporation. They are collective housing estates constructed of brick, cement and adobe accommodating many tens of thousands of Lima's middle-class citizens. On the seaward side extend the beaches and residential resorts which provide a recreational oasis for Lima's large population.

A relatively new feature, originating during the period after World War II, is the development of slum quarters in the northern foothills and along the Rímac terraces, consisting of shacks of every conceivable construction, known as *barriadas*. Many are inhabited by Indians from the sierra.

Cultural Institutions and Services.—The University of San Marcos has faculties of theology, law, medicine, arts and economics, and although some of its old buildings survive in the city centre, the new campus between Lima and Callao is a modern university city. There are also a Roman Catholic university; a school of engineering and mines; an agricultural college; military, naval and air academies; and a wide range of other educational institutions training students for commerce, teaching and arts and crafts. In addition to a well-developed state educational system of primary and secondary schools, there are schools of high reputation maintained by the British and American communities in Lima, along with many other private and convent schools.

Lima is well-endowed with museums, which include collections of Peruvian antiquities, arts, costumes and paintings of scenes and characters in national history. The Museum of the Republic is housed in a palace of the viceroys which was later the home of José de San Martín and Simón Bolívar, while the Museum of Anthropology and Archaeology contains a representative collection of the material culture of Peru's prehistory. The national library, founded by San Martín in 1821 and destroyed during the Chilean occupation of 1881–83, was razed by fire in 1943, destroying the library's valuable collection of some 120,000 volumes. A new building on the same site was opened in 1947. Learned societies include the national academy of medicine (1885); the Athenaeum, founded (1877) as a literary organization; the Historical institute (1905); and the Geographical society (1888), which includes a library, map room, museum and seismological observatory. The city is also an important publishing centre, and *El Comercio* (1839) is one of the oldest newspapers in South America.

Many of the city's parks provide athletic facilities, and in the Campo de Marte there is an auditorium used by the national symphony orchestra for public concerts. The national stadium, with a seating capacity of 70,000, is the nation's leading football arena, and country clubs, horse racing tracks and golf courses are other recreational facilities. Bullfighting is a popular spectator sport.

In the 20th century increasing attention has been paid to the provision of medical facilities, and modern social insurance hospitals of impressive size and design have been built in the city. There are also several hospitals maintained by charity and private organizations.

Trade, Industry and Finance.—Lima's acquisition of important industries is a development of the 20th century, and today the city has by far the largest industrial concentration in Peru, accounting for nearly 70% of the nation's industrial income. The industries are extremely varied, embracing woolen and cotton textiles, tanneries and factories producing leather goods, furniture, clothing, foods, beverages, and a great variety of consumer goods such as aluminum utensils, soap, cigarettes, glassware and silverwork. Foundries, cement works, motorcar assembly plants and oil refineries are also important.

Although there are isolated factories in the north and south of the city, most of the industrial sections of Lima lie in a five-mile band of territory between the capital and Callao. This permits them to utilize both the imports entering through the latter port and the labour supply of the metropolis, as the zone is served by three main roads and a railway. Oil-generated and hydroelectric power is relatively abundant for industrial development.

Nearly all commercial, banking and industrial firms involved in Peruvian business have their headquarters in the capital. The five principal banks are the Continental, Popular, Lima, National City and Credit Bank of Peru, the three latter being supported by French, United States and Italian capital, respectively.

The city also dominates Peruvian communications. The airport at Limatambo is one of Latin America's finest and plays an important role in national and international links within the continent. About 60% of Peru's motor traffic is based in the capital, and Lima is the great consuming centre for most of the imports arriving by way of Callao. Its administrative, professional and religious functions also provide employment for a great proportion of its population.

The rapid growth of the city has confronted Lima with many grave problems, among which the more important are traffic congestion, especially in the heart of the city, inadequate housing accommodation, the provision of sufficient schools (20% of Lima's population is of school age) and increasing demands upon such urban facilities as water supply and public transport.

(G. J. B.)

LIMA, a city of northwest Ohio, U.S., is located on the Ottawa river (Hog creek), 79 mi. S.S.W. of Toledo; the seat of Allen county. The site was designated by state law in 1831, and its name was chosen by lot, the last to be drawn from a hat. It was incorporated in 1842.

Lima became the centre of the northwest Ohio oil fields in the 1880s and 1890s, especially after scientists discovered a commercially profitable method of removing the oil's sulfur content, and peak annual output once surpassed 20,000,000 bbl. As production diminished in the 20th century, Lima became the centre of a pipeline system operated by six major oil companies from fields in Wyoming, Texas and Oklahoma and supplying the Great Lakes and east coast.

Lima's factories manufacture machine tools, automotive engines, aircraft parts, power shovels and cranes, quarry and road-building equipment, cigars, electric and neon signs, enamelware, steel castings, school and highway buses, hearses, electric motors, rubber, petroleum products and chemicals. It is also the centre of a diversified agricultural area producing grain, soybeans, sugar beets, potatoes, and dairy, poultry and meat products. Nearby are Indian Lake, Lake St. Mary's and Ft. Amanda State parks. Pop. (1960) 51,037; standard metropolitan statistical area (Allen county) 103,691. For comparative population figures *see* table in Ohio: *Population.* (R. C. Do.)

LIMAN VON SANDERS, OTTO (1855–1929), German army officer famous for his services in Turkey, was born at Stolp (Slupsk) in Pomorze on Feb. 17, 1855. He entered the Hessian life guards in 1874 and rose to become lieutenant general commanding the Kassel 22nd infantry division in 1911. In 1913 he was made head of a German military mission to reorganize the Turkish army. In consequence of a Russian protest at his appointment to command the 1st Turkish army, he was made inspector general. Up to the outbreak of World War I in 1914, he did much to improve the Turkish army, which was in poor shape after the Balkan Wars.

In March 1915 Liman was sent to command the 5th Turkish army at Gallipoli (*see* Dardanelles Campaign). With other Turkish commanders under him, he succeeded in holding the British and Australians and ultimately causing them to evacuate the peninsula. Later, in March 1918, he commanded the 4th, 7th and 8th Turkish armies in Syria and Palestine and for a time held up the British advance. He withdrew most of his forces to Aleppo. After the armistice, he was for a time interned in Istanbul but then organized the repatriation of the German soldiers serving in Turkey. He spent his last years in retirement in Germany and died in Munich on Aug. 22, 1929. Gen. Sir Ian Hamilton, his opponent at Gallipoli, described him as a "clean fighter and a generous foe." He published *Fünf Jahre in Türkei* (2nd ed., 1922; Eng. trans. 1927). (M. P. P.)

LIMASSOL (Gr. Lemissos), a port of Cyprus on Akrotiri bay on the southern coast, lies about 85 km. (53 mi.) S.W. of Nicosia by road. Pop. (1960) 43,593. The sea front is lined with hotels and tourist and customs offices. There is a pier and small dock for vessels under ten-foot draft. Larger ships are served by lighters (barges). Behind the sea front are law courts, banks, municipal

offices, churches, shops and houses. Features of interest include a 100-bed hospital (1957), a housing estate, public gardens with a zoo and the Curium Palace hotel. Limassol castle, now a museum, is chiefly 15th century but has traces of many architectural periods. Limassol is connected by road with the rest of the island.

The chief products are carob, wine, raisins, asbestos and chrome. Bricks, tiles, buttons and soft drinks are manufactured, and fruit is canned. There are umber mines in the district. West and southwest of Limassol are the British military base of Episkopi and the Royal Air Force (R.A.F.) base of Akrotiri in a small enclave of British territory.

The ruins of Amathus (old Limassol), an early Phoenician settlement, are situated 8 km. (5 mi.) E., and Curium, 14 km. (9 mi.) W., was once a flourishing Mycenaean colony. In Roman times Limassol (Lemessus) was the capital of one of the four divisions of Cyprus. It was there that Richard I Coeur-de-Lion landed in 1191 and was married to Berengaria of Navarre. The emperor Frederick II landed at Limassol in 1228 with a claim to the regency of Cyprus. The castle was the first in Cyprus to be captured by the Turks when they took the island from the Venetians in 1570. Limassol was an important trading centre under the Turks and British and remains so in independent Cyprus. (M. Ro.)

LIMBACH-OBERFROHNA, an industrial town of Germany, which after partition of the nation following World War II was in the *Bezirk* (district) of Karl-Marx-Stadt, German Democratic Republic, is about 26 km. (16 mi.) W.N.W. of the city of Karl-Marx-Stadt. Pop. (1961 est.) 26,281. It is a combination of three towns, Limbach, Oberfrohna and Niederfrohna. In the 18th century it was a centre of the Saxon knitting industry, which survives in its many textile plants producing mainly knitted undergarments, stockings and gloves. A short distance from Limbach-Oberfrohna is the Sachsenring motor race course near Hohenstein-Ernstthal.

LIMBE: *see* Blantyre-Limbe.

LIMBO (Limbus), in Roman Catholic theology, denotes the border of hell, where dwell those who, while not condemned to torture, are deprived of the joy of heaven. In medieval theology there are (1) the *limbus infantum* and (2) the *limbus patrum*.

The *limbus infantum* or *puerorum* is the abode to which human beings dying without actual sin, but with their original sin unwashed away by baptism, were held to be consigned; the category included not unbaptized infants merely but also the mentally defective. The word "limbus," in the theological application, occurs first in the *Summa* of Thomas Aquinas; for its extensive currency it is perhaps most indebted to Dante. The question as to the destiny of infants dying unbaptized presented itself to theologians at a comparatively early period. Generally speaking it may be said that the Greek Fathers inclined to a cheerful and the Latin Fathers to a gloomy view. Indeed, some of the Greek Fathers expressed opinions which it is almost impossible to distinguish from the Pelagian view that children dying unbaptized might be admitted to eternal life, though not to the Kingdom of God. In his recoil from Pelagian heresy, Augustine was compelled to sharpen the antithesis between the state of the saved and that of the lost; thus he taught that there are only two alternatives—to be with Christ or with the devil, to be with him or against him. Later theologians and schoolmen followed Augustine in rejecting the notion of any final position intermediate between heaven and hell but otherwise inclined to take the mildest possible view of the destiny of the irresponsible and unbaptized.

The first authoritative declaration of the Latin Church upon this subject was that made by the second Council of Lyons (1274) and confirmed by the Council of Florence (1439), with the concurrence of the representatives of the Greek Church, to the effect that "the souls of those who die in mortal sin or in original sin only forthwith descend into hell, but to be punished with unequal punishments." The damnation of infants and also the comparative lightness of the punishment involved in this are thus *de fide;* but nothing is determined as to the place they occupy in hell, as to what constitutes the disparity of their punishment or as to their condition after the day of judgment. In the Council of Trent there was considerable difference of opinion as to what was implied in deprivation of the vision of God, and no definition was attempted. Some theologians continue to maintain with Robert Bellarmine that the infants "in limbo" are affected with some degree of sadness because of a felt privation; others hold that they enjoy every kind of natural felicity, as regards their souls now and as regards their bodies after the resurrection, just as if Adam had not sinned.

The *limbus patrum* or *sinus Abrahae* ("Abraham's Bosom"; Luke xvi, 22) is defined in medieval theology as the place in the underworld where the saints of the Old Testament were confined until liberated by Christ on his "descent into hell." Regarding the locality and its pleasantness or painfulness nothing has been taught as *de fide*. It is sometimes regarded as having been closed and empty since Christ's descent, but other authors do not think of it as separate in place from the *limbus infantum*. The whole idea has been described as the mere *caput mortuum* of the old doctrine of Hades (the place of waiting, of "the spirits in prison"; I Pet. iii, 19), which was gradually superseded in the Roman Church by that of purgatory (*q.v.*).

LIMBURG (Limbourg), **POL** (fl. *c.* 1400), Flemish miniature painter, was the most famous of three brothers whose family name was Malouel, all of whom followed the same profession. At one time Pol traveled to Italy to study at first hand the works of contemporary Italian artists, whose influence is clearly evident in his later work, but little else is known of the details of his early life. Any records there may have been have disappeared, probably destroyed by the wars which ravaged the Netherlands during his lifetime.

For a time he and his two brothers, Hermann and Janneken, worked for Philip the Bold, duke of Burgundy, beginning for him the illustration of the *Bible historiée*. This manuscript was later finished by other hands after Philip's death in 1404. Not long after, probably about 1411, the brothers entered the service of Philip's brother, John, duke of Berry, and it was under his patronage that Pol did his best work, the illuminating of the two prayer books *Les Très riches Heures du duc de Berry* and *Les Heures d'Ailly* (also known as the *Belles Heures*).

Although Pol did not finish the first manuscript in his lifetime, he and his brothers are thought to be responsible for nearly half of it, and it may have been partially completed after Pol's death by Hubert and Jan van Eyck, whose style Pol was one of the first of the Flemish painters to foreshadow.

See The Metropolitan Museum of Art, *The Belles Heures of Jean, Duke of Berry, Prince of France* (1958).

LIMBURG (Fr. Limbourg), the most northeasterly of the nine provinces of Belgium, consists of 3 administrative *arrondissements* (Hasselt, Maaseik and Tongeren), 13 judicial cantons and 206 communes. Pop. (1961) 574,606. Area 2,408 sq.km. (930 sq.mi.).

Except for the small Maastricht territory in the Netherlands, Limburg is bounded on the east by the Meuse river. The province divides into three physical regions: the eastern Kempenland plateau in the north, the Demer valley and, in the south, part of the plateau of Hesbaye.

The Kempenland, a plateau between the incised valleys of the Meuse and Demer, is covered by superficial deposits of Quaternary sands and gravels of fluvial origin, laid down by the Meuse in postglacial times when it was swollen and heavily laden. These overlie a mass of Pliocene and other late Tertiary sands. The surface consists of gentle eminences, separated by shallow marshy depressions. The plateau forms a broad indeterminate watershed (maximum altitude, 330 ft.) between streams that drain northward to the lower Meuse and southward to the Demer. It is characterized by sands, often blown into dunes, and has heathland vegetation in the bleaker moorlands, developed where waterlogging has been caused by an underlying impervious hardpan.

The broad Demer valley lies along the southern edge of the plateau; the river meanders westward to join the Dyle, picking up headstreams from both north and south. It has been regularized, and the flat alluvium-covered floor is crossed by a maze of cutoffs and artificial drainage channels.

The southern part of Limburg consists of part of the low

plateau of Hesbaye, with Oligocene sands and clays covered with *limon*. The plateau slopes gently northward to the Demer furrow, crossed by its many tributaries.

The Kempen plateau has coarse sandy soils supporting scanty agriculture, despite much reclamation. Small areas of rye, potatoes and fodder beet are cultivated near villages, pastures are sown with drought-resistant grasses and about a quarter is covered with plantations of Scots and Corsican pine. The Demer valley, with its damp alluvial soils, has dairy farming, and along its margins, between Diest and Hasselt, market gardening is prosperous. Northern Hesbaye, with its sandy loams, has mixed agriculture, including wheat and sugar beet, vegetable-growing and fruit cultivation, as near Tongeren (French, Tongres). Nearly half the province is under arable crops, and nearly a quarter of all Belgian fruit cultivation is found there. The heathlands are grazed by large flocks of sheep, cattle and pigs.

Settlements in the sparsely populated Kempen are on the plateau edges and in the Meuse and Demer valleys. The regional centre is Hasselt (*q.v.*; pop. [1961] 36,618), in the Demer valley, an administrative centre, with a variety of industries—flour mills, distilleries, tobacco factories, breweries, a gelatin works, brickworks, timberyards, tanneries, glue works and fertilizer factories. Farther south are Sint-Truiden (French, St. Trond; pop. [1961] 20,776), an important strategic position, and Tongeren (pop. [1961] 16,176), with local food-processing industries.

Limburg is underlain by the "concealed" Kempen coal field, where coal was discovered in 1901 and first raised commercially in 1917. Its collieries produce nearly one-half of Belgium's coal. A third of the miners are of foreign origin. The commune of Genk (*q.v.*; pop. [1961] 47,416) has three collieries. Zinc and other nonferrous refineries and chemical works are located on cheap, spacious heathland sites.

The needs of industry involved the construction of new roads, railways and tramways and the Albert canal between Antwerp and Liège. Two railway lines cross the province from west to east: from Antwerp via Mol to Mönchengladbach, Ger.; and from Antwerp via Hasselt to Maastricht. The main south-north line is Leuven (Louvain)–Turnhout–Tilburg–Utrecht. For history *see* LIMBURG, DUCHY OF. (F. J. M.)

LIMBURG, the southeasternmost province of the Netherlands, is bounded north by Gelderland, northwest by North Brabant, south and southwest by the Belgian provinces of Limburg and Liège and east by Germany. Area 2,251 sq.km. (869 sq.mi.). Pop. (1962 est.) 911,568. The southern part, extending to Sittard, consists of a plateau of Cretaceous rocks, sloping downward from the south (near Vaals is the highest part of the Netherlands, 1,054 ft.) to the north, intersected by the Geul and Gulp rivers and covered with loess. There is a coal field underneath some parts of this plateau. In the rest of the province the soil consists mainly of Pleistocene sands. The province is watered by the Maas (Meuse), which forms part of its southwestern boundary and then flows through its northern portion, and by tributaries like the Geul and the Roer.

There is coal mining around Heerlen, Kerkrade and Geleen. At Geleen there is a large chemical works. Coal is shipped from the river ports of Bonn and Stein. The chief industrial centre is Maastricht, the provincial capital, where glass, porcelain, paper, cement, rubber and chemicals are produced and printing is carried on.

Although the loess plateau has fertile arable ground for the cultivation of wheat, rye and sugar beet, dairy farming is increasing as a result of the large increase in population. There is much fruitgrowing, especially cherries.

In the sandy regions farming is mixed, although there is more arable land (mostly producing rye). Pigs and poultry production are important, Roermond having the largest egg market in the Netherlands. Venlo is the centre of a market-gardening area exporting to Germany. Industry is mainly concentrated in the larger centres, such as Roermond, Weert, Venlo and Sittard, and includes light-metal, clothing, hosiery and chemical works and flour mills. The region east of the Meuse between Venlo and Roermond is an important brick- and tilemaking district. For history *see* LIMBURG, DUCHY OF. (H. J. KE.)

LIMBURG, DUCHY OF, a historic territory of the Low Countries, whose name survives in that of the two provinces of Limburg, one belonging to the kingdom of Belgium, the other to the kingdom of the Netherlands.

When Walram II, count of Arlon, married Judith, daughter of Frederick of Luxembourg, duke of Lower Lorraine (d. 1065; *see* LORRAINE), he received from his father-in-law some lands lying on either side of the Meuse river and proceeded to build a castle at Limburg. The castle stood on the Vesdre river east of Liège and southwest of Aachen, and from it he took the title of count of Limburg (as Walram I). His son Henry I of Limburg (d. 1119?) was invested as duke of Lower Lorraine by the Holy Roman emperor Henry IV in 1101 but was removed from that dignity by Henry V in 1106 and fell into the hands of the new duke, Godfrey the Bearded of Louvain (d. 1139). This Godfrey, however, was in turn deposed from the duchy in 1128 in favour of Henry I's son Walram II of Limburg, but after the latter's death (also 1139) the duchy of Lower Lorraine, or Lothier as it was now called, was restored to Godfrey II of Louvain (d. 1142). Walram II's son Henry II of Limburg (d. 1167) failed to wrest the title of duke of Lothier from Godfrey III of Louvain and finally gave him his daughter Margaret in marriage (1155), contenting himself with the title of duke of Limburg. The emergence of this new duchy marks the end of Lower Lorraine or Lothier as a real entity: Godfrey III's successor in 1190, Henry I of Louvain, styled himself duke of Brabant (*q.v.*).

With Henry II's successors in Limburg, namely Henry III (d. 1220), Walram III (d. 1226), Henry IV (d. 1246 or 1247) and Walram IV (d. 1279 or 1280), the direct male line of the house of Arlon came to an end. After the death of Walram IV's daughter Irmingard (1282 or 1283), the War of the Limburg Succession broke out, since her cousin Adolf V of Berg disputed the right of her widower, Reinald I of Gelre (*see* GELDERLAND), to remain in possession of the duchy. Adolf sold his rights to John I of Brabant, and most of the neighbouring states became involved in the struggle: Holland, Jülich, Cleves and the city of Cologne took John's side; Flanders, Nassau and Archbishop Siegfried of Cologne took Reinald's. Reinald eventually sold his own rights to Henry III of Luxembourg; but in the battle of Woeringen or Worringen (June 5, 1288), John won the duchy of Limburg for Brabant.

The duchy of Limburg at this time comprised the bailiwicks of Hervé, Montzen, Baelen, Sprimont and Wallhorn and the counties of Rolduc, Daelhem and Falkenberg. In personal union with Brabant, it conserved its separate institutions. In 1396 the widowed duchess Joan of Brabant ceded it to her niece Margaret of Flanders, wife of Philip the Bold, duke of Burgundy, whose second son Anthony succeeded to it in 1404, two years before he became duke of Brabant also. On the death of Anthony's son Philip (1430) Limburg and Brabant were united with the rest of the Netherlands under Philip the Good, duke of Burgundy. In 1482 Limburg passed to the house of Habsburg with the Burgundian inheritance (*see* NETHERLANDS, THE: *History*). Maastricht was attached to Limburg in 1530.

In the latter phases of the war between the United Provinces of the Netherlands and the Spanish Habsburgs, the Dutch conquered the northern part of Limburg; and at the peace of Westphalia (1648) Daelhem, Falkenberg and Maastricht were ceded to them, to become one of the so-called "Generality lands" under the joint rule of the states-general. Southern Limburg passed with the rest of the Spanish Netherlands to the Austrian Habsburgs under the peace of Rastatt at the end of the War of the Spanish Succession (1714). Annexed by the French in 1795 and divided between the *départements* of Ourthe and Meuse-Inférieure, Limburg was reconstituted as a province of the new kingdom of the Netherlands in 1815. This province, however, comprised not only the old duchy but also a piece of Gelderland and the county of Looz.

At the Belgian revolution of 1830 all Limburg except Maastricht took the Belgian side (*see* BELGIUM: *History*); and so long as William I of the Netherlands refused to recognize the London treaty of Oct. 1831, the province remained, together with Luxembourg, under Belgian occupation and sent its representatives to

Brussels. At last, in 1838, William decided to accept the treaty, and in April 1839 Belgium accordingly had to renounce parts of Limburg and of Luxembourg. That part of Limburg which lay on the right bank of the Meuse, together with Maastricht and a number of communes on the left bank (including a large area in the north), then became a sovereign duchy under the rule of the king of the Netherlands; but in order to compensate the German confederation for the loss of its rights over the part of Luxembourg which Belgium was allowed to retain, the duchy of Limburg (apart from the communes of Maastricht and Venlo) was declared to belong to the confederation, as did the rest of Luxembourg. When the German confederation had been dissolved after the Seven Weeks' War (1866), a conference met in London to consider the Luxembourg-Limburg question; and in 1867 it was decided to sever all connection of the two duchies with Germany. Thereafter eastern Limburg was integrated with the Netherlands, though the province continued to be described officially as a duchy till 1906. Belgian attempts to secure the cession of eastern Limburg after World War I, chiefly on the grounds that the Germans had been able to violate Dutch neutrality to Belgium's disadvantage during the war, were overruled by the peace conference of Paris in 1919.

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LIMBURGITE, a dark-coloured volcanic rock resembling basalt in appearance, but normally containing no feldspar. The name is taken from Limburg (Germany). It consists essentially of olivine and augite with a brownish glassy ground mass, in which a second generation of small augites frequently occurs; more rarely olivine is present also as an ingredient of the matrix.

The principal accessory minerals are titaniferous iron oxides and apatite, and in some limburgites large phenocrysts of hornblende and biotite are found; in others large crystals of soda-orthoclase or anorthoclase. Haüynite, a variety of sodalite (*q.v.*), is an ingredient of some of the limburgites of the Cape Verde Islands. Rocks of this group occur in considerable numbers in Germany (Rhine district) and in Czechoslovakia (Bohemia), also in Scotland (Whitelaw hill, Haddington), France (Auvergne), Spain, Africa (Kilimanjaro), Brazil, etc. They are associated principally with basalts, nephelite- and leucite-basalts and monchiquites. From the last-named rocks the limburgites are not easily separated as the two classes bear a very close resemblance in structure and in mineral composition. The ground mass of the monchiquites is not a glass, however, but crystalline analcite (*see* LAMPROPHYRE). Limburgites may occur as flows, as sills or dikes, and are sometimes highly vesicular.

LIME. The tree and fruit of the species *Citrus aurantifolia,* widely grown for its acid fruits throughout the tropical and subtropical areas of the world. The native home of the tree is believed to be the East Indian archipelago and perhaps the nearby mainland of Asia. (In England "lime" is also used to designate the basswood tree or linden; *q.v.*) The Arabs are believed to have taken limes, as well as lemons, from India to the eastern Mediterranean countries and Africa around A.D. 1000 or possibly earlier. Limes were introduced to the western Mediterranean countries by returning crusaders in the 12th and 13th centuries A.D. Columbus took citrus fruit seed, probably including limes, to the West Indies on his second voyage in 1493 and the trees soon became widely distributed and partially naturalized in the West Indies, Mexico and Florida.

Plant Characteristics.—The tree seldom grows more than 8 to 15 ft. high and if not pruned becomes shrublike. Its branches spread and are irregular, with short stiff twigs, small leaves and an abundance of small, sharp thorns. The leaves are pale green; the small white flowers are usually borne in clusters. The fruit is 1¼ to 1¾ in. in diameter, oval to nearly globular, often with a small apical nipple; the peel is thin, and greenish-yellow when the fruit is ripe. The pulp is tender, juicy, yellowish-green in colour and decidedly acid. As a group, limes somewhat exceed lemons in both acid and sugar content. There are, however, some varieties so lacking in citric acid that they are known as sweet limes. These are grown to some extent in Egypt and other tropical countries.

Varieties and Hybrids.—The two general groups of acid limes are the Mexican and the Tahiti. The Mexican group is characteristic of the species *C. aurantifolia,* described above. Several varieties, including Everglade and Yung, have been named but in general differ but little from each other. Numerous thornless strains of Mexican limes have arisen from seedlings and from bud sports.

The trees of the Tahiti group resemble the lemon and are larger and more vigorous than those of the Mexican group, with leaves larger and darker coloured. The fruit is larger and more elongated than the Mexican lime; the peel is thicker and the fruit nearly seedless.

The flavour of the fruit of the two groups is similar, but the Tahiti lime lacks some of the bouquet which is typical of the Mexican. The Tahiti lime so closely resembles a lemon that the fruit could easily be confused except for the colour of the pulp and the distinctive taste. From the appearance of the Tahiti group there seems to be a possibility that this fruit may be a hybrid between the lemon and the typical Mexican lime. Leading varieties of the Tahiti group are Bearss, Pond and Tahiti, also called Persian.

The lime hybridizes readily with other species of citrus and some closely related genera. Some of these hybrids are grown as novelties and, to a limited extent, commercially. The Perrine lemon, a cross of Mexican lime and Genoa lemon, is grown locally in Florida and warmer parts of Louisiana and Texas. The limequats, crosses of limes and kumquats, are hardier and more disease resistant than limes and are grown in areas slightly too cold for limes or lemons. Hybrids of limes and mandarin oranges are acid fruits grown locally and also used to some extent as rootstocks for the propagation of other kinds of citrus.

Production and Use.—Mexico is a leading country in lime production, producing around 2,000,000 boxes per year. Egypt produces about 1,000,000 boxes annually, but some estimates are much higher. From 300,000 to 400,000 boxes per year are produced in the United States, mainly in southern Florida. Limes are grown throughout the West Indies and to a limited extent in practically all citrus-growing areas. The trees are a little less cold resistant than most kinds of citrus, so production is largely restricted to relatively frost-free locations.

Limes are used mainly for flavouring drinks, food and confections, much as are lemons. Limeade and other lime-flavoured drinks have a flavour and bouquet quite distinct from those made from lemons. The juice may be concentrated, dried, frozen or canned in a manner similar to lemon juice.

The yield of fresh juice depends upon the variety and the condition of the fruit and varies from 60 to 90 gal. per ton of fruit. The small Mexican lime is less readily handled by machinery in the reaming process than are the larger varieties. Limes contain vitamin C (ascorbic acid) and were formerly used in the British navy to prevent scurvy (hence the nickname "Limey"). Lime oil is a by-product of the fruit, the chief centre for its production being the West Indies. Citrate of lime and citric acid are also prepared from it.

Methods of culture, propagation and pest control for limes are comparable to those used in other citrus orchards. *See* also LEMON and ORANGE.

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LIME. In the strict chemical sense lime refers only to calcium oxide (or quicklime); however, lime which is commercially manufactured from limestone is rarely produced in the pure state and the presence of other substances gives rise to different types of limes having commercial importance. High-calcium limes, chiefly used for various chemical and industrial purposes, are produced from calcareous materials (generally limestone but also chalk and oyster shells) containing 95% to 99% calcium carbonate. Lime-

stones containing various proportions of magnesium carbonate are widely found and are also used to make lime. Magnesium limes are produced from stones containing magnesium carbonate in excess of 5%. One magnesium lime of special importance is dolomitic lime, produced from the mineral dolomite, a type of limestone containing from 30% to 45% magnesium carbonate (*see* CALCITE; DOLOMITE; LIMESTONE). In the U.S. only limes made from high calcium and dolomitic limestones have commercial significance.

In common usage the term lime includes the various chemical or physical forms of quicklime, hydrated lime and hydraulic lime. When limestone is heated under controlled calcination conditions, the carbonates decompose, producing quicklime. Commercially, quicklime is commonly produced by burning carefully graded limestone in rotary kilns, similar to those used in portland cement manufacture, and in large stationary vertical kilns. The by-product carbon dioxide gas is generally permitted to escape from the kilns, though sometimes it is collected and used to manufacture precipitated calcium carbonate, dry ice, etc. Quicklime, as it is normally manufactured, is highly reactive; however, when calcined for a prolonged time at elevated kiln temperatures, the porous structure contracts. The material loses its chemical reactivity and the lime is said to be "dead-burned." Some dolomitic limestone is commercially processed in this manner; it is known as dead-burned dolomite and is widely used as a lining for basic open-hearth steel furnaces.

When quicklime reacts with water the process is called slaking; the reaction is exothermic, and proceeds at times with almost explosive violence. Dry hydrated lime is produced when quicklime is reacted with just sufficient water to satisfy its chemical affinity for moisture under the conditions of hydration. High calcium quicklimes react readily with water; on the other hand, dolomitic quicklimes, because of the less reactive magnesium oxide component, do not hydrate completely in ordinary processing equipment.

Dolomitic limes hydrated in equipment operated at atmospheric pressures and low retention times are known as dolomitic normal hydrated limes and essentially consist of calcium hydroxide and magnesium oxide with a small quantity of magnesium hydroxide. The magnesium oxide portion of dolomitic lime along with the calcium oxide can be hydrated completely in special equipment using longer retention periods or elevated pressures and temperatures. These "pressure hydrated" or highly hydrated limes are commercially known as dolomitic special hydrated lime.

Hydraulic lime is a type of cementitious lime that will set and harden under water in a manner similar to portland cement. It is obtained by calcining an impure limestone containing large quantities of silica and alumina so that sufficient calcium silicates and aluminates are formed to give the lime its characteristic hydraulic properties. Hydraulic limes are widely used in Europe for mortars in masonry construction; use in the United States, however, is limited.

Limes vary considerably in chemical and physical properties. In part this is due to differences in geology and chemical analyses of the raw limestone. More markedly, however, the degree of overcalcination and other processing variables and conditions affect the rate of slaking, plasticity, density and chemical reactivity of the limes produced. Both quick and hydrated limes are usually white in colour, though some grayish impure limes are known. Calcium and magnesium hydroxides are only slightly soluble in water; nevertheless, the term lime water denotes a weak aqueous solution. Milk of lime is a suspension of lime solids in water.

Lime is widely used to neutralize acids; on the basis of neutralizing values, quick and hydrated limes are stronger bases than sodium hydroxide and sodium carbonate.

Uses.—Next to sulfuric acid, lime was the most widely used chemical in industry in the second half of the 20th century, and was the leading alkali in tonnage consumed. Both quick and hydrated lime products find extensive application in the agricultural, building and chemical industries. Formerly lime was considered primarily a building and agricultural material, and in many underdeveloped parts of the world applications for lime are still largely confined to these fields. However, lime is employed basically as a chemical in industry. In the U.S. alone three-fourths of the annual lime tonnage is consumed industrially. Chemical lime is consumed in large quantities by the metallurgical industry in the manufacture of open-hearth and electric-furnace steel, production of magnesium, treatment of aluminum, gold and silver ores, and the smelting and refining of copper, zinc and other metals. Dead-burned dolomite is extensively used as a refractory material to line high-temperature kilns and furnaces. Large quantities of lime are required in the manufacture of paper, calcium carbide and glass, as well as in the purification of water supplies and in the treatment of sewage and industrial wastes. Other chemical applications are in sugar and petroleum refining and in the manufacture of sand-lime brick and concrete products, insecticides, leather goods, bleaching powder, sodium hydroxide, varnish and paints, grease and other products. A market for lime was also developed as a soil-stabilizing agent in the construction of base courses for modern highways and airport runways.

In agriculture, lime—not to be confused with pulverized limestone—is one of several soil liming materials used for promoting crop production by correcting soil acidity and furnishing important plant nutrients.

History.—Lime is one of the oldest products known to man, dating possibly as far back as the cave-man era and the discovery of fire. Primitive kilns which are believed to have been used for preparing lime during the Stone Age have been excavated. It is certain that lime was the first manufactured chemical used by mankind, probably the first agricultural material employed for soil fertility, and certainly one of the oldest mortar and plastering building materials known. Virtually every civilization has utilized lime. Lime plaster, still in good condition, has been found in some pyramids built more than 4,500 years ago in Egypt. The Old and New Testaments of the Bible mention lime several times. Lime was extensively used in mortars and plasters by the Greeks, Romans, Arabians, Moors and other Mediterranean cultures. It was also used by the Incas and Aztecs in South and Central America and by the Chinese in constructing their Great Wall. The first mention of lime as a chemical reagent was by the Roman Xenophon, who recorded that ships carrying a cargo of linen and lime (for its bleaching) were wrecked in 350 B.C. near Marseilles. And another Roman, Vitruvius, an architect under Augustus, wrote the first detailed lime specification. The Romans also used lime in building the road base of the famous Appian way. The Romans originated cement (hydraulic lime), which they prepared from mixtures of lime putty and volcanic ash. Old relics and records in England indicate that lime was used as a mortar material during the Roman occupation. Lime plastering and stuccoing reached their peak during the Italian Renaissance; and during the same period Michelangelo, Raphael and other famous artists created their mural and fresco masterpieces using lime putties extensively. (*See* also FRESCO PAINTING.)

In North America lime was probably first used by the Spaniards in Florida in the 16th century. Tabby construction consisting of oyster-shell lime, sand and crushed shells was employed for building walls. Early Spanish missions in California and the southwest were invariably constructed of lime stucco. As early as 1635 in Rhode Island quicklime was produced from limestone; however, the Pilgrims probably burned lime from shells at an earlier date shortly after settling at Plymouth, Mass. Lime manufacturing first became a significant industry in commerce about 1733, when boats were used to ship lime from Rockland, Me., to Boston, Mass.

Technical progress since the beginning of the 20th century markedly advanced lime manufacturing to its modern important industrial position.

See LIMING; MORTAR IN BUILDING; *see* also references under "Lime" in the Index. (K. J.)

LIMEHOUSE, a district in the Stepney (*q.v.*) area of the East End of London, Eng., lies on the north bank of the river Thames. It has a large population of workers employed in the nearby West India and East India docks, and sailors, both natives

of London and foreigners, off merchant ships temporarily in port. A common form of philanthropy has been the establishment of homes and hostels for seamen in Limehouse. The Limehouse Cut, a channel which connects the Lea with the Thames, was opened in 1770. St. Anne's, the parish church, completed in 1724, was designed by Nicholas Hawksmoor, a pupil of Sir Christopher Wren. It was restored in 1850 after being partially destroyed by fire on Good Friday. In the West India Dock road is "Charley Brown's," a tavern noted for its collection of antiques. West India Dock road is the centre of the now much reduced Chinese quarter which spills into Pennyfields (in Poplar). In Narrow street, the western continuation of Limehouse causeway, stands the "Bunch of Grapes," said to be the original of "The Six Jolly Fellowship Porters" in Charles Dickens' *Our Mutual Friend*. The name Limehouse is probably a corruption of the original Lymehostes, which referred to the lime oasts or limekilns in the district.

(He. Wa.)

LIMERICK, THOMAS DONGAN, 2nd Earl of (1634–1715), colonial governor of New York, was born at Castletown, County Kildare, Ireland. The Dongan family went into exile with other Stuart supporters in 1649, and young Thomas entered an Irish regiment of the French army and by 1674 reached the rank of colonel. He was recalled to England in 1677, granted a pension of £500 and appointed lieutenant governor of Tangier (1678–80). In 1682, the Duke of York named him governor of the colony of New York. He was an unusually competent official and left a lasting imprint on the history of New York and other American colonies. He called the first representative assembly in New York and espoused a very liberal "Charter of Liberties" and a broad tolerance in religious matters. His territorial ambitions for New York were practically boundless, but his aggressive policy did result in fixing the boundaries between New York and the other English colonies and later with Canada. Dongan must be given credit for seeing the importance of the position of New York and of the Iroquois tribes in the international struggle for North American supremacy. He carried on his vigorous policy against the French in America despite the fact that his masters in Europe, the Duke of York and Charles II, were allied with Louis XIV and despite French-Canadian appeals to his religious sympathies as a Roman Catholic. James II tardily sanctioned Dongan's French and Indian policy, and many years later the treaty of Utrecht vindicated it by acknowledging the Iroquois as British subjects and Lake Ontario as the boundary of New York.

In 1688 during the period of colonial consolidation, Dongan was relieved of the governorship. He returned to England in 1691, succeeded his brother as earl of Limerick in 1698, and died in London on Dec. 14, 1715. His last years were spent unsuccessfully in trying to recoup his fortune by regaining title to his family lands in Ireland, by collecting the arrears on his pension, and by receiving payment for his personal expenditures for the expansion of New York.

See J. H. Kennedy's *Thomas Dongan, Governor of New York (1682–1688)* (1930) and E. Channing's "Colonel Thomas Dongan, Governor of New York" in *Proceedings of the American Antiquarian Society*, vol. xviii, pp. 336–345 (1906–07). (Ra. Mu.)

LIMERICK (Luimneach), a county of the Republic of Ireland in the province of Munster, covers 1,037 sq.mi. and has a population (1961) of 133,339. All of its northern boundary is the Shannon estuary and river, except at the city of Limerick, where an area north of the river has been included because of suburban growth. The river Maigue bisects the county and flows north into the Shannon. On the west the Kerry boundary runs through Carboniferous uplands, plateaus mainly 1,000–1,200 ft. high with unproductive Coal Measures, and on the east the boundary with Tipperary runs from the Shannon to Slievefelim (1,411 ft.), then across the Golden vale southward to the Galtee mountains, to the summit of Galtymore (3,018 ft.). The southern boundary, with Cork, follows the Ballyhoura hills, a continuation of the line of the Galtees. These uplands, the Slievefelim, the Galtees and the Ballyhouras, are mainly formed of Devonian (Old Red) Sandstones.

Lowland Limerick is in the main a rolling hummocky landscape with a variety of glacial drifts, 150–350 ft. high. It is diversified by a number of hills, partly formed of igneous rocks, which rise to 612 ft. near Ballingarry. There are also a number of isolated volcanic hills, including several a few miles south of Limerick city: of these, one of the most striking is Carrigogunnel, a fine crag rising above the Shannon "slob lands," or floodplain. It is crowned by a medieval castle. At one time parts of the lowland were covered with peat bog, but virtually all this has been removed, and pastoral farming gives unity to the scene. The farms are mainly of medium size, from 50 to 80 ac.

The area formed part of the old kingdom of Desmond. With the coming of the Anglo-Norman invaders, it fell largely to the FitzGeralds, created earls of Desmond in 1329. For a while their headquarters were at Kilmallock in the southeast of the modern county and later at Askeaton. With the downfall of the earls of Desmond, a large part of county Limerick fell within the scope of the plantation of Munster, begun in 1586. Later changes in land ownership occurred in Cromwellian times. Early in the 18th century some German settlers came from the Palatinate and they were still a recognizable community in the 1830s but have since merged with the general population.

There are remains of round towers at Ardpatrick and at Dysert, and of stone circles, pillar stones and altars at Lough Gur where excavations have been made. Besides the monasteries in the city of Limerick, the most important monastic ruins are those of Adare abbey, Askeaton abbey, Galbally friary, Kilfiin monastery, Kilmallock and Monaster-Nenagh abbey. The Ardagh chalice, now in the Dublin National museum, came from the county and is one of the most perfect specimens of Irish jeweled metalwork.

A county council meets at Limerick, the county town, and there is a county manager. Limerick city is a borough with mayor and corporation and a city manager who is a separate official from the county manager. Newcastle West and Rathkeale are administered by town commissioners. For electoral purposes there are two constituencies of East and West Limerick, the former returning four members and the latter three members to *dáil éireann*. Except for Limerick (pop. [1961] 50,786), only four places within the county have more than 1,000 people: these are Newcastle West, Rathkeale, Kilmallock and Abbeyfeale.

Limerick, the biggest town on the west side of Ireland, is a distributing centre for an area far wider than the county. It has two cathedrals serving dioceses roughly conterminous with the county. None of the country towns and villages have become industrialized, except for a few local mills. The numerous villages are shopping centres and many have fairs. Though they are fairly prosperous, their populations do not increase.

Much of Limerick lies within the Golden vale which spreads into County Tipperary round Tipperary town and Cashel. It is famed for its rich pastures and is a main centre of dairying. Nine-tenths of the county is used for crops and pasture, and in many areas almost all the land is under grass and hay, for the main wealth lies in the dairy herds. Surplus stock is sold at fairs and near the city of Limerick there are good fattening pastures. Pig production is to some extent associated with dairying, as the animals are fed on the residue after the cream is separated. Bacon-curing is an old-established industry in the city of Limerick. The village of Foynes on the Shannon was the terminus of a transatlantic seaplane service until it was superseded by the establishment of the Shannon airport in County Clare.

See P. Fitzgerald and J. J. M'Gregor, *The History, Topography and Antiquities of the County and City of Limerick*, 2 vol. (1826–27); Maurice Lenihan, *Limerick: its History and Antiquities* (1866).

(T. W. Fr.; Hu. S.)

LIMERICK (Luimneach), a county borough, port and the chief town of County Limerick, Republic of Ireland, occupying both banks and an island (King's Island) of the river Shannon, at the head of its estuary, 129 mi. W.S.W. of Dublin by rail. Pop. (1961) 50,786.

Limerick is said to have been the Regia of Ptolemy and the Rosse-de-Nailleagh of the Annals of Multifernan. There is a tradition that it was visited by St. Patrick in the 5th century, but it is first authentically known as a settlement of the Danes, who sacked

it in 812 and afterward made it the principal town of their kingdom of Limerick but were expelled from it toward the close of the 10th century by Brian Boru. From 1106 till its conquest by the English in 1174, it was the seat of the kings of Thomond or North Munster, and, although in 1177 the kingdom of Limerick was given by Henry II to Philip de Braose, the city was frequently in the possession of the Irish chieftains till 1195. Richard I granted it a charter in 1197.

By King John it was committed to the care of William de Burgh, who founded English Town, and for its defense erected a strong castle. The city was frequently besieged in the 13th and 14th centuries. In the 15th century its fortifications were extended to include Irish Town, and until their demolition in 1760 it was one of the strongest fortresses of the kingdom. In 1651 it was taken by Gen. Henry Ireton, and after an unsuccessful siege by William III its resistance was terminated in 1691 by the treaty of Limerick (*see* IRELAND: *History: The Jacobite War, 1689–91*). The dismantling of the town's fortifications began in 1760, but fragments of the old walls remain. In 1609 it received a charter constituting it a county of a city and also incorporating a society of merchants of the staple, with the same privileges as the merchants of the staple of Dublin and Waterford.

The prosperity of the city dates chiefly from the foundation of Newtown Pery in 1769 by Edmund Sexton Pery (d. 1806), speaker of the Irish house of commons. Under the Local Government act of 1898 Limerick became one of the six county boroughs having a separate county council. The city is divided into English Town (on King's Island), Irish Town and Newtown Pery, the first including the ancient nucleus of the city, and the last the principal modern streets. The main stream of the Shannon is crossed by Thomond bridge and Sarsfield or Wellesley bridge. The first is commanded by King John's castle, on King's Island, a Norman fortress fronting the river. At the west end of the bridge is preserved the Treaty stone, on which the treaty of Limerick was signed in 1691. The Protestant cathedral of St. Mary, also on King's Island, was originally built in 1142–80 and exhibits some Early English work. The modern Roman Catholic cathedral of St. John is in early pointed style. The churches of St. Munchin (to whom is attributed the foundation of the see in the 6th century) and St. John, Whitamore's castle and a Dominican priory are of interest.

Communication with the Atlantic ocean is open, while inland navigation is facilitated by a canal which avoids the rapids above the city. Quays extend on each side of the river, and vessels of 600 tons can moor alongside at spring tides. There is a graving dock and a wet dock. The principal imports are grain, timber, oil and coal. The exports consist mainly of fish and agricultural produce. The principal industrial establishments include flour mills (Limerick supplying most of the west of Ireland with flour), factories for bacon curing and for condensed milk and creameries. Some brewing, distilling and tanning are carried on, and the manufacture of lace is maintained at the Convent of the Good Shepherd. The salmon fisheries of the Shannon, for which Limerick is the headquarters of a district, are the most valuable in Ireland. The city benefited greatly from the establishment of the Shannon hydroelectric power station close by (*see* SHANNON) and from the proximity of Shannon airport, about 20 mi. to the west.

BORD FAILTE

KING JOHN'S CASTLE AND THOMOND BRIDGE WITH ST. MUNCHIN'S PROTESTANT CHURCH IN THE BACKGROUND, AS SEEN FROM CLANCY'S STRAND, LIMERICK, ON THE RIGHT BANK OF THE SHANNON

LIMERICK. The origin of this popular type of nonsense verse is unknown. Langford Reed, the limerick's only historian and principal anthologist, suggested that the name derives from a song brought back from France by returning members of the Irish brigade in the 18th century, the chorus of which was "Will you come up to Limerick?" To this chorus impromptu verses were added, telling the adventures of persons from various Irish cities. Reed did not state the source of this tradition, for which there is no confirmation.

The first English verse in something like limerick form is the jingle "Hickory, Dickory, Dock," of which the earliest printed version dates from 1744. The French epigram, "On s'étonne ici que Caliste," quoted by James Boswell in his *Life of Johnson*, dates from 1716. Again the form is not identical, but this, and the existence of a French version of "Hickory, Dickory, Dock," offers some support to Reed's theory of a French origin.

The first collections of limericks in English date from about 1820. Edward Lear (*q.v.*), who composed those in his *Book of Nonsense* (1846) in the early 1830s to amuse the children of his friend the earl of Derby, claimed to have got the idea from a nursery rhyme beginning "There was an old man of Tobago." This is quoted by Eugene Wrayburn at the Veneerings' dinner table in chapter ii of Dickens' novel *Our Mutual Friend*, but Wrayburn remembers it only partially. He gives the rhymes "Tobago" and "dago," but forgets the almost certain second line ending, "sago." Instead he says "isinglass," and he gives no hint of the third and fourth lines.

Lear's limericks are, on the whole, less developed in form than his hypothetical model, since his fifth line usually repeats the rhyme word of the first or second, as in the case of the typical "Old Person of Rheims":

> There was an Old Person of Rheims,
> Who was troubled with horrible dreams;
> So, to keep him awake,
> They fed him on cake,
> Which amused that Old Person of Rheims.

The last line of a Lear limerick is certainly its weakest member. However there are some in which he uses the full form with a new rhyme word for the fifth line, as, for example, in:

> There was an Old Man who supposed
> That the street door was partially closed;
> But some very large rats
> Ate his coats and his hats,
> While that futile Old Gentleman dozed.

Here, however, Lear departed from the original "Tobago" form, which he more usually followed, of ending the first line with the name of a place or country.

Langford Reed quotes Bernard Shaw's opinion that "Edward Lear's *Book of Nonsense* is the only collection which any reputable publisher or printer could touch." Certainly the limericks of the Pre-Raphaelite circle were reputed both libelous and indelicate. Those of D. G. Rossetti's that survive are dull and careless. Other men of letters toward the end of the century were far more expert. W. S. Gilbert, for instance, in his sequence of limericks which Sir Arthur Sullivan set as the song in *The Sorcerer* (1877):

> Oh, my name is John Wellington Wells,
> I'm a dealer in magic and spells,
> In blessings and curses,
> And ever-filled purses,
> In prophecies, witches and knells.

Gilbert also wrote one of the first offbeat limericks, which were to become almost as popular as the true sort, their charm lying in

the unexpected jolt of failing to find the expected rhyme:

There was an old man of St. Bees,
Who was stung in the arm by a wasp,
When asked, "Does it hurt?"
He replied, "No, it doesn't,
I'm so glad it wasn't a hornet."

Rudyard Kipling, Arnold Bennett, E. V. Knox, Ronald Knox, Dean Inge and Pres. Woodrow Wilson contributed some noteworthy limericks to the Edwardian repertory, which was also enriched by a stream of "bluer" specimens, attributed, without proven basis, to members of the stock exchange. Many of these anonymous verses circulated in several versions of varying decency.

The limerick had, by the first decade of the 20th century, acquired widespread popularity; and in 1907–08 limerick contests were organized by journals and business houses either for the completion of the last line, or for original verses composed on a certain place name or to advertise a particular product. The sale of rhyming dictionaries is said to have boomed. The true limerick addict, however, transferred his attention to more complicated verses, of the type of the anonymous tongue twister:

A tutor who taught on the flute
Tried to teach two young tooters to toot.
Said the two to the tutor,
"Is it harder to toot, or
To tutor two tooters to toot?"

Others wrote limericks in French or Latin, and yet others exploited the anomalies of English orthography. An example of the first, written in unidiomatic French, betrays its English origins in every line:

Il était une jeune fille de Tours
Un peu vite, qui portait toujours
Un chapeau billy-coque,
Un manteau peau-de-phoque,
Et des p'tits pantalons de velours.

while that on the lady of Leicester betrays an insular pride in the illogical spelling of certain place names:

An obstinate lady of Leicester
Wouldn't marry her swain, though he preicester.
For his income, I fear,
Was a hundred a year
On which he could never have dreicester!

Others pithily summed up the intellectual quandaries of the day. Ronald Knox's comment on the nature of reality has almost outlived the original arguments which he satirized:

There once was a man who said, "God
Must think it exceedingly odd
If he finds that this tree
Still continues to be
When there's no one about in the quad."

(Reproduced by kind permission of Monsignor R. A. Knox's literary executor, Mr. Evelyn Waugh.)

And the argument about predestination which raged in Oxford early in the 20th century is immortalized in a limerick by Maurice E. Hare:

There once was a man who said, "Damn!
It is borne upon me that I am
An engine that moves
In predestinate grooves,
I'm not even a bus, I'm a tram."

Later in the 20th century the limerick lost caste, yielding its popularity to the more offhand clerihew (*q.v.*) and to the various forms of quatrain used by the U.S. poet Ogden Nash. Its hold remains strong only on the bluer portion of its former empire. Competitions seldom call for the limerick, and very few new examples seem to gain currency.

The best limericks, according to E. V. Knox, "have the consecutive fluency of conversational prose, the metre being faultlessly dactylic throughout," and as the perfect example he quotes:

There was an old man of Khartoum
Who kept two tame sheep in his room:
"For," he said, "they remind me
Of one left behind me,
But I cannot remember of whom."

This piece fulfills his further requirement that it shall "contain the largest amount of improbable incident or of subtle innuendo that can be crowded into the available space." Knox's standards were perhaps too strict; by them many of Edward Lear's best pieces would fail, since they make only one zany point and are seldom uniformly dactylic. Some of the most memorable limericks syncopate the last line, and endless variations of internal rhyme and dissonance have been used to vary a verse form which would otherwise have grown monotonous. Little except the fixed number of lines and the rhyme scheme is constant in the limerick, and even the latter is provocatively violated in one of the most famous of offbeat limericks, which outdoes its Gilbertian model:

There was an old man of Dunoon
Who always ate soup with a fork.
For he said, "As I eat
Neither fish, fowl, nor flesh,
I should otherwise finish too quick."

See Langford Reed (ed.), *The Complete Limerick Book* (1925).
(Jo. M. C.)

LIMES, a Latin word, originally meaning "path," which came to mean especially a frontier of the Roman empire (sometimes, but not invariably, an artificial frontier as opposed to a natural one); traces of these frontiers survive in Europe, the middle east and north Africa. Earlier, the word *limes* was applied to any Roman military road. These were driven forward into subdued territory and linked up into a network, including watchtowers and forts, thus securing the country behind a further advance. Once a given line became regarded as a frontier rather than a lateral communication road, however, the towers and forts tended to be concentrated along it and the road between them was often replaced by a continuous barrier, though forts and *limites* ahead of or behind it were not necessarily abandoned.

The *limes* as a continuous barrier can best be seen in Britain (*see* below) and Germany. The Rhine and Danube rivers, adopted from A.D. 9 as the natural frontiers of the Roman empire, make an inconvenient re-entrant angle; Roman influence beyond them was consolidated under Vespasian (emperor 69–79) by the construction of roads and forts in the Black forest (the *agri decumates; q.v.*). The war of Domitian against the Chatti in 83 involved the construction of a chain of forts and towers along the Taunus ridge, soon linked via the Neckar river with a line running north of the Danube. Under Hadrian (117–138) and Antoninus Pius (138–161) the *limes* became a continuous ninefoot palisade running, in its final form, over 300 mi. from the Rhine opposite the Vinxtbach river along the Taunus and south to the Main river, which it followed from Seligenstadt to Miltenberg, then in a straight line to Lorch and roughly east via Gunzenhausen to the Danube near Eining. The original appearance of the palisade and towers can be guessed from reliefs on the column of emperor Marcus Aurelius at Rome. The palisade was replaced under Caracalla (212–217) by a stone wall east of Lorch and supplemented by an earth wall (*vallum*) and ditch west of it. The Alamanni broke through the *limes c.* 260 and the Roman frontier was withdrawn to the Rhine and Danube once more.

The *limites* in Britain are Hadrian's Wall (*q.v.*) between the rivers Tyne and Solway and, farther north, the turf wall of Antoninus Pius (*see* BRITAIN: *Roman Britain*) between the rivers Forth and Clyde. In modern Rumania an earth wall with forts (perhaps built under Domitian) and a later stone wall running from near Cernavoda on the Danube to Constanţa (ancient Tomis) on the Black sea are the most conspicuous signs of the *limes* in the Dobruja area, part of the lower Danube defenses. From 106 to *c.* 270 these were extended northward to include Dacia (*q.v.*); on the east, lines of forts have been traced from the Danube along the Olt river to the Red Tower pass and from Flaminda via Piteşti and Cimpulung to Braşov, and on the west in the Mezeş mountains, especially near Moigrad (ancient Porolissum). The roads and fortifications along the Danube were, however, maintained during the occupation of Dacia.

In Asia Minor a continuous barrier was neither practicable nor necessary, as the Romans controlled the roads and river crossings. In Syria, however, an elaborate *limes* system was established, as

much to control the transhumant native population and the caravan routes as for defense against Parthian or Persian attacks. The chief road, known as *strata Diocletiana* after the emperor (284–305) who reorganized it, ran from Bostra (Busra) via Damascus to Palmyra (*q.v.*) and Sura (Suriya), then down the Euphrates and up the Chaboras (Khabur) river to join the eastern frontier cities of Nisibis (Nusaybin) and Singara (Sinjar). From Bostra another road led southward through Arabia to the Gulf of Aqaba. The eastern end was partly abandoned by Jovian (363), but the main line held until the Arab conquest in the 7th century.

In north Africa control of nomads was also necessary. The network system of roads, forts and watchtowers was adopted, but the defenses also included a continuous barrier, a ditch and either a stone or earth wall. In the 5th century, this was known as the *fossatum*, while the term *limes* was applied to the whole system. Here there is particularly good evidence—ancient irrigation- and field-systems—for the settlement of the *limes* area by *limitanei*, the frontier forces of the later empire, who cultivated land in the *limes* area on condition of manning the *limes*.

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LIMESTONE, a rock containing at least 50% calcium carbonate, $CaCO_3$, but generally not including such rocks that have been recrystallized and chemically altered by metamorphism (*see* MARBLE). Limestones are typically soluble in cold dilute acids and have a specific gravity of 2.6 to 2.8. They are soft, for calcite, the most abundant mineral constituent, has a hardness of only 3, and are white to cream-coloured unless stained yellow or brown by iron oxides or rendered bluish to black by included organic matter and iron disulfide. Limestones are typically well cemented and without large amounts of intergranular porosity, although chalk and calcareous sinter are incoherent and earthy.

Limestone is appreciably soluble in water enriched in organic acids and carbonic acid, such as ground water which has passed through soil. Terrain which is underlain by limestone in humid regions develops underground drainage and the characteristic karst topography, and abounds in caves and sinkholes (*see* CAVE). Limestones are noteworthy in that extensive solution and reprecipitation may take place in them after formation, sufficient in some cases to obscure fossils and other evidence of their manner of formation.

Formation and Composition.—The carbonate portion of limestones consists of mixtures in various proportions of land-derived detrital particles, or debris, of older limestone, fecal pellets of invertebrates, fossils and fragments of partly consolidated limestone torn loose by waves in the depositional environment. These materials are cemented by microcrystalline carbonate ooze and coarser-grained pore-filling calcite cement. With increasing numbers of dolomite (*q.v.*) crystals replacing the calcium carbonate of the rock, limestones grade into dolomitic (*i.e.*, rich in magnesium carbonate) limestones and dolomites. The noncarbonate minerals include detrital quartz and feldspar and resistant minerals such as zircon, garnet and tourmaline. Calcium phosphate and silica are contributed by the shells of some organisms. Well-formed crystals of albite and monoclinic potash feldspar, quartz, pyrite and other minerals which grew in the rock during or after its formation are said to be authigenic. The nodules and bands of chert (flint) which replace limestones can be shown in some cases to have resulted from concentration of silica originally present in organic spicules and tests.

Most limestones are partly or entirely of organic origin. The soft, whitish limestones known as coquinas are composed almost entirely of shells and shell fragments, and were formed in warm shallow water like that around the Bahamas today, where organisms grew abundantly and the waves were able to wash away finer-grained material. Some chalks are largely composed of foraminifera such as *Globigerina*. Another foraminiferal limestone, that made by the disc-shaped *Nummulites*, is famous as the rock from which the pyramids of Egypt were built. Crinoidal limestones are found in older rocks such as the Carboniferous.

Reef limestones were formed by organisms that were able to erect rigid wave-resistant structures in relatively shallow water near upwelling currents rich in nutrients. Corals and calcareous algae are the principal frame builders today in places such as the Pacific atolls and the Great Barrier reef of Australia, but other organisms played this role in the past. Reef limestones are very pure carbonate rocks, and are often dolomitized.

The oölites in oölitic limestones are composed of $CaCO_3$ chemically deposited about nuclei of various kinds. The purer oölitic limestones contain very little fine-grained material and were formed in agitated water like that overlying the underwater oölite dunes near the edge of the Bahaman platform.

The origin of fine-grained limestones is frequently in doubt because of recrystallization of original features. Some probably were formed from the minute remains of primitive unicellular organisms (coccolithophores and rhabdoliths), others from tiny aragonite (*q.v.*) needles like those resulting from chemical precipitation and from the disarticulation of algal remains in the drewite muds of the Bahamas. Fine grained limestones containing appreciable amounts of clay minerals, pyrite and organic matter were formed below the level of wave action where tiny detrital particles could settle out, in a stagnant, oxygen-poor environment suitable for the preservation of organic matter and the formation of pyrite.

Limestones and dolomites associated with beds of anhydrite and salt, as in the rocks of Permian Age west of the great Capitan reef in west Texas and New Mexico, contain very few fossils and are believed to be chemical precipitates from saline waters concentrated by evaporation. The solubility of these carbonates is such that they should precipitate before anhydrite and salt. This sequence of precipitation is observed today in a long narrow inlet on the arid Peruvian coast.

Limestones formed from accumulations of carbonate rock particles carried by streams are found in the Arbuckle mountains of Oklahoma and in the region north of the Alps. Such rocks are uncommon and formed only in regions of high relief and abundant limestone outcrops, for limestone particles are quickly reduced in streams by abrasion and solution. Relatively common along tropical coasts, however, are limestones formed by the cementation of calcareous beach deposits and dunes.

Lakes in regions such as the north central part of the United States, where ground waters contain large amounts of calcium carbonate dissolved from glacial drift, contain fine-grained carbonate-rich deposits precipitated in large part by the activity of fresh-water algae. The deposits in Lake Zurich are made up of seasonal layers or varves which are alternately rich in carbonates and in organic matter. The dolomitic lake deposits of Eocene Age in Wyoming and Utah are also varved but the varied and unusual suite of authigenic minerals here indicates that the lake waters became highly concentrated.

Occurrences of limestone are discussed in articles on the various geologic systems and epochs, as CRETACEOUS SYSTEM; EOCENE AND PALEOCENE, etc., and on states and countries, as INDIANA; JAPAN. (*See* also GEOLOGY; OCEAN AND OCEANOGRAPHY: *Marine Sediments;* SEDIMENTARY ROCKS.)

Uses.—Limestone has a large variety of economic uses. High purity calcium carbonate rock is used in the production of sodium carbonate from sodium chloride (salt) by the Solvay process, the manufacture of aluminum oxide (alumina) by the Bayer process, production of synthetic phenol, calcium nitrate, dyestuffs and intermediates, and the refining of beet sugar by the carbonation process.

It is a food supplement for livestock and poultry and is used in whiting (*see* also CHALK) and as a reactant in the refining of salt brines and the manufacture of glass. The calcination of limestone at temperatures high enough to dissociate calcium carbonate yields both carbon dioxide and lime for commercial use. The latter is used in the construction industries and in manufacturing chemicals including calcium carbide, which is produced by fusing lime with coke in the electric-arc furnace.

Limestones containing impurities of the proper kind and amount are desired for some purposes, although other materials can be mixed with high purity limestone to achieve the same result. The manufacture of portland cement requires one part of shale or clay to three or four parts of limestone. Natural cement is made from rock containing 10% to 22% silica and 4% to 16% aluminum oxide and iron oxide. Rock wool manufacture requires 45% to 65% calcium carbonate (or magnesium carbonate), with the remainder of the rock principally silica.

Limestones may be phosphatic because of original concentrations of phosphatic shells or pellets. On some Pacific islands they become phosphatized from the replacement of carbonate by phosphates removed by ground water from guano. Such rock-phosphate is used for artificial fertilizers. Limestones, because of their susceptibility to attack by acid hydrothermal solutions, are also hosts for deposits of many valuable metals. Like other sedimentary rocks, they may contain accumulations of petroleum and natural gas.

Rocks high in dolomite are used for the manufacture of Epsom salts, of basic magnesium carbonate, which is mixed with asbestos for an insulating material, and of high-magnesium lime which is used in the building industry and in the production of certain chemicals such as magnesia. Dead-burned dolomite is used for patching and repair of basic open-hearth furnaces and for electric furnace bottoms.

There are many applications for which either limestone or dolomite may be used. These include monuments, exterior and interior facings and floors in buildings, flagstone for walks, and chips for roofing, stucco, etc. Crushed rock is used for railroad ballast, riprap fill around the base of dams, piers, etc., filter beds in sewage treatment and surfacing for airports, playground, tennis courts, etc. It is employed extensively in road construction, either alone or mixed with cement or bitumen, and as aggregate in making concrete for buildings and other structures. Agstone (crushed limestone for agricultural and other uses) is employed to regulate soil acidity, to improve soil structure, and to furnish nutrients. Used as fluxes in blast furnaces producing pig iron, during the manufacture of steel in basic open-hearths, and in nonferrous metal smelters, limestone and dolomite combine with impurities to form a slag which can be removed. More finely ground material is added as a filler and conditioner in fertilizers and is employed in the manufacture of paper by various processes.

The specifications for carbonate rock vary greatly with the particular application. Colour is particularly important for many uses of whiting substitutes. Poultry grit should contain less than 0.1% fluorine. A low iron oxide content is particularly important in glassmaking, and building stone used on exterior surfaces should not contain pyrite or marcasite which would yield iron oxide stains on weathering. The total carbonate content is of cardinal importance for agstone. Resistance to repeated freezing and thawing is important for flagstone, for concrete aggregate, and for crushed rock in riprap and railroad ballast. Resistance to abrasion is a required quality of limestone for floors and for road surfaces. Limestones are preferred to dolomite for use in the neutralization of acidic sewage and industrial wastes because of higher reaction rate.

See QUARRYING; STONE; *see* also references under "Limestone" in the Index. (D. L. G.)

LIMICOLAE, in former classifications an order or suborder of shore or wading birds, now known as the suborder Charadrii, including jaçanas, snipes, oyster catchers, lapwings, plovers, woodcocks, sandpipers, stilts, avocets, phalaropes, pratincoles and sheathbills (*qq.v.*).

LIMINA APOSTOLORUM (literally, "The Thresholds of the Apostles"), an ecclesiastical term used to denote Rome and especially the church of St. Peter and St. Paul. A *Visitatio Liminum* might be undertaken *ex voto* (in accordance with a vow) or *ex lege* (in accordance with a law). In 743 a Roman synod decreed that all bishops subject to the metropolitan see of Rome should meet personally every year in that city to give an account of the state of their dioceses. Gregory VII and Sixtus V greatly enlarged the number of bishops subject to this law and Benedict XIV in 1740 extended the summons to all abbots, provosts and others who held territorial jurisdiction. Under the regulation of Pius X established in 1909, the *Visitatio ad Limina Apostolorum* must be made, either personally or by representative, by all ordinaries and vicars apostolic who have jurisdiction; the periods are five years for those whose dioceses are in Europe and ten for those outside Europe. During the middle ages *ex voto* pilgrimages *ad Limina Apostolorum* were popular among laymen.

LIMING is the application of lime (calcium) materials to cropland soils to improve productivity. The principal effects are: (1) to supply needed calcium and (2) to reduce soil acidity. This practice was known long before the Christian era and has been used since the beginnings of agricultural history (*see* LIME: *History*). It was not, however, until the early years of the 20th century that the underlying chemical principles began to emerge. By mid-20th century, the liming of noncalcareous soils in the humid regions of the world had become a most important land-use practice.

Chemically, liming materials are chiefly carbonates of calcium. They are found abundantly in nature as limestone, dolomite, chalk, marl (*qq.v.*) and shell, as well as in other forms. The soft forms, as chalk, can be prepared readily for applying and mixing with soils. The stone forms are of little use until reduced to suitable particle sizes. At one time this was done by burning and slaking. The development of rock crushing, screening and applying equipment in the first half of the 20th century quickly expanded the use of liming materials. With these developments, the amount applied to U.S. soils, to take one example, reached 25,000,000 tons annually.

Both crops and soils are involved in the need for and usefulness of liming materials. Crops require soil-derived calcium in various amounts and vary in their ability to obtain the supplies they need from different soils. For instance, buckwheat, a high-calcium requiring crop, can obtain its supplies from soils of low-supplying powers, while sweet clover, with a moderate requirement, does best on soils of high-supplying powers. Some reasons for such behaviour are: differences in feeding capacities; in ratio balances between basic and acidic soil components; and symbiotic effects which bring atmospheric nitrogen into the plant without accompanying basic components. Soils vary in their supply of calcium and in ability to release it, largely according to the variable amounts of clay-mineral complexes developed in the soil by soil-forming processes. These clays are characterized by various capacities for holding and exchanging basic chemical substances in which calcium and hydrogen are dominant.

In productive soils a large proportion of calcium is released to crops and drainage waters. Liming materials, if present, provide replacements; if not present, hydrogen is substituted and acidity begins to develop. As the acidity intensifies soils become less favourable for crop production: nutrient availabilities decline, soil micro-organisms are handicapped in their activities, substances toxic to plants may develop and physical conditions appear that lead to tillage, drainage and erosion difficulties. Well-planned liming practices will do much to correct these difficulties and to prevent their recurrence.

Liming practices are based chiefly on the principle of correcting acidity by supplying sufficient calcium to satisfy the base exchange requirements of soils for high productivity. Soil tests for acidity (pH) provide guiding information. Where low-cost limestones are abundant, a product with particle sizes ranging downward from an eighth of an inch to dust may be applied in larger amounts for immediate and long-time efficiency. Subsequent applications may not be needed for periods ranging upward from 4 years to as much as 12 or more years. Used in this manner, liming practices will do much to keep soils physically fit, chemically balanced and biologically active for continuing high productivity. *See* also FERTILIZERS AND MANURES; SOIL.

(F. C. BR.)

LIMIT, a concept fundamental in mathematical analysis, occurs in so many contexts that its general definition can only be given in the setting of general topology. Here will be given a sketch of its origin and principal occurrences. Among the an-

cients the method of exhaustion (so-named in modern times) was the precursor of the theory of limits; it was employed by Euclid and Archimedes in proofs of theorems concerning figures with curved boundaries. A circle, for example, may be approximated by a sequence of inscribed regular polygons (fig. 1), beginning with the square ABCD and the octagon AEBFCGDH and so on, each figure having twice as many vertices as the preceding. If each polygon is regarded as having removed its area from that of the circle, it seems clear that the latter is progressively exhausted, in the sense that the remaining area becomes smaller than any previously assigned amount, however small. If p_1 is the perimeter of ABCD, then $\left(\frac{p_1}{2}\right)a_1$ is the area of ABCD;

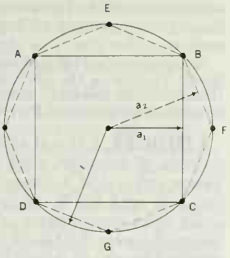

FIG. 1.—METHOD OF EXHAUSTION: POLYGONS APPROXIMATING THE CIRCLE

if p_2 is the perimeter of the octagon, then $\left(\frac{p_2}{2}\right)a_2$ is its area; and in general, $\left(\frac{p_n}{2}\right)a_n$ is the area of the nth approximating polygon. In modern language one would say that a_n becomes arbitrarily close to r, the radius of the circle, and p_n becomes arbitrarily close to $2\pi r$, the perimeter of the circle, as n increases. Thus $\left(\frac{p_n}{2}\right)a_n$ approaches $\left(\frac{2\pi r}{2}\right)r$ or πr^2, which must therefore be the area of the limiting configuration, the circle.

This sort of argument was characteristic of the 18th century; actually, the ancients argued more closely: to prove the area of the circle could not be *less than* πr^2 they would imagine by way of contradiction that it was, say, πs^2, with s less than r. Then an approximating polygon could be shown to exist whose area exceeded this amount. The part being less than the whole (for the polygon lay within the circle), this was impossible. That the area could not be *greater than* πr^2 could then be proved using circumscribed polygons, which exhausted the exterior of the circle. In the argument sketched here, there is not the slightest appeal made to notions of the infinite. The construction of polygons need not be pushed "to the limit"; some one finite polygon can be shown to produce the desired contradiction (*see* SCIENCE: *Alexandrian Science: First Period, 300–30* B.C.).

Something, if not most, of the finite flavour of such rigorous argument was lost when, in the 17th century, the notion of limit appeared in the work of Newton, Leibniz and their successors in the development of the calculus. It seemed convenient, for example, sometimes to regard a curve (such as a circle) as a polygon of an infinite number of sides, each of infinitesimal length. Arguments based on such apparently nonsensical notions yielded results of such richness and scope that the ideas of the "infinitesimal calculus" survived the most devastating (and just) philosophical attacks. Yet errors and paradoxes occurred which were the work of a later era to resolve.

For example (fig. 2) the broken line ACB has twice the length of AB. So does ADEFB. So does AGHIEJKLB. If this process is continued, the area between the broken lines and AB diminishes to zero, and AB is clearly the limiting configuration. It might be argued that AB should therefore have twice its own length, because all the approximations do. This paradox is the result of the mistaken idea that the limiting configuration must have properties which are the limiting cases of the corresponding properties of the approximating configurations. By such reasoning, however, one would have also to claim that AB had an infinite number of corners, each a 60° angle.

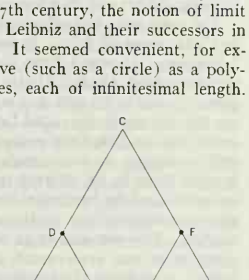

FIG. 2.—LIMIT PARADOX: THE POLYGONS APPROXIMATING STRAIGHT LINE AB ARE ALL TOO LONG

Beginning with the work of Augustin Cauchy on the convergence of infinite series the 19th century carried to completion the work of arithmetizing analysis. The notion of limit, previously quasi-geometrical, was put into numerical language and divested of all trace of the language of "ultimate behaviour."

Arithmetical Theory of Limits.—If $a_1, a_2, a_3, \ldots, a_n, \ldots$ is a number sequence, we say it has the limit L if the following statement is true: for every positive number ϵ, however small, there corresponds an index p such that if $n > p$ (n greater than p), then $a_n - L$ is less than ϵ in absolute value. Thus, for example, if $a_n = \frac{n}{n+1}$, *i.e.*, if the sequence is $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \ldots$, the limit L is clearly 1 because $a_n - L = \left(\frac{n}{n+1}\right) - 1 = \left(\frac{-1}{n+1}\right)$, whose absolute value is surely as small as any ϵ that might be named, once n is chosen answeringly large. In symbols, one writes

$$\lim_{n \to \infty} \left(\frac{n}{n+1}\right) = 1$$

Other sequences do not have so obvious a limit; a famous example is where $a_n = \left(1 + \frac{1}{n}\right)^n$. Here the limit is conventionally named e, and is approximately 2.71828. The proof, in this case as in many others, that a limit does exist makes use of the criterion of Cauchy: a sequence a_n has a limit if and only if to each positive ϵ there corresponds an index p such that $a_n - a_m$ is less than ϵ in absolute value whenever m and n both exceed p. Georg Cantor (about 1880) made this criterion a part of the definition of real number. If f is a real function, that is, if for each real number x there corresponds a real value $f(x)$, we say

$$\lim_{x \to a} f(x) = L$$

if the following statement holds: for every positive number ϵ, there is an interval I surrounding a (say all real numbers between $a - \alpha$ and $a + \alpha$) such that if x is in I, but x is not a itself, then $f(x) - L$ has absolute value less than ϵ. This definition gives precision to the intuitive notion "$f(x)$ is near L when x is near a" and makes possible the rigorous proof of the theorems connecting the limit-taking operation with the more usual arithmetic procedures. These theorems are at the root of the utility of the calculus.

Generalizations.—The statements "$f(x)$ is near L when x is near a," and "a_n is near L when n is far out," whose precise definitions are given above, continue to have meaning even when the quantities involved are not real numbers or integers but instead are members of more general structures in which appropriate notions of nearness and far-outness have been defined. Nearness takes on meaning in all topological spaces, of which the real numbers, the complex numbers, and most geometric configurations are examples; and far-outness takes on a useful meaning in many ordered sets, of which the integers form an example.

See ANALYSIS; CALCULUS, DIFFERENTIAL AND INTEGRAL; INFINITE PRODUCTS; INFINITESIMAL; NUMBER; SERIES; TOPOLOGY, GENERAL. *See* also references under "Limit" in the Index.

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LIMITATION, STATUTES OF, the name given to legislative acts restricting the times within which legal proceedings may be brought. Typically these statutes limit the time within which an action may be commenced to a fixed period after the occurrence of the events which gave rise to the cause of action, the length of the period varying with the nature of the action. These statutes, found in all systems of jurisprudence, are designed primarily to attain a degree of stability in the ordering of human affairs. It is commonly said that they are statutes of repose, enacted to protect

against stale claims after evidence has been lost, memories have faded or witnesses have disappeared.

In English-speaking jurisdictions, civil actions commonly are limited by general statutes which classify the actions into broad groups, such as those for the recovery of real property, actions on written contracts, actions on oral contracts and actions arising from torts. Although the periods prescribed are arbitrary, the classification bears a rough relation to the times for which reliable evidence of the respective transactions may be expected to endure. The bringing of actions for the recovery of real property and of actions on contracts under seal commonly is limited to periods of from 10 to 20 years after the cause of action arose. Actions on oral or simple written contracts usually are limited to periods of from three to six years, and those for personal injury to three years or less. There is considerable variation in the periods prescribed in different jurisdictions. Supplementing these general statutes of limitation are a large number of special acts which limit the times within which particular actions, or actions by or against particular parties, may be brought. Thus, in North Carolina and Tennessee an action for slander must be commenced within six months after the cause arose; in New York, the state may bring an action to recover land at any time within 20 years. In addition to actions for slander, actions for claiming forfeitures or penalties and those against certain public officials frequently are restricted by short periods of limitation. Proceedings involving the administration of the estates of decedents also are subject to short limitation periods, normally measured from the appointment of the executor or administrator. Special statutes, where applicable, replace the periods prescribed by the general limitation acts. In Great Britain virtually all civil limitation enactments are gathered in the Limitation act of 1939 (2 & 3 Geo. VI, c. 21) as amended by the Law Reform (Limitation of Actions) act of 1954 (2 & 3 Eliz. II, c. 36). Under these acts most limitations are standardized at either 3, 6 or 12 years.

General statutes of limitation uniformly include provisions allowing persons who are under a legal disability at the time a cause of actions accrues to bring the action within some fixed period after the disability has been removed. Infancy, imprisonment and insanity commonly are included in the disabilities so treated. A disability arising after the accrual of a cause of action will not suspend the running of the period of the statute; it must have existed at the time the cause of action arose. Fraud on the part of the defendant which prevents the plaintiff from discovering the existence of a cause of action prevents the running of the statute until the facts reasonably might have been discovered. Similarly, the period of the statute does not run while the defendant is outside the jurisdiction and thus beyond the reach of its courts, whether the defendant's absence exists at the time the cause of action accrues or occurs thereafter. The part payment of a debt, or other acknowledgment of it, generally is held to start the period of the statute running anew; but statutes in Great Britain and in about half of the states of the U.S., derived from Lord Tenterden's act (9 Geo. IV, c. 14), require a mere acknowledgment of a debt to be in writing and signed by the party to be charged before it will have that effect.

In civil actions, statutes of limitation have been held not to be applicable to a government suing in its own courts, an exception based on the theory of sovereignty. However, in many instances, legislatures have waived this governmental immunity by express statutory enactments.

General statutes limiting the times within which prosecutions for crimes must be begun are common in the Continental countries and in the United States. In the United States the periods normally are shorter than in Europe and the limitations are restricted to misdemeanours and, sometimes, minor felonies. As in the case of limitations on civil actions, the period prescribed in a criminal statute of limitation does not run in the case of a defendant who has fled or concealed himself in order to avoid prosecution. In England there is no general statute of limitation applicable to criminal actions, although statutes creating crimes frequently have included a time limit for the prosecution of the particular crime.

Statutes of limitation appeared early in Roman law and these are the basis of the limitations found in the Continental codes. In England a fixed period of limitation on actions to recover land was first established in 1540 (32 Hen. VIII, c. 2). The Limitation act of 1623 (21 Jac. I, c. 16) established limitations for personal actions, as well as for those for the recovery of real property. Later general statutes of limitation, English and U.S., have been modeled rather closely on this act.

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(C. C. CA.)

LIMOGES, a city of south central France, capital of the old province of Limousin, chief town of the *département* of Haute-Vienne and seat of a bishop, is situated on the Vienne river 375 km. (233 mi.) S.S.W. of Paris by road. Pop. (1962) 113,378. Lying in an amphitheatre of hills which face south, it is about halfway between the Massif Central and the Atlantic. Boulevards surround the site of the old town, which is crossed by the modern Rue Jean Jaurès. There is the cathedral of St. Étienne, a 13th-century building with a fine choir and choir screen, and a noteworthy apse and portal. The church of St. Pierre dates from the 12th and 13th centuries; that of St. Michel des Lions (14th and 15th centuries) has a tower 198 ft. high, with a spire surmounted by an enormous bronze ball. It contains the relics of St. Martial, patron of the town. Both churches contain 15th- and 16th-century stained glass. Also of interest are the former Jesuit college (17th and 18th centuries), the presidential court (18th century) and the former bishops' palace (18th century) with fine gardens and terraces overlooking the valley of the Vienne. Of the bridges over the river, those of St. Martial (4th-century foundations) and St. Étienne (13th century) are outstanding. Among modern buildings, the most important are the town hall (1883), the law courts, the railroad station (1929) and the municipal sports ground (1946–59). Limoges is well supplied with educational establishments. There are a municipal library and two museums—the Adrien Dubouche National Museum of Ceramics, the richest in France after Sèvres, and the municipal museum in the former bishops' palace, which has a collection of old enamel.

Limoges is on the main railway from Paris to Toulouse; other lines run to Bordeaux, Angoulême, Montluçon and Clermont-Ferrand. The chief industry is the manufacture of porcelain, which goes back to the second half of the 18th century. Enamelware, shoes, gloves, paper and furniture are also manufactured, and precision engineering, weaving and printing are carried on. The discovery of uranium in Limousin opened new vistas for the industrial activity of the region. Limoges is the centre of the stock-farming district and thus is important in the meat trade.

The town owes its beginnings to a ford across the Vienne, hence its Celtic name of Ritu. It was the capital of a Gallic tribe, the Lemovices. It sent a large troop under Sedulix to help Vercingetorix defend Alesia. Under Roman rule the town added Augustus' name to its own and was known as Augustoritum, but in the 4th century it was called Lemovice. It was an important road centre and at that time possessed palaces and thermal baths as well as having its own senate and currency. Christianity was brought there by St. Martial early in the 4th century. The town was destroyed by barbarian invaders in the 5th century, and the survivors built a town on the rock where the cathedral was later erected. This was known as the "city." In the 9th century another town was constructed about 2,000 ft. away, the "castle town"; it enclosed the castle of the counts and the abbey of St. Martial (demolished in 1794) in the old crypt of which was found St. Martial's tomb. The two towns, one under the bishops' authority, the other under the abbots', then the viscounts' and finally the consuls', remained separate until 1792. In the Hundred Years' War the castle town came under the English while the city remained loyal. In 1370 the city was besieged, stormed and sacked by the Black Prince. In the middle ages Limoges was famous for the work of its enamelers and goldsmiths. It was also an important centre for manuscripts made by the monks of the abbey of St. Martial. Plague, famine and the wars of religion devastated the

town until the 16th century, but under great administrators, especially the marquis de Tourny and A. R. J. Turgot in the 18th century, the town recovered its former prosperity.

Every seven years Limoges celebrates the feast of the Ostensions when the relics of St. Martial are exposed for seven weeks and attract numerous visitors. These ceremonies go back to the 10th century and commemorate the miracle by which the saint is said to have halted an outbreak of the plague.

See also references under "Limoges" in the Index. (R. DA.)

LIMÓN, principal Caribbean port of the republic of Costa Rica. Pop. (1960 est.) 15,806. Located in the vicinity of the land seen by Columbus in 1503, Limón was used alternately with other small ports by Spanish colonial merchants as well as smugglers and was the occasional target of pirate and Mosquito Indian attacks. It began to grow in importance after the end of the William Walker filibustering era (*see* WALKER, WILLIAM) and about 1867 the port was opened to foreign commerce. Under the leadership of Minor Keith, an American, a railroad through very difficult terrain finally joined Limón and San José in 1890. Construction cost 4,000 lives and about $8,000,000. Much of the construction was done by West Indian Negroes who, until the 1940s, were prohibited by law from migrating to other Costa Rican provinces. The banana industry was developed along the tracks to provide a cash cargo, and by 1900 the United Fruit company had taken the lead in this business.

The chief business of Limón is exporting and importing and it yearly handles more freight than any other port in Costa Rica. Limón is the capital of Limón province, area 3,591 sq.mi., pop. (1960 est.) 59,240. The province is an area of heavy rainfall (about 100 in. annually) that produces sugar cane and two corn crops a year. The region suffered from Panama disease in the 1930s, banana production fell drastically and about 100,000 ac. of banana land were abandoned as the companies moved to the Pacific coast of Costa Rica. (T. L. K.)

LIMONITE, a natural hydrated ferric oxide, is one of the major iron-bearing minerals. The name is from the Greek word for meadow, in allusion to its occurrence as bog ore in meadows and marshes. Limonite was originally considered to be one of a series of hydrated ferric oxides, some with specific names, including turgite, limonite, xanthosiderite and limnite. Investigation showed, however, that there is only one hydrated form, $Fe_2O_3{\cdot}H_2O$. This compound is dimorphous, and occurs in two crystalline forms which differ in the nature of the hydrogen-oxygen bonds, and whose formulas may be written as follows: goethite, $HFeO_2$ and lepidocrocite $FeO(OH)$. It was then assumed that limonite was this monohydrate in an amorphous condition, but X-ray studies clearly established the fact that most of the so-called limonite, especially the type with a radial fibrous structure, is distinctly crystalline, and is actually goethite.

The name limonite should properly be restricted to impure hydrated iron oxide, with variable water content, and colloidal or amorphous in character. It is sometimes pitchlike or has a vitreous lustre, with a black colour, occurring in stalactitic or botryoidal forms; or more commonly as earthy or porous masses, brown to yellow in colour (yellow ochre). The streak is yellow-brown. The hardness may be as high as 5.5, but usually is apparently less. It is commonly mixed with clay, sand and manganese oxide. It is formed as an alteration product of other iron minerals, such as the hydration of hematite or the oxidation and hydration of siderite and pyrite. *See* also GOETHITE; IRON AND STEEL INDUSTRY: *Iron Ore.* (L. S. RL.)

LIMOSIN (LIMOUSIN), **LÉONARD** (*c.* 1505–*c.* 1577), French painter best known for his fine portraits in enamel, the most famous of a family of seven enamel painters of Limoges, was the son of an innkeeper in that city. He was influenced at the beginning of his career by the German school; indeed, his earliest authenticated work, signed "L. L." and dated 1532, is a series of 18 plaques of the "Passion of the Lord," after Albrecht Dürer. But this influence was counterbalanced by that of the Italian masters of the school of Fontainebleau, Primaticcio, Rosso, Giulio Romano and Solario, from whom he acquired his taste for arabesque ornament and mythological subjects. Nevertheless, the French tradition was sufficiently ingrained to save him from becoming an imitator. In 1530 he entered the service of Francis I as painter and *varlet de chambre,* a position which he retained under Henry II. For both these monarchs he executed many portraits in enamel—among them plaques depicting Diane de Poitiers in various characters—plates, vases, ewers and cups, besides decorative works for the royal palaces, for, though he is best known as an enameler distinguished for rich colour, and for graceful designs in grisaille on black or bright-blue backgrounds, he also enjoyed a great reputation as an oil painter. His last signed works bear the date 1574, but the date of his death is uncertain, though it could not have been later than the beginning of 1577. He executed nearly 2,000 enamels. He is best represented at the Louvre, which has his two famous votive tablets for the Sainte Chapelle, each consisting of 23 plaques, signed "L.L." and dated 1553; and many portraits. *See* also ENAMEL: *Origin and European Development.*

LIMOUSIN, a geographical region and, in a more limited sense, a historic province of France. For the geographer, Limousin is the western part of the Massif Central; *i.e.,* the wide zone of Archean and primary rocks that spreads from the upper valleys of the Cher and the Dordogne, over the three *départements* of Haute-Vienne, Corrèze and Creuse (*qq.v.*) and the *arrondissements* of Confolens in Charente and Nontron in Dordogne. Little affected by the Tertiary earth movements, it consists mostly of peneplains or rolling plateaus and falls slowly from 3,018 ft. in the Montagne Limousine to 1,000 ft. in the west; yet it is a hilly country with deep river valleys. The rough climate and the low fertility of the acid topsoils gave it a reputation for poverty.

Limousin, as well as its chief town, Limoges (*q.v.*), takes its name from that of the Lemovices, whose territory in prehistoric Gaul was probably at least as large as the geographical region. Subdued by the Romans in 49 B.C., the tribal community or *civitas* of the Lemovices was included in the province of Aquitaine in 27 B.C. Under Frankish rule from A.D. 507, the pagus Lemovicinus, or Limousin district, was disputed by rival Merovingian kings; and from 760 to 768 the Carolingian king Pepin and Waifer of Aquitaine fought over it. With the growth of feudalism, however, the country lost its administrative unity. By the middle of the 11th century the viscounts of Limoges (recorded from 876) had scarcely more authority than the viscounts of Comborn, of Turenne and of Ventadour; border zones of the old pagus were annexed by the counts of Poitiers, of Auvergne and of Angoulême; and as early as 944 the northern areas of the pagus were erected into the separate countship of Marche (*q.v.*).

The feudal disruption of Limousin in the middle ages was offset by three factors. First, there was the continuing prestige of the bishops of Limoges, whose diocese was undiminished and who played a role both as protectors of the people and as mediators in dynastic conflicts. Second, Limousin preserved its cultural tradition, thanks not only to its great abbeys, such as that of St. Martial at Limoges, but also to its possession of an individual dialect, which was taken as a model by the troubadours. Third, the local feudatories themselves, however envious they were of each other, were drawn mainly from indigenous stock and closely intermarried. A concrete manifestation of the regional culture is provided by the enamels of Limoges, renowned from the 12th century (*see* ENAMEL).

The marriage of Eleanor of Aquitaine to the future Henry II of England (1152) brought suzerainty over Limousin to the Plantagenet dynasty. In the ensuing Anglo-French wars the local viscounts transferred their allegiance according to expediency. Philip II Augustus and Louis VIII recovered Limousin for France; but by the treaty of Paris (1259) Louis IX conceded to Henry III of England such rights as Henry II had enjoyed over fiefs and domains within the boundaries of the diocese of Limoges—an arrangement fraught with controversy because the lands in question were not enumerated and because the local lords could appeal over the English king's head to his French suzerain. Consequently the French retained their hold on Limousin. With the Hundred Years' War the English began incursions; and the whole country was ceded to them in full sovereignty under the treaty of Brétigny

(1360). The French reconquest, started in 1370, was complete by 1374; later English counterattacks, baronial rebellions and devastation by mercenary companies had only a temporary effect.

In the last centuries of the *ancien régime* the intendant of Limoges was responsible for a *généralité* established from 1586 to comprise Angoumois and Basse Marche, as well as the province or military *gouvernement* of Limousin, which was coextensive with the territory of the four feudal viscounties. The viscounty of Limoges, having passed by marriage through the houses of Comborn, of Brittany and of Blois to that of Albret, was formally annexed to the French crown by Henry IV in 1607, but Turenne survived as a fief till the house of La Tour d'Auvergne sold it to the French crown in 1738. In the 18th century the intendants worked to develop the economy and produced a fine system of roads; and the manufacture of porcelain was begun at Limoges and at St. Yrieix-la-Perche. Yet the country was poor and backward at the time of the French Revolution. Dissolved into *départements* in 1790, the country as a whole did not begin to prosper till the construction of railways (from the 1850s onward). Then the import of fertilizers led to a great expansion of agriculture and stock raising, while industrial products (porcelain and footwear) found markets throughout France. During World War II, there was widespread guerrilla warfare in the region.

LIMPKIN (*Aramus guarauna*), a large raillike bird of the Americas, constituting the family Aramidae, closely related to the crane (*q.v.*). It is 28 in. long and brown with white spots from head to wing bases. Called also courlan or crying bird from its loud, prolonged, wailing cry, and limpkin from its peculiar halting gait as it hunts along the ground, it ranges the lowlands from central Argentina north to the southeastern U.S., Puerto Rico and Hispaniola. One race (*A. g. pictus*) is resident in the Florida peninsula and southern Georgia (Okefenokee swamp). It is found along borders of wooded streams, bayous, sloughs or in open marshes, sometimes uplands, where it runs raillike through brush with long strides or perches on small trees. The limpkin flies like a crane, with short concave wings slowly flapping, neck extended and legs dangling. It feeds on mollusks, crustaceans, aquatic insects, frogs and worms. In the Everglades it feeds chiefly on large, greenish fresh-water snails (*Ampullaria*). These, carried to its nest or favourite feeding perch and held firmly in one foot, are struck several powerful blows with the four-inch bill; the bill is then forced into the spiral opening of the shell to pull out the animal. The bulky nest of leaves, twigs and Spanish moss is found among grasses or shrubs, or in a low tree over or near water; the eggs, four to six, rarely eight, are buff splashed with brown and drab. (G. F. Ss.; X.)

LIMPOPO (Crocodile or Krokodil), a river of southeast Africa and, next to the Zambezi, the longest river of Africa entering the Indian ocean. Parts of it are also known by the local names of Oori and Bembe. The name Limpopo is thought to be connected with an African word, *uku popozi* ("to rush"), but this connection is conjectural. The river, whose length is about 1,100 mi., rises on the northern slopes of the Witwatersrand in the southern Transvaal, where its upper course is known as the Krokodil, a name sometimes applied to the whole river. It flows northward transversely to the Magalies mountains, through which it cuts at the Hartebeestpoort gap, the site of a dam. To the north of the Magaliesberg the river flows across the Bushveld basin (*see* South Africa, Republic of: *Physical Geography*). Passing into the open granite country, the Crocodile is joined by the Marico river, after this confluence being known as the Limpopo. About 33 mi. farther downstream it is joined on its right bank by the Notwani, a headwater from the Kalahari.

Farther north the river enters country made rugged by outcrops of Waterberg sandstone and other hard formations where it receives two large right-bank tributaries, the Palala and the Magalakwin, and on the left bank the Maklautsi. Below the Maklautsi confluence the river receives the Shashi and turns eastward in the direction of the faulting of the Limpopo trough, which extends to the Mozambique boundary. Near Liebig's drift, a mile or two above the Beitbridge, which connects Southern Rhodesia with the Republic of South Africa, the river forms the Tolo Azimé cataract, in which it falls about 40 ft. over a dolerite dike intruded into the Primitive rocks of this part of the basin. From this point to a little above the Pafuri confluence, nearly 100 mi. downstream, is the fall zone, in which the river passes from the plateau surface to the Mozambique plain. The three largest cataracts, according to W. Ramke, the South African geographer, are at Malala drift (about 30° 35′ E.), Molukwe (about 30° 40′ E.) and, a little lower, at Quiquequi, the total fall in the zone being about 800 ft., most of it concentrated in 27 mi. of rapids.

Below the Pafuri confluence the Mozambique plain is broken by ridges and *kopjes;* at the confluence of the Olifants the plain is much more even, becoming increasingly flatter toward the coast. The river gradient near the mouth is low, the plain being liable to frequent flooding. The mouth is partially blocked by a sand bar, but a channel about 200 yd. wide and 8 ft. deep at low-water spring tide allows coastal steamers to enter the river at high tide and reach the town of Vila de João Belo (generally known as Chai Chai) without navigational difficulties.

Occupying about one-fifth of the Limpopo basin, its major tributary, the Olifants, enters the Bushveld basin at Loskop, north of Middelburg, where it is dammed. After flowing through the eastern part of the basin floor it turns eastward and cuts successively gorge after gorge through the quartzites and limestone of the eastern margin of the basin and the Transvaal Drakensberg, joining the Limpopo 50 mi. E. of the Lebombo range.

The Limpopo has not been gauged to any considerable extent except in the upper reaches. At the Hartebeestpoort dam the Crocodile headwaters have a mean annual discharge of 124,000 ac.ft. (1 ac.ft. = 43,560 cu.ft.). The flow is at a maximum in February (21,000 ac.ft.) and a minimum in August (4,000 ac.ft.). The dam has an approximate capacity of 136,000 ac.ft., which irrigates about 33,000 ac. around Brits in the Bushveld basin, the main crops being wheat and tobacco. The general regimen of the Limpopo in its middle and lower courses is, however, fairly well known. The maximum flow is generally in February or March, the minimum in August or September. In the winter months the bed may contain a series of pools with little or no connecting flow. Summer floods are sometimes of astonishing proportions, as in 1933 when the peak flow was 505,000 cu.ft. per second.

On the Olifants river the annual discharge at Loskop dam averages about 539,000 ac.ft., the maximum flow being in February (124,000 ac.ft.) and the minimum in September (11,000 ac.ft.). The dam has a capacity of about 167,000 ac.ft. and serves to irrigate about 24,000 ac. of alluvial ground along the river's course. In other parts of the Olifants basin about 14,000 ac. are irrigated by tributaries of the Olifants, including the Zebediela estate where 5,500 ac. of citrus groves are watered by the Gompies river in the northern part of the basin.

In Mozambique the Limpopo is dammed about 100 km. (62 mi.) from its mouth by a barrage about 22 km. (14 mi.) above the village of Guijá, the barrage serving also as a bridge for the Mozambique-Southern Rhodesia railway. The complete Guijá scheme was designed to bring 74,000–99,000 ac. under the furrow, the European plots to be worked by Portuguese labour alone and the African plots by African labour. The scheme was inaugurated in 1955 by the settlement of a pilot nucleus of 50 Portuguese families and 319 African families on the irrigated land. By the end of the 1950s wheat, rice and other crops had been successfully produced. The development of other riparian areas below Guijá was planned.

Though claiming the territory through which it ran, the Portuguese made no attempt to trace the river, which was called Rio do Espiritu Santo by Vasco da Gama in 1497. Capt. J. F. Elton, traveling from the Tati gold fields in 1870, was the first to seek an open road to the sea via the Limpopo. He voyaged down the river from the Shashi confluence to the Tolo Azimé cataract, which he discovered, following the stream thence on foot to the low country. The lower course of the river had been explored 1868–69 by another British traveler, St. Vincent Whitshed Erskine.

See W. Ramke, "Down the Limpopo," *S. Afr. Geogr. J.*, xv (1932).
(J. H. Wn.)

LINACEAE, the flax family of dicotyledonous herbs and shrubs, the most important genus of which is *Linum,* comprising cultivated flax and several species of garden plants. *See* LINUM; FLAX.

LINACRE, THOMAS (*c.* 1460–1524), English humanist and physician, founder (1518) and first president of the Royal College of Physicians, was probably born *c.* 1460 at Canterbury, Kent. Educated at the universities of Oxford and Padua, he was fully imbued with the "new learning" and *c.* 1501 was called to court as tutor to Prince Arthur. On the accession of Henry VIII he was appointed the king's physician and he also treated most of the great statesmen and prelates. He made benefactions to medical teaching at Oxford and Cambridge, wrote a Latin grammar and a work on Latin composition and published Latin translations of several of the works of the Greek physician Galen. He died in London on Oct. 20, 1524. An intimate friend of Erasmus, Sir Thomas More, John Colet, William Grocyn and others, Linacre is the prototype of the great scholar physicians of the Renaissance.

See J. N. Johnson, *Life of Thomas Linacre,* ed. by R. Graves (1835). (W. J. BP.)

LINARES, inland province of central Chile. The province was separated from Maule province in 1873, reabsorbed in 1927 and recreated in 1936. Area 3,635 sq.mi. Pop. (1960) 170,278. The province consists of central valley and Andean cordillera terrain, all lying within the Maule drainage system. In the rolling central valley soils are not outstanding, but the province is of major agricultural significance because there is an abundance of water for irrigation. It ranked high in wheat and in wine and flax production, in *chacareria* area (beans, corn, chick-peas, potatoes, peas and lentils), and in rice and sunflower acreage. The San Javier-Villalegre district is noted for its vineyards. Livestock raising (cattle and sheep) is general. Crops are processed and shipped through the market and administrative centres of San Javier (pop. [1960] 8,541), Parral (12,973) and Linares (27,568), the provincial capital. The towns are served by the state railway; at Parral the Cauquenes (Arauco province) branch line begins. The longitudinal highway also traverses the province, and lesser lateral roads lead to spas at Longaví, Panamávida, Catillo and Quinamávida. Although the city of Linares was founded as San Javier de Bella Isla (1755) and renamed Villa de San Ambrosio de Linares (1794), its present name became official in 1875. (J. T.)

LINARES, a town in the province of Jaén, region of Andalusia, southern Spain, lies among the southern foothills of the Sierra Morena, 5 km. (3 mi.) N.W. of the Guadalimar river and 53 km. (33 mi.) N.E. of Jaén by road. Pop. (1960) 60,068 (mun.). Linares is connected by branch railways with the argentiferous lead mines on the northwest, and with the main railways from Madrid to Seville, Granada and the principal ports on the southern coast. Its population is chiefly employed in the lead mines and in the manufacture of powder, dynamite, match for blasting purposes and rope. The mining plant is entirely imported, and smelting, desilverizing and the manufacture of lead sheets and pipes are carried on. Linares lead is unsurpassed in quality. About 0.8 km. (½ mi.) S. is the village of Cazlona, with remains of the ancient Iberian settlement of Cástulo. The bullfighter Manolete (Manuel Rodríguez) was killed in the bull ring of Linares. (M. B. F.)

LINCOLN, EARLS OF. This English title was first created for WILLIAM D'AUBIGNY, who was created earl of Lincoln about 1139. He soon lost the title and became earl of Sussex, although he is more generally known as earl of Arundel. This creation was much resented by the earl of Chester and his half brother, WILLIAM DE ROUMARE (*c.* 1096–d. before 1161), both great landholders in Lincolnshire. After they had helped to capture King Stephen at Lincoln in 1141 on behalf of the empress Matilda they changed sides and William was made earl of Lincoln in 1141. The earldom was then granted to GILBERT DE GANT (*c.* 1120–56) about 1147–48, but on his death the title lapsed. RANULPH DE BLUNDEVILLE (*c.* 1172–1232), earl of Chester, held the Lincoln earldom from 1217 until 1231 when he resigned it in favour of his sister HAWISE (d. *c.* 1142) through whom it passed through her son-in-law JOHN DE LACY (*c.* 1192–1240), into the Lacy family.

HENRY (1251–1311), 3rd Lacy earl of Lincoln, served Edward I as both soldier and diplomatist, but under Edward II he joined the baronial opposition led by Thomas, earl of Lancaster, and became one of the ordainers in 1310. He married Margaret, granddaughter of William Longsword, 2nd earl of Salisbury, and his only surviving child, Alice, carried the earldoms of Salisbury and Lincoln to her husband THOMAS (*c.* 1277–1322), earl of Lancaster. His nephew HENRY (*c.* 1300–61), earl (afterward duke) of Lancaster, was created earl of Lincoln in 1349, and then the title merged in the crown when his grandson Henry ascended the throne as Henry IV in 1399.

The title was regranted to JOHN DE LA POLE (*c.* 1462–87), a nephew of Edward IV, who later supported Lambert Simnel, the Yorkist impostor, and was killed at the battle of Stoke, leaving no children. Henry VIII regranted the title to his cousin HENRY BRANDON (1516–34), son of Charles, duke of Suffolk, who also died childless and the title again lapsed. The last creation was for EDWARD CLINTON FIENNES (1512–85), Lord Clinton, who was made earl of Lincoln in 1572 and who managed to serve Henry VIII, Edward VI, Mary I and Elizabeth I without political repercussions or suspicion. The title is still held by his descendants. HENRY (1720–94), 9th earl, succeeded his uncle Thomas Pelham as duke of Newcastle in 1768, and since that time the earldom of Lincoln has been the courtesy title held by the eldest son of the dukes of Newcastle.

LINCOLN, ABRAHAM (1809–1865), 16th president of the United States, was born on Feb. 12, 1809, in a backwoods cabin three miles south of Hodgenville, Ky. When he was two years old he was taken to a farm in the neighbouring valley of Knob Creek. His earliest memories were of this home and, in particular, of a flash flood that once washed away the corn and pumpkin seeds he had helped his father plant. The father, Thomas Lincoln, was descended from a weaver's apprentice who had migrated from England to Massachusetts in 1637. Though much less prosperous than some of his Lincoln forebears, Thomas was a sturdy pioneer. On June 12, 1806, he married Nancy Hanks. The Hanks genealogy is difficult to trace, but Nancy appears to have been of illegitimate birth. She has been described as "stoop-shouldered, thin-breasted, sad," and fervently religious. Thomas and Nancy Lincoln had three children: Sarah, Abraham and Thomas (died in infancy).

In Dec. 1816, faced with a lawsuit challenging the title to his Kentucky farm, Thomas Lincoln moved with his family to southwestern Indiana. There, as a "squatter" on public land, he hastily put up a "half-faced camp"—a crude structure of logs and boughs, with one side open to the weather—in which the family took shelter behind a blazing fire. Soon he built a permanent cabin, and later he bought the land on which it stood. Abraham helped to clear the fields and take care of the crops but early acquired a dislike for hunting and fishing. In after years he recalled the "panther's scream," the bears that "preyed on the swine," and the poverty of Indiana frontier life, which was "pretty pinching at times." The unhappiest period of his boyhood followed the death of his mother in the autumn of 1818. As a ragged nine-year-old, he saw her buried in the forest, then faced a winter without the warmth of a mother's love. Fortunately, before the onset of a second winter, Thomas Lincoln brought home from Kentucky a new wife for himself, a new mother for the children. Sarah Bush Johnston Lincoln, a widow with two girls and a boy of her own, had energy and affection to spare. She ran the household with an even hand, treating both sets of children as if she had borne them all, but she became especially fond of Abraham, and he of her. He afterward referred to her as his "angel mother."

This stepmother doubtless encouraged Lincoln's taste for reading; yet the original source of his desire to learn remains something of a mystery. Both of his parents were almost completely illiterate, and he himself received very little formal education. He once said that, as a boy, he had gone to school "by littles"—a little now and a little then—and his entire schooling amounted to no more than one year's attendance. His neighbours later recalled how he used to trudge for miles to borrow a book. According to his own statement, however, his early surroundings provided "absolutely nothing to excite ambition for education. Of course when I came of age I did not know much. Still somehow,

I could read, write, and cipher to the Rule of Three; but that was all." Apparently the young Lincoln did not read a large number of books but thoroughly absorbed the few that he did read. These included Parson Weems's *Life of Washington* (with its story of the little hatchet and the cherry tree), *Robinson Crusoe, Pilgrim's Progress* and Aesop's *Fables*. From his earliest days he must have had some familiarity with the Bible, for it doubtless was the only book his family owned.

In March 1830 the Lincoln family undertook a second migration, this one to Illinois, with Lincoln himself driving an ox team. Having just reached the age of 21, he was about to begin life on his own. Six feet four inches tall, he was rawboned and lanky but muscular and physically powerful. He was especially noted for the skill and strength with which he could wield an ax. He spoke with a backwoods twang and walked in the long-striding, flat-footed, cautious manner of a plowman. Good-natured though somewhat moody, talented as a mimic and storyteller, he readily attracted friends. He was yet to demonstrate what other abilities he possessed.

Prairie Lawyer.—After his arrival in Illinois, having no desire to be a farmer, Lincoln tried his hand at a variety of occupations. As a "rail splitter," he helped to clear and fence his father's new farm. As a flatboatman, he made a voyage down the Mississippi river to New Orleans (this was his second visit to that city, his first having been made in 1828, while he still lived in Indiana). On his return he settled in New Salem, a village of about 25 families on the Sangamon river. There he worked from time to time as storekeeper, postmaster and surveyor. With the coming of the Black Hawk War (1832), he enlisted as a volunteer and was elected captain of his company. Afterward he joked that he had seen no "live, fighting Indians" during the war but had had "a good many bloody struggles with the mosquitoes." Meanwhile, aspiring to be a legislator, he was defeated in his first try and then repeatedly re-elected to the state assembly. He considered blacksmithing as a trade but finally decided in favour of the law. Already he had taught himself grammar and mathematics, and now he began to study lawbooks. In 1836, having passed the bar examination, he began to practise law.

The next year he moved to Springfield, the new state capital, which offered much larger opportunities for a lawyer than New Salem did. At first he was a partner of John T. Stuart, then of Stephen T. Logan, and finally, from 1844 on, of William H. Herndon. Nearly ten years younger than Lincoln, Herndon was more widely read, more emotional at the bar, and generally more extreme in his views. Yet this partnership seems to have been as nearly perfect as such human arrangements ever are. Lincoln and Herndon kept few records of their law business, and they split the cash between them whenever either of them was paid. It seems they had no money quarrels.

Within a few years after his removal to Springfield, Lincoln was earning from $1,200 to $1,500 annually, at a time when the governor of the state received a salary of $1,200 and circuit judges only $750. He had to work hard. To keep himself busy he found it necessary not only to practise in the capital but also to follow the court as it made the rounds of its circuit. Each spring and fall he would set out by horseback or buggy to travel hundreds of miles over the thinly settled prairie, from one little county seat to another. Most of the cases were petty and the fees small.

The coming of the railroads, especially after 1850, made travel easier and practice more remunerative. Lincoln served as a lobbyist for the Illinois Central to assist in getting a charter from the state, and thereafter he was retained as a regular attorney for that railroad. After successfully defending the company against the efforts of McLean county to tax its property, he received the largest single fee of his legal career—$5,000. (He had to sue the Illinois Central in order to collect the fee.) He also handled cases for other railroads and for banks, insurance companies, mercantile and manufacturing firms. In one of his finest performances before the bar, he saved the Rock Island bridge, the first to span the Mississippi river, from the threat of the river transportation interests who demanded the bridge's removal. His business included a number of patent suits and criminal trials. One of his most effective and famous pleas had to do with a murder case. A witness claimed that, by the light of the moon, he had seen Duff Armstrong, an acquaintance of Lincoln's, take part in a killing. Referring to an almanac for proof, Lincoln argued that the night had been too dark for the witness to have seen anything clearly, and with a sincere and moving appeal he won an acquittal.

By the time he began to be prominent in national politics, about twenty years after launching upon his legal career, Lincoln had made himself one of the most distinguished and successful lawyers in Illinois. He was noted not only for his shrewdness and practical common sense, which enabled him always to see to the "nub" of any legal case, but also for his invariable fairness and utter honesty.

Private Life.—While residing in New Salem, Lincoln was acquainted with Ann Rutledge. Apparently he was fond of her, and certainly he grieved with the entire community at her untimely death, in 1835, at the age of 19. Afterward stories were told of a grand romance between Abraham and Ann, but these stories lack the support of sound historical evidence. A year after the death of Miss Rutledge, Lincoln was carrying on a half-hearted courtship with Mary Owens. Miss Owens concluded that Lincoln was "deficient in those little links that make up the chain of woman's happiness." She turned down his proposal.

So far as can be known, the first and only real love of Lincoln's life was Mary Todd. High-spirited, quick-witted and well-educated, Miss Todd came from a rather distinguished Kentucky family, and her Springfield relatives belonged to the social aristocracy of the town. Some of them frowned upon her association with Lincoln, and from time to time he too had doubts whether he ever could make her happy. Nevertheless, they became engaged. Then, on a day in 1841 that Lincoln recalled as the "fatal first of January" they broke the engagement, apparently on his initiative. For some time after that, he was overwhelmed by a mood of terrible depression and despondency. Finally the two were reconciled and, on Nov. 4, 1842, were married.

Four children, all boys, were born to the Lincolns. Robert Todd, the eldest and the only one to survive to adulthood, was never very close to his father. Edward Baker died at the age of 4 and William Wallace at 12. Thomas, affectionately known as "Tad," outlived his father; Tad, who had a cleft palate and a lisp, was Lincoln's favourite. Lincoln left the upbringing of his sons largely to their mother, who was alternately strict and lenient in her treatment of them.

The Lincolns had a mutual affectionate interest in the doings and welfare of their boys, were fond of one another's company and missed each other when apart, as existing letters show. Like most married couples, the Lincolns also had their domestic quarrels, which sometimes were hectic but which undoubtedly were

BY COURTESY OF CHICAGO HISTORICAL SOCIETY

ABRAHAM LINCOLN'S SPRINGFIELD HOME, NOW PRESERVED AS A MUSEUM BY THE STATE OF ILLINOIS. THE PHOTOGRAPH, TAKEN IN 1860 BY J. A. WHIPPLE, A BOSTON NEWSMAN, SHOWS LINCOLN AND ONE OF HIS SONS IN THEIR FRONT YARD, AND TWO PASSERS-BY

exaggerated by contemporary gossips. Mrs. Lincoln suffered from recurring headaches, fits of temper, and a sense of insecurity and loneliness that was intensified by her husband's long absences on the lawyer's circuit. After his election to the presidency, she was afflicted in spirit by the death of her son Willie, by the ironies of war that made enemies of Kentucky relatives and friends, and by the unfair public criticisms of her as mistress of the White House. She lost all money sense and ran up embarrassing bills. She also put on some painful scenes of wifely jealousy. At last, in 1875, she was officially declared insane, but that was after she had undergone the further shock of seeing her husband murdered at her side. During their earlier married life, Mrs. Lincoln unquestionably encouraged her husband and served as a prod to his own ambition. During their later years together she probably strengthened and tested his innate qualities of tolerance and patience.

With his wife, Lincoln attended Presbyterian services in Springfield and in Washington, but he never joined any church. He once explained: "When any church will inscribe over its altar the Saviour's condensed statement of law and gospel: 'Thou shalt love the Lord thy God with all thy heart and with all thy soul and with all thy mind, and love thy neighbor as thyself,' that church will I join with all my heart." Early in life he had been something of a skeptic and freethinker. His reputation had been such that, as he once complained, the "church influence" was used against him in politics. When running for congress in 1846, he issued a handbill to deny that he ever had "spoken with intentional disrespect of religion." He went on to explain that he had believed in the doctrine of necessity—"that is, that the human mind is impelled to action, or held in rest, by some power over which the mind itself has no control." Throughout his life he also believed in dreams and other enigmatic signs and portents. As he grew older, and especially after he became president and faced the soul-troubling responsibilities of the Civil War, he developed a profound religious sense, and he increasingly personified Necessity as God. He came to look upon himself quite humbly, as an "instrument of Providence," and to view all history as God's enterprise. "In the present civil war," he wrote in 1862, "it is quite possible that God's purpose is something different from the purpose of either party—and yet the human instrumentalities, working just as they do, are of the best adaptation to effect His purpose."

Lincoln was fond of the Bible and knew it well. He also was fond of Shakespeare. In private conversation he used many Shakespearean allusions, discussed problems of dramatic interpretation with considerable insight, and from memory recited long passages with rare feeling and understanding. He liked the essays of John Stuart Mill, particularly the famous one on liberty, but disliked heavy or metaphysical works.

Though he enjoyed the poems of Lord Byron and Robert Burns, his favourite piece of verse was the work of an obscure Scottish poet, William Knox. Lincoln often quoted Knox's lines beginning: "Oh! why should the spirit of mortal be proud?" He liked to relax with the comic writings of Petroleum V. Nasby, Orpheus C. Kerr, and Artemus Ward, or with a visit to the popular theatre.

To the Presidency.—When Lincoln first entered politics, Andrew Jackson was president. Lincoln shared the sympathies which the Jacksonians professed for the common man, but he disagreed with the Jacksonian view that the government should be divorced from economic enterprise. "The legitimate object of government," he was later to say, "is to do for a community of people whatever they need to have done, but cannot do at all, or cannot do so well for themselves, in their separate and individual capacities." He most admired Henry Clay and Daniel Webster among the prominent politicians of the time. Clay and Webster advocated using the powers of the federal government to encourage business and develop the country's resources by means of a national bank, a protective tariff and a program of internal improvements, for facilitating transportation. In Lincoln's view, Illinois and the west as a whole desperately needed such aid to economic development. From the outset, he associated himself with the Clay and Webster party, the Whigs.

As a Whig member of the Illinois state legislature, to which he was elected four times from 1834 to 1840, he devoted himself to a grandiose project for constructing with state funds a network of railroads, highways and canals. Whigs and Democrats joined in passing an omnibus bill for these undertakings, but the panic of 1837 and the ensuing business depression brought about the abandonment of most of them. While in the legislature he demonstrated that, though opposed to slavery, he was no abolitionist. Resolutions were introduced, in 1837, in response to the mob murder of Elijah Lovejoy, an antislavery newspaperman of Alton. Instead of denouncing lynch law, these resolutions condemned abolitionist societies and upheld slavery within the southern states as "sacred" by virtue of the federal constitution. Lincoln refused to vote for the resolutions. Together with a fellow member he drew up a protest against them. This maintained, on the one hand, that slavery was "founded on both injustice and bad policy" and, on the other, that "the promulgation of abolition doctrines tends rather to increase than to abate its evils."

During his single term in congress (1847–49), Lincoln as the lone Whig from Illinois gave little attention to legislative matters as such. He proposed a bill for the gradual and compensated emancipation of slaves in the District of Columbia, but the bill was to take effect only with the approval of the "free white citizens" of the district. It displeased abolitionists as well as slaveholders, and never was seriously considered.

Much of his time Lincoln devoted to presidential politics, to unmaking one president, a Democrat, and making another, a Whig. He found an issue and a candidate in the Mexican War. With his "spot resolutions" he challenged the statement of Pres. James K. Polk that Mexico had started the war by shedding American blood upon American soil. Along with other members of his party, Lincoln voted to condemn Polk and the war while voting supplies for carrying it on. At the same time he laboured for the nomination and election of the war hero Zachary Taylor. After Taylor's success at the polls, Lincoln expected to be named commissioner of the general land office as a reward for his campaign services, and he was bitterly disappointed when he failed to get the job. His criticisms of the war, meanwhile, had not been popular among the voters in his own congressional district. At the age of 40, frustrated in politics, he seemed to be at the end of his public career.

For about five years he took little part in politics, and then a new sectional crisis gave him a chance to re-emerge and rise to statesmanship. In 1854 his political rival Stephen A. Douglas maneuvered through congress a bill for reopening the entire Louisiana Purchase to slavery and allowing the settlers of Kansas and Nebraska (with "popular sovereignty") to decide for themselves whether to permit slaveholding in those territories. The Kansas-Nebraska act provoked violent opposition in Illinois and the other states of the old northwest. It gave rise to the Republican party while speeding the Whig party on the way to disintegration. Along with many thousands of other homeless Whigs, Lincoln soon became a Republican (1856). Before long, some prominent Republicans in the east talked of attracting Douglas to the Republican fold, and with him his Democratic following in the west. Lincoln would have none of it. He was determined that he, not Douglas, should be the Republican leader of his state and section. In their basic views he and Douglas were not quite so far apart as they seemed in the heat of political argument. Neither was an abolitionist, neither a proslavery man. But Lincoln, unlike Douglas, insisted that congress must exclude slavery from the territories. He disagreed with Douglas' belief that the territories were by nature unsuited to the slave economy and that no congressional legislation was needed to prevent the spread of slavery into them. He declared (1858): "'A house divided against itself cannot stand.' I believe this government cannot endure permanently half slave and half free." He predicted that the country eventually would become "all one thing, or all the other." Again and again he insisted that the civil liberties of every U.S. citizen, white as well as black, were at stake. The territories must be kept free, he further said, because "new free states" were "places for poor people to go and better their condition." He agreed with Thomas Jefferson and other founding fathers, how-

ever, that slavery should be merely contained, not directly attacked. In the Lincoln-Douglas debates of 1858, while contesting for Douglas' seat in the United States senate, he drove home the inconsistency between Douglas' "popular sovereignty" principle and the Dred Scott decision (1857), in which the U.S. supreme court held that congress could not constitutionally exclude slavery from the territories. Though he failed to obtain the senate seat, Lincoln gained national recognition and soon began to be mentioned as a presidential prospect for 1860.

BY COURTESY OF CHICAGO HISTORICAL SOCIETY

LITHOGRAPH "ABRAHAM LINCOLN (CANDIDATE)" PREPARED BY EDWARD MENDEL OF CHICAGO FOR THE CAMPAIGN OF 1860

On May 18, 1860, after Lincoln and his friends had made skilful preparations, he was nominated on the third ballot at the Republican convention in Chicago. He then put aside his law practice and, though making no stump speeches, gave his full time to the direction of his campaign. His "main object," he had written, was to "hedge against divisions in the Republican ranks," and he counseled party workers to "say nothing on points where it is probable we shall disagree." With the Republicans united, the Democrats divided, and a total of four candidates in the field, he carried the election on Nov. 6. No one in the deep south voted for him, and fewer than 40 out of 100 in the country as a whole. Still, the popular votes were so distributed that he won a clear and decisive majority in the electoral college.

The War Comes.—After Lincoln's election and before his inauguration, the state of South Carolina proclaimed its withdrawal from the Union. To forestall similar action by other southern states, various compromises were proposed in congress. The most important, the Crittenden compromise, included constitutional amendments (1) guaranteeing slavery forever in the states where it already existed and (2) dividing the territories between slavery and freedom. Though Lincoln had no objection to the first of these amendments, he was unalterably opposed to the second, and indeed to any scheme infringing in the slightest upon the free-soil plank of his party's platform. "I am inflexible," he privately wrote. He feared that a territorial division, by sanctioning the principle of slavery extension, would only encourage planter imperialists to seek new slave territory south of the American border and thus would "put us again on the highroad to a slave empire." From his home in Springfield he advised Republicans in congress to vote against a division of the territories. The proposal was killed in committee. Six additional states then seceded and, with South Carolina, combined to form the Confederate States of America.

So, before Lincoln took office, a disunion crisis was upon the country. Attention North and South focused in particular upon Ft. Sumter, in Charleston harbour. This fort, still under construction, was garrisoned by U.S. troops under Maj. Robert Anderson. The Confederacy claimed it and, from other harbour fortifications, threatened it. Foreseeing trouble, Lincoln while still in Springfield confidentially requested Winfield Scott, general in chief of the U.S. army, to be prepared "to either hold, or retake, the forts, as the case may require, at, and after the inauguration." In his inaugural address (March 4, 1861), besides upholding the Union's indestructibility and appealing for sectional harmony, Lincoln restated his Sumter policy as follows: "The power confided in me, will be used to hold, occupy, and possess the property, and places belonging to the government, and to collect the duties and imposts; but beyond what may be necessary for these objects, there will be no invasion—no using of force against, or among the people anywhere." Then, near the end, addressing the absent southerners: "You can have no conflict, without being yourselves the aggressors."

No sooner was he in office than Lincoln received word that the Sumter garrison, unless supplied or withdrawn, would shortly be starved out. Still, for about a month, Lincoln delayed to act. He was beset by contradictory advice. On the one hand, General Scott, Secretary of State William H. Seward and others urged him to abandon the fort, and Seward through a go-between gave a group of Confederate commissioners to understand that the fort would in fact be abandoned. On the other hand, many Republicans insisted that any show of weakness would bring disaster to their party and to the Union. Finally Lincoln ordered the preparation of two relief expeditions, one for Ft. Sumter and the other for Ft. Pickens, in Florida. (He afterward said he would have been willing to withdraw from Sumter if he could have been sure of holding Pickens.) Before the Sumter expedition got under way, he sent a messenger to tell the South Carolina governor: "I am directed by the President of the United States to notify you to expect an attempt will be made to supply Fort-Sumpter with provisions only; and that, if such attempt be not resisted, no effort to throw in men, arms, or ammunition, will be made, without further notice, or in case of an attack upon the Fort." Without waiting for the arrival of Lincoln's expedition, the Confederate authorities presented to Major Anderson a demand for Sumter's prompt evacuation, which he refused. On April 12, 1861, at dawn, the Confederate batteries in the harbour opened fire.

"Then, and thereby," Lincoln informed congress when it met on July 4, "the assailants of the Government began the conflict of arms." The Confederates, however, accused him of being the real aggressor. They said he had cleverly maneuvered them into firing the first shot so as to put upon them the onus of war guilt. Though some historians have repeated this charge, it appears to be a gross distortion of the facts. The facts apparently are these: Lincoln was determined to preserve the Union; to do so, he thought he must take a stand sooner or later against the pretensions of the Confederacy, and he concluded he might as well take this stand at Sumter.

Lincoln's primary aim was neither to provoke war nor to maintain peace. In preserving the Union, he would have been glad to preserve the peace also, but he was ready to risk a war, which he thought would be short.

Commander in Chief.—After the firing on Ft. Sumter, Lincoln called upon the state governors for troops (Virginia and three other states of the upper south responded by joining the Confederacy). He then proclaimed a blockade of the southern ports. These steps—the Sumter expedition, the call for volunteers and the blockade—were the first important decisions of Lincoln as commander in chief of the army and navy. He still needed a strategic plan and a command system for carrying it out.

General Scott advised him to avoid battle with the Confederate forces in Virginia, to get control of the Mississippi river, and by tightening the blockade to hold the South in a gigantic squeeze. Lincoln had little confidence in Scott's comparatively passive and bloodless "Anaconda" plan. He believed the war must be actively fought if it ever was to be won. Overruling Scott, he ordered a direct advance on the Virginia front, which resulted in defeat and rout for the Union forces at Bull Run (July 21, 1861). After a succession of more or less sleepless nights, Lincoln produced a set of memoranda on military policy. His basic thought was this: the armies should advance concurrently on several fronts and should move in such directions as to hold and use the support of Unionists in Missouri, Kentucky, western Virginia and eastern Tennessee. "I state my general idea of this war to be," he later explained, "that we have the greater numbers, and the enemy has the greater facility of concentrating forces upon points of collision; that we must fail, unless we can find some way of making our advantage an overmatch for his; and that this can only be done by menacing him with superior forces at different points, at the same time." This, with the naval blockade, comprised the essence of Lincoln's strategy.

From 1861 to 1864, while hesitating to impose his ideas upon his generals, Lincoln experimented with command personnel and organization. Accepting the resignation of Scott (Nov. 1861) he put George B. McClellan in charge of the armies as a whole. After a few months, disgusted by the slowness of McClellan, he demoted

him to the command of the army of the Potomac alone. He questioned the soundness of McClellan's plans for the peninsular campaign, repeatedly compelled McClellan to alter them, and after the Seven Days' battle before Richmond (June–July 1862) ordered him to give them up. Then he tried a succession of commanders for the army in Virginia—John Pope, McClellan again, Ambrose E. Burnside, Joseph Hooker and George Gordon Meade—but was disappointed with each of them in turn. Meanwhile he had in Henry W. Halleck a general in chief who gave advice and served as a liaison with field officers but who shrank from making important decisions. For nearly two years the Union armies had no very effective unity of command. President Lincoln, General Halleck and War Secretary Edwin M. Stanton acted as an informal council of war. Lincoln, besides transmitting official orders through Halleck, also communicated directly with the generals, sending personal suggestions in his own name. To generals opposing Robert E. Lee, he suggested that the object was to destroy Lee's army, not to capture Richmond or to drive the invader from northern soil.

Finally Lincoln looked to the west for a top general. He admired the Vicksburg campaign of Ulysses S. Grant. Nine days after the Vicksburg surrender (which occurred on July 4, 1863), he sent Grant a "grateful acknowledgment for the almost inestimable service" he had done the country. Lincoln sent also an admission of his own error. He said he had expected Grant to bypass Vicksburg and go on down the Mississippi, instead of crossing the river and turning back to approach Vicksburg from the rear. "I feared it was a mistake," he wrote in his letter of congratulations. "I now wish to make the personal acknowledgment that you were right, and I was wrong."

In March 1864 Lincoln promoted Grant to lieutenant general and gave him command of all the Union armies. At last Lincoln had found a man who, with such able subordinates as William T. Sherman, Philip Sheridan and George H. Thomas, could put into effect those parts of Lincoln's concept of a large-scale co-ordinated offensive that still remained to be carried out. Grant was only a member, though an important one, of a top-command arrangement that Lincoln eventually had devised. Overseeing everything was Lincoln himself, the commander in chief. Taking the responsibility for men and supplies was Stanton, the secretary of war. Serving as a presidential adviser and as a liaison with military men was Halleck, the chief of staff. And directing all the armies, while accompanying Meade's army of the Potomac, was Grant, the general in chief. Thus Lincoln pioneered in the creation of a high command, an organization for amassing all the energies and resources of a people in the grand strategy of total war. He combined statecraft and the over-all direction of armies, with an effectiveness that year by year increased. His achievement is all the more remarkable in view of his lack of training and experience in the art of warfare. This lack may have been an advantage as well as a handicap. Unhampered by outworn military dogma, Lincoln could all the better apply his practical insight and common sense—some would say his military genius—to the winning of the Civil War.

Emancipation.—There can be no doubt of Lincoln's deep and sincere devotion to the cause of personal freedom. Before his election to the presidency he had spoken often and eloquently on the subject. In 1854, for example, he said he hated the Douglas attitude of indifference toward the possible spread of slavery to new areas. "I hate it because of the monstrous injustice of slavery itself," he declared. "I hate it because it deprives our republican example of its just influence in the world—enables the enemies of free institutions, with plausibility, to taunt us as hypocrites. . . ." In 1855, writing to his friend Joshua Speed, he recalled a steamboat trip the two had taken on the Ohio river 14 years earlier. "You may remember, as I well do," he said, "that from Louisville to the mouth of the Ohio there were, on board, ten or a dozen slaves, shackled together with irons. That sight was a continual torment to me; and I see something like it every time I touch the Ohio, or any other slave-border."

Yet, as president, Lincoln was at first reluctant to adopt an abolitionist policy. There were several reasons for his hesitancy. He had been elected on a platform pledging no interference with slavery within the states, and in any case he doubted the constitutionality of federal action in the premises. He was concerned about the possible difficulties of incorporating nearly 4,000,000 Negroes, once they had been freed, into the nation's social and political life. Above all, he felt that he must hold the border slave states in the Union, and he feared that an abolitionist program might impel them, in particular his native Kentucky, toward the Confederacy. So he held back while others went ahead. When Gen. John C. Frémont and Gen. David Hunter, within their respective military departments, proclaimed freedom for the slaves of disloyal masters, Lincoln revoked the proclamations. When congress passed confiscation acts (in 1861 and 1862), he refrained from a full enforcement of the provisions authorizing him to seize slave property. And when Horace Greeley in the *New York Tribune* appealed to him to enforce these laws, Lincoln patiently replied (Aug. 22, 1862): "My paramount object in this struggle is to save the Union, and is not either to save or to destroy slavery. If I could save the Union without freeing any slave I would do it, and if I could save it by freeing all the slaves I would do it; and if I could do it by freeing some and leaving others alone I would also do that."

Meanwhile, in response to the rising antislavery sentiment, Lincoln came forth with an emancipation plan of his own. According to his proposal, the slaves were to be freed by state action, the slaveowners were to be compensated, the federal government was to share the financial burden, the emancipation process was to be

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FIRST READING OF THE EMANCIPATION PROCLAMATION TO THE CABINET: (LEFT TO RIGHT) EDWIN M. STANTON, SALMON P. CHASE, PRESIDENT LINCOLN, GIDEON WELLES, CALEB SMITH (STANDING), WILLIAM H. SEWARD, MONTGOMERY BLAIR (STANDING) AND EDWARD BATES. THIS ENGRAVING WAS MADE IN 1866 BY ALEXANDER HAY RITCHIE AFTER A PAINTING BY FRANCIS BICKNELL CARPENTER

gradual, and the freedmen were to be colonized abroad. Congress indicated its willingness to vote the necessary funds for the Lincoln plan, but none of the border slave states was willing to launch it, and in any case few Negro leaders desired to see their people sent abroad.

While still hoping for the eventual success of his gradual plan, Lincoln took a quite different step by issuing his preliminary (Sept. 22, 1862) and his final (Jan. 1, 1863) Emancipation Proclamation. This famous decree, which he justified as an exercise of the president's war powers, applied only to those parts of the country actually under Confederate control, not to the loyal slave states nor to the Union-occupied areas of the Confederacy. Directly or indirectly the proclamation brought freedom during the war to fewer than 200,000 slaves. Yet it had great significance as a symbol. It indicated that the Lincoln government had added freedom to reunion as a war aim, and it attracted liberal opinion in England and Europe to increased support of the Union cause.

Lincoln himself doubted the constitutionality of his step, except as a temporary war measure. After the war the slaves freed by the proclamation would have risked re-enslavement, had nothing else been done to confirm their liberty. Something else was done: the 13th amendment was added to the constitution, and Lincoln played a large part in bringing about this change in the fundamental law. Through the chairman of the Republican national committee he urged the party to include a plank for such an amendment in its platform of 1864. The plank, as adopted, stated that slavery was the cause of the rebellion, that the president's proclamation had aimed "a death blow at this gigantic evil," and that a constitutional amendment was necessary to "terminate and forever prohibit" it. When Lincoln was re-elected on this platform, and the Republican majority in congress was increased, he was justified in feeling, as he apparently did, that he had a mandate from the people for the 13th amendment. The newly chosen congress, with its overwhelming Republican majority, was not to meet until after the lame-duck session of the old congress during the winter of 1864–65. Lincoln did not wait. Using his resources of patronage and persuasion upon certain of the Democrats, he managed to get the necessary two-thirds vote before the session's end. He rejoiced as the amendment went out to the states for ratification, and he rejoiced again and again as his own Illinois led off and other states followed one by one in acting favourably upon it. (He did not live to rejoice in its ultimate adoption.)

Lincoln deserves his reputation as the Great Emancipator. His claim to that honour, if it rests uncertainly upon his famous proclamation, has a sound basis in the support he gave to the antislavery amendment. It is well founded also in his greatness as the war leader who carried the nation safely through the four-year struggle that brought freedom in its train. And, finally, it is strengthened by the practical demonstrations he gave of respect for human worth and dignity, regardless of colour. During the last two years of his life he welcomed Negroes as visitors and friends in a way no president had done before. One of his friends was the distinguished former slave Frederick Douglass. Afterward Douglass wrote: "In all my interviews with Mr. Lincoln I was impressed with his entire freedom from prejudice against the colored race."

Wartime Politics.—To win the war, President Lincoln had to have popular support. The reunion of North and South required, first of all, a certain degree of unity in the North. But the North contained various groups with special interests of their own. Lincoln faced the task of attracting to his administration the support of as many divergent groups and individuals as possible. So he gave much of his time and attention to politics, which in one of its aspects is the art of attracting such support. Fortunately for the Union cause, he was a president with rare political skill. He had the knack of appealing to fellow politicians and talking to them in their own language. He had a talent for smoothing over personal differences and holding the loyalty of men antagonistic to one another. Inheriting the spoils system, he made good use of it, disposing of government jobs in such a way as to strengthen his administration and further its official aims.

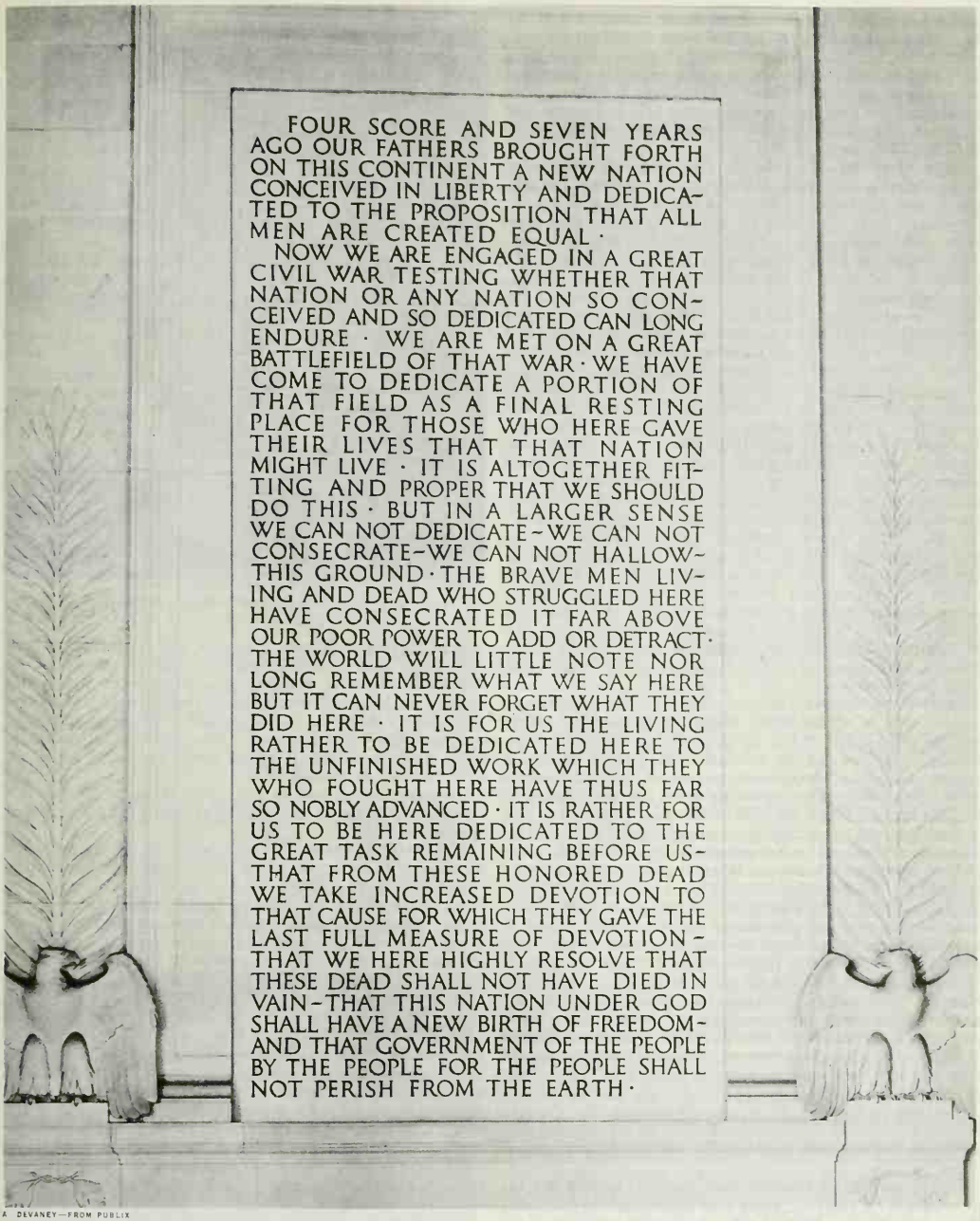
The opposition party remained alive and strong. Its membership included war Democrats and peace Democrats, often called "copperheads," a few of whom collaborated with the enemy. Lincoln did what he could to cultivate the assistance of the war Democrats, as in securing from congress the timely approval of the 13th amendment. So far as feasible, he conciliated the peace Democrats. He gave heed to the complaints of one of them, Gov. Horatio Seymour of New York, in regard to the draft quota for that state. He commuted the prison sentence of another, Congressman Clement L. Vallandigham of Ohio, to banishment within the Confederate lines. In dealing with persons suspected of treasonable intent, Lincoln at times authorized his generals to make arbitrary arrests. He justified this action on the ground that he had to allow some temporary sacrifice of parts of the constitution in order to maintain the Union and thus preserve the constitution as a whole. He let his generals suspend several newspapers, but only for short periods, and he promptly revoked a military order suppressing the hostile *Chicago Times*. In a letter to one of his generals he expressed his policy thus: "You will only arrest individuals and suppress assemblies or newspapers when they may be working palpable injury to the military in your charge, and in no other case will you interfere with the expression of opinion in any form or allow it to be interfered with violently by others. In this you have a discretion to exercise with great caution, calmness, and forbearance." Considering the dangers and provocations of the time, Lincoln was quite liberal in his treatment of political opponents and the opposition press. He was by no means the dictator critics often accused him of being.

Within his own party he confronted factional divisions and personal rivalries that caused him as much trouble as did the activities of the Democrats. True, he and most of his fellow partisans agreed fairly well upon their principal economic aims. With his approval the Republicans enacted into law the essentials of the program he had advocated from his early Whig days—a protective tariff, a national banking system, and federal aid for internal improvements, in particular for the construction of a railroad to the Pacific coast. The Republicans disagreed among themselves, however, on many matters regarding the conduct and purposes of the war. Two main factions arose: the "radicals" and the "conservatives." Lincoln himself inclined in spirit toward the conservatives, but he had friends among the radicals as well, and he strove to maintain his leadership over both. In appointing his cabinet, he chose his several rivals for the 1860 nomination and, all together, gave representation to every important party group. Wisely he included the outstanding conservative, Seward, and the outstanding radical, Salmon P. Chase. Cleverly he overcame cabinet crises and kept these two opposites among his official advisers, until Chase's resignation in 1864.

He had to deal with even more serious factional uprisings in congress. The big issue was the "reconstruction" of the South. The seceded states of Louisiana, Arkansas and Tennessee having been largely recovered by the Union armies, Lincoln late in 1863 proposed his "ten per cent plan," according to which new state governments might be formed when 10% of the qualified voters had taken an oath of future loyalty to the United States. The radicals rejected Lincoln's proposal as too lenient, and they carried through congress the Wade-Davis bill, which would have permitted the remaking and readmission of states only after a majority, not a tenth, had sworn to past, rather than prospective, loyalty. When Lincoln pocket-vetoed that bill, its authors published a "manifesto" denouncing him.

Already he was the candidate of the "Union" (that is, the Republican) party for re-election to the presidency, and the Wade-Davis manifesto signalized a movement within the party to displace him as the party's nominee. He waited quietly and patiently for the movement to collapse, but even after it had done so, the party remained badly divided. A rival Republican candidate, John C. Frémont, nominated much earlier by a splinter group, was still in the field. Leading radicals promised to procure Frémont's withdrawal if Lincoln would obtain the resignation of his conservative postmaster general, Montgomery Blair. Eventually Frémont withdrew and Blair resigned. The party was reunited in time for the election of 1864.

In 1864, as in 1860, Lincoln was the chief strategist of his own



A. DEVANEY—FROM PUBLIX

LINCOLN'S GETTYSBURG ADDRESS AS IT IS INSCRIBED IN GRANITE ON THE WALL OF THE LINCOLN MEMORIAL IN WASHINGTON, D.C. THE SPEECH WAS DELIVERED NOV. 19, 1863 AT CEREMONIES DEDICATING A PORTION OF THE GETTYSBURG BATTLEFIELD AS A CEMETERY FOR THOSE WHO DIED THERE IN THE BATTLE FOUGHT ON JULY 1, 2 AND 3 OF THAT YEAR

electoral campaign. He took a hand in the management of the Republican speakers' bureau, advised state committees on campaign tactics, hired and fired government employees to strengthen party support, and did his best to enable as many soldiers and sailors as possible to vote. Most of the citizens in uniform voted Republican, and their ballots were a great help to Lincoln. He was re-elected with a large popular majority (55%) over his Democratic opponent, George B. McClellan.

Peace Planning.—In 1864 the Democratic platform called for an armistice and a peace conference, and prominent Republicans as well as Democrats demanded that Lincoln give heed to Confederate peace offers, irregular and illusory though they were. So, in a public letter (July 18, 1864), he stated his own conditions: "Any proposition which embraces the restoration of peace, the integrity of the whole Union, and the abandonment of slavery, and which comes by and with an authority that can control the armies now at war against the United States, will be received and considered by the Executive government of the United States, and will be met by liberal terms on other substantial and collateral points." When conservatives protested to him against the implication that the war must go on to free the slaves, even after reunion had been won, he explained: "To me it seems plain that saying reunion and abandonment of slavery would be considered, if offered, is not saying that nothing else or less would be considered, if offered." After his re-election, in his annual message to Congress, he said: "In stating a single condition of peace, I mean simply to say that the war will cease on the part of the government, whenever it shall have ceased on the part of those who began it." On Feb. 3, 1865, he met personally with Confederate commissioners on a steamer in Hampton Roads. He promised to be liberal with pardons if the south would quit the war, but he insisted on reunion as a precondition for any peace arrangement. In his second inaugural address he embodied the spirit of his policy in the famous words "with malice toward none, with charity for all." His terms satisfied neither the Confederate leaders nor the radical Republicans, and so no peace was possible until the final defeat of the Confederacy.

At the end of the war Lincoln's policy for the defeated South was not clear in all its details; though he continued to believe that the main object should be to restore the "seceded states, so-called," to their "proper practical relation" with the Union as soon as possible. He possessed no fixed and uniform program for the region as a whole. As he said in the last public speech of his life (April 11, 1865), "so great peculiarities" pertained to each of the states, and "such important and sudden changes" occurred from time to time, and "so new and unprecedented" was the whole problem that "no exclusive and inflexible plan" could "safely be prescribed." With respect to states like Louisiana and Tennessee, he continued to urge acceptance of new governments set up under his ten per cent plan during the war. With respect to states like Virginia and North Carolina, he seemed willing to use the old rebel governments temporarily as a means of transition from war to peace. He was on record as opposing the appointment of "strangers" (carpetbaggers) to govern the South. He hoped that the southerners themselves, in forming new state governments, would find some way by which whites and Negroes "could gradually live themselves out of their old relations to each other, and both come out better prepared for the new." A program of education for the freedmen, he thought, was essential for preparing them for their new status. He also suggested that the vote be given immediately to some Negroes—"as, for instance, the very intelligent, and especially those who have fought gallantly in our ranks."

On the question of reconstruction, however, Lincoln and the extremists of his own party stood even farther apart in early 1865 than a year before. Some of the radicals were beginning to demand a period of military occupation for the South, the confiscation of planter estates and their division among the freedmen, and the transfer of political power from the planters to their former slaves. In April 1865 Lincoln began to modify his own stand in some respects and thus to narrow the gap between himself and the radicals. He recalled the permission he had given for the assembling of the rebel legislature of Virginia, and he approved in principle—or at least did not disapprove—Stanton's scheme for the military occupation of southern states. After the cabinet meeting of April 14, Attorney General James Speed inferred that Lincoln was moving toward the radical position. "He never seemed so near our views," Speed believed. What Lincoln's reconstruction policy would have been, if he had lived to complete his second term, can only be guessed at.

BY COURTESY OF CHICAGO HISTORICAL SOCIETY; PHOTOGRAPH BY BOB TOBIAS

LINCOLN'S TOMB IN OAK RIDGE CEMETERY, SPRINGFIELD, ILL.

On the evening of April 14, 1865, John Wilkes Booth shot Lincoln as he sat in Ford's theatre in Washington, and early the next morning he died.

The Living Lincoln.—"Now he belongs to the ages," Stanton is supposed to have said as Lincoln breathed his last. Many thought of him as a martyr. The assassination had occurred on Good Friday, and on the following Sunday, memorable as "Black Easter," hundreds of speakers found a sermon in the event. Some of them saw more than mere chance in the fact that assassination day was also crucifixion day. One declared: "Jesus Christ died for the world; Abraham Lincoln died for his country." Thus the posthumous growth of his reputation was influenced by the timing and circumstances of his death, which won for him a kind of sainthood.

Among the many who remembered Lincoln from personal acquaintance, one was sure he had known him more intimately than any of the rest, and influenced the world's conception of him more than all the others put together. That one was his former law partner, Herndon. When Lincoln died, Herndon began a new career as Lincoln authority, collecting reminiscences wherever he could find them and adding his own store of memories. Though admiring Lincoln, he objected to the trend toward sanctifying the man. He saw, as the main feature of Lincoln's life, the far more than ordinary rise of a self-made man, a rise from the lowest depths to the greatest heights—"from a stagnant, putrid pool, like the gas which, set on fire by its own energy and self-combustible nature, rises in jets, blazing, clear, and bright." To emphasize this point, Herndon gave his most eager attention to evidences of the dismal and sordid in Lincoln's background. An extremely significant event in Lincoln's development, as Herndon viewed it, was a "romance

of much reality" with Ann Rutledge. Lincoln loved no one but Ann and, after her death, never ceased to grieve for her. His memory of her both saddened and inspired him. As for his wife, Mary Todd, she married him out of spite, then devoted herself to making him miserable. So Herndon would have it, and after him countless biographers and novelists and playwrights elaborated upon his views, which persist as accepted knowledge about Lincoln despite their refutation by historical scholarship.

Lincoln has become a myth as well as a man. The legendary is to be sought in imaginative literature and in folklore, in poems, plays, novels, anecdotes and the like. It is also to be found in ostensibly factual productions, including footnoted biographies and histories.

The Lincoln of legend has grown into a protean god who can assume a shape to please almost any worshiper. He is Old Abe and at the same time a natural gentleman. He is Honest Abe and yet a being of superhuman shrewdness and cunning. He is also Father Abraham, the wielder of authority, the support of the weak, and he is an equal, a neighbour and a friend.

Lincoln the man has a reputation which may be considered apart from that of Lincoln the myth. While he was yet alive, this reputation began to grow, and before his death his qualities of greatness already were widely recognized. In the midst of the Civil War, for instance, the *Washington Chronicle* found a resemblance between him and George Washington in their "sure judgment," "perfect balance of thoroughly sound faculties," and "great calmness of temper, great firmness of purpose, supreme moral principle, and intense patriotism." The *Buffalo Express* referred to his "remarkable moderation and freedom from passionate bitterness," then added: "We do not believe that Washington himself was less indifferent to the exercise of power for power's sake." An English newspaper, the *Liverpool Post*, suggested that "no leader in a great contest ever stood so little chance of being the subject of hero worship as Abraham Lincoln," if one were to judge only by the way he looked. His long arms and legs, his grotesque figure, made him too easy to caricature and ridicule. "Yet," this newspaper concluded, "a worshiper of human heroes might possibly travel a great deal farther and fare much worse for an idol than selecting this same lanky American." His inner qualities—his faithfulness, honesty, resolution, insight, humour and courage—would "go a long way to make up a hero," whatever the man's personal appearance.

Among American heroes, Lincoln continues to have a unique appeal for his fellow countrymen and also for people of other lands. This charm derives from his remarkable life story—the rise from humble origins, the dramatic death—and from his distinctively human and humane personality as well as from his historical role as saviour of the Union and emancipator of the slaves. His relevance endures and grows especially because of his eloquence as a spokesman for democracy. In his view, the Union was worth saving not only for its own sake but also because it embodied an ideal, the ideal of self-government, which was of interest to the people of the entire world. Hence the universality of his continuing appeal.

WINSTON POTE FROM A DEVANEY—PUBLIX

LINCOLN MEMORIAL, POTOMAC PARK, WASHINGTON, D.C., ERECTED BY THE UNITED STATES GOVERNMENT AND DEDICATED MAY 30, 1922. ARCHITECT, HENRY BACON. THE 36-COLUMN COLONNADE REPRESENTS THE STATES EXISTING AT THE TIME OF LINCOLN'S DEATH

His best ideas and finest phrases did not occur in impromptu speeches. Rather, his long-remembered sayings were written and rewritten with meticulous revisions ahead of time. Some resulted from a slow gestation of thought and phrase through many years. One of his recurring themes—his central theme—was the promise and the problem of self-government. As early as 1838, speaking to the Young Men's Lyceum of Springfield on "The Perpetuation of Our Political Institutions," he recalled the devotion of his Revolutionary forefathers to the cause, and went on to say: "Their ambition aspired to display before an admiring world a practical demonstration of the truth of the proposition, which had hitherto been considered at best no better than problematical; namely, the capacity of a people to govern themselves." Again and again he returned to this idea, especially after the coming of the Civil War, and he steadily improved his phrasing. In his first message to congress after the fall of Ft. Sumter he declared that the issue between North and South involved more than the future of the United States. "It presents to the whole family of man, the question whether a constitutional republic, or a democracy—a government of the people, by the same people—can, or cannot, maintain its territorial integrity, against its own domestic foes." And finally at Gettysburg he made the culminating, the supreme statement, concluding with the words: "that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain—that this nation, under God, shall have a new birth of freedom—and that government of the people, by the people, for the people, shall not perish from the earth."

See also references under "Lincoln, Abraham" in the Index.

BIBLIOGRAPHY.—For the general reader, the most usable and valuable guide is Paul M. Angle's *A Shelf of Lincoln Books* (1946). Practically all the known writings of Lincoln himself are available in *The Collected Works of Abraham Lincoln*, edited by Roy P. Basler, 9 vol. (1953–55). A judicious selection from these volumes is reprinted in *The Living Lincoln*, edited by Angle and Earl S. Miers (1955).

Classic multi-volume biographies are John G. Nicolay and John Hay, *Abraham Lincoln: A History*, 10 vol. (1890); Albert J. Beveridge, *Abraham Lincoln, 1809–1858*, 2 vol. (1928); Carl Sandburg, *Abraham Lincoln: The Prairie Years*, 2 vol. (1926), and *The War Years*, 4 vol. (1939); and James G. Randall, *Lincoln the President*, 4 vol. (1945–1955). The best of the one-volume lives is Benjamin P. Thomas' *Abraham Lincoln* (1952).

Matters of controversy and conflicting interpretation are discussed in *Lincoln Reconsidered* (1956), by David Donald, and in *The Lincoln Nobody Knows* (1958), by Richard N. Current. Important works dealing with aspects of Lincoln's statesmanship are David M. Potter, *Lincoln and His Party in the Secession Crisis* (1942); William B. Hesseltine, *Lincoln and the War Governors* (1948); Kenneth M. Stampp, *And the War Came* (1950); and T. Harry Williams, *Lincoln and the Radicals* (1941), and *Lincoln and His Generals* (1952). Ruth Painter Randall writes authoritatively of Lincoln's family life in *Mary Lincoln: Biography of a Marriage* (1953), and *Lincoln's Sons* (1955). Mrs. Randall effectively refutes the views of William H. Herndon, which may most conveniently be found in Herndon's *Life of Lincoln*, edited by Paul M. Angle (1930). An able and realistic treatment of Lincoln's legal career is John J. Duff's *A. Lincoln, Prairie Lawyer* (1960).

(R. N. Cr.)

LINCOLN, a city and county of a city, municipal, county and parliamentary borough, the county town of Lincolnshire, Eng., and the chief town of the Parts of Lindsey, lies 132 mi. N. by W. of London by road. Pop. (1961) 77,065. Lincoln is built on the north side of a gap occupied by the river Witham in the limestone ridge known as the Lincoln edge or cliff. The cathedral stands on the hill and is a landmark for miles, and the town spreads from north of the summit (200 ft.) down the hill and over the flat plain. Fosse way (*q.v.*) ends at Lincoln, and Ermine street (*q.v.*) runs through it.

Architecture.—The Newport arch or north gate of Lindum is one of the most interesting pieces of Roman architecture in England. It consists of a carriageway, flanked by two footways, of which one remains, and a west tower with curved segmental front is now exposed. The Roman Ermine street runs through it, leading northward straight to the Humber. Fragments of the town

wall remain at various points. There is an extensive collection of Roman antiquities from the *colonia* in the City and County museum. Several Roman cemeteries have been discovered; buildings, including baths, an aqueduct pipeline and a public fountain, have been excavated, as have pottery kilns. Of the buildings the most striking is the series of column bases in Bailgate belonging to a portico on the west side of the Roman main street leading to the Newport arch. There is a fine Roman altar to the Parcae in St. Swithin's church found during the building of the church. (I. A. Rd.)

Among churches, apart from the minster, two of outstanding interest are those of St. Mary-le-Wigford and St. Peter-at-Gowts (*i.e.*, sluice gates), both in the lower part of High street. Their towers are probably of mid-11th-century date. Bracebridge church shows similar early work, but as a whole the churches of Lincoln show plainly the results of the siege of 1644.

There were formerly three small priories, five friaries and four hospitals in or near Lincoln. The preponderance of friaries over priories of monks is explained by the fact that the cathedral was served by secular canons. Bishop Grosseteste was the devoted patron of the friars, particularly the Franciscans, who were always in their day the town missionaries. The Grey friary, near St. Swithin's church, is a picturesque two-storied building of the 13th century, now housing the City and County museum. The building known as John of Gaunt's stables, actually St. Mary's guildhall, is of two stories, with Norman doorway and molding. St. Mary's was the leading religious and social guild of the city. The Jew's house is another 12th-century building, and Norman remains appear in several other houses, such as Deloraine court and the house attributed to Aaron the Jew. Among medieval gateways, the Exchequer gate, used by the Lincolnshire Archives committee, is a fine specimen of 14th-century work. Pottergate is of the 14th century, and Stonebow in High street of the 15th, with the guildhall above it. In the Strait lived the Christian boy afterward known as "little St. Hugh," who was asserted to have been crucified by the Jews in 1255. His shrine remains in the S. choir aisle of the minster. Other antiquities are the Perpendicular conduit of St. Mary in High street and the Norman High bridge, carrying High street over the Witham and retaining some 16th-century houses upon it. Among modern buildings is the Usher art gallery, built in 1927, containing the Usher collection of watches, the Peter de Wint collection of oils and water colours, and the Tennyson collection. G. F. Walts's statue of Tennyson stands on the cathedral green.

Lincoln castle, lying west of the cathedral, was newly founded by William the Conqueror when Bishop Remigius decided to establish his minster under its protection. There are Norman remains in the Gateway tower and parts of the walls are of this period; the keep dates from the middle of the 12th century.

(J. W. F. H.; F. T. Ba.)

The Cathedral.—Lincoln cathedral contains some of the earliest purely Gothic work extant, as well as every style from the simple massive Norman of the central west front and the later Norman of the west doorways and towers onward through all the Gothic styles, of each of which both early and late examples appear. The building material is the golden oölite and calcareous stone of Lincoln heath and Ancaster, which has the peculiarity of becoming hardened on the surface when tooled. Formerly the cathedral had three spires, all of wood or leaded timber. The spire on the central tower, which would appear to have been the highest in the world, was blown down in 1547. Those on the two western towers were removed in 1808. In 1921 the towers were found to be in imminent danger of collapse and to save them they, with the west transept, Galilee porch and nave, were treated by grouting, the work (with the help of American contributions) being completed in 1932. The peal of 12 bells in the southwest tower, of which four were a World War I memorial to ringers, were lowered 30 ft. and the upper part of the tower was reconstructed with a lantern roof and the lower louvers were closed.

The ground plan of the first church, adapted from that of Rouen, was laid by Bishop Remigius in 1086, and the church was consecrated three days after his death, on May 6, 1092. The west front consists of an Early English screen (*c.* 1225) thrown over the Norman front, the west towers rising behind it. The earliest Norman work is part of that of Remigius and the great portals and the west towers up to the third story are also Norman (*c.* 1148); the upper parts of them date from 1365 and the Perpendicular windows were inserted about 1450. The nave and aisles were completed about 1220. The transepts, mainly built between 1186 and 1235, have two rose windows: that in the north with contemporary stained glass is Early English, that in the south Decorated—these are called respectively the Dean's Eye and Bishop's Eye. A Galilee of Early English work forms the entrance of the south transept. Of the choir the western portion, known as St. Hugh's (1186–1200), is the famous first example of pointed work; the eastern, called the Angel choir, is ornate work completed in 1280. Perpendicular canopied stalls fill the western part. The great east window, 57 ft. high, is an example of transition from Early English to Decorated (*c.* 1288). Other features of the interior are the Easter sepulchre (*c.* 1300) and the organ screen of a somewhat earlier date. The great central tower is Early English as far as the first story; the continuation dates from 1307. The total height is 271 ft. and the west towers are 206 ft. high. The central tower contains the bell, Great Tom of Lincoln, weighing more than 5 tons.

The buildings of the close that call for notice are the chapter house of ten sides, 60 ft. in diameter, 42 ft. high, with a vestibule of the same height, built about 1225 and therefore the earliest of English polygonal chapter houses, and the library, built by Sir Christopher Wren. The episcopal palace contains work of the date of St. Hugh, and the ruined great hall is mainly Early English. There is some Decorated work and much Perpendicular.

The see covers almost the whole of the county, with very small portions of Nottinghamshire. At its earliest formation, when Remigius, almoner of the abbey of Fécamp, removed the seat of the bishopric there from Dorchester in Oxfordshire in 1072, it extended from the Humber to the Thames, eastward beyond Cambridge and westward beyond Leicester. It was reduced, however, by the formation of the sees of Ely, Peterborough and Oxford, and by rearrangement of diocesan boundaries in 1837. Lincoln cathedral possesses the finest copy extant of Magna Carta (1215); it was exhibited at the New York world's fair, 1939–40, and was afterward sent to the Library of Congress, Washington, D.C., where it remained during World War II. Postwar changes include the rebuilding of the great organ and the establishment (1960) of a cathedral treasury of diocesan plate.

(J. W. F. H.)

History.—The known history of Lincoln begins with the establishment at Lindum by A.D. 47 of the fortress of the 9th legion. After a short tenure by the 2nd legion *Adiutrix* from A.D. 71 onward, the fortress was converted into a *colonia* or settlement for time-expired legionary soldiers. The walls, following the legionary defenses, enclosed a rectangular area of 41 ac., bounded on the north by the Roman gateway of Newport arch, on the west by the west wall of the castle, on the south by the edge of the plateau, and on the east by a line running through the cathedral choir. The town increased in size and early in the 3rd century the western and eastern walls were extended to the south down the hillside almost as far as the river Witham to enclose a second rectangular area of some 56 ac. There was ribbon development along the road to the south across the river, where the railway stations now lie. The Roman enclosures formed the nucleus of medieval Lincoln to which additions were made outside the walls as the population grew. (I. A. Rd.)

The first mention of post-Roman Lincoln is Bede's record that St. Paulinus preached in Lindsey in 628 and built a stone church at Lincoln in which he consecrated Honorius archbishop of Canterbury.

The Danes, in about 877, established themselves at Lincoln, which was one of the five boroughs recovered by King Edmund in 940. Coins were struck there by the Danes in imitation of Alfred pennies and there was a mint from the reign of Edgar to that of Edward I. At the time of Domesday, Lincoln was governed by 12 lawmen, relics of Danish rule, each with hereditable

franchises of sac and soc. The strength of the position of the castle built by William I the Conqueror in 1068 brought much fighting on Lincoln.

In 1141 King Stephen was imprisoned for a short time in the castle by Ranulf, earl of Chester, fighting for the empress Maud. In 1149 Stephen bought the friendship of Ranulf by conceding him, among other territories, the castle and city of Lincoln. King John went to Lincoln in 1200 to attend the obsequies of St. Hugh and while there he received the homage of the king of Scotland. In 1216 the castle stood a siege by the partisans of the French Prince Louis, who were defeated at the battle called Lincoln Fair on May 20, 1217. John de Lacy, nephew by marriage of Ranulf, became the first earl of Lincoln of the Lacy family in 1232 on the death of Ranulf. By the marriage of his descendant, Alice, to Thomas Plantagenet, the castle became part of the future duchy of Lancaster, which was united with the crown on the accession of Henry IV. By the time of the Civil War the defenses had been so neglected that in 1644 the castle was easily taken by the parliamentarians who did a great deal of damage to the city. In 1831 the castle was sold to the counts of Lincoln.

In *c.* 1157 Henry II gave the citizens their first charter, granting them the city at a fee-farm rent and all the liberties which they had had under William II. In 1200 the citizens obtained release from all but pleas of the crown without the walls, and pleas of external tenure, and were given the pleas of the crown within the city according to the customs of the City of London, on which those of Lincoln were modeled. The charter also gave them quittance of toll and lastage (ship-loading privileges) throughout the kingdom, and of certain other dues. The office of mayor is first mentioned in 1206. In 1275 the citizens claimed the return of writs, assize of bread and ale and other royal rights, and in 1301 Edward I, when confirming the previous charters, gave them quittance of murage, pannage, pontage (taxes or payments for building or repairing town walls, pasturage of swine and maintaining bridges) and other dues. The borough court or moot held weekly meetings in the guildhall from 1272. The mayor and citizens were given criminal jurisdiction in 1327 when the mayor and bailiffs were ordered to hear all local pleas, which led to friction with the judges of assize. The city became a separate county by charter of 1409, when it was decreed that the bailiffs should henceforth be sheriffs and the mayor the king's escheator, and the mayor with four others, justices of the peace, with defined jurisdiction. As the result of numerous complaints of inability to pay the fee-farm rent of £180 Edward IV enlarged the bounds of the county of the city in 1466, while Henry VIII in 1546 gave the citizens four advowsons, and possibly also in consequence of declining trade the city markets were made free of tolls in 1554. A charter was granted by Charles I in 1628 after quo warranto proceedings. It provided for 13 aldermen, 4 coroners and other officers. Lincoln surrendered its charters in 1684, but the first charter was resumed after the revolution of 1688 and was in force till 1835.

Parliaments were held at Lincoln in 1301, 1316 and 1328, and the city returned two burgesses from 1295 to 1885, when it lost one. The county borough now returns one member. After the 13th century the chief interests of Lincoln were ecclesiastical and commercial. As early as 1103 Orderic Vitalis, the chronicler, declared that a rich citizen of Lincoln kept the treasure of King Magnus of Norway, supplying him with all he required, and there is other evidence of intercourse with Scandinavia. There was an important Jewish colony, Aaron of Lincoln being one of the most influential financiers in the kingdom between 1166 and 1186. Made a staple (a town appointed by the king to trade in a certain product) of wool, leather and skins in 1291 and famous for its cloths of scarlet and of Lincoln green in the 13th century, Lincoln had a few years of great prosperity, but with the transference of the staple to Boston early in the reign of Edward III, its trade began to decrease. The craft guilds remained important until after the Reformation, a pageant still being held in 1566. The fair now held during the last whole week of April seems to be the successor of that granted by Charles II in 1684. Edward III authorized a fair from St. Botolph's day to the feast of SS. Peter and Paul in 1327. Henry IV granted one in 1409 for 15 days before the feast of the Burial of St. Hugh, and William III gave one for the first Wednesday in September.

Industries and Communications.—The principal industry is now heavy engineering: oil engines, excavators, pumps, castings, agricultural machinery and automobile components. The market has a large trade in corn and agricultural produce.

Seven main roads converge on Lincoln and two railway lines pass through it; there are two railway stations. In 1958 Queen Elizabeth II opened Pelham bridge, a fly-over (overpass) to the east of the city, to relieve traffic congestion in High street. The racecourse, to the northwest, is famous for the Lincolnshire handicap; it is owned by the corporation.

See also references under "Lincoln" in the Index.

See J. W. F. Hill, *Mediaeval Lincoln* (1948), *Tudor and Stuart Lincoln* (1956). (J. W. F. H.)

LINCOLN, city and seat of Logan county, Ill., U.S., is located 29 mi. N. of Springfield. Founded in 1853 and incorporated in 1857, it was named after Abraham Lincoln, then a Springfield attorney, who performed the legal work of the incorporators. Lincoln had tried cases in Postville (the 1835 settlement now part of Lincoln city), and was legislative sponsor of Logan county. Through his influence Lincoln became the county seat.

Situated in an area rich in tillable lands, coal and building materials, it is a shipping point for grains, poultry and dairy products, manufactures, sand and gravel. Manufactures include chinaware, glass containers, cosmetics, store fixtures, metal castings, electrical goods, women's garments and corrugated boxes.

It is the seat of Lincoln college (Presbyterian) chartered in 1865 as Lincoln university, the Lincoln State school for mentally retarded children, the Lincoln Bible institute for theological training, and the Illinois Odd Fellows' Orphans' home.

For comparative population figures *see* table in ILLINOIS: *Population.* (S. R. K.)

LINCOLN, the capital city of Nebraska, U.S., and seat of Lancaster county, is located 55 mi. S.W. of Omaha in a grain and livestock raising region.

Lincoln came into existence in 1867 as a compromise site for a state capital between two conflicting factions, the North Platters who favoured Omaha and the South Platters who favoured a location south of Salt creek. A commission selected the village of Lancaster in Lancaster county, and renamed it Lincoln after Pres. Abraham Lincoln. This location was also chosen because of the salt basin along Salt creek, but industrial development of the saline deposits never materialized.

The admittance of Nebraska to the union as a state in March 1867, the establishment of Lincoln and the beginning of railroad building in the region were almost simultaneous.

Lincoln was incorporated in 1869 and succeeded in getting its first rail connection, the Burlington and Missouri River line from Plattsmouth, in 1870. It was made a city of the first class in 1887 and became a junction of the Burlington railroad system for the major routes from Chicago to Denver, and from Kansas City to Billings, Mont. Lincoln attracted other railroad connections and by the late 19th century there were 19 different rail routes leading from the city.

A communication hub, Lincoln also developed as a distribution and wholesale centre. Railroads furnished Lincoln with its most important continuing industry through the establishment of major repair and locomotive shops in suburban Havelock. Havelock, University Place, College View and Bethany, previously separate towns, were annexed by Lincoln during 1926–30.

In the early 20th century the political life of Lincoln was dominated by William Jennings Bryan (*q.v.*) who lived there from 1887 to 1921 and published the *Commoner.* A long period of prosperity, growth and civic improvement followed World War I until the area was hit by the economic depression of the 1930s, aggravated by drought. By the 1940s the agricultural market was again stable, and Lincoln's economy was given an industrial and commercial boost during the World War II period when a number of large business enterprises were established there.

Lincoln also has a large milling and grain storage business and

manufactures industrial rubber V-belting, agricultural machinery, light self-propelled vehicles, telephone equipment, valves and plumbing supplies, office equipment, dairy and meat products, bricks and pharmaceuticals. The wholesale and jobbing business remained important and the city also became a focus for retail trade. Of added commercial significance was Lincoln's growth as a major insurance centre. A number of federal activities including an air force base and a veterans hospital added to the city's development.

Lincoln early acquired and maintained a position as an educational, cultural and religious centre in the state. The University of Nebraska (founded 1869, state supported), Nebraska Wesleyan university (1887, Methodist), Union college (1891, Seventh-day Adventist) and Cotner School of Religion (1889, Christian Church) are schools of collegiate rank. There is a concentration of state and regional church offices, religious organizations and schools. The Nebraska Art association, the Lincoln Symphony orchestra and the Lincoln Community playhouse are representative of the cultural groups active in the city.

Outstanding on the prairie is the Nebraska state capitol, completed in 1932. A central tower of 400 ft. rises from a massive two-story base. Designed by Bertram Grosvenor Goodhue, it was a pioneer in changing the architectural concepts of the nation in regard to the design of public buildings, holding a place as one of the nation's architectural showpieces. The Nebraska State Historical society building houses an outstanding museum with collections of Indian and pioneer relics.

The population in 1950 was 98,884; in 1960 it was 128,521. The population of the Lincoln standard metropolitan statistical area (Lancaster county) was 155,272 in 1960. For comparative population figures *see* table in NEBRASKA: *Population.*

(W. D. A.)

LINCOLN JUDGMENT, an ecclesiastical *cause célèbre* which marked the climax of the ritual prosecutions in the Church of England during the 19th century. It was delivered in 1890 by Archbishop E. W. Benson (*q.v.*), sitting in his own court, which had not been convened since 1699, upon complaints by the Church association against Edward King, bishop of Lincoln, who had committed certain alleged breaches of ritual in the communion service. The judgment, based on a minute historical analysis of ritualistic practices, sanctioned the eastward position of the celebrant, the use of the mixed chalice of wine and water (if mixed before the service), altar lights and the singing of the *Agnus dei.* Manual acts not visible to the congregation and the sign of the cross in the blessing were declared illegal. The fact that Benson ignored previous rulings of the judicial committee of the privy council, making historical tradition the test of validity, meant that ritualists who had previously defied the decisions of secular courts were now prepared to fall into line. The judgment contributed greatly to the ending of the unedifying ritual prosecutions which had dated from the Purchas judgment passed by the judicial committee of the privy council in 1871, but frequently disobeyed because it lacked spiritual authority.

See E. S. Roscoe, *The Bishop of Lincoln's Case* (1891); A. C. Benson, *Life of E. W. Benson* (1899). (D. H. N.)

LINCOLN PARK, a city of Wayne county, Mich., U.S., is one of Detroit's many residential suburbs. It is grouped with several other communities along the west side of the Detroit river, which are referred to as the "down river communities." The building of the nearby Ford River Rouge plant at Dearborn (*q.v.*) during World War I created a need for many workers' residences.

The alkali industries of Wyandotte (*q.v.*) are nearby and many people from Lincoln Park are also employed there. Lincoln Park was incorporated as a village in 1921 and became a city in 1925. Ecorse and Wyandotte lie between Lincoln Park and the Detroit river.

The population in 1960 was 53,933; for comparative population figures *see* table in MICHIGAN: *Population.* (F. E. LE.)

LINCOLNSHIRE, a county of eastern England, is bounded north by the Humber, east by the North sea and the Wash, and from south to northwest by Norfolk, Cambridgeshire, Northamptonshire, Rutland, Leicestershire, Nottinghamshire and Yorkshire. The geographical area is 2,664 sq.mi.

Physical Features.—The sinking of exploratory bore holes for coal and oil has shown that geologically Lincolnshire rests on a foundation of Carboniferous rocks. The later overlying sedimentary deposits dip to the east, a factor which determines the bold north-south lines of the county's landscape and the west-east drainage of the ancient rivers. There are two upland areas: in the west the Lincolnshire Limestone, with Northampton Beds below; and in the east the Chalk Wolds. During its passage through the county the limestone escarpment narrows from a broad plateau some 20 mi. in width southwest of Grantham to a ridge only 2 to 3 mi. across north of Lincoln. Prominent breaks in the escarpment occur at three points: in the north the Humber gap; centrally the Lincoln gap, through which the river Witham now flows but which owes its origin to the early Trent before its capture by a tributary of the Humber; and in the south the Ancaster gap which is now dry. The Wolds to the east are 45 mi. long and vary in width from 5 to 12 mi. The western escarpment is steep in the north, rising to 548 ft. near Caistor. The dip slope of the Wolds extends eastward to an old cliff line once overlooking a wave-cut platform which is now thickly covered with Boulder Clay and known as the Marshland. The other major geographical area of Lincolnshire is the Fens (*q.v.*). The coast line in the north is sheltered by the Spurn headland, and quiet conditions allow for the deposition of silt and sand, producing salt marshes and sand dunes with sandy beaches. The easternmost bulge of the coast line from Mablethorpe to Ingoldmells is subject to erosion and is strengthened by massive concrete sea defenses to prevent the inundation of the marshland. After the storms of Jan. 1953 these defenses had to be heavily restored. South of Skegness there is another area of accretion giving rise to sand banks and mud flats that form the Lincolnshire shore of the Wash beyond Gibraltar point.

Lincolnshire is predominantly an agricultural county. There are, however, reminders of the early vegetation. In the southwest, on the Lias Clay, there are still fine woodlands, some now managed by the Forestry commission. In the northwest, relics of the blown-sand heath land still remain, and open pine and birch woodlands that were once so typical of this region are conserved in nature reserves at Scotton common and Linwood warren. The typical calcareous heath lands of the late 18th century with their rabbit warrens and thorn and gorse scrub, on the limestone and chalk uplands, have given place to large arable fields with occasional deciduous woodlands planted to the east and west of the wolds. The Forestry commission has changed the character of the countryside in the north of the county by planting extensive coniferous forests on much of the sandy heath in the neighbourhood of Scunthorpe, Market Rasen and Gainsborough. These alterations have produced widespread changes in the flora and fauna, and since 1948 the Lincolnshire Naturalists' trust, in collaboration with the local authorities and landowners, has achieved much in the field of nature conservation. In the early 1960s there were at least 28 sites of special scientific interest, including 10 nature reserves owned, leased or managed by the trust and 4 over which the trust had consultative agreements with landowners. The Skegness and Gibraltar point nature reserve has a fine bird observatory.

History.—The earliest evidence for human settlement in the county is seen in a widely distributed series of Lower Paleolithic implements found mainly since 1945. Upper Paleolithic people, normally cave dwellers from Derbyshire, occupied open sites in north Lincolnshire during the warmer part of the year, particularly at Sheffield's hill, 3 mi. N. of Scunthorpe. The subsequent Mesolithic settlement was concentrated largely in three regions: north and south of Scunthorpe; the extreme south of the Wolds; and the Sleaford-Grantham area. The most impressive feature of the Neolithic immigration is seen in the fine series of 15 long barrows located on the Wolds. The Bronze Age saw the heaviest settlement in prehistoric times, and in the Early Bronze Age entry into the county appears to have been through the Humber and Wash estuaries. At Tathwell, south of Louth, a

fine group of six round barrows remains. In the Middle Bronze Age, trade links have been proved between the Lincolnshire Wolds and central Europe. Notable Early Iron Age antiquities have come from the river Witham at Lincoln and point to the importance of this site at the crossing of the river and important prehistoric trackways. The most outstanding field monument of this period in the county is the earthwork sited on the limestone plateau at Honington, near Grantham, and known as Honington camp. An extensive Early Iron Age salt industry was developed on the coast round Ingoldmells. There are few areas of Lincolnshire that were not occupied by the Romans. The Ermine street passed right through the county and the Fosse way terminated at Lincoln. Even the fenland was effectively drained by the Lincolnshire and Cambridgeshire Car dykes and became part of the great grain-growing area, the produce of which was carried north in barges along the Car dyke to Lincoln and then via the Foss Dyke canal to the Trent and the north. A vast network of fields and farms in the Fens was revealed by aerial photography. As well as the Roman colony at Lincoln (Lindum colonia), there were important smaller, walled towns at Caistor, Horncastle and Ancaster. Ironstone was smelted by the Romans, and there is evidence of the working of deposits at Scunthorpe and near Grantham. The subsequent Anglo-Saxon invasion was largely along the Humber and into the Wash. Archaeological evidence and place names show that the broad lines of settlement were along the Roman roads.

The three divisions of Lincolnshire are older than the county. The ancient kingdom of Lindsey, known in Anglo-Saxon times as Lindesig—the territory of the Lindissi—had the same boundaries as the modern administrative county of that name, though it was practically an island in early times. Kesteven, south of the Witham, has an Anglo-Saxon name the first element of which means a wood, and it was always a well-wooded district. Holland, so often confused with the common name for the Netherlands, has a different derivation and refers to land overlooked by high ground.

From the 7th and 8th centuries there survives an interesting list of the kings of Lindsey, going back to the 6th and continuing to the end of the 8th century. In the 7th century the supremacy over the kingdom of Lindsey alternated between Mercia and Northumbria. St. Paulinus preached in Lincoln in the 7th century and converted the governor of the city and his household. He built a stone church there: the first recorded Christian church in the county. Kesteven and Holland belonged to Middle Anglia. The Danish invasion of the 9th century swept away many of the Saxon institutions, and by 878 Lincoln and Stamford were included among the five Danish boroughs. The division of the land among Danish settlers, the naming and settlement of villages and the introduction of the Scandinavian tongue had a permanent effect on the county: only Holland remained uninfluenced by this settlement.

In the struggles of the reign of Stephen, castles at Newark and Sleaford were raised by Alexander, bishop of Lincoln, against the king. In the struggles between John and his barons in 1216 Lincoln remained loyal to the king, but after the landing of Louis of France the city was captured by Gilbert de Gant, created earl of Lincoln by Louis. The castle held out successfully against the invaders. After his disastrous march to Swineshead abbey, John journeyed through Sleaford to Newark, where he died, and in the battle called Lincoln Fair in 1217 Gilbert de Gant was captured by the royalists and the city sacked. At the time of the Wars of the Roses the county, because of territorial influence, was mainly Lancastrian, and in 1461 the Yorkist strongholds of Grantham and Stamford were sacked to such effect that the latter never recovered. In the Civil War of the 17th century, Lindsey for the most part declared for the king. Lord Willoughby of Parham was a prominent parliamentary leader, and the Isle of Axholme and the Puritan yeomanry of Holland declared for parliament.

As early as 1295 two knights were returned to parliament for the county and two burgesses each for Lincoln, Grimsby and Stamford. In the 14th century, parliament met several times at Lincoln and Stamford, the most notable time being at Lincoln in 1301. Grantham was enfranchised in 1463 and Boston in 1552. Under the act of 1832 the county was divided into a northern and southern division each returning two members; in 1868 it returned six members in three divisions and in 1885 seven members in seven divisions. In 1935 Lincolnshire and Rutland were together divided into seven constituencies: Brigg, Gainsborough, Grantham, Holland with Boston, Horncastle, Louth, and Rutland and Stamford.

At the time of the Domesday survey there were between 400 and 500 mills in Lincolnshire, 2,111 fisheries producing large quantities of eels, 361 saltworks, and iron forges at Stow, St. Mary and Bytham. Lincoln and Stamford were flourishing centres of industry, and markets existed at Kirton-in-Lindsey, Louth, Old Bolingbroke, Spalding, Barton and Partney. The early manufactures of the county are all connected with the woolen trade, Lincoln being noted for its scarlet and green cloths in the 13th century, while an important export trade in the raw material sprang up at Boston. The deforestation of Kesteven in 1230 brought large areas under cultivation, and the same period is marked by the growth of the maritime and fishing towns, especially Boston (which had a famous fish market), Grimsby, Barton, Saltfleet, Wainfleet and Wrangle. The Lincolnshire towns suffered from the general decay of trade in the 15th century, but agriculture was steadily improving; and with the gradual drainage of the Fens, culminating in the vast operations of the 17th century, more than 330,000 ac. in the county were brought under cultivation, including more than two-thirds of Holland. The fen drainage resulted in the extinction of many local industries, such as trade in goose feathers and the export of wild fowl to the London markets.

Ecclesiastical History and Architecture.—Lindsey was originally included in the Mercian diocese of Lichfield, but when it was conquered by Egfrith of Northumbria about 671 it came under the bishop of York. On the subdivision of the Northumbrian see by Archbishop Theodore in 677, it was made into a separate diocese. There is a list of the bishops of Lindsey from 678 to 869 and again from 953 to 1004. The Danish invasions of the 9th century put an end to the bishopric and to organized ecclesiastical life; monastic foundations which existed at Ikanho (perhaps near Boston), Barrow, Bardney, Partney and Crowland as early as the 7th century were destroyed and only Bardney was ever rebuilt. The Middle Anglian diocese had its seat at Leicester but in 877, during the Danish occupation, it was transferred to Dorchester in Oxfordshire, which became the episcopal centre for the whole region and remained so until Bishop Remigius transferred it to Lincoln in 1072.

There are examples of Saxon and Norman architecture in many of the churches. St. Peter's at Barton-upon-Humber is the finest Saxon church, built shortly before A.D. 1000. There is an impressive Saxon tower at Broughton, near Brigg, but the best-known pre-Conquest church is at Stow. The characteristic Saxon-Norman towers, built about the time of the Conquest, are best illustrated at Bracebridge (Lincoln), Marton, Rothwell, Clee and Great Hale. The outstanding example of domestic architecture of this period outside of Lincoln is the manor house at Boothby Pagnell.

At the time of the suppression of the monasteries under Henry VIII there were upward of 100 religious houses, and in the Fens rose some of the finest abbeys held by the Benedictines. The Gilbertines were a pure English order which arose in Lincolnshire. Sempringham, the chief house of the order, was founded by St. Gilbert *c.* 1135. Barlings (Premonstratensian), northeast of Lincoln, was founded in 1154. The Benedictine Mitred abbey of Crowland existed in 1051. Thornton abbey (Black Canons), with its fine 14th-century brick gatehouse, was founded in 1139 at the same time as Kirkstead where the Cistercian monks built a chapel for lay people outside the precincts. There is a wealth of Early English churches in the county: St. James's, Grimsby, is a good example; Tattershall is typical of the fine Perpendicular churches; and Grantham, Sleaford, Heckington and Crowland of the Decorated style. There are good examples of 15th-century

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THE WESTERN LANTERN TOWER OF ST. BOTOLPH'S CHURCH, BOSTON, KNOWN AS THE "BOSTON STUMP" (1309–1460)

village churches in the wolds; *e.g.*, at Bag Enderby and Sutterby. Louth church, with one of the finest spires in England, belongs to the later middle ages, and the spire was erected between 1501 and 1515. To this period belongs also the famous "Boston Stump," the tower of St. Botolph's church at Boston. The 15th century is also reflected in the brick castle at Tattershall built by Ralph Cromwell, 1433–55.

Population and Administration.—Lincolnshire is divided into three administrative counties called the Parts of Holland, the Parts of Kesteven and the Parts of Lindsey, each with a county council. Holland, the smallest, covers 418.6 sq.mi. and contains one municipal borough, Boston (pop. [1961] 24,903); one urban and three rural districts; its population in 1961 was 103,388. Kesteven, in the southwest, covers 722 sq.mi. and within it are two municipal boroughs, Grantham (25,030) and Stamford (11,743); two urban districts and four rural districts; its population in 1961 was 135,317. Lindsey, covering 1,523 sq.mi., including the county boroughs of Lincoln (77,065) and Grimsby (96,665), contains three municipal boroughs, Cleethorpes (32,705), Louth (11,556) and Scunthorpe (67,257); nine urban and nine rural districts; its population in 1961 was 504,678. Apart from the industrial areas in the north and northwest, the seaside resorts and a number of market towns, Lindsey is mainly a county of small villages. The provision of adequate schools, village halls, public transport and other amenities is therefore a special problem. By arrangement between the three administrative counties there is a single police force outside Lincoln and Grimsby.

For judicial purposes Lincolnshire lies in the midland circuit of the high court, and the assize town is Lincoln. Separate commissions of the peace are issued for Holland, Kesteven, Lindsey (divided into 6, 5 and 14 petty sessional divisions respectively), Grantham, Grimsby and Lincoln; and separate quarter sessions are held for each of these areas. Lincoln has its own assizes, being a county of a city.

The crown is represented by a lord lieutenant appointed for the entire geographical county and by a high sheriff for the entire county except Lincoln, which elects its own.

At Cranwell, 12 mi. N.E. of Grantham, is the Royal Air Force college set up in 1920 and officially opened in 1934. It is the training place for permanent commissioned officers. There is also a training station for short-service officers.

The Economy.—Lincolnshire is one of the principal arable counties of England, 80% of the total area being cultivated. The agriculture is highly mechanized. Barley, wheat and oats are the chief grain crops and potatoes the main root crop. Cattle, pigs and sheep are raised in large numbers; the Lincoln Red shorthorn has been bred in the county since the middle of the 19th century, and a favourite breed of pig is the Lincolnshire Curly Coat. On the wolds and heaths are flocks of the largest British sheep—the Lincoln Longwool—whose popularity outside the county has increased since World War II. It has been of great value for crossing with Merino in New Zealand, Australia and the Argentine.

One-sixth of the vegetable acreage of England and Wales is in Lincolnshire, and almost one-sixth of the sugar beet. Horticultural crops are predominant in the south of the county round the Wash, while the Spalding area is notable for its bulb fields, especially daffodils and tulips.

In a county of such varied geological structure the surface extraction of minerals is a considerable industry. Ironstone is won from rich beds at several places. The Frodingham ironstone (Lower Lias) is quarried along 7 mi. of its outcrop near Scunthorpe, the Marlstone ironstone (Middle Lias) near Grantham and the Northampton ironstone (Inferior Oölite) at Colsterworth; and there is mining of the Claxby ironstone (Lower Cretaceous) south of Caistor. There are large cement works near Barton-upon-Humber (using chalk) and at Kirton Lindsey (using the Lincolnshire limestone). Building stone from the Lincolnshire limestone has long been famous, the finest quarries being at Ancaster. Clay, sand and gravel are also worked.

At Scunthorpe are some of the largest and most up-to-date iron foundries and rolling mills in Europe, and between 1901 and 1961 the population of the town grew from 9,000 to 67,257 on account of its steel industry. Lincoln, Grantham and Gainsborough long enjoyed an international reputation for the manufacture of agricultural machinery; but the scope of their engineering and other industries has greatly extended. There are smaller but established industries such as milling, brewing, beet-sugar extraction, ropemaking, canning (especially at Boston and Bardney) and oil-cake manufacture at Barton-upon-Humber, Brigg, Boston, Louth, Sleaford and elsewhere. At Immingham on the Humber a deep-water dock was constructed in 1912 and has been extensively used for trading, chiefly in coal, iron, grain, timber and motor vehicles. With the development close by, since 1945, of large chemical and fertilizer factories and an oil refinery, the village is expanding into a small but prosperous town. At Keadby on the Trent an electric power station was put into operation in 1952. Grimsby is the greatest deep-sea fishing port in England and has a numerous fleet of steam trawlers. Boston is a port whose shipping trade with the European continent consists largely of the importing of timber and agricultural produce.

Lincoln was an important meeting place of Roman roads and canals and is now a railway centre. Canals are little used, but the rivers Trent, Witham, Ancholme and the Roman Foss Dyke are navigable by barge. A ferry crosses the Humber from New Holland to Kingston upon Hull in Yorkshire.

The Lincolnshire coast is a popular holiday area for the industrial Midlands, the principal resorts being Cleethorpes, Mablethorpe and Sutton, Chapel St. Leonards, Ingoldmells and Skegness.

(F. T. BA.)

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LIND, JAMES (1716–1794), Scottish physician, who has been called the "founder of naval hygiene in England," took his M.D. degree at Edinburgh in 1748 and was physician at the Haslar hospital for men of the Royal Navy, Gosport, Hampshire, Eng., from 1758 until his death. When Lind went to Haslar, scurvy was a common disease among sailors, causing more

deaths in the Royal Navy in wartime than did the enemy. As early as 1564 the Dutch had discovered the health advantages of including fresh citrus fruits and juices in the diet of sailors. Lind revived the principle, an admiralty order prescribed the use of lemon juice (1795) and scurvy disappeared from the navy. He also studied typhus, recommending (1758–63) shipboard delousing procedures similar to the techniques used today; suggested the use of hospital ships for sick sailors in tropical ports; arranged (1761–62) for the shipboard distillation of sea water for drinking purposes; and secured many important and beneficial changes in life on board ship. Lind died at Gosport on July 13, 1794. His three classical works are: *A Treatise on the Scurvy* (1754); *An Essay on the Most Effectual Means of Preserving the Health of Seamen in the Royal Navy* (1757); and *An Essay on Diseases Incidental To Europeans in Hot Climates* (1768).

LIND, JENNY (JOHANNA MARIA LIND) (1820–1887), Swedish operatic and oratorio soprano, was born at Stockholm on Oct. 6, 1820. She made her debut in *Der Freischütz* at Stockholm in 1838 and in 1841 studied with Manuel García in Paris. Meyerbeer wrote the part of Vielka for her in his opera *Ein Feldlager in Schlesien*, which she sang in Berlin in 1844, and in 1847 she sang in London the role of Amelia in *I Masnadieri*, written for her by Verdi. She first appeared in London in Meyerbeer's *Robert le Diable* (May 4, 1847); Henry Chorley reported that the town "went mad about the Swedish nightingale." She was remarkable for her vocal control and agility and also for her florid cadenzas. But it was the purity and naturalness of her art that made the greatest impression, and eventually her sincere piety, responsible for these qualities, made her determined for moral reasons to quit the stage. Success in oratorio and recital made it easier for her to do so, and her final stage appearance took place on May 10, 1849, in *Robert le Diable*. The following year she toured the U.S. under P. T. Barnum's auspices, and in 1852 she married her accompanist, Otto Goldschmidt (1829–1907). She and her husband made their home first in Dresden, Ger., and from 1856 in England. In 1870 she appeared in Goldschmidt's oratorio *Ruth* at Düsseldorf, Ger., and in 1875 she led the sopranos in the Bach choir in London, which Goldschmidt had founded. Her last appearance was at a charity concert at Malvern, Worcestershire, Eng., in 1883. From 1883 to 1886 she taught at the Royal College of Music, London. She died at Malvern on Nov. 2, 1887.

See J. Bulman, *Jenny Lind* (1956). (WI. S. M.)

LINDBERGH, CHARLES AUGUSTUS (1902–), U.S. aviator, probably the best-known but least understood figure in aeronautical history, the man whose dramatic solo flight across the Atlantic in May 1927 accelerated world-wide interest in aviation. That flight brought him fame, wealth and a great personal tragedy, but in retrospect it stands only as one episode in a career that greatly influenced the development of commercial and military flying.

Lindbergh was born in Detroit, Mich., on Feb. 4, 1902. His early years were spent mostly in Little Falls, Minn., and in Washington, D.C. (His father represented the 6th district of Minnesota in congress for ten years.) His formal education terminated during his second year at the University of Wisconsin, Madison, when his growing interest in aviation led to enrollment in a flying school in Lincoln, Neb., and the purchase of a World War I Curtiss "Jenny," which he flew on barnstorming tours through southern and midwestern states. After a year at the army flying schools in Texas (1924–25), he became an airmail pilot (1926), flying the route from St. Louis, Mo., to Chicago, Ill. During this period he obtained financial backing from a group of St. Louis businessmen to compete for the $25,000 prize offered by Raymond Orteig for the first nonstop flight between New York and Paris. In the Ryan monoplane "Spirit of St. Louis" he made the flight in 33½ hours on May 20–21, 1927. There followed a series of flights in Europe and America.

In Mexico, Lindbergh met Anne Morrow, daughter of the United States ambassador, Dwight Morrow. They were married on May 27, 1929, at the Morrow home in Englewood, N.J. Together they made flights that took them into many countries of the world. During this period Lindbergh acted as technical adviser to Transcontinental Air Transport and to Pan American Airways, personally pioneering many of their routes.

In March 1932 Lindbergh's two-year-old son, Charles Augustus, Jr., was kidnaped from their home near Hopewell, N.J., and murdered. Partly because of Lindbergh's world-wide popularity, this became the most celebrated crime of the 1930s, and it was a major subject of newspaper attention until April 1936, when Bruno Richard Hauptmann was executed after being convicted of the kidnap-murder. The publicity was so distasteful to the Lindberghs that they took refuge in Europe. After 1936, when he visited German centres of aviation, Lindbergh repeatedly warned against the growing air power of Germany. His decoration by the German government in 1938 led to considerable criticism, as did the neutrality speeches he made in 1940–41 after his return to the United States. Criticism of his public statements by Pres. Franklin D. Roosevelt led Lindbergh to resign his air corps reserve commission in April 1941.

When the United States entered World War II, however, Lindbergh, as a civilian, threw himself unobtrusively into the war effort, serving as a consultant to the Ford Motor company and to the United Aircraft corporation. In the latter capacity he flew 50 combat missions during a tour of duty in the Pacific, and later, after the end of the war in Europe, he accompanied a navy technical mission in Europe investigating German aviation developments.

Following World War II Lindbergh and his family lived quietly in Connecticut. He continued as consultant to Pan American World Airways and to the U.S. department of defense. He was a member of the National Advisory Committee for Aeronautics and served on a number of other aeronautical boards and committees. He received many honours and awards, including the medal of honor (by special act of congress, 1927), the Guggenheim medal and the Wright Brothers Memorial trophy. For his services to the government he was appointed brigadier general in the air force reserve by Pres. Dwight D. Eisenhower in 1954. His book *The Spirit of St. Louis*, describing the flight to Paris, was published in 1953 and gained him a Pulitzer prize. He was also the author of *We* (1929), *Of Flight and Life* (1948) and, with Alexis Carrel, *The Culture of Organs* (1938), concerning researches on which he and Carrel had collaborated.

ANNE MORROW LINDBERGH (1906–) wrote essays and poetry, in addition to accounts of her trips. Her books include *North to the Orient* (1935), *Listen! The Wind* (1938), *Gift From the Sea* (1955) and *Unicorn and Other Poems, 1935–1955* (1956).

(S. P. J.; X)

LINDE, CARL VON (1842–1934), German engineer, inventor of a process of liquefying gas that is basic to the science of refrigeration, was born at Berndorf, in Bavaria, on June 11, 1842. He attended the Polytechnikum at Zürich, Switz., during 1861–64 and then obtained employment at locomotive works, first in Berlin, then in Munich. In 1868 Linde became assistant professor of machine design at the newly established Technische Hochschule in Munich. A scientific paper published in 1870 dealing with the withdrawal of heat at low temperature by mechanical means decided his life work. Another paper relating to refrigeration followed, and brewers, taking note of the practical value of his studies, financed his development of a methyl-ether refrigerator in 1874. In 1876 he took out his first patent for an ammonia refrigerator. Other refrigeration machines had been in use, but Linde's was the first one based upon precise calculations of efficiency. In 1891 he established an experimental laboratory to study refrigeration and related matters. Utilizing the Joule-Thomson effect, he succeeded in producing liquid air in 1895. A rectifying column devised by Linde produced either fairly pure oxygen or fairly pure nitrogen in a single rectification. Many later developments in this field have used essentially Linde's methods, and modern research in the physics of low temperatures and also of very high vacuum has been made possible by his work. He was raised to the nobility in 1897 and died at Munich on Nov. 16, 1934.

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LINDEMANN, (CARL LOUIS) FERDINAND VON (1852–1939), German mathematician, known particularly for his proof that the number π is transcendental, that is, does not satisfy any equation with rational coefficients, was born at Hanover on April 12, 1852. Educated at the universities of Göttingen, Erlangen, Munich, Paris and London, he served as professor of mathematics at the universities at Freiburg im Breisgau, Königsberg and Munich. His mathematical papers were mainly on geometric topics. His famous proof establishes that the classical Greek construction problem of squaring the circle by compass and ruler is insoluble. He died in Munich, March 7, 1939. (O. OE.)

LINDEN, a city in Union county, N.J., U.S., 18 mi. S.W. of New York city. Because of its metropolitan location, many major companies operate plants there, and manufactures include chemicals, oil, metal products, cars and trucks, aircraft parts, furniture, clothing, and foods and beverages. The town was settled early in the 18th century on four village sites, which combined in 1861 to form the township of Linden, a name chosen to reflect the existence of many linden trees in the area. It was largely a farming centre until local industrialization began around 1900; it was incorporated as a city in 1924.

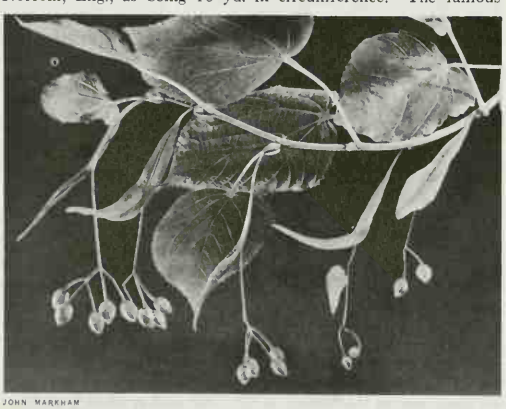
For comparative population figures *see* table in NEW JERSEY: *Population.* (W. L. CA.)

LINDEN (LIME, BASSWOOD), the common name for deciduous trees of the genus *Tilia* of the family Tiliaceae; native to the north temperate zone, they are widely planted for shade and ornament in urban centres. Lime and linden both have their origin in *lind,* an Old English term for these trees.

The genus *Tilia* includes about 30 species of deciduous trees and a number of natural and well-established hybrids. The lindens are readily recognized by their coarsely toothed, irregularly heart-shaped leaves and their flowers and fruits, borne in clusters at the termination of long stalks suspended from leafy or straplike bracts. Few trees emit greater fragrance when in blossom, and the cream and gold flowers, rich in nectar, attract the honeybee. Linden honey, light in colour, is highly regarded for its food value.

Linden wood, soft yet firm, has been a prime favourite with continental wood carvers for centuries. Many of the best expressions of their art are the exquisite frets and carvings of religious motifs to be found in churches of both the old and new worlds. The inner bark of the lindens is rich in fibre and several species are still cultivated by the Russians for paper, cloth and cordage fibres. The soft inner tissues were used by ancients as an antiseptic for binding and healing wounds.

Several of the lindens acquire great size; one is recorded in Norfolk, Eng., as being 16 yd. in circumference. The famous linden tree which gave the town of Neuenstadt in Württemberg the name of Neuenstadt an der grossen Linden was nine feet in diameter. Among the many famous avenues of lindens are the Unter den Linden, of Berlin, and the avenue at Trinity college, Cambridge.



JOHN MARKHAM

FRUIT AND FOLIAGE OF LINDEN OR EUROPEAN LIME (TILIA EUROPAEA)

The large-leaved linden (*T. platyphyllos*), a large tree often 100 ft. tall, is found over much of Europe, including France, Germany, Belgium, Poland, Spain and Italy, and extends eastward into Greece and the Crimea. The small-leaved linden (*T. cordata*), another tree of commercial proportions, occurs naturally in the Scandinavian countries, thence south to Spain, the Balkans and east to the Crimea and Siberia.

The common and widespread European linden (*T. europaea*) is generally regarded by most taxonomists as being a natural hybrid between the two foregoing species. The Crimean linden (*T. euchlora*) is a well-established hybrid between *T. cordata* and *T. dasystyla,* the latter species a tree of southeastern Europe, the Caucasus and northern Iran. Two Asiatic species, the Japanese linden (*T. japonica*) and Mongolian linden (*T. mongolica*), are locally important timber trees.

Most important of the American species is the American linden or basswood (*T. americana*), a tree of modest proportions that occurs in mixed hardwood forests from New Brunswick to southern Manitoba, thence south to North Carolina and Missouri. Its moderately soft, straight-grained wood of light colour is used in manufacturing venetian blinds, piano keys, luggage, millwork and, especially, cabinets and excelsior. (E. S. HR.)

LINDENTHAL, GUSTAV (1850–1935), U.S. engineer, was born at Brünn, Aus., May 21, 1850, and was educated there and at Vienna. After some experience in railway and bridge work in Austria and Switzerland, he moved to the United States in 1871. He was engineer at the Centennial exposition, Philadelphia, Pa., 1874–77, and then practised in Pittsburgh as consulting engineer in railway and bridge construction till 1890, when he moved to New York city. In 1902–03 he was commissioner of bridges for the city of New York.

Lindenthal designed and acted as consulting engineer for the steel-arch railway bridge spanning the East river at Hell Gate, which was opened for traffic in March 1917. With its approaches, it is about 3½ mi. in length and at the date of completion contained the longest steel arch in the world (977 ft.). It remains one of the greatest arches of all time; its outline, framed between great masonry towers, produces a monumental composition. Lindenthal died July 31, 1935.

LINDGREN, WALDEMAR (1860–1939), U.S. economic geologist, was born near Kalmar, Swed., on Feb. 14, 1860. His father was a district judge and a member of the Swedish parliament. Lindgren was educated at Kalmar and at the Royal Academy of Mines at Freiberg, Ger., then Europe's foremost school of mining and geology, from which he graduated in 1883. He went to the United States in the same year and, in 1884, began 28 years of continuous service with the United States geological survey (USGS), during which he acquired the varied firsthand familiarity with the ore deposits of the western states that became the cornerstone of his career. His acute observations during those years, interpreted with rare judgment and presented with clarity, made it possible to diagnose from the mineralogy and textures of ores, with an accuracy not before attained, the physical and chemical conditions under which they formed. They established more firmly than before the igneous sources of many of the mineralizing solutions and clarified the methods by which ores were deposited, notably the method of replacement, the importance of which was not appreciated at the time.

Lindgren became chief geologist of the USGS in 1911, but a year later he resigned to become professor of economic geology and chairman of the department of geology at the Massachusetts Institute of Technology. There, during 27 years, he shared with his students his exceptional knowledge of the work of other geologists and the results of his own rich experience. During his last years in the USGS, he wrote *Mineral Deposits* (4th ed., 1933) which became generally recognized as the leading advanced text in its field. Lindgren was the recipient of many honours, in-

cluding membership in the National Academy of Sciences, the presidency (1924) and the Penrose gold medal of the Geological Society of America (1933), and the presidency of the International Geologic congress (1933), and many others. He died at Brighton, Mass., on Nov. 3, 1939. For further discussion of Lindgren's theories of mineralization and additional information about his classification of mineral deposits *see* ORE DEPOSITS: *Classification and Genesis.* (E. S. BA.)

LINDLEY, JOHN (1799–1865), English botanist, known for his attempts to formulate a natural system of plant classification and for his services to horticulture, was born Feb. 5, 1799, at Catton, near Norwich, where he was educated. On Lindley's going to London in 1819, Sir William Jackson Hooker gave him an introduction to Sir Joseph Banks, who employed him as assistant librarian. In 1820 he published an original *Rosarum Monographia,* with descriptions of new species and drawings executed by himself, and in 1821 *Digitalium Monographia.*

Shortly afterward, while writing the descriptive portion of the *Encyclopaedia of Plants,* he became convinced of the superiority of the "natural" system of plant classification of A. L. de Jussieu, as distinguished from the "artificial" system of Linnaeus followed in that encyclopaedia. This conviction found expression in Lindley's *A Synopsis of the British Flora; Arranged According to the Natural Orders* (1829) and *An Introduction to the Natural System of Botany* (1830).

In 1829 Lindley accepted the chair of botany in University college, London, which he retained till 1860. He was also assistant secretary of the Royal Horticultural society in 1830 and secretary in 1858 and served on many government committees and commissions. He died at Acton, Middlesex, on Nov. 1, 1865.

Lindley's works also include *The Fossil Flora of Great Britain* (with W. Hutton, 1831–37); *Flora Medica* (1838); *Theory of Horticulture* (1840); *The Vegetable Kingdom* (1846); *Folia Orchidacea* (1852–59); and *Descriptive Botany* (1858). He was editor of the *Botanical Register* and *Gardeners' Chronicle.*

LINDLEY, WILLIAM (1808–1900), English civil engineer especially remembered for his work in Hamburg, Ger., was born in London on Sept. 7, 1808. He was engaged on railway work on the continent of Europe and settled in Hamburg as engineer in chief to the Hamburg-Bergedorf railway (1838–60). In May 1842 a great fire raged in Hamburg for three days. Lindley organized strong measures to check its spread, including the blowing up of the town hall, and was afterward appointed consulting engineer to the city, its water board and board of works. He surveyed the burned city and drew up a plan for its complete rebuilding (1842). He constructed a system of sewers, waterworks (1844–48), gasworks (1846), public baths and washhouses; and planned extensions to the port that were carried out in 1854. For Altona in 1855 he constructed waterworks and gasworks. After 1860 he worked in many other cities—Frankfurt am Main, for which he acted as consulting engineer (1865–79), Warsaw, Pest, Düsseldorf, Galaţi and Basel. He also carried out works in Heligoland for the British government. Lindley died at Blackheath, London, on May 22, 1900.

See memoir in *Min. Proc. Inst. Civ. Engrs.,* vol. cxcii (1899–1900). (S. B. HN.)

LINDSAY, the family name of the earls of Crawford, chiefs of clan Lindsay. Of great antiquity, the Lindsay family is believed to be connected with the Norman house of Limesay; there is no territorial district of Lindsay in Scotland. The earliest known member of the family is Sir Walter de Lindesia who accompanied David, earl of Huntingdon (afterward King David I of Scotland), when he conquered Cumbria. His descendants divided into three branches whose heads sat as barons in the Scottish parliament for more than 200 years until their chief attained an earldom in 1398. The Lindsays held the great mountain district of Crawford in Clydesdale (from which the name of the earldom derives) from the 12th century to the close of the 15th, when it passed to the Douglas earls of Angus.

See A. W. C. Lindsay, *Lives of the Lindsays,* 3 vol. (1849).

LINDSAY, NORMAN ALFRED WILLIAM (1879–), Australian artist and novelist, was born at Creswick, Victoria, on Feb. 23, 1879. He began to draw for a Melbourne newspaper at 16, and in 1901 moved to New South Wales. He was for many years the chief cartoonist of the *Sydney Bulletin.* His chief characteristics of imaginative power, grim strength and a certain coarseness of style are apparent in his illustrations to Theocritus, Boccaccio, Casanova and Petronius, the best of which were collected in *The Pen Drawings of Norman Lindsay* (1918). Among his other published works are *Redheap* (1931), *Saturdee* (1933), *Pan in the Parlour* (1934), *Age of Consent* (1938) and *The Cousin from Fiji* (1945). He illustrated many books, including his own novel *The Cautious Amorist,* and was joint founder of the Endeavour press. (D. L. FR.)

LINDSAY, (NICHOLAS) VACHEL (1879–1931), U.S. writer, a gifted and original poet notable for his "General William Booth Enters Into Heaven" and similar poems, was born at Springfield, Ill., Nov. 10, 1879. In 1897 he entered Hiram college, in Ohio, but left after three years to study art in Chicago and New York city. He supported himself, in part, by lecturing for the Y.M.C.A. and the Anti-Saloon league. Meanwhile he had turned to the writing of poetry, and for several summers he wandered through the states, reciting his poems in return for food and shelter. His ambition was to convert America to his vision of beauty. "If I put my soul and body without reserve into the hands of the Lord," he wrote in his diary, "my part will be done. Then let them lead or kill or cure me as they will." (Quoted by Edgar Lee Masters in *Vachel Lindsay: a Poet in America,* Charles Scribner's Sons.)

Lindsay's fame began in 1913 when *Poetry* magazine in its fourth issue published his poem on Booth; subsequently it was included in many anthologies and is probably his best-known single work. His poems of this kind, based on the American rhythms of the crowd and the camp meeting, are his best. Audiences for years delighted to hear him perform them as a kind of "higher vaudeville." Much of Lindsay's poetry is visionary and "hieroglyphic," but he understood the leaders of American cults and causes, men like Alexander Campbell (a founder of the Disciples of Christ), Johnny Appleseed, John Peter Altgeld and William Jennings Bryan. The 20 or so poems which audiences demanded so often that Lindsay grew weary of reciting them ("General William Booth," "The Congo," "Bryan, Bryan, Bryan, Bryan" and "The Santa Fe Trail," for example) became a part of the United States poetic heritage. His "Moon-Poems" and others of this phantasmic kind have been forgotten. Lindsay's best work was done by 1920. Of his later volumes of verse, only *The Candle in the Cabin* (1926) contains poems of distinction. Lindsay died on Dec. 5, 1931.

BIBLIOGRAPHY.—Edgar Lee Masters, *Vachel Lindsay: a Poet in America* (1935); Stephen Graham, *Tramping With a Poet in the Rockies* (1922). Full annotations to 16 Lindsay poems will be found in H. H. Clark (ed.), *Major American Poets* (1936). *See* also Alfred Kreymborg, *Our Singing Strength* (1929), and T. K. Whipple, *Spokesmen* (1928). For additional bibliography and a full listing of Lindsay's works *see* R. E. Spiller (ed.), *Literary History of the United States,* vol. iii (1948) and Supplement (1959). (W. T.)

LINDSEY, BENJAMIN BARR (1869–1943), U.S. judge, a pioneer in juvenile court work and first judge of the conciliation court at Los Angeles, Calif., was born in Jackson, Tenn., on Nov. 25, 1869. At the age of 16 he moved to Denver, Colo., and in 1894 was admitted to the Colorado bar. He sponsored legislation establishing the juvenile court at Denver, served as its presiding judge from 1900 to 1927 and made it the model for similar courts throughout the country. His philosophy, now widely accepted, was that the juvenile offender should be under the protection of the state and a ward of the court, that equity rather than criminal procedure should be employed and that treatment of the juvenile's problem rather than punishment should be the objective. From 1939 until his death he served as judge of the conciliation court at Los Angeles, a special court he helped establish to deal with divorce cases where there was some chance to reconcile the parties. He was one of the first to propose a "family court" with integrated jurisdiction over delinquency and divorce. His ardent championship of "companionate marriage," by which he meant practising birth control to prevent parenthood until a

marriage was solidly established, divorce by mutual consent where the marriage had failed and there were no children but no divorce as of right if children were involved, created great controversy and was confused by his critics with the "trial marriage" proposal of Bertrand Russell. Outspoken, at times contentious, he was an implacable foe of political machines and a leading reformer of archaic legal procedures concerning family social problems. He wrote *Problems of the Children* (1903); *The Beast and the Jungle* (with Harvey O'Higgins) (1910); *Children in Bondage* (with George Creel) (1914); *Pan-Germanism in America* (1919); *The Doughboy's Religion* (with Harvey O'Higgins) (1919); *The Revolt of Modern Youth* (with Wainwright Evans) (1925); *Childhood, Crime, and the Movies* (1926); *The Companionate Marriage* (with Wainwright Evans) (1927); *The Dangerous Life* (with Rube Borough) (1931), an autobiography; and many brochures on juvenile delinquency, domestic relations and crime. He died in Los Angeles, March 26, 1943. (H. H. F.)

LINDSEY, an Anglo-Saxon kingdom probably conterminous with the modern district of Lindsey, Lincolnshire, was an area of early Anglian settlement. A genealogical list of its royal house, extending to Aldfrith, who can be identified with a king of this name who attests a charter of Offa of Mercia between 787 and 796, shows that it had kings of its own. One name in the list, Caedbaed, has a British first element, which may suggest some intermarriage with the Britons. About 631 it was subject to Edwin of Northumbria, and Oswald of Northumbria also obtained control there, which was resented by the inhabitants. Before 674 Lindsey had become subject to Wulfhere of Mercia, who lost it to Egfrith of Northumbria in that year; but Wulfhere's brother, Aethelred of Mercia, recovered it after his victory at the Trent in 678, and it probably remained subject to Mercia until the Danish settlement.

The Danes raided Lindsey in 841 and wintered at Torksey in 873. When they settled in northeast Mercia in 877, Lincoln became one of the Five Boroughs (*see* DANELAW), and Lindsey was probably divided at that time into its three ridings. It seems to have submitted to Edward the Elder in 918. It was raided by the Danes in 993, accepted Sweyn I as king in 1013 and supported Canute when Sweyn died in 1014, thus calling down the vengeance of King Aethelred II. Place names show an intensive Danish settlement, which explains this incident.

After the conversion by Paulinus in about 631, nothing is heard of the church in Lindsey until 677, when Archbishop Theodore created a diocese, with its see at an unidentified Sidnaceaster. This ceased at the Danish settlement, and the religious history of Lindsey becomes obscure. A bishop Leofwine, first recorded in 953, is said by Florence of Worcester to have united the sees of Lindsey and Dorchester-on-Thames in Edgar's reign, and Lindsey remained part of the latter diocese except that it had a bishop of its own, Sigeferth, from about 997 to 1004. After the Norman conquest, the see was moved from Dorchester to Lincoln. Lindsey was claimed unsuccessfully by 11th-century archbishops of York as part of their diocese.

See F. M. Stenton, "Lindsey and Its Kings," in H. W. C. Davis (ed.), *Essays in History Presented to Reginald Lane Poole* (1927) and *Anglo-Saxon England*, 2nd ed. (1947). (D. WK.)

LINDUS (Gr. LINDOS), an ancient and now modern town on the east coast of Rhodes (*q.v.*). It was one of the three city-states of Rhodes before their union (408 B.C.). Danish excavations (1902–14, resumed 1952) revealed the Doric temple of Athena Lindia on the acropolis, rebuilt in the 4th century B.C. after a fire, propylaea (entrance gates) and a stoa (colonnade); the temple and stoa were partially restored during the Italian occupation of Rhodes. Among other discoveries was a chronicle of the temple compiled in 99 B.C. by a local antiquarian, listing mythical and historical dedications from many parts of the Mediterranean. The acropolis contains a castle built in the 14th century by the Knights of St. John, who also built many houses in the modern town.

See C. Blinkenberg *et al., Lindos* (1931–).

LINE, in mathematics, is an abstraction to which the stroke of a pen only approximates. Euclid defines it as length without thickness and specifies that the boundaries of a line are points and that lines define the boundaries of a surface. Another classical definition (not in Euclid) regards the line as generated by the motion of a point and, similarly, a surface by the motion of a line. Starting from the other end, a surface can be defined as the boundary of a space, a line as the intersection of two surfaces, and a point as the intersection of a line and a surface or of two lines on one surface.

In modern geometry (at least in English) the term line generally means a straight line (the more general curved line being called a curve) thought of as extended indefinitely both ways; if bounded at one end it is called a half line, if at both ends a segment. Some old-established phrases survive, such as line of force and line of striction, which do not imply straightness. Euclid defines a straight line as one that lies evenly with respect to the points on itself, a phrase that has called for a good deal of exegesis; for Archimedes it is the shortest distance between two points; and another definition, essentially due to Hero of Alexandria, is that a straight line does not change its position when rotated about its two ends. The properties of straight lines that are most fundamental for modern geometers are those that belong to the aggregate of straight lines, rather than to each one, and include the notions that any two points can be joined by a straight line, that no two straight lines can have more than one common point and that two straight lines in one plane either meet in a point or are parallel; all of which are among Euclid's axioms and postulates.

In analytic or algebraic geometry the straight line is represented by one or more equations of the first degree, in plane geometry by a single equation and in solid geometry by two independent equations.

The special study of line geometry deals with the properties of families of straight lines in space that satisfy one or more conditions, such as passing through a given point, meeting or touching a given curve or touching a given surface. *See* ANALYTIC GEOMETRY; CURVES; CURVES, SPECIAL. (P. DU V.)

LINEA, LA (LA LÍNEA DE LA CONCEPCIÓN), a town in the province of Cádiz, Andalusia region, Spain, is situated between Gibraltar and San Roque. Pop. (1960) 59,456 (municipality). La Línea, which derives its name from the *linea* or boundary dividing Spanish territory from the district of Gibraltar, stands on the isthmus of sand forming the eastern arm of the Bay of Gibraltar and is a frontier post and headquarters of the Spanish commandant of the lines of Gibraltar. It has no port and is a modern town brought into existence solely by the British occupation of Gibraltar, which it supplies with fruit and vegetables. The fortifications erected there in the 16th century were dismantled by the British in 1810 to prevent the landing of French invaders. (M. B. F.)

LINEAR PROGRAMING: *see* MANAGEMENT SCIENCES.

LINE ENGRAVING: *see* ENGRAVING, LINE.

LINEN, HOUSEHOLD: *see* TEXTILES, HOUSEHOLD.

LINEN MANUFACTURE. Linen includes all yarns spun and fabrics manufactured from flax fibres. For a comparative discussion of flax and other textile fibres *see* FIBRE.

Flax is one of the oldest textile fibres known and linen manufacture was one of the most extensive of the domestic industries; at the beginning of the modern period it was developed in Russia, Austria, Germany, the Netherlands, Belgium, northern France, Northern Ireland, Scotland and certain parts of England. In the late 18th century, however, the spinning and weaving inventions of Richard Arkwright, James Hargreaves and Samuel Crompton benefited the cotton industry almost exclusively; and the consequent increase in cotton fabric production caused a widespread reduction in the linen industry, beginning in the United Kingdom but quickly spreading over Europe.

In an effort to bolster the industry in France, Napoleon I in 1810 offered a reward of 1,000,000 fr. to the inventor who devised the best system for spinning flax yarn. Philippe de Girard patented a system within a few weeks but failed to make his invention a commercial success in either France or Austria. Meanwhile in England John Kendrew and Thomas Porterhouse had laid

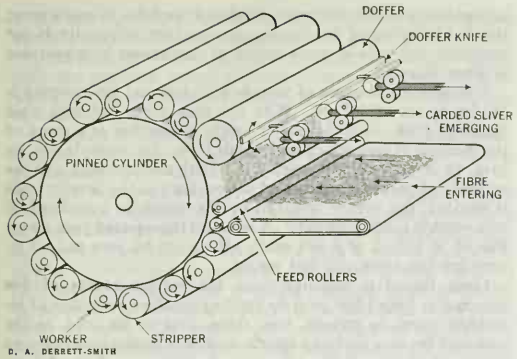


FIG. 1.—DIAGRAM SHOWING THE CARDING OF FLAX

the real foundation of the present industry by developing a successful process from a patent granted to them in 1787, for "a mill or machine upon new principles for spinning yarn from hemp, tow, flax or wool."

Technical difficulties likewise delayed the introduction of factory weaving for many years after the system was fully applied to other textiles, but these were overcome by improvements in spinning and in methods of preparation. A. J. Warden in *The Linen Trade, Ancient and Modern* (1864) states that power was applied on a small scale to the weaving of canvas in London in about 1812 and that in 1821 power looms for weaving linen were started at Kirkcaldy, Scot. In 1824 Maberly and Co. of Aberdeen had 200 power looms erected for linen manufacture in their Broadford factory; the power loom has continued in uninterrupted use there ever since and the company may be considered the effective introducers of power-loom weaving in the linen trade. Hand-loom weaving has virtually disappeared as a manufacturing method, but in Northern Ireland fine damask cloths continue to be hand-woven for such special occasions as the coronation of Queen Elizabeth II.

Much of the apparel and household linen used in the United States and Great Britain is manufactured in Northern Ireland, with lesser amounts from Belgium, Czechoslovakia, Japan and elsewhere.

YARN MANUFACTURE

Flax fibre is separated from the woody portion of the stem by retting, breaking and scutching; for an explanation of these processes *see* FLAX. The flax scutching machine yields long fibre, which consists of fibre strands in a roughly parallel state called line, and short fibre which consists of partly broken and tangled strands called tow. The three basic operations in yarn manufacture are hackling and spreading, for line fibre, or carding, for tow; preparing; and spinning.

Hackling and Spreading.—The scutched line fibre in stricks (or bundles) of about 30 in. in length is carefully combed during the hackling operation in order to remove broken and tangled fibres and to subdivide the gross fibre strands into finer units. The broken and tangled fibres separated out in the process are called machine tow. The hackling machine was almost completely mechanized in the early 1900s and the principles of the early machine have remained largely unchanged ever since; hand hackling, as a means of commercial production, has completely disappeared.

The hackled line fibre may be produced as a sliver by automatically spreading and overlapping each piece of flax with another on a slow-moving belt, and passing these through a drawing operation as described in the section on preparing (*see* below). Alternatively, this spreading operation may be carried out by hand; both methods are in everyday use.

The spreadboard sliver produced in either of these two ways is the starting point for the manufacture of yarns suitable for weaving into sheeting, pillowing, handkerchiefs, damask cloths, drill suitings, cambrics and lightweight fabrics, as well as the finer quality linen threads, twines and netting.

Carding.—The fibre removed as tow from the strick of flax during the scutching and hackling processes is identical in many ways with the line fibre, from which it has been derived. The main differences lie in the shorter length and tangled state, and these differences prevent the tow fibre from being formed into a sliver by a spreading process. The flax card straightens the tow fibres by a combing action, rejects remaining impurities, such as woody material from the stem of the flax plant, and converts the fibre into a continuous sliver. It is similar in general principles to the jute card (*see* JUTE) but has more rollers for combing and cleaning and a greater density of pins on the rollers. The sliver produced by the card may be combed further if required, or passed directly to the preparing system. The carded or combed tow sliver is the starting point for the manufacture of yarns suitable for dress linens, toweling, interlinings, canvases and other heavier fabrics.

Preparing.—The preparing process is essentially the same for both line and tow fibre and the basic principle is the use of pins to penetrate the sliver and control fibre movement during the drawing process. This process takes place between two sets of rollers. The drafting rollers are driven at a surface speed of from 4 to 30 times the speed of the retaining rollers and between these pairs of rollers the sliver is held in pins set in bars which are moved at a slightly faster forward speed than the retaining rollers. The pins separate the sliver into a number of units, from which the drafting rollers draw out fibres. The friction exerted by the pins prevents those fibres not gripped by the drafting rollers from being carried forward out of turn. The relatively fine slivers produced at the drafting rollers are usually doubled together in sandwich fashion by passing them over a perforated guide plate and delivering them as a composite sliver through a pair of rollers to a sliver can, which rests on a turntable driven so as to coil the sliver neatly into the can. The drawing and doubling operation is repeated three to six times depending on the type of fibre and the end product required. The pins on the faller bars also vary in number according to the material used and the stage of processing. As few as eight pins per inch may be used at the early part of a coarse system of drawing, and as many as 40 pins per inch at the later part of a fine system. The spacing, or pitch, of the faller bars and the number employed also vary; the pitch may be as wide as $\frac{5}{8}$ in. in a coarse system and as fine as $\frac{3}{16}$ in. in a fine system. The number employed is specified as the length of the faller bed between the two pairs of rollers; this may be as long as 30 in. when dealing with line fibres or as short as 6 in. when dealing with tow fibres. The quality of the final product is dependent on the skilful use of this pin-controlled drawing system.

The sliver must finally be presented in a form suitable for spinning, and in most cases it is necessary for it to be held to-

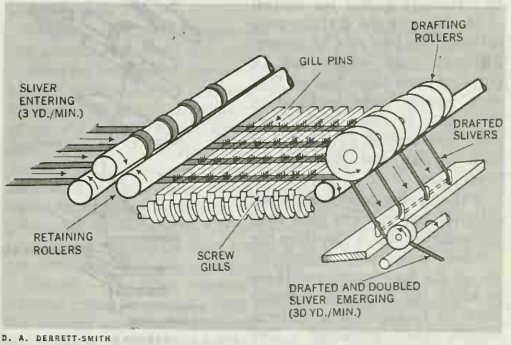


FIG. 2.—DIAGRAM SHOWING THE PREPARING OF FLAX

gether lightly with twist. This is done on a frame which carries out the final drafting operation and, by means of a positively driven spindle, inserts twist in the sliver, at the same time winding it onto a suitable bobbin, which is also positively driven. The bobbin and spindle are connected through an ingenious differential-drive mechanism, which ensures that the twisted sliver, called rove, is accurately wound under precise conditions without strain. The bobbins of rove and, in some cases, cans of sliver are then ready for spinning.

Spinning.—This process may be carried out dry on rove or sliver, or wet on rove; the finer yarns are usually wet spun and the coarser yarns dry spun. The wet-spinning frame is equipped with a trough of heated water, through which the rove is passed to two pairs of drawing rollers set in an almost vertical plane and spaced from $1\frac{3}{4}$ to 4 in. apart, depending on the type of yarn being spun. There is no positive control of the fibre in the space or "reach" between the two pairs of rollers, the control being achieved by selecting spacings and twists suitable for the individual fibres and roves. The function of the hot water is to soften the binding materials in the flax strands and so make it possible to draw out from them ultimate fibres and small groups of ultimate fibres. These are then twisted together into a compact mass as they emerge from the drafting rollers and are wound onto a package. Spinning frames of the older type employed spindles or flyers to insert the twist and wind the yarn onto small wooden bobbins, but modern machines are fitted with ball-bearing spindles, stainless-steel rings and nylon travelers to achieve the same object, making possible the use of larger packages and metal bobbins, at much increased speeds of production. The old practice of winding the wet yarn into hanks and drying it in lofts has virtually disappeared and the yarn may now be dried directly on the spinning bobbin in special machines, and wound into a large package of about 3 lb. weight on modern high-speed cone- or cheese-winding machines at about 600 yd. per minute. An alternative method, also in use, is to wind the wet yarn into a package and dry the package on specially designed machines. Both methods reduce handling costs and present the yarn in a form immediately suitable for the processes that follow.

Dry spinning of flax is carried out from sliver on spinning frames with a drafting control system based on faller bars and pins, as used in preparing, and also on frames in which the drafting control is provided by an apron and rollers. The latter is a modern development, using the ring and traveler system for twist insertion and winding on, and was rapidly finding favour in the 1960s as it allowed the yarns to be more economically and better spun. As these sliver-spinning frames use the fibre strands without further splitting, they are limited to the production of the coarser-count yarns. With a pin-controlled drafting frame, a damping roller is generally provided between the drafting roller and the bobbin of yarn, so that the fibres are damp when the twist is inserted and bind together better in the yarn. Dry spinning is also carried out from rove, using machines which rely on a system of stationary guides for control of the fibres in the drafting zone between the two sets of rollers. Although good results can be obtained using these frames, they were largely being replaced in the 1960s by those with apron and roller control, on grounds of both quality and economy in production.

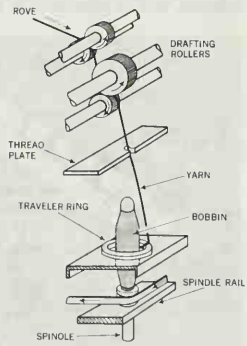


FIG. 3.—DIAGRAM SHOWING THE SPINNING OF FLAX

Wet spinning produces a more compact and uniform yarn than dry spinning and is therefore the method commonly employed for all the finer yarns, and those in which the maximum strength must be realized, or a uniform smooth yarn produced. Dry spinning is a cheaper process but produces a more irregular yarn, which is often hairy in appearance; this is ideally suited for coarser yarns where uniformity is not necessary and, indeed, some degree of unevenness in appearance is often desirable.

The common measure of yarn in both wet and dry spinning is the lea or cut of 300 yd. With wet spun yarns and with most Northern Irish yarns the size or weight is specified as a count of the number of leas which will weigh 1 lb.; for example 16s lea yarn, 16 × 300 yd., will weigh 1 lb. With coarser yarns, and the majority of yarns from Scotland where much of the heavier trade is situated, the yarn is specified by the weight in pounds of 48 cuts which is called a spyndle. A so-called three pound yarn means that 48 × 300 yd. of it will weigh 3 lb.; a 16s lea yarn and a 3 lb. yarn are the same size and weight.

Linen thread is prepared from the various counts of fine bleached or boiled line yarn by twisting together a number of individual yarns or strands, two, three, four or six cord, as the case may be, on a doubling spindle similar in principle to the yarn spinning frame, excepting, of course, the drawing rollers. A large trade in linen thread has been created by its use in the machine manufacture of boots and shoes, saddlery and other leather goods, and in heavy sewing-machine work generally. Fine cords, net twine and ropes are also twisted from flax.

Man-Made Fibres.—The manufacturing process evolved for flax is ideally suited for the processing of all types of man-made fibres, provided they are supplied with a minimum amount of crimp and the correct fibre dressing. Fibre lengths in use range from $1\frac{1}{2}$ to 8 in., the short fibre being used to produce slub or fancy yarns, but the flax system will produce level yarns from fibres of 3 to 4 in. upward in length. The flax card is used as the starting point; cut staple fibre processes well on the card, which is remarkable for the gentle way it treats the fibres, forming into a sliver with very little breakage. The pin-controlled drafting process described in preparing (*see* above) is the best way of controlling the relatively long fine fibres, which are the most suitable for the economic production of strong level yarns. Modern dry-spinning machines produce both blends of yarns and yarns of a single fibre type of very good quality at a reasonable cost. Wet-spinning methods allow a variety of blends of man-made fibres and flax to be produced which are of interest for their special properties.

The flax manufacturing system tends to produce lean compact yarns that make fabrics well suited for household and other similar uses but not suited for clothing. This limitation was overcome by the use of the thermoplastic properties of man-made fibres, so as to develop open-structured yarns suitable for clothing fabrics. Yarns now spun on the flax system are finding an increasing variety of end uses.

The first man-made fibre to be spun on a large scale by this process was viscose rayon; this was followed by acetate, triacetate, polyester, polyamide, polyacrylic and polyolefin fibres (*see* FIBRE, MAN-MADE).

FABRIC MANUFACTURE

Weaving.—The various operations connected with linen weaving, such as winding, warping, sizing, beaming and drawing-in, are similar in essential features to processes used in cotton weaving; neither is there any significant modification in the looms employed. (*See* COTTON MANUFACTURE: *Production of Fabrics.*) Sizing is a matter of importance in the preparation of linen warps for weaving. The sheet of yarn is treated with a film-forming paste of starch and lubricant, applied by flannel-covered rollers, the lowest part of which are submerged in a trough of size paste as they revolve. The size paste is distributed uniformly on the yarn by brushing, and dries to a thin film on the yarn by passing the sheet over fan heaters and steam-heated cylinders, before it is finally wound on the beam for drawing-in and weaving.

Bleaching.—Mechanically and chemically the methods used for bleaching linen resemble closely those used for bleaching cotton, and they require similar care and skill to reduce the amount of nonfibrous impurity to a level which readily enables the required degree of whiteness to be obtained. The process begins

with a thorough boiling in alkaline liquor, followed by neutralization in a weak acid liquor. Bleaching itself depends on the action of weak solutions containing oxidizing agents, such as hypochlorite, hydrogen peroxide, sodium chlorite, chlorine or chlorine dioxide. The bleaching sequences are controlled to give the desired degree of whiteness.

Impurities in the flax fibre—adhering tissue and gummy impurities, with traces of highly coloured waxy materials from the brownish-green skin of the plant—amount to about 25% of the raw fibre, compared with 5%–10% in cotton. Compact, closely woven white fabrics with a full handle—those used for clothing and embroidery linens, for example—can be more easily produced by weaving from bleached yarn. The yarn is mostly bleached in compact cross-wound packages on perforated centres which are mounted in special package bleaching machines, designed so that the scouring and bleaching liquors can be circulated through the layers of yarn. The weight and construction of linen fabrics woven from unbleached (gray) yarn vary greatly and the mode and duration of bleaching must be adjusted to each quality. Flax fibre is sometimes bleached before spinning. There are advantages in doing this when the fibre will be blended with other fibres. (*See* also BLEACHING.)

Fabrics.—Linen fabrics are widely different in their qualities, appearance and the uses to which they can be put, ranging from heavy canvas to the most delicate cambrics. The most important of the heavier manufactures are canvas, tarpaulin and carpet backing. The medium weights of linen are used principally for toweling, linings, curtains and upholstery, apparel fabrics, sheeting and embroidery fabrics. Damask for table linen is made in both the single or five-leaf damask and double or eight-leaf damask, the pattern being formed by the intersection of warp and weft yarns at intervals of five and eight threads of yarn respectively. Double damask allows the introduction of more detail in design than single damask. The fine linens are cambrics, sheers and handkerchiefs. Printed and dyed linen fabrics may also be considered a special class, which embraces a variety of weights, textures and finishes, as well as of patterns and colours, since linen is of increased importance for women's dress fabrics.

Linen fabrics are generally of an excellent quality and have several advantages, resulting principally from the structure of the flax ultimate fibre. The cloth is smooth and lustrous, strong and long-lasting; it is lint-free and highly absorbent but dries quickly; it is clean, cool and launders beautifully.

LINEN TRADE DEVELOPMENTS

A number of factors affected the linen industry in the 20th century, especially during the decade of the 1950s. Competition greatly increased from man-made fibres, offering not only lower prices but also claims of "crease resistance" and "wash and wear" for apparel fabrics. Competition within the industry also increased as Belgium and Japan began to produce lower-priced linen. The change in living habits also significantly affected the market for linen; although worldwide, this change has been particularly notable in the United States, where paper tissues have reduced the use of fabric handkerchiefs, paper towels curtailed the use of linen towels and the trend toward informal living has reduced the demand for elegant table and household linens.

A number of developments took place to meet these new conditions. The industry in Northern Ireland consolidated its position with mergers of individual processors within a group. New processes were developed for making linen crease-resistant by the use of suitable resins.

Much diversification took place in the industry. Even before World War II some linen weaving capacity was diverted to the manufacture of cotton and rayon damask tablecloths; Japan emerged as a dominant competitor in this type of product. Northern Ireland also became the centre of a substantial man-made fibre and fabric manufacturing industry, and the complementary properties of flax and man-made fibres are being used in blend fabrics, *e.g.*, flax with acrylic, polyester and triacetate fibres.

Another significant development was the expansion of the U.S.S.R. in the field of linen manufacture. Measured in terms of flax production, it produced 157,000 tons in 1953 and 430,000 tons in 1958. Production for 1961 was 397,000 tons, compared with about 100,000 tons for the western world.

See also references under "Linen Manufacture" in the Index.

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LINE SPECTRA: *see* SPECTROSCOPY.

LING (*Molva molva*), a food fish of the cod family (Gadidae), elongate in form, with strong canine teeth in the lower jaw that are arrow-shaped and movable; it has a short first dorsal fin, long second dorsal and anal fins, and a rounded caudal fin. A cold-water fish, ranging from Greenland and Spitsbergen to the Bay of Biscay, the ling lives at depths of 80–150 fathoms. It is a fish eater, and reaches a length of up to seven feet.

In North America several other marine fishes are sometimes called ling, especially western Atlantic members of the genus *Urophycis* and the Pacific greenling (*Ophiodon elongatus*). *See* also FISH: *Survey of the Bony Fishes.* (L. A. WD.)

LING is another name for the common heather, a low evergreen shrub native to the open woods of western Europe and the British Isles, and introduced into eastern North America. *See* HEATHER; ERICACEAE.

LINGUA FRANCA is an auxiliary or compromise language used between peoples speaking mutually incomprehensible vernaculars. It may be one of a number of native languages like Swahili in east Africa, Hausa in west Africa, and Hindustani in India; or it may be a mixed jargon like the pidgin English of the western Pacific or the Sabir (a mixture of French, Italian, Spanish, Greek and Arabic) of the Mediterranean ports.

The term lingua franca was perhaps first applied to a jargon based on southern French and Italian which crusaders and traders developed in the eastern Mediterranean during the middle ages. Extension of trade routes, overseas colonization and slavery, during and after the Renaissance, gave rise to a number of mixed contact jargons like Indo-Portuguese (Ceylon), Annamito-French (Cochin China), Spanish Papiamento (Curaçao) and several varieties of pidginized English—all based on the languages of the colonizing nations.

Origin.—Such jargons generally begin as a compromise between two groups, each desiring to communicate, but unwilling or unable to learn the language of the other. The European may try to make himself understood by imitating the native's effort to speak the European language. The native, taking this imperfect imitation as a model, tries to reproduce it as best he can with the pronunciation and some of the grammatical structure of his own language, thus giving the European further distortions to imitate—and so on, until a new compromise language is developed. In plantations, slaves from mutually unintelligible tribes got their model from infrequent contacts with European masters and used their vague impressions of their masters' language as a basis of a lingua franca for communication among themselves.

Spread.—The more polyglot an area, the better the chance for a lingua franca to spread. Thus Beach-la-mar or Sandalwood English became an important language in Melanesia where neighbouring villages might speak distinctly different languages; but not so in Polynesia where many dialects are mutually intelligible. Lin-

guistic diversity in the American northwest was largely responsible for the spread of the Chinook jargon, a lingua franca based on Chinook and other American Indian languages, with English admixture. It became the trade language used not only between white traders and Indians but also between different Indian tribes, and for a time it was the native language of the offspring of Oregon squaws and French-Canadian *voyageurs*.

When such jargons supplant the mother tongue they become known as Creole languages. Examples of these are Haitian French Creole, Cape Verde Portuguese, and Taki-Taki, a language developed out of a jargonized English used by the African slaves of English and Portuguese landholders who settled in Dutch Guiana in the middle of the 17th century.

Some contact vernaculars may thus develop into written and standardized national languages. Malay, a compromise of various Malayo-Polynesian languages, was used as a lingua franca in British Malaya and the Dutch East Indies and later became the national language of the Republic of Indonesia.

See also BILINGUALISM; PIDGIN. (W. F. MY.)

LINGUET, SIMON NICOLAS HENRI (1736–1794), French journalist and lawyer whose delight in taking the view opposed to everyone else's made him many enemies, was born in Reims on July 14, 1736. His early writings include *Histoire du siècle d'Alexandre le Grand* (1762), in which he declared that Nero caused far fewer deaths than Alexander, and *Le Fanatisme des philosophes* (1764), a violent attack on the most widely held doctrines of the Enlightenment. Admitted as an advocate in the Paris *parlement* in 1764, Linguet defended the chevalier de La Barre (J. F. Lefebvre), who was condemned to death on charges of blasphemy and sacrilege in 1766. His greatest masterpiece of pleading was his *Mémoire* of 1772 on behalf of the comte de Morangiès (J. F. C. de Molette), accused of trying to defraud his creditors.

Linguet's attacks on other lawyers, on Pierre Gerbier in particular, led to his expulsion from the bar in 1775. He went into exile, traveled in Switzerland, Holland and England and launched the *Annales politiques, civiles et littéraires du XVIIIème siècle* (1777–92). Soon after his return to France he began an attack on the duc de Duras (Emmanuel de Durfort) and was imprisoned in the Bastille (1780–82). On his release he went back to England, where he published *Mémoires sur la Bastille* (1783). Proceeding to Brussels, he obtained titles of nobility and 1,000 ducats from the Holy Roman emperor Joseph II; yet in 1789 he argued in favour of the Belgian insurgents against Joseph's regime.

At the beginning of the French Revolution, Linguet tried to win election as a deputy. Among the fiery and eloquent petitions that he subsequently presented was one to the constituent assembly in defense of the inhabitants of San Domingo against the "white tyrants" in 1791. He retired to Marnes, near Ville d'Avray, in 1792. Arrested there, he was eventually tried and condemned to death in Paris for having "flattered the despots of Vienna and London." He was guillotined in Paris on June 27, 1794.

Among his more important works are the following: *Théorie des lois civiles* (1767), an attack on Montesquieu; *Histoire impartiale des Jésuites* (1768); and *Histoire des révolutions de l'empire romain*, 2nd edition (1766–68).

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LINGUISTIC GEOGRAPHY: *see* DIALECT GEOGRAPHY.

LINGUISTICS is the study of language (*q.v.*). It covers the structure of languages, their bearing on other human activities and on one another, and their history. The description of structures has come to involve methods like those of mathematics, especially in the fields of communication and information theory (*q.v.*). Language is a part of human behaviour, and linguistics therefore a social science; or, in some aspects, even a branch of anthropology. It is also linked with the humanities, because some of its source material comes from literature, art and history.

Divisions.—The field may be divided into pre-, micro- and metalinguistics. The first deals with the physical and biological aspects of language, the second with analysis of language systems (descriptive, comparative and general), the third with the links between language and culture as a whole, and thus with meaning. Finally, there is the history of languages, both of systems as such and of their social impact. The main divisions of this article are as follows:

I. History of Linguistic Studies
II. Descriptive Linguistics
  A. Descriptive Phonology
  B. Morphemic Analysis
  C. Syntax
  D. Linguistic Patterning
  E. Meaning
  F. Linguistic Change
III. The External History of Language
  A. Language as a Social Force
  B. Common and Hybrid Languages
  C. Formation of Dialects
  D. Reciprocal Influence of Languages
  E. Growing Time

I. HISTORY OF LINGUISTIC STUDIES

Beginnings.—Observations on language are often first made on sacred texts that have survived unchanged for long periods; thus may arise a body of grammar and a tradition of grammatical examination. The Vedas of India have been studied in this way, the extant compilation being attributed to Pāṇini (*c.* 400 B.C.), the first known precursor of modern linguistics. He expressed his findings on the original texts in quasi-mathematical symbols, a method that has remained exemplary in many respects.

Greek literature, too, provided a vast field for linguistic study. However, the Greeks had no sacred texts but were interested rather in studying the world around them by means of language. They developed a grammatical tradition which enabled them to give an adequate theoretical account of their language. This philosophical grammar passed to the Romans with some differences because of the peculiarities of Latin. The Greco-Roman tradition survived into medieval times, and after the Renaissance was applied to the modern languages of Europe. Since the latter were different in structure, the classical analysis did not fit, but was stretched to cover the differences.

With the discovery of the new world the linguistic experience of the western peoples widened, but grammatical tradition made it difficult to record and describe accurately the newly found languages. In the 17th century, however, Europeans became acquainted with the traditions of India and began to learn Sanskrit. In doing so they learned about the Indic grammatical school of Pāṇini and his followers. This led to a new view of languages and of grammatical description. As the principles of Pāṇini's descriptive techniques became known and as more new languages were found, the foundations of modern linguistic and logical analysis became firmer. However, they were not fully established until the end of the 19th century in European and American linguistic schools (*see* below). The discovery of Sanskrit brought about the rise of 19th-century comparative linguistics. The techniques thus developed were the first scientific linguistics in the western world.

Comparative Linguistics.—Among the 18th-century Englishmen in India who learned Sanskrit and began to study Indic literature was Sir William Jones. In 1786 he announced that the resemblance of Sanskrit to Greek and Latin was too close to be due to chance, and showed that all three "sprung from some common source which, perhaps, no longer exists," and that Germanic and Celtic probably had the same origin. This is not the first recorded recognition of what constitutes language relationship as understood by modern linguistics, but it may be counted as the beginning of comparative linguistics.

Little had been done to state resemblances systematically. Where it was apparent that a language like Italian was somehow a later form of Latin, it was considered a corruption of a perfect original. The thinking started by Jones led to the recognition that languages change constantly, that the changes are systematic and regular, and that by careful examination of the changes within a

language and comparison of the differences between languages, origins and relationships can be correctly established.

For the Indo-European languages, the beginning of systematic comparison was a treatise on verb inflection in Sanskrit, Greek, Latin, Persian and Germanic, published in 1816 by Franz Bopp. In 1818 Rasmus C. Rask and in 1819 Jacob Grimm examined the relationships of the Germanic languages to one another. In 1833–56 August Friedrich Pott published his etymological studies of Indo-European. August Schleicher, in 1861, published a comparative grammar of the Indo-European languages, and in 1886 Karl Brugmann and Berthold Delbrück began to publish their *Outline of the Comparative Grammar of the Indo-European Languages,* which remained the standard work of reference in the field. Friedrich C. Diez studied the Romance languages in a comparative grammar (1836–44), Johann Kaspar Zeuss began the study of Celtic (1853) and Franz von Miklosich wrote a comparative grammar of the Slavic languages (1852–74).

The interest in comparative linguistics led to the investigation of other language families (Finno-Ugric and Semitic at first), and also to the beginning of the descriptive treatment of contemporary languages as if they had no history. The comparative linguistics of the 19th century was the beginning of all modern linguistic science, and from it grew what is now called structural linguistics.

Philosophical and Scientific Approaches to Linguistics.—Although linguistics in the 19th century remained mainly a historical science, general linguistics was initiated by scholars with a philosophical interest in language. Foremost among them was the German Wilhelm von Humboldt (1767–1835). Especially through his introduction to the work *Über die Kawisprache auf der Insel Java* (1836–39), he has been regarded in Germany as the founder of general linguistics. He considers language in general as a spontaneous emanation of the spirit; the individual languages, however, have been developed by the different peoples and marked by their spiritual characteristics. Language is not a thing (*ergon*) but activity (*energia*). Humboldt characterizes a number of structurally very different languages: Semitic, Delaware, Chinese and Burmese. His philosophical and psychological point of view, however, is very different from that of modern linguists and his exposition and style are often obscure. Darwin, too, had a great influence among linguists, many of whom in the latter half of the 19th century regarded their subject as a natural science. Schleicher compared it to botany. The phonology of the earlier comparatists had not been very rigorous. In the 1870s and 1880s a group of German scholars, August Leskien (1840–1916), Karl Brugmann (1849–1919), Wilhelm Braune (1850–1926), Hermann Paul (1846–1921) and Hermann Osthoff (1847–1909), contended that linguistic development follows laws which are without exceptions but which operate only during a certain period of time. Apparent exceptions were said to be due to analogy; *i.e.,* to be forms developed on the pattern of others of the same inflection or group of words which had replaced the "true," "phonetic" form. Although some of the leading linguists, such as William Dwight Whitney (1827–94), Hugo Schuchardt (1842–1927) and, later, Otto Jespersen (1860–1943) and the so-called French school, did not partake in this theory, which has now been abandoned, it contributed very effectively to making the comparative method more rigorous. At the same time the instrumental study of phonetics led by J. P. Rousselot (1846–1924) had similar results. The French school, with its most prominent representatives M. Grammont (1866–1946), A. Meillet (1866–1936) and J. Vendryès (1875–1960), showed that the phonetic/phonemic changes belong to general types found in all languages. They stressed the importance of the linguistic system in which the change takes place. The Dutchman Jacobus van Ginneken (1877–1945) connected their views with the theory of the nature of psychological automatism propounded by Pierre Janet (1859–1947). Meillet, who was also a comparativist, published outstanding contributions to the Indo-European languages. He is also the founder of the sociology of language. He took his point of departure in Émile Durkheim's definition of what is social, established that the definition fits language exactly and showed some of the consequences that the social character of language has for the understanding of linguistic change.

Toward the end of the 19th century and the beginning of the 20th, dialect studies received a great impetus. A new branch of linguistics, dialect geography (*q.v.*), got its precise methods particularly through the work of J. Gilliéron (1854–1926), whose dialect atlas of France became a model of other atlases in many countries.

Descriptive and Structural Linguistics.—The great interest in comparative linguistic studies in Europe did not include much descriptive work. As interests in comparative work spread to the lesser known languages, extensive descriptive studies became necessary to provide a base for reconstruction; likewise for the languages of Asia and the dialects of the standard languages of Europe.

Meanwhile, certain theoretical problems arose, such as the question of the relation of language to things talked about. This was met by a study of the meaning or content of linguistic forms, which soon required increasing attention to language as a systematic structure rather than as an aggregate of isolated forms. Ferdinand de Saussure (1857–1913), in his teaching at Geneva, developed a theory of linguistic structure. As a young man he had already exercised his structural bent by suggesting (in 1875) a theoretical approach to the phonological structure of Indo-European that differed markedly from the accepted doctrine as found in the work of Karl Brugmann and his predecessors. De Saussure postulated a relationship between the apparent short and long vowels of proto-Indo-European in which the short vowels were basic, and the long vowels were reconstructed as original sequences of a short vowel and a lengthening element which was described as some kind of *h*-like consonant. When Hittite was discovered in 1907 and later analyzed it was found that several such consonants had actually existed and that De Saussure's structural extrapolation had been a correct reconstruction (made also independently by the Dane A. Möller). This gave a new theoretical basis to Indo-European studies.

In Russia, working with the structure of the Slavic languages, Jan Baudouin de Courtenay (1845–1929) in 1894 produced a study of their phonological structure in which the modern concepts of phonemes and morphophonemic relationships were set forth for the first time. His ideas influenced various Russian and other European scholars and gave rise under the leadership of Nikolai Trubetskoi (of Vienna; 1890–1938) and Roman Jakobson to the so-called Prague school of phonology. The new theories of Trubetskoi and his colleagues first became known at the First International Congress of Linguists at The Hague in 1928; they formulated their principles at a congress of Slavic scholars in Prague in 1929. The results were published in the first volume of the series *Travaux du Cercle Linguistique de Prague.* This set of principles was the start of modern phonemic analysis.

De Saussure's and Baudouin de Courtenay's theoretical approaches have also guided the work of other European linguists. These came to be known as structuralist studies, though much of the comparative work of the 19th century and most of the anthropological linguistic work has also explicitly dealt with systematic structure.

Meanwhile linguistics in the United States had developed methods of description which have proved to be of great importance, for the Amerindian languages furnish highly interesting and important material. As early as the 17th century Roger Williams in Rhode Island was describing an Algonkian language under the title of "the language of America." When the American Philosophical society was founded under the leadership of Benjamin Franklin, some of its members, Thomas Jefferson among them, showed much interest in American Indian languages and their description. As the frontier moved westward, white settlers met with many hitherto little known Indian tribes whose movements and habits became of vital concern to the U.S. government. Various agencies were established to deal with these matters, and some of the persons engaged in the work became interested in the languages of the Indians. Thus began a tradition of American Indian linguistics.

In 1842 the American Ethnological society was founded; one of its principal aims was the study of American Indian languages. About 30 years later the Bureau of American Ethnology was

started, as a part of the Smithsonian institution. The first director of the bureau, J. W. Powell, made it his principal interest to describe or at least identify the various languages of the Indians. In 1891 there was published, in the seventh annual report of the bureau for 1885–86, Powell's "Linguistic Families of North America" (pp. 1–142). This work used the already established principles of comparative linguistics to make preliminary classifications of the languages of the Indians of the United States and Canada. European scholars also became interested, and approximately 55 families were established so soundly that no serious error has been found since, though some of the families have been combined into larger groups. The result of this work, however, was not to lead to immediate further comparative work but to spur on the study of the individual languages.

In 1896 Franz Boas (1858–1942) began to teach anthropology at Columbia university. Originally trained as a natural scientist, he was led to approach linguistic study as a matter of description and not history. All his anthropological researches are accompanied by extensive study of the languages of the people observed.

While Boas was founding and fostering American anthropology and anthropological linguistics, work was also being done in the United States in the more traditional fields of Indo-European comparative linguistics. William Dwight Whitney, professor of Sanskrit at Yale, wrote a Sanskrit grammar that was, in effect, a modern version of Pāṇini's, without the esoteric symbolism. Whitney also wrote books on general linguistics.

The students of Whitney and Boas and their associates were thus all imbued with an interest in language description and structure. The most noted of these was Edward Sapir (1884–1939), Boas' most brilliant student, who became the leading theorist in the field of American Indian languages. In 1916 he published a paper suggesting the relationship of historical linguistic information to anthropological time perspective. In 1921 he published *Language*, a general work in linguistic science; in 1925 he produced a study that was a forerunner of modern phonemics, and in the last years of his life, as professor of linguistics and anthropology at Yale, contributed much to the development of Indo-European comparative studies.

Leonard Bloomfield (1887–1949) began his career as a traditional comparativist linguist, in Germanic studies. He soon began to take an interest in American Indian languages. In 1914 he published a general work on linguistics, and in 1933 wrote it into a new work entitled *Language*, still valuable as a text.

The kind of linguistic work done by the Americanists is comparatively rare in other parts of the world. In African languages there are linguistic studies with theoretical approaches similar in many respects, and some work of the same kind was done in India, the far east, and with the languages of the Pacific area.

Linguistics is gaining recognition as an autonomous science in an increasing number of universities. More languages are being studied from the comparative point of view in the hope of allotting them to families. The discovery, mainly on cuneiform tablets, of further extinct languages in the near east has been of great help to Indo-European and Semitic linguistic history. The discovery of Hittite, especially, has compelled modification of the theory of the Indo-European parent language. The decipherment by Michael Ventris (1922–56) of the Greek of the Aegean period promised rich results in the 1960s. Similarly important for the Semitic languages was the discovery of Ugaritic, a west Semitic language in a cuneiform alphabet on tablets found at Ras Shamra. Descriptive studies of languages and surveys of languages and dialects were being published not only in countries of European culture but also in Japan and China.

(G. L. T.; A. A. S.)

II. DESCRIPTIVE LINGUISTICS

This is the analysis of the elements that make up the system of signs we call a language. An utterance is split into a sequence of segments that are either phonemes (units of sound) or morphemes (units of structure or signs).

A. Descriptive Phonology

The utterances of individual speakers are made up of sound patterns produced by the organs of speech. These patterns must conform to the linguistic system, which has a social existence and is the vehicle for communication between members of a group. Phonetics deals with the physiological aspects of speech; it studies sounds and articulations. Phonemics studies the phonemes of a language; a phoneme, as such, has no meaning, but serves to distinguish morphemes from each other.

Phonetics.—Speech sounds may be classified into vowels and consonants. Vowels are produced in the oral passage, with or without the help of the nasal passage. The former functions like a resonance chamber, allowing the freely and regularly vibrating air to pass almost unhindered from the throat. Consonants arise when there are various obstacles, formed by tongue, teeth, palate and lips, introducing noise (irregular vibrations) into the sound. Vowels and consonants may be voiced (when the vocal cords vibrate) or voiceless.

Articulation is governed by tongue height, tongue advancement or retraction, and lip spreading or rounding (*see* Table I).

Table I.—*Table Used in Classifying Vowels*

	Front		Central		Back	
	Unrounded	Rounded	Unrounded	Rounded	Unrounded	Rounded
High						
Lower high						
Higher mid						
Mid						
Lower mid						
Higher low						
Low						

A set of symbols representing the various sounds is called a phonetic alphabet. If defined as, *e.g.*, in Table I, the set may lead to predictions. Before 1950, the vowel sounds in the higher low and low front rounded positions had never been encountered in any language, though any phonetician could make them; then a Mongolian dialect was found which did have them, and they were easily identified when heard.

The following are some examples, using the initials of the rows and columns of Table I: HFU like French *i* in *si;* LhFU like English *i* in *hit;* HmFU like French *é* in *café;* MFU like English *e* in *met;* LmFU like French *e* in *nette;* HlFU like English *a* in *hat;* LFU like French *a* in *patte;* HFR like French *u* in *tu;* MCU like English *a* in *sofa;* LBU like American English *o* in *hot;* HlBR like southern standard English *o* in *hot*. Sounds slightly different from the standard are described by modifying terms and denoted by symbols with added diacritics. Thus Spanish *i* in *si* is lower and less tense than French *i* in *si;* if the symbol [i] is used for the French sound, the Spanish one can be denoted by [i˯], where ˯ means lower, and ◡ means relaxed. It is customary to put phonetic symbols in brackets.

Consonants are classified in a table showing place of articulation and manner of articulation as in Table II.

Bilabials are made with the two lips, as *p* in *pit*, *b* in *bid* (voiceless and voiced bilabial stops respectively), *m* in *mid* (voiced

Table II.—*Consonant Table Showing Place and Manner of Articulation*

	Labial		Apical			Frontal			Dorsal			Faucal	
	Bi-labial	Labio-dental	Dental	Alve-olar	Cacu-minal	Pre-	Mid-palatal	Post-	Pre-	Mid-velar	Post-	Pharyn-geal	Glottal
Stops													
Nasals													
Spirants													
Laterals													
Vibrants													

nasal). Labiodentals are the *f* and *v* sounds (voiceless and voiced spirants). Apical sounds are made by the tip of the tongue against the teeth (dental—as *th* in *thin*, a voiceless spirant), against the upper gums back of the teeth (alveolar—as English *t* in *tin*, a voiceless stop), or slightly raised or curled back of the gums (cacuminal—as American English *t* after *r* as in *hurt*, a voiceless stop). Frontals or palatals are made by the middle portion of the tongue (the "front" technically) against the roof of the mouth: English *sh* in *shoe* is for most speakers a midpalatal voiceless spirant. Dorsals are made by the back of the tongue against the roof of the mouth: English *c* in *car* represents the midvelar voiceless stop. A glottal spirant is English *h* in *hot*. Stops are made by closing the passage and then releasing it. Nasals are stops with accompanying opening of the nasal passage. Spirants are sounds made by approaching the articulating organs but leaving part of the passage open. Laterals are made by leaving a passage open at one or both sides of the articulator (as *l* in English *low*). Vibrants are made by rapidly striking the articulating organs together; the sound represented by *brrr*, indicative of cold, is usually a bilabial voiced vibrant; the heavily trilled *r* of Spanish *rey* is an alveolar voiced vibrant; some speakers of Parisian French use a postvelar voiced vibrant for *r* in *rouge*. Some or all consonants of a language may oppose palatal and nonpalatal types; in other languages a certain number of consonants may be combined with a glottal stop. All languages use the same general types of sound, differing in minor details; for example, the voiceless English stops *p, t, k* are followed by a voiceless breath, the corresponding French sounds are not. As with vowels, there are symbols for all the sounds in the table and various other symbols and modifiers which are not shown in it.

In addition to vowels and consonants, various other sound phenomena can be recorded, such as pitch (high, mid, low, falling, rising, etc.), stress (loud, medial, soft, etc.), quantity (short, long, extra-long, etc.) and various kinds of voice qualities and other modifications (nasal twang, whisper, etc.); on these there is less agreement than on vowel and consonant analysis. (*See* PHONETICS.)

Phonemics.—In every language the number of different sounds is quite large; the number of significant differences is smaller. For instance, in English the word *pit* begins with a voiceless bilabial fortis (tense) stop, with aspirated release; in *spit* the *p* represents a voiceless bilabial lenis (lax) stop, with smooth release into the vowel; in *upper* the internal consonant sound is a voiceless bilabial fortis stop with smooth release; in *up* the final consonant is usually a voiceless bilabial fortis stop without release. The phonetically untrained speaker of the language is unaware of these details, and to him these are all the "same" sound. On the other hand the difference between the voiceless bilabial sounds in *pit, ripping, rip* and the voiced bilabial lenis stop in *bit, ribbing, rib* is heard and noted by the speaker of English. In the latter case he does not note, however, that *b* in *bit* begins without voice, *b* in *ribbing* is fully voiced and *b* in *rib* ends voiceless.

The various *p* sounds discussed are the members of a class of sounds which, as a whole, is in significant contrast with other such classes. Such a class of sounds is called a phoneme. It is the smallest unit of sound. It is customary to represent phonemes by symbols chosen from among those used for the various members of the class, and to enclose them in slant lines; *i.e.*, the phoneme /p/, the phoneme /b/, etc. The members of a phoneme are called its allophones. The allophones of a phoneme form a complementary distribution: each occurs in statable positions, and no two occur in the same positions. Thus aspirated *p* is an initial allophone of /p/; lenis *p* is the allophone after *s;* fortis with smooth release is the allophone between vowels if the following vowel is weak; unreleased is the allophone in final position. Another criterion for phoneme membership is phonetic similarity: all the allophones of English /p/ are voiceless bilabial stops. But the /b/ allophones are also bilabial stops, so that mere phonetic similarity is not decisive.

The extent of the phonemic unit is found by substituting contrasting elements of utterances, and especially by comparing minimal pairs (elements that are partly identical). English *bit, pit, sit* show that *b, p* and *s* are separate phonemes. Some linguists distinguish between phonemes (or sound types) and phones, the latter being the elements found by substitution. English *tattoo* contains four phones /t + æ + t + u/ but only three phonemes /t/, /æ/ and /u/.

The phonemes may be analyzed into their inherent features. These, like the prosodic features (*see* below), belong to pairs of opposed qualities in the two series of sonority and tonality. Examples of sonority are the opposition between vocalic and nonvocalic phonemes found in all languages, of voiced versus voiceless (*e.g.*, English *b, d, g* versus *p, t, k*); examples of tonality are the opposition between grave and acute, between velar and labial, palatal and dental. Russian and many other languages systematically oppose palatal and nonpalatal consonants. Some oppositions are found only in certain parts of the world; *e.g.*, the contrast between glottalized and nonglottalized consonants is especially frequent in the Caucasian and Amerindian languages.

Languages also make use of other elements which characterize syllables, words, phrases or sentences. These elements are called prosodic or supersegmental. For example, pitch may be used to distinguish between a question and a statement; it may also be used to oppose words or forms. Swedish and Norwegian have two lexical tones; *e.g.*, Norwegian *bryter* "(he) breaks" has a falling tone, while *bryter* "(a) wrestler" has a rising-falling tone. The ancient Greek tone was distinctive (*e.g.*, *tomós* "cutting," "sharp," *tómos* "slice"), but it could not be further back from the end of the word than on the third last syllable if the final vowel was short; or than on the penultimate syllable if the final vowel was long. The Latin tone was mechanically placed on the penultimate syllable if this was long; on the third last if the penultimate was short. Some languages use difference in length between the syllable crests as a distinctive trait. Latin distinguished between *lātus* "broad," "wide" and *lătus* "side." When a language has both stress and quantity, the quantity is usually subordinate to stress. In Norwegian and Swedish a long vowel is usually found only in a stressed open syllable. In a stressed closed syllable and in all unstressed syllables the vowel is short (*e.g.*, Nor. *bāke* "to bake"; *bāske* "to struggle"), except where other forms keep it long (*e.g.*, *spīst*, past participle of *spise* "to eat").

Many languages use stress, giving certain syllables of the utterance a stronger stress than others. The stress may be merely phonetic and lie on the same syllable of each word, as, *e.g.*, in Finnish or Czech, where it lies on the first syllable and merely serves to indicate where a new word begins; or it may serve to distinguish between different words or different forms, as in Russian, where *zamók* means "a lock," but *zámok* "a castle."

The spoken phonemes of the utterance are grouped into rhythmical units which are called syllables. A syllable has a peak where it is most sonorous, usually a vowel or a diphthong; but the peak may also be a consonant—most frequently a liquid, a nasal or a vibrant (*e.g.*, in Serbo-Croatian, *sŕpski* "Serbian"). The syllable may consist of only a vowel or of the sonorous part preceded and followed by one or more consonants. The physiological basis of the syllable seems to be a puff of air forced upward through the vocal channel by compression of the intercostal muscles. Thus the syllable consists of release, culmination and arrest of the pulse. The point where the arrest of the pulse falls in the spoken chain varies in the different languages; as a rule it is of no semantic significance. In some languages, such as classical Latin and Greek, the different types of verse forms depend on the number and character of the syllables.

To understand an utterance it is necessary to grasp not only its different elements (vowels, consonants, etc.) but also the boundaries inside the spoken chain. This falls into rhythmic groups characterized by intonation and stress, and scanned by pauses. The transition from the pause to the first phoneme of the utterance and from the last phoneme to the pause is called juncture or open juncture; the ordinary passage inside the chain is often called close juncture. Inside the chain, however, there may be open juncture where there are morphological boundaries, as can be seen in the difference between Eng. *night rate* and *nitrate; a name,* but *an aim.* French has close juncture in such

cases; there is no difference between the elements of the group and the word as far as junctures are concerned. By using the methods sketched above with additional refinement of detail, all the sounds of a language may be grouped into a limited number of phonemes. Some languages, such as, for example, the Oceanic, have a relatively small number of phonemes, others as many as 50 or more. The greatest number known is 78 consonants and 2 (or 3) vowels, found in a Northwest Caucasian dialect spoken by Ubykhs in Turkey.

B. Morphemic Analysis

An utterance falls into syllables with boundaries called junctures. From the point of view of function and meaning it is composed of unities called morphemes. They are its smallest individually meaningful elements and may either refer to something outside language, containing what is called a lexical meaning, or may be an element of formation and have a special function inside the utterance. In European linguistics the former type are often called semantemes (in the U.S. sometimes lexemes); the latter, morphemes. Americans use "morpheme" in both senses. The morphemes may be simple or complex. They may contain bound forms (also called grammatical morphemes) which are never used alone, as, for example, *-ish* in English *boyish, reddish,* or *-s* in *boys, girls.* There may also be free forms which can be used alone in the utterance. A minimum free form is a word. Words can be divided into word classes or parts of speech. In traditional grammar books the parts of speech are usually defined semantically, but such definitions are not consistent. Thus, a noun is usually defined as a part of speech that denotes a person (or an animal) or a thing. In an example like *buy this car,* the form *buy* is a verb, whereas in *this car is a good buy* it is a noun; and in both cases it designates an action. The main parts of speech must be defined syntactically, through their forms and distribution. A verb and a noun do not appear in the same surroundings in the utterance.

A morpheme may have different phonemic forms according to the environment in which it occurs. Such different forms are called allomorphs or morphemic variants. Some linguists use the term morph to designate each different representative of a morpheme and call allomorphs all the different morphs that represent a given morpheme. The morphs *sell* and *sold* are allomorphs, since they are phonemically different and are used in different environments.

Morphophonemics.—The study of the phonemic structure of the morpheme is called morphophonemics. A detailed examination of such structures demands a thorough knowledge of a language and of its phonetic and phonemic character. This study is still in its beginnings. If a language is known only in some conventional written form, important elements of its morphophonemic structure may be unknown. An important morphophonological trait in many languages is the change within the morpheme of phonemes that express a grammatical relation, accompanied or not by additional elements. Examples are English *bind:bound, knife:knives;* Russian *son* "dream": genitive *sna* (change from *o* to nothing); Irish *bád* "boat": genitive *báid* (change from *d* to palatal *d;* the *i* is a nonphonemic glide).

English words may begin with a vowel; of the nine simple vowels five are common as initials—those in *it, elder, at, up, otter;* in weak-stressed syllables, a sixth vowel occurs frequently, that used in *event* and other words by people who also use the *up* vowel in *above, allow.* The vowel of *put* occurs initially for some speakers only in the exclamation *oops* (others use here the vowel-plus-semivowel of *food*). In *obey* and other words spelled with *o* there may be instances of the short vowel also found in New England *coat;* in *already* as pronounced by some, the ninth vowel is found. English words may also begin with one of the vowel-plus-semivowel combinations, varying according to geographical region. An English word may begin with any of the single consonants except the *ng* of *sing.* Also found initially are groups of two or three consonants; the two-consonant clusters are numerous but limited to certain kinds: *tr-* exists but not *tl-,* while both *pr-* and *pl-* are found; there are only a few three-consonant clusters: *spl-, spr-, str-,* /skl/ spelled *scl-,* /skr/ spelled *scr-,* /skw/ spelled *squ-,* /spy/ in words spelled *sp-* before *u* or *eu* or *ew,* /sty/ in words spelled *st-* before *u* or *eu* or *ew* (but many speakers of English do not use the /y/ in these words). English words may end in a weak-stressed short vowel, or in a vowel-semivowel combination with any stress, or in any single consonant, and in clusters of two or, more rarely, three or four consonants. Every English word has at least one vowel and, when said by itself, has one (and only one) primary stress. English words may be of one syllable (*i.e.,* with one vowel) or of many syllables, though most are of one, two or three syllables. Various stress patterns are noted in English words: *upper, above, animal, allowing, entertain,* etc. All English utterances, whether long or short, are said with a sequence of pitches of some kind, the most usual (declarative sentence) being 2–3–1, the 3 falling on the syllable with the primary stress.

There are also many instances of addition of one or two (or occasionally more) sounds to a word to form related words: *cat, cats; bed, beds; rose, roses; go, going; nice, niceness; starve, starvation.* In some cases there are notable changes in the original form: *knife, knives; take, took; vain, vanity.*

A complete morphophonemic analysis has not been made for any language. English has inflectional morphemes, derivational morphemes and base morphemes. The first two are suffixes; they come after the base, inflectional suffixes being last. There are also supersegmental phonemes and morphemes. These are the patterns of stress (with or without one or more internal junctures). Thus *boy, boys, boyish, boyishness, boyishnesses* are analyzed morphemically as follows: base *boy-;* inflectional suffix *-s* (pronounced /z/); derivational suffixes *-ish* and *-ness;* inflectional suffix *-es* (pronounced /iz/, *i* being the high midvowel of the first syllable of *event*); supersegmental "primary stress" on *boy* and *boys,* "primary-weak" on *boyish,* "primary-weak-weak" on *boyishness,* "primary-weak-weak-weak" on *boyishnesses.* English also has some morphemes like *pre-, in-, a-, be-, re-,* that precede the base; these function like special kinds of bases, and are best labeled prebases.

In some languages there are genuine prefixes that function like suffixes in inflection or derivation. Classical Arabic has forms like *katabat* "she wrote," with *-t* for feminine third person subject; but *taktuba* "she is writing," where the prefix *t-* is the sign of the feminine. In the language of Taos Pueblo, New Mexico, most subject and object relations of verbs and the indications of possession for nouns are shown by prefixes: *tik'olq* "I ate it," where *ti-* means first person subject and third person singular object of one of five classes; *kikana* "our mother," where *ki-* means "our" (we being more than two). Some languages also have infix morphemes. Latin *relinquo* as compared with *relictus* shows an old *-n-* infix that functioned freely in Indo-European. Another kind of morpheme may be called the pattern morpheme: in Arabic *kataba* the base (or "root") is *k-t-b* "to write," and the pattern *-a-a-a* indicates suffix tense (perfect); in *taktuba* there is the same base, but the pattern is *a-u-a,* indicating the prefix-infix-suffix tense (imperfect).

The inflectional morphemes of a language occur in paradigm sets. The paradigms are the basis for determining the kinds of words ("parts of speech") a language has. English has paradigms like the following: *boy, boy's, boys, boys'; man, man's, men, men's;* these establish the class of nouns, which are then defined as words that have inflection for plural and for possessive (or for one of these). The paradigms *go, goes, going, went, gone; talk, talks, talking, talked,* etc., establish the word class of verbs, defined as words inflected for past and, in most cases, also for gender indicated subject in the nonpast (*he, she, it talks*), present participle and past participle. English also has the personal pronouns *I, you* (and *thou*), *we, he, she, it, they, who,* with an irregular inflectional pattern (*I, me, my, mine,* etc.). All other English words are uninflected (including adjectives with derived comparative and superlative), and their further classification as adverbs, prepositions, etc., is made by syntactic criteria (*see* below).

These definitions may be supplemented by criteria of distribution. In English, adjectives, for example, can only appear in certain places in the utterance. Each language has its own pattern and its own set of parts of speech specially to be defined. For

spoken French, adjectives are defined as words that may be inflected both in gender (*e.g., bon* "good," fem. *bonne*), in number (sing., *égal* "equal," pl. *égaux* [fem. pl. *égales*]), and as words placed behind the noun. But there are exceptions to this rule. The adjective *bon /bo/* is pronounced the same in the plural (but written *bons*); the feminine form *bonne /bon/* is likewise pronounced the same in the plural (written *bonnes*). An adjective such as *brave* is pronounced the same in all forms (but written *braves* in the plural). Certain adjectives may sometimes be placed before the noun and this may entail a change of meaning: *e.g., un personnage sacré* "a holy person"; but *un sacré personnage* "a damned person," in the metaphorical sense.

Although the parts of speech used in languages of the same origin or belonging to the same cultural area are very similar, none occurs everywhere. It was an error of earlier linguists to believe that the classical Latin-Greek system was universal. As an example of the differences there is the Amerindian language Nootka, which shows a contrast between inflected and uninflected forms very different from that between nouns and verbs in European languages. Without any overt inflectional affix, stems like [*wała ˙ k-*] "go"; [*qo ˙ ʔ as-*] "man," "person"; [*ʔ i ˙ ḥ-*] "large"; and [*ʔ aṯḥija-*] "at night" are uses syntactically in a way that corresponds to "a going," "a trip"; "a man," "a person"; "a large thing"; "the night time" (ʔ is the symbol of the glottal stop; *ḥ* designates a pharyngeal spirant, ˙ indicates length). With the inflectional affix *-ma,* which denotes an implicit third person singular subject, the words can be translated "he goes"; "he is a man"; "he is large"; "he does it at night." The words of a language without inflections can be classified only by distribution; *i.e.,* by syntactical means.

C. Syntax

A description of a linguistic structure must not only delimit its phonemes and morphemes but also determine how the units called words and their forms are construed within the utterance. Traditional grammar distinguishes between study of grammatical forms as such, which is called morphology, and study of their use and of their order within the utterance. Some linguists prefer another division extending morphology to the use of the grammatical forms and establishing a special division for the word order within the utterance.

Phrases and Sentences.—Syntax deals with the grouping of the free forms into phrases and the arrangement of the phrases into simple or complex sentences, the maximum forms in an utterance. Exclamations such as *Come! Down!* are called minor sentences, whereas full sentences consist of two main parts, one usually called subject and the other predicate. In the commonest type of English sentence the relation between these two is that of actor (the subject) and action (the predicate). In older Indo-European languages there was also another kind, in which the first component (corresponding to the subject-actor of the English type) was a substantive and the second component (equated to the first) might be a substantive, an adjective or an adverb. This usage still exists in Russian: *e.g., Ivan durak* "Ivan is a fool"; *otets doma* "father is at home." This variety is also called a nominal sentence. A variant of the subject-predicate type is found in certain languages such as Latin, which opposes an actor-action construction *amat* "he (she, it) loves," to a goal-action construction *amatur* "he (she, it) is loved" (an opposition which in traditional grammar is called active:passive).

A full sentence need not be bipartite. In German there are so-called impersonal sentences such as *mir ist kalt* "to me is cold" (*i.e.,* "I feel cold"); or *hier wird geraucht* "here it is smoked" (*i.e.,* "people smoke here").

The sentence contains different syntactic constructions. Two or more free forms may be combined in a resultant phrase. This may be exocentric, as when it belongs to a form-class other than that of any of the members. *John ran,* for example, is neither a noun-expression like *John* nor a finite verb like *ran.* Another kind of exocentric construction is the combination of a preposition and its complements; yet another is the subordinate clause containing an element expressing subordination (*e.g., when Charles married*). Other constructions, called endocentric, are either co-ordinating (as in *boys and girls*), where the members belong to the same form-class (the co-ordinator *and* may be absent); or attributive or subordinative, where the resultant phrase belongs to the same form-class as one of the constituents (called the head, the primary or the centre). *Poor John* belongs to the same form-class as the head *John; poor* is the attribute. The latter may be a subordinate phrase, *e.g., very fresh milk,* where *fresh* is in the same relation to *very* as *milk* is to *very fresh.*

In inflected languages the form of one member of an exocentric construction may be determined or "governed" by the other. In German the object of a verb may be in the accusative case: *einen Brief schreiben* "to write a letter"; in the dative: *einem auf der Strasse begegnen* "to meet someone in the street"; or in the genitive: *sich eines Dinges erinnern* "to remember a thing." In such languages the members of an endocentric as well as of an exocentric phrase may be subject to rules of number. In many Indo-European languages the verb is dependent upon the subject for number, and the attributive on the member it qualifies.

Word Order.—There are in all languages rules of word order for both endocentric and exocentric constructions. In the attributive endocentric construction, the attribute precedes the head in English but follows (with certain exceptions) in French: *fresh butter;* but *du beurre frais.* In the attribute, however, French has the same word order as in English: very fresh butter: *du beurre très frais.* In Irish the verb comes first in the sentence, in German last in the subordinate clause. In highly inflected languages the word order is free and may be used to throw into relief a member of the sentence: Latin *Aulus puellam amat; puellam Aulus amat; amat Aulus puellam* all mean "Aulus loves the girl." In the first case "Aulus," in the second "the girl" and in the third "loves" are emphasized. Syntactic constructions and sentences are accompanied by special prosodic elements such as intonation and stress. Intonation may distinguish a statement from a question. In English the members of an attributive endocentric construction are both equally stressed: *the first prize;* in French the group has final stress: *une jeune fille; un homme bon.*

D. Linguistic Patterning

Phonemic Systems.—The phonemic systems vary from language to language; their variations are, however, limited by the speech organs, which are practically the same in all men. In all languages the phonemes are arranged into structures with contrasting series. In the vocalic systems of most languages, use is made of sonority and tonality—contrasting *a* with *i* and *u,* for example. The series of vowels contrasting in tonality are usually, above the lowest level (the *a* level), composed of the same number of phonemes, so that a language which contrasts *i* and *u* and has an *e* will also have an *o.* The vowels above the *a* level of the dark (or back) series are usually rounded. At the lowest level some languages have only one *a,* others contrast two types. Languages may also have one or (less often) more than one intermediate series, the members of which are not more numerous than those of the two contrasting series. French, for example, has the following system (of nonnasal vowels):

i	*ü*	*u*	
e̯	*oe̯*	*o̯*	(closed)
e̯ *ɛ̯*	*oe̯* *œ̯*	*o̯* *ɔ̯*	(open)
a		*ɑ̯*	

Few languages have systems in which there is only contrast in sonority between the vowels. An example, however, is Adyghe in the Caucasus, which has three vowels contrasting only in sonority: one closed, transcribed *ə;* one half open, *e;* and one open, *a.* These vowels have a series of allophones; the *ə* has the phonetic form *i* after a palatal and *u* after a rounded guttural, etc. Vowels are often pronounced with a nasal twang which has no phonemic relevance, but a certain number of languages have nasalized vowels as phonemes. In French there is a system of such vowels which

corresponds to the open types of the nonnasal vowels:

$$\underset{\text{ę}}{\tilde{\text{e}}} \quad \underset{\text{ę}}{\tilde{\text{o}}\tilde{\text{e}}} \quad \underset{\text{ę}}{\tilde{\text{o}}}$$

$$\underset{\text{ą}}{\tilde{\text{a}}}$$

(as in *fin, un, on, dans*).

In some languages the vowels of the different syllables are dependent on one another, a phenomenon usually called vowel harmony. In Ibo (west Africa) all vowels of the word must be either closed or open. In Turkish the vowel of the ending is grave or acute according to the vowel of the radical; *e.g., peder-ler* "fathers" from *peder;* but *atlar* "horses" from *at.*

The consonant systems show as a rule more complicated contrasts. Most languages oppose dentals, labials and gutturals and have an *s* (the latter is absent from some languages, *e.g.,* the Australian languages, except those of Cape York; and from eastern Nuba). Some languages, especially in America, have laterals; others, series of laryngeals. In Bushman, Hottentot, Zulu and Sandawe in south Africa, clicks are used.

Some languages contrast voiced and voiceless types in the stops, often also in the spirants, less often in the liquids and vibrants; others do not distinguish *d, b, g* from *t, p, k.* Certain languages, such as Russian or Modern Irish, have a palatal series opposed to a neutral or more or less velarized series. Certain languages, for example in the Caucasus and in America, have series of consonants accompanied by a glottal stop in contrast with ordinary consonants. Some contrast weak and short consonants with intense and long ones. In the archaic dialects of Modern Irish, for example, [*gaN*] "without" is distinguished from [*gaN*] (written *gann*) "scarce"; [*mə l'abi*] "my bed" from [*ə L'abi*] "her bed" (written *mo leabaidh* and *a leabaidh; l'* and *L'* are palatal consonants).

Efik in west Africa distinguishes the aorist from the subjunctive by tonal differences (ˊ before the syllable indicates a high tone, ˌ a low). The roots, which function as imperatives, of the verbs meaning "to think," "to put" and "to run" have different tones, *viz. ˊkeˌre* "think"; *ˊdoˌri* "put"; *ˌfeˊhe* "run." In the aorist they keep these tones; *ˊNˊkeˌre* (*N* is a prefix, indicating the first person singular, which is phonetically assimilated to a following consonant); *ˊN.doˌri, ˊNˌfeˊhe;* but in the subjunctive the final syllable is always low *ˊNˊkeˌre, ˊNˊdoˌri, ˊNˊfeˌhe.*

Grammatical Systems.—The grammatical structures of the languages of the world differ widely. It has been customary to distinguish "analytic" or "isolating" languages, which do not use inflections but always identify the word with the radical element (having no bound forms); "synthetic" languages, which have inflections combining the radical element of the word with a certain number of bound forms indicating its grammatical function in the sentence; and, finally, "polysynthetic" languages, which unite long strings of bound forms into single words corresponding to a number of different forms in the synthetic languages. Examples usually quoted are Chinese, an isolating language; Latin or Greek as synthetic languages; and a number of American Indian languages representing the polysynthetic type. Among the synthetic languages, agglutinative and fusional languages are distinguished. In the former, affixes are juxtaposed in such a way that they stand out clearly from one another, whereas in the latter they are more or less completely run together with the radical. A typical example of an agglutinative language is Turkish, with *peder* "father"; *peder-im* "my father"; *peder-ler* "fathers"; *peder-ler-i* "their fathers." In the older Indo-European languages fusion is more or less pronounced, as in such examples as Latin *pater* "father" (accusative *patrem,* genitive pl. *patrum*); *iecur* "liver" (gen. *iecinoris*); Sanskrit *yákrt* "liver" (gen. *yáknas*).

Special grammatical categories occur. In the noun many languages contrast animate and inanimate forms by morphemes referring to living beings or to lifeless objects respectively. Some Indo-European languages also distinguish gender: masculine, feminine and neuter. Number also is expressed, in noun, verb and pronoun; more usually as singular versus plural. Dual, however, is also found; *e.g.,* in Slovenian. Some languages have four categories: singular, dual, trial (triple) and plural; or singular, dual, paucal (few) and multiple (numerous).

Differences in time are important in the verbal systems especially of western European languages (*e.g.,* the English contrast between *run* and *ran*), but in most languages the contrast is not between forms expressing time but between forms denoting aspect, *i.e.,* the development of the action—its instantaneousness or duration; its intensity; its approach to a goal, etc. Aspect was also the dominating category in the older Indo-European languages (expressed in Greek by the present, the aorist and the perfect); it is partially expressed in modern western European languages. The French imperfect, for example, has aspect meaning; aspects in English are formed by tenses of the verb *to be* combined with a present participle. (*See* also GRAMMAR.)

Glossematic Analysis.—This type of analysis, first practised by Louis Hjelmslev, proceeds by gradual subdivision of a text until a complete and consistent description has been given; this requires more than attending to only one aspect of the text, *e.g.,* phonology; linguistic form is important too. The substance of a language is regarded as variable and as manifesting itself as utterance, as written text or in other ways. The method uses new technical terms. On the whole it has not met with the approval of most other linguists, despite its original points of view.

E. MEANING

The definitions of the term "meaning" in linguistics are varied and controversial. According to the traditional point of view a word stands for something, refers to something, which is called its meaning or signification. F. de Saussure regards the linguistic sign as a combination of a concept and an acoustic image, the *signifié* "that which is signified," and *signifiant* "that which signifies." The relation, however, is not between the word and the *signifié* or "thing meant" (also called the "referent") but between what has been called the "name" or the "expression" (*i.e.,* the morpheme) and the sense or "content" (also called the "reference"). An often-used example will show this. The words for colours in different languages often do not correspond but omit parts of the spectrum. Welsh "green" is *gwyrdd* or *glas;* "blue" is *glas;* "gray" is *glas* or *llwyd;* "brown" is *llwyd.* Thus the parts of the spectrum have different limits in Welsh and in English; the line dividing "green" from "blue" in English is not found in Welsh. The pattern may be shown thus:

green	*blue*	*gray*	*brown*
gwyrdd	*glas*		*llwyd*

The relationship of expression, content and "thing meant" enables any one of them to evoke one or both of the others.

It is customary to distinguish lexical meaning from grammatical meaning and referential meaning from distributional meaning. This last is the element of meaning which opposes one member of a paradigm to another or which is implied in the distribution of the morphemes of a sentence. Grammatical meaning may be the same, though it is differently expressed. In Latin *puer puellam amat* and in English *the boy loves the girl* the grammatical meaning is the same; but it is expressed in Latin through the accusative of *puella* and in English by the position of *the girl* after the verb.

Referential or lexical meaning may be very complex. According to the *Shorter Oxford Dictionary* the verb *reason* has the following actual meanings: (1) to employ reasoning or argument (with a person) in order to influence his conduct or opinions; (2) to think in a connected, sensible or logical manner; to employ the faculty of reason in forming conclusions; (3) (with object clause): to explain, support, infer, deal with by (or as by) reasoning; (4) to bring (a person) *into, out of* a state of mind by reasoning; (5) to put (down by reasoning); and (6) to think (out), to arrange the thought of in a logical manner. Cases with many more different meanings could be quoted.

One might expect the lexical meanings of a word to form a system, but no convincing method of exhibiting this has yet been found.

Adherents of behaviourist methods in linguistics see meaning as something outside the proper structure of language, the study of it belonging to what is called metalinguistics. L. Bloomfield, who introduced these methods, describes meaning in terms of

stimulus and reaction. An extralinguistic stimulus (S) prompts the speaker to a linguistic reaction (r) which, reaching the listener as a linguistic stimulus (s), elicits an extralinguistic reaction (R) on his part, thus:

S — r . . . . . s — R

It has even been attempted, by Zellig S. Harris, to describe language without reference to meaning. The attempt was not a success, but it has shown that a description of a language must start with the form and distribution of morphemes. *See* SEMANTICS IN LINGUISTICS.

F. LINGUISTIC CHANGE

No language is stable, though the rate of change varies widely; and not all linguistic elements are equally exposed to change. Most exposed is the vocabulary, especially in languages of rapidly evolving societies. Vocabulary changes may not affect the structure of a language or only slightly so. The changes that usually have the greatest effect in linguistic development are those in phonetic-phonemic structure.

Speech is realized through a network of movements of the speech organs which are directed from the brain. These movements are extremely short, being measured in hundredths of seconds. The delicate equilibrium of articulation of the sounds that produce the phonemes of a language is therefore easily upset. One part of an articulation may come too early or last too long; articulations may be shortened or slurred over under the influence of coming articulations or at the end of an utterance before pause. Changes then follow. They belong to categories or types of which the most important are assimilation, dissimilation and differentiation.

Assimilation.—This type of change often occurs in clusters of homorganic consonants (Anglo-Saxon *lamb* has become *lam*[*b*]), it arises also in other cases, usually where the two elements have something in common, as with Latin *octo,* which has become Italian *otto* (*cf.* also Latin *septem,* Italian *sette* "seven"; Latin *irrumpere* "break into" from *in* + *rumpere,* etc.). Vocalic elements may be similarly treated. Diphthongs may be fused into single vowels; *e.g.,* Danish and Swedish *ben* "bone" from older *bein* and still older *bain.* Assimilation at a distance is also found, not so frequently between consonants as between vowels: *e.g.,* Latin *quinque* "five" from an older **penque; cf.* Greek *pénte,* Sanskrit *pánca* (an asterisk denotes a hypothetical form whose existence is inferred). A well-known case of such assimilation is the metatony (or umlaut) of the Germanic languages, where a vowel of an unstressed syllable changes the stressed vowels: *e.g.,* common Nordic *gastiR* "guest" (*R* denotes a palatal vibrant); Old Norse *gæstr, gestr,* where the unstressed vowel has disappeared; or Old Norse *mǫgr* "son" from *maguR* (Gothic *magus*); *længi, lengi* "for long" (where the *i* remains; *cf.* Gothic *laggei*); *lýkr* "you shut" from **lūkiR* (Gothic *lukis*); *hialdr* "fight" from common Nordic *heldaR,* etc. Assimilation of consonants to vowels is also common. Guttural stops are usually influenced by front vowels, first becoming allophones and sometimes developing into affricates and spirants. The assimilation to front vowels may be extended to all consonants and, when the original condition of position before a front vowel is changed (*e.g.,* through the disappearance of this vowel), the palatal consonant may become a phoneme contrasting with an ordinary consonant. This has taken place in Irish, Scottish Gaelic and Slavic, and also in certain Asian languages. Similarly, consonants may be velarized before back vowels.

Rhythm plays a great role in this development. A dominating syllable, which bears the stress or is long in languages with free quantity, may shorten or absorb a weak syllable. Such a change is usually called syncopation. In a final syllable a vowel may also be weakened because of its occurrence before the pause; in this position a consonant may become implosive and finally be lost. In languages with a strong stress accent the vowel is often reduced to a midvowel of more or less indeterminate timbre, usually transcribed *ə*. In languages with free quantity the shortened vowel is reduced in length and forced upward as a high vowel, which, other things being equal, is shorter than a low one. The first kind of development has reduced the length of English words: *e.g., bind,* Middle English *binde*(*n*), Anglo-Saxon *bindan* and other infinitives; *cf. reel,* Anglo-Saxon *hréol,* from **hrehula.* Instances of the second type are found, for example, in Latin, where *novitas* "newness" goes back to **newotā*(*t*)-; *cf. novus* "new" (from **newos*); *occupo* "I take possession of"; *incipio* "I begin"; compounds of *capio* "I take." In some cases the vowel has disappeared completely; *e.g., surgo* "I lift up" (beside *surrigo*); *porgo* "I stretch," "I spread out" (beside *porrigo*); *cf. rego* "I guide," "I conduct."

Dissimilation.—The same rhythmic tendency leads to change in identical or partly identical phonemes which are separated by other phonemes; this is called dissimilation. One of two consonants may be dominating physiologically, *e.g.,* through being part of a stressed syllable or through being protected by a preceding or following consonant; or functionally, by belonging to a separate morpheme. The first *r* belonging to the stressed syllable and "protected" by another consonant immediately following it has dissimilated the second in Irish *corneal* and Welsh *cornel;* the two borrowed from Anglo-Irish and Anglo-Welsh *corner* respectively. In English *mulberry,* however, which goes back to an older *murberi* and which is either borrowed from French *mûre* or else represents Anglo-Saxon *morberie,* the dissimilation which from the physiological point of view might be expected to affect the second *r* has been reversed on account of the influence of *berry.* The first element is a loan from Latin *morus.*

Differentiation.—The process of differentiation counteracts the tendency of assimilation and may take place between vowels, between consonants and also between a vowel and a consonant. It happens, for example, that in part of a dialect area a diphthong, *e.g., ei,* becomes a monophthong through assimilation-fusion (*ei* becoming *e* or *i*), whereas in another part of the area it develops into a stabler diphthong (*ei* becoming *ai*). Similarly, *-nm-* may be differentiated. Latin *anima* became *anma* and then *alma* in Italian, Spanish, Catalonian and Portuguese and *arma* in Sicilian. Latin *k* before a front vowel became identical with *t* in the same position; the palatal *t'* developed a consonantal *y* before the front vowel. This *y* was differentiated into a sibilant *s* or *š; e.g.,* Latin *cera* which became Italian *cera* (pronounced *tšera*) and French *cire* (where the *ts-* has been assimilated into *s*). The development of the *t'* is a special case of differentiation called segmentation, the breaking of a phoneme into two; this often protects one phoneme against another. In Latin, *-m-* before a dental became *-n-* by partial assimilation: *e.g., centum* "a hundred," which originally had a labial nasal as shown by Lithuanian *šimtas; eundem* "the same," a compound with *eum* "him"; *septendecim* "seventeen," from *septem* + *decem.* In *emptus, sumptus,* past participles of *emo* "I buy," *sumo* "I take," the influence of the present has led to a differentiation of the voiceless glide at the end of the *m* into a full phoneme *p.* This *p* is also found before *s* in the perfect: *empsi, sumpsi.*

Long vowels in languages which contrast long with short vowels may be broken up into diphthongs, the final wavering of the articulation being differentiated into a diphthongal element or a consonant phoneme. The development of the original long vowels in English is a case in point.

Metathesis, *i.e.,* transposition of phonemes, may take place when the sequence causes difficulty. Irish did not have the sequence *-ts-*; therefore English *-ts-, -dz-* became Irish *-s't'-*: *e.g., bríste,* Eng. *breeches; maistín* from *match; bagaiste* from *baggage; caraiste* from *carriage* (the newest loans have *-t's'-*; *e.g., bitseach* "bitch," a fact which testifies to the increased influence of English).

Contrasting series of phonemes may react on one another, as in Old Celtic, which had a difference between tense and lax consonants. The former appeared in initial position and in certain clusters, the latter in intervocalic position and in certain other clusters, so that they were further weakened. In British the intervocalic voiceless stops became voiced and the voiced stops became spirants; in Gaelic, voiceless and voiced spirants developed: *e.g.,* Irish *múch* "smoke"; Welsh *mug* "smoke"; Breton *moug, mog* "fire" (cognate with Eng. *smoke* from Anglo-Saxon *smoca*); Irish *cath* "combat," "fight"; Welsh *cad,* Gaulish *Catu-rix* (a name

meaning "king of the combat") and *Caturiges,* name of a tribe; Irish *bodhar* "deaf"; Welsh *byddar,* Breton *bouzar,* cognate with Sanskrit *badhirás* "deaf." In Old Norse *e* became *ea, ia* as in *hialdr* above; but *u* did not become *ui* in **lūkiR* because of the system of quantity: *ūi* would have created a third degree of quantity, which is a very rare phenomenon.

Theories of Phonetic Change.—When precise phonetic description began in the 19th century, a theory arose that language was subject to phonetic changes following laws similar to the laws of nature. These "phonetic laws" were said to be without exception, to affect the same phoneme or phoneme sequence in all positions, and to last a certain time, after which they ceased to be active. Exceptions were explained as due to analogy and to the influence of forms in which the conditions of the "law" did not occur. These views were never accepted by all scholars and have now been abandoned. The process of change is in fact psychophysiological; its nature is largely determined by linguistic structure. Precise dialectal investigation has shown that it starts in a few words used, perhaps, only by a single individual and then extends to other words and to other individuals geographically and socially. If it affects a phoneme as such, it may be complete. In standard French, for example, the old palatal *l* (that of Italian *figlio*) has become the consonant *y* (*fille* pronounced *fiy*). All palatal *l*'s have disappeared, but they have not all necessarily become *y*.

Since the phonemes of all languages belong to the same types (though certain types are of limited extension, such as the clicks) and since the speech organs and the brain are of the same nature in all men, changes in the phonemic systems, as already indicated, may be classified into types. In such cases as those of dissimilation which occur in very precise psychophysiological conditions, it is possible to formulate "laws" which express a general experience; for example: of two intervocalic consonants the first is dissimilated (*e.g.,* Italian *veleno* "poison," from Latin *venenum;* Old Irish *araile* "other," from *alaile*). The "law" takes a given form in a given language, according to the nature of its system (*n-n* > *l-n* in Italian, *l-l* > *r-l* in Irish, etc.; > signifies: is changed into). The "law," of course, does not lay down a rule but merely predicts that any change will likely take a certain form.

Grammatical Changes.—These are very often the result of phonetic-phonemic changes. In the older Indo-European languages, endings of cases and verbs came in the final syllable or syllables of the word. As these syllables disappeared, the formal system of the language was reduced. Prepositions and word order replaced the cases, pronouns the verbal endings. But other factors may also favour change; for example, two cases in old Indo-European might have had overlapping functions, with the result that one of these became obsolete; other forms fell into disuse for different reasons.

Inventory Changes.—Such changes occur through adoption of new words and the disappearance of old. Words are born, die and are borrowed more or less freely by all languages. Inventions and social developments create new words. In the countries of western culture most of these words are composed of Latin-Greek elements. Particularly striking examples are the terms introduced in the 20th century through the invention of aviation, radio, television and nuclear physics as well as through political movements such as communism and international co-operation. Words denoting outmoded objects and ideas tend to disappear.

Changes of Meaning.—These involve both extension and restriction of meaning. Understanding of this process requires study of the associations between vocabulary-words and sentence-words. The first are called associative; they associate words of similar meaning or form within the vocabulary: *e.g., intellect, mind, brains, understanding, comprehension,* etc.; or words ending in the same suffix, such as *-ness, -sion, -tion: boldness, awareness; caution, action,* etc. A writer constantly makes use of such associations. Sentence-word associations, called syntagmatic, are those which lie behind the scheme of distribution of the different words of the sentence and make it possible for one element of it to call forth the rest. Associations of meaning or form explain how meanings may pass from one object to a new one or from one situation to another, provided that the two have certain elements in common. English *bead,* for example, originally meant a prayer; it was used of the rosary and, in the plural, came to designate it, the singular form coming to mean the perforated ball on the string of the rosary. From this the word was transferred to other similar objects. The word *foot,* which originally meant the lowest part of the leg beneath the ankle, has likewise been transferred to parts of objects similar in form, function or position, such as the support of a table, the base of a mountain, etc. *Meat* originally meant food in general (Norwegian and Swedish *mat* still do), but having been used in contexts where this referred to the flesh of an animal, it acquired its present restricted meaning. The French negative particle *pas* goes back to Latin *passus,* "step." As *pas* is usually combined with *ne,* "not," the negative meaning has passed on to it. The Scandinavian *ikke,* which originally signified "something" (Old Norse *eitgi*), is now the negative, having received this connotation from a *ne* which later disappeared.

III. THE EXTERNAL HISTORY OF LANGUAGE

The external history of language deals with such problems as the role of language in society, the geographical extension of languages, the division of languages into dialects, and the rise of standard languages and of literary and international languages. It is not always possible to keep problems of the external and internal history of a language apart because they may be closely related.

A. Language as a Social Force

Language is probably the greatest force of socialization that exists (E. Sapir). Through it knowledge is passed on from generation to generation. The development of implements can be understood only through the existence of language; some form of it, very different from even the most "primitive" of today, must therefore have existed at the time when the first implements were made.

Language is the medium through which the child becomes a member of his society. There seems to be a general sequence of steps by which he learns to use a linguistic system, especially the sounds. The sound categories are mastered at intervals varying according to the child, but in the same order. Dental consonants appear before velar (*e.g., t* before *k*). The first vowel is *a,* the first consonant a labial. The first consonant contrast is that between an oral and a nasal (*e.g., p:m*). It is followed by one between labials and dentals (*e.g., papa-tata* or *mama-nana*). Then comes the contrast between an open vowel (*a*) and a narrow one (*i; e.g., papa-pipi*), and so on. (Note that aphasics lose their sounds in the reverse order.)

In the course of its history a language tends to vary geographically and to split into dialects if there is no central counteracting influence: from this results the extreme linguistic diversity of the world. Regions in which no higher civilization has developed are usually peopled by a great number of tribes speaking different languages or dialects (for the term "dialect," *see* below). Whether all languages have one common origin cannot be traced. At all periods the relations between languages and dialects have been upset by the migrations and conquests of peoples. North American Indian languages have expanded southward, Asian languages westward into Europe, European languages eastward into Asia, north European languages into south Europe, etc. In modern times such languages as Spanish, Portuguese, English, French, Dutch and Russian have conquered vast territories. In the more composite societies languages tend to vary within themselves and to characterize different social groups or layers. The refined language of literate societies is usually strongly influenced by the written language and becomes opposed to popular or vulgar language. Different crafts and trades use special vocabularies. There are thieves' and other slangs and secret languages. In certain societies different social classes use quite different languages.

The question whether any special relations exist between the structure of a language (or important features of it) and that of the society which uses it is exceedingly difficult to answer. A linguistic system may remain more or less unchanged in its most

important elements while a society is undergoing very great changes. Russian, for example, has remained the same despite the Revolution of 1917, apart from relatively minor changes in vocabulary and style and the dropping of some literary grammatical forms. Languages must be stable to serve as vehicles for general communication.

Causes of Linguistic Change.—Semantic changes are often caused by social conditions and evolution. When a word passes from the general language of a society to a restricted group, its meaning tends to shrink; the opposite happens when it passes from a restricted group to the general language. Latin *ponere* "put," *cubare* "to lie down," *trahere* "to draw," *movere* "to move" remained in the language of the peasants and acquired the meanings: "to lay eggs," "to brood," "to milk," "to molt." Thence they passed back into general usage and re-extended their meaning. Similarly, the verb *arrive* has been borrowed from French *arriver*, itself derived from nautical vocabulary (Latin *ad-ripare* "to come to the beach").

The causes of phonetic-phonemic changes, however, are largely unknown, except in cases where a population adopts a new language, when speakers will carry over traits from their original tongue. "Economy of effort," climate, etc., cannot explain change. Succession of generations is not in itself a cause, but nevertheless an important element in the process. At first the new and the old forms or words are used side by side. As the new become more and more frequent the use of the old is correspondingly restricted until a generation of young people grows up that has never heard them. Thus phonetic-phonemic changes in a language with a long tradition must be due to extralinguistic causes, often favoured by the conditions of the linguistic system itself. Changes may destroy its balance, and this will increase the tendency toward further change.

Grammar and Social Needs.—By means of the distinction between nouns, adjectives and verbs, objects (and beings), qualities and actions are differentiated. This classification of phenomena is of fundamental importance to thought: users of languages that have other categories, or other limits between them, will think differently because their referents differ. Benjamin Whorf compared the categories of Hopi with those of the western European languages. He contrasted the western European system of time, expressed in three tenses placed in a row (past—present—future), with that of Hopi, which has no tenses, but assertions (validity forms), aspects and modes (clause-linking forms). The validity forms denote that the speaker (not the subject) reports the situation (corresponding to European past and present), or that he expects it (corresponding to European future), or that he makes a nomic (customarily or generally valid) statement (corresponding to European nomic present). The aspects denote different degrees of duration and different kinds of tendency "during duration." Need to express sequence of events does not arise until there are two verbs, *i.e.*, two clauses; and then the modes denote relations between the clauses, including relations of later to earlier and of simultaneity. The modes and aspects may be supplemented with many detached words.

In the Indo-European languages, for example, the terms *summer, winter, September, morning, noon, sunset* are nouns and are "objectified." In Hopi they are not nouns nor special fixed parts of speech like German *des Abends* but a part of speech in themselves, different from verbs, nouns or adverbs; they may be called "temporals." They are best translated by "when it is summer," etc. One does not say, "this summer," but "summer now," "summer recently," etc.

Such contrasts between linguistic categories raise the question whether they imply a different way of viewing the world or just a difference in emphasis. Some linguists think the first, others the second. The study of these problems was only beginning in the early 1960s. Still, where new categories are created they correspond to some social need. It is significant, for example, that while a simple society of food gatherers such as the Australian aborigines does not usually have a series of numerals (for they have nothing they need to count), as soon as a society is food producing, numerals become necessary.

Many modern Indo-European languages, especially those of western Europe, have had their inflections greatly reduced. The whole system of cases has disappeared and the number of verbal forms has decreased. Some linguists think that this development must be due to the increase of abstract thought: it cannot be explained simply by the disappearance of the endings. Armenian was subject to a similar reduction of its case endings, but has re-created them. This phenomenon too is as yet unexplained.

B. Common and Hybrid Languages

At an early period, peoples of different native tongues came to adopt special forms of language to make communication easier, especially for commerce. This kind of language is now called a lingua franca (*q.v.*). Such languages are still widely used. They may begin as national languages as, for example, Awar in the Caucasus or Swahili in Africa. Often they are so-called minimum or rudimentary languages with a very small number of grammatical forms of mixed origin. The Russenorsk used by Norwegian and Russian traders until World War I was of this kind. Its very simple and reduced grammar had Norwegian, Swedish and Russian elements and a very composite vocabulary, so that the Russians thought that they were speaking Norwegian and the Norwegians that they were speaking Russian.

Standard Languages.—When languages of civilizations with great literatures arose, they were able to spread beyond their national homes and oust a great number of local dialects and languages; great examples are Ionian-Attic, Hellenistic Greek and Latin. The same trend continues in modern times.

In general, these "common" or "standard" languages expand from some administrative or cultural centre, often helped by the growth of literature. Standard Italian, for example, which has been called *lingua toscana in bocca romana* ("a Tuscan language in a Roman mouth"), was largely created by the work of Dante. The Frankish dialect of the French kings and of the Île de France became standard French, which has ousted the dialects from a region extending approximately 200–500 km. from Paris. Modern German goes back to the language of the Saxon chancellery, which Luther chose for his translation of the Bible. An author may even create a new literary language. The Norwegian poet and scholar Ivar Aasen deliberately constructed *landsmål* (now officially called New Norwegian), one of the two standard languages of Norway, on the basis of the western dialects of that country. There exists an important literature in this language; but the other Norwegian (*riksmål*) predominates in administration and journalism.

In many states, especially from the 19th century onward, the administrative language has become a national symbol to be forced on minorities, who often oppose it because they regard their own language as part of their separate social entity.

The languages of great civilizations may have much influence beyond the areas where they are spoken, through borrowing or translation of their words; as, for example, with Chinese and Sanskrit in the east. In the west, words for new objects or ideas are usually formed from Latin and Greek elements, but words from modern languages are also taken over. In Scandinavia, for example, it is possible to follow the sequence of cultural influences through the loans: Old Celtic, Latin, Anglo-Saxon, Medieval French, Low German with Dutch, High German, French and English following one another.

Medieval Latin had a profound influence on the new literary languages of Europe. A literary language may continue to be spoken in certain circumstances long after it has ceased to be current speech. Sumerian continued as a religious and learned language in Mesopotamia long after it had been supplanted in popular use by Akkadian. Similarly Greek and Church Slavonic are still used in eastern liturgical worship and Latin in western; while Latin was the international language of European scholars during the medieval period. Such languages may also be used for diplomacy, as were Akkadian, Greek and Latin; followed by French from the 18th century, with the addition of English in the 20th. These two languages have remained the foremost in international communication, French especially in southern Europe and South America, English elsewhere. But Russian, Spanish and Chinese are advanc-

ing and have been used, as, for example, in the United Nations. Arabic after World War II has gained international importance; German, through technicians, scientists and scholars, has retained considerable influence.

The prestige of a language of civilization enables it not only to exert influence without the support of political power but also to resist contrary political pressure, so that it may even be adopted by military conquerors; as was Latin by the Teutonic invaders of the Roman Empire. Likewise the Norse Vikings who gave their name to Normandy adopted French very quickly.

Artificial languages have been created to facilitate international communication (*see* UNIVERSAL LANGUAGE).

C. Formation of Dialects

When the Roman Empire broke up, spoken Latin became differentiated, and during the medieval period there arose large dialect groups each characterized by its own main traits. Similar dialect groups are found in other parts of the world where they go back to a common language known by tradition or inferred from linguistic forms (*see* below). The term dialect has various connotations. It is generally used to mean a variety of language characteristic of a locality or of a social group or class seen in relation either to a standard language or to other varieties with which it is historically connected. It may or may not have a literature. The individual speaker's variety of the language of his community is sometimes called a "dialect," but "idiolect" is a better term. The demarcation between dialect and language depends on social and historical conditions and not, as is sometimes argued, on the ability of speakers of the different varieties to understand one another. Educated Danes, Norwegians and Swedes do understand one another; but they use different standard languages with different traditions dating back to the time when writing was introduced into Scandinavia. Sometimes a language seen in its relation to the linguistic family to which it belongs is called a dialect.

It is characteristic of the larger dialect groups that there are no sharp limits between the different varieties within the group like the frontiers between, for example, French and German, Swedish and Finnish. In principle every word and every grammatical form has its own extension, or isogloss, within a great dialect area. Traveling through the area of a dialect group, for example the French, the German or the Scandinavian, one usually finds small differences between neighbouring localities, but the longer the journey the greater the contrast between a given locality and the point of departure. The changes in phonemics, morphemics and vocabulary are gradual. But it happens also that sharper limits can be observed where there are special population changes. Here innovations usually start from some central points such as important towns and follow lines of communication. Archaic features may persist in the outlying zones.

The Tracing of Linguistic Relationships.—From the above considerations, it is to be expected that various languages which are now very different from one another may once have been one, just as the Romance languages were once popular Latin. Special linguistic methods, elaborated mostly for the study of the Indo-European languages, enable one to determine the genetic relationships between languages by a comparison of their forms. These relations permit the supposition that there once existed a parent language. Full knowledge of a root language cannot be gained in this indirect way, but certain important traits of it may be determined. For it is extremely unlikely that the grammatical morphemes should be expressed by the phonemes just by accident. It is not necessary that these morphemes should be phonemically identical—they rarely are—but when the phonemes can be shown to correspond in a way that is explained by a common origin, it is evident that the morphemes in question are only different forms of a common original: as, for example, in Latin *genus, generis* "birth," "descent," corresponding to Greek *génos, géneos,* Sanskrit *jánas, jána-as;* etc. Compare further the forms of the verb "to be" in the various persons singular and plural.

Sanskrit	sing. 1 *ásmi*, 2 *ási*, 3 *ásti* pl. 1 *smás*, 2 *sthá*, 3 *sánti*
Greek	*eimí*, (=*emi*), *eî* (from **esi*), *èsti* *eimén, èsté, eisi* (Doric, *enti*)
Latin	*sum, es, est, sumus, estis, sunt*
Old Irish	*am* (from *esmi*), *a-t, is* *ammi, adib, it* (from **senti*, Old Welsh *hint*)
Gothic	*im, is, ist*, pl. 3 *sind* (from **senti*)
Old Lithuanian	*esmì, esì, èsti*
Hittite	*e-eš-mi* (= *esmi*), 3 sing. *e-eš-zi* (=*eszi*), 3 pl. *a-ša-an-zi* (=*asanzi*)

By proceeding in this way it has been possible to posit such language families as the Indo-European, the Semitic, the Finno-Ugrian, etc. Correspondences between phonemes are the necessary prerequisite for the establishment of linguistic parentage, as, for example, in Indo-European. A list of vowels in the Indo-European languages can be drawn up as in Table III, from which it is possible to conclude that Indo-European had *e, o, a*. Similarly, Table IV shows how the originally voiced stops correspond in the same language family; this indicates the following system in Indo-European: $b : d : g : g^w$.

When, as for Indo-European, it is possible to draw up a number of such tables, where the corresponding phonemes occur not only in lexical but also in grammatical morphemes, the conclusion is easy. But neither phonemic nor lexical correspondences alone are decisive indications of linguistic parentage. There may be regular phonemic concord between the loan words of a language and the source words in the lending language. On the other band, a language may lose most of its vocabulary without losing its grammatical framework.

D. Reciprocal Influence of Languages

Languages, especially neighbouring ones, may show general similarities which are not due to genetic relationship. Conversely, genetically related languages may belong to different types; *e.g.,* English and Lithuanian. The similarities appear in areas exposed to the same cultural influence, where there will be groups of bilingual speakers who introduce loanwords, expressions and constructions from one language into the other. The western European languages exhibit many corresponding traits which do not go back to the earliest period. A striking example is the spread of the definite article. This is found in Late Egyptian and Semitic, in Greek (later than the Homeric poems); in Late Latin; in Basque; in Irish and Welsh from the earliest periods and in Teutonic, where the Scandinavians must have introduced it in the 10th century. Linguists used erroneously to regard such cases as the result of parallel developments. The concrete form and the etymological origin of the article differ from language to language. In Latin and Romance it is a form of the pronoun *ille* (in some cases *ipse*); in Celtic, an old pronoun **sindo-*; in Scandinavian, both the preposited *hinn* and the postposited *-inn* are original demonstrative pronouns.

In cases where two languages confront each other in the same

TABLE III.—*List of Vowels in the Indo-European Languages*

Greek	Italic	Celtic	Teutonic	Lithuanian	Slavic	Armenian	Hittite	Indo-Iranian
e	*e*	*e*	*e(i)*	*e*	*e*	*e*	*e*	*a*
o	*o*	*o*	*a*	*a*	*o*	*o*	*o*	*a*
a	*a*	*a*	*a*	*a*	*o*	*a*	*a*	*a*

TABLE IV.—*Correspondence of Originally Voiced Stops in the Indo-European Languages*

Hittite	Tocharian	Sanskrit	Avestic	Old Slavonic	Lithuanian	Armenian	Greek	Latin	Irish	Gothic
p	*p*	*b*	*b*	*b*	*b*	*p*	*b*	*b*	*b*	*p*
t	*t(c)*	*d*	*d*	*d*	*d*	*t*	*d*	*d*	*d*	*t*
k	*k*	*j*	*z*	*z*	*ž*	*c*	*g*	*g*	*g*	*k*
kw	*k(c)*	*g(j)*	*g(j)*	*g(ž, dz)*	*g*	*k*	*b(d)*	*w(gw)*	*b*	*q*

society, the dominating one having to be learned by the original population or by people brought together who speak different languages, the influence may take two main forms. If the two languages are very different the population that adopts the new one will carry over both words and categories from its original speech, expressing them with elements from the new language. The phonemic-phonetic system will also be strongly influenced, though phonemes not found in the new language are seldom carried over from the old. Anglo-Irish uses the verbal aspects of Irish; Breton-French in large parts of Brittany stresses the penultimate syllable as in Breton, and the voiced stop, labial and guttural spirants *z* and *ž* are devoiced before a pause. In that position *tad* "father" is pronounced *tat*. Creolian French is a form of French completely remodeled to fit the general scheme of western African languages, though no African elements and very few words have been taken over. Haitian French has no temporal tenses, but uses aspects. The durative aspect is expressed by the prefix *apr-*, the momentaneous by *fek-*; *e.g., m-apr-alé* "I am going," from French *moi-après-aller; m-fek-rivé* "I have just arrived," from French *moi-(ne) fais-que-arriver*.

When the two languages are already closely akin, so that their speakers understand each other without great difficulty, the result may be a mixed language, having grammatical forms of different origins. In the 18th-century Russian of the Muscovite state, for example, three languages co-existed: pure Church Slavonic, used in worship and in religious writings; Russian proper used for business and in the home; and simplified Church Slavonic, called Slavo-Russian, for secular literary speech and writing. This third language had a purely Church Slavonic vocabulary but avoided and eventually eliminated certain "scriptural" words. Its grammar approached that of conversational Russian, avoiding certain Church Slavonic forms and using specifically Russian flexions and syntactic constructions. It and the business language were perceived not so much as distinct languages but as different styles of the same language; whereas Church Slavonic was a separate linguistic entity. By the beginning of the 19th century these business and literary forms had coalesced, the former becoming more literary and the latter more russified, some of its Church Slavonic lexical elements being replaced by Russian.

A similar process had taken place in Norway, where Danish was adopted as the literary language when Old Norse became unintelligible (the two countries being united under one king since the 14th century). But the literary language was used as a spoken form only on solemn occasions, as for preaching or the public reading of official declarations, when it was called the "official" or "solemn" language. Its phonetics were Norwegian; it used the Norwegian lexical tones, unknown to Danish; and had many other Norwegian traits. Country people and lower-class townspeople spoke dialects derived from Old Norse. The language of the towns was more subject to foreign influence, especially lexically, than that of the country. Better-off people, such as merchants, intermixed influences from the "solemn language" with the dialect of their town; the result was called the "intermediate language." Then, in the 18th century, in the towns of the southeast, the "solemn language" and the "intermediate language" coalesced into a common spoken standard form. This had grammatical forms of both Danish and Norwegian origin and a vocabulary with Norwegian words especially for practical everyday life and Danish words for spiritual or literary matters. The amount of Danish grammatical forms in Norwegian has varied somewhat, but has been gradually reduced, especially in the 20th century, by conscious policy of the authorities after the adoption of the spoken language as basis for the written language by the reform of 1907. This written and spoken language is called the *riksmål* (*i.e.*, language of the realm; officially the "book language"). The Norwegianizing of the language has made headway owing to competition with the other official language, the *landsmål* (*i.e.*, language of the country; officially New Norwegian).

E. Growing Time

Since 1951 theories have been set up to measure how long it takes for a dialect to grow from its parent language. The glottochronological method is mainly statistical; cases where the time lapse is known are studied in an attempt to establish a general formula. Such a theory would do (less accurately) for language what carbon-dating does for archaeology. Linguistic change is slow: 3,000 years lie between modern Greek and Homer. Moreover, the rate of change is not uniform. The formulas offered do not agree very well with known facts. So far mainly lexical items have been studied: basic root morphemes, names of family relationships, parts of the body, numerals up to ten, simple adjectives like good and bad, demonstratives like here and there; all of these occur in almost all languages. (See *International Journal of American Linguistics*, 21:121–137 [1955]; for a critique of the theory, see *Language*, 32:48–60 [1956] and *Current Anthropology*, 3:115–153.)

See also references under "Linguistics" in the Index.

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LINKAGES, in mechanics, are combinations of links or bars, in general connected by pins, slides, rollers or screws. If the combination is such that no relative motion can exist between the parts a structure results. If the links can move relative to each other the linkage becomes a kinematic chain. Specific forms of kinematic chains are useful when the motions of the links are controlled so that constrained relative motion results. Such linkages are commonly referred to as mechanisms when the transmission of energy is not important.

Many linkages, or mechanisms, are used to obtain specific motions with little regard to the performance of work. Such devices as watches, typewriters, record changers, mechanical computers and working models are of interest for the relative movements of the parts, not the energy involved. Machines, however, commonly involve the performance of work or the transmission of power to some useful end. Thus, practically all machines may be thought of as being mechanisms or linkages in various combinations in which work or energy is significant. The automobile, for example, is made up of many linkages, some of which—parts of the engine and transmission—function as machines, while others—steering

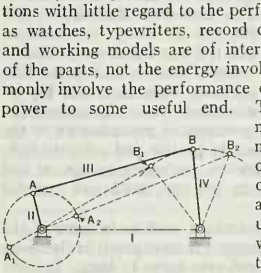

FIG. 1.—FOUR-BAR LINKAGE

and throttle linkages—are present primarily to provide certain desired motions of the parts.

Historical Background.—Many linkages in common usage have had their origin in centuries past. From the time of the great early Egyptian civilizations, the minds of men have sought means to produce motions not obtainable with the human hand alone. Multiplication of effort, faster speeds, more complex motions over greater distances or in smaller spaces have been the goals of such men as Archimedes, Hero of Alexandria, Leonardo da Vinci, James Watt and others.

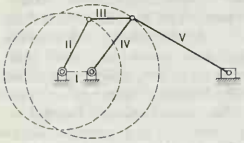

FIG. 2.—DRAG-LINK MECHANISM

Hinged tongs were in use as early as the 6th century B.C. The screw of the Archimedean screw was invented, according to some authorities, around 400 B.C., and was in use in Egypt before Archimedes' time. By the 1st century A.D. the lever and the screw press were in use for crushing grapes. The ratchet and pawl (*see* RATCHET AND PAWL) were shown in types of crossbows described by Hero and Philo in the same century. A linkage for operating a fascinating hydraulic organ also was described by Hero. But for nearly 1,000 years, from about A.D. 400 to 1400, little advance

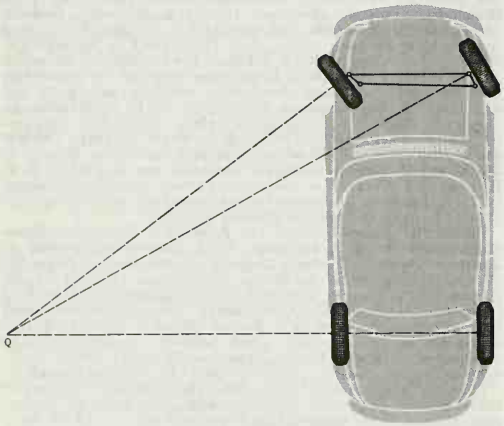

FIG. 3.—IDEAL RELATION OF AUTOMOBILE WHEELS WHEN TURNING A CORNER

was made in the use of mechanisms and linkages.

Then the gradual awakening of western civilization and development of the industrial age stimulated many new and improved devices. Weaving and spinning machines and machines of war occupied Da Vinci's thoughts with ingenious and far-reaching results. Stamp mills and water-driven bellows used crude linkwork in the 16th century, the joints being constructed of interlocking eyes, as are the links of a chain. The Industrial Revolution saw the rise of many new linkages and led into the development of complex devices such as the Stephenson, Walschaert and Joy locomotive valve arrangements. Better methods of analysis and precision of manufacture in the 20th century gave rise to increasingly precise and complex linkages in typewriters, computing devices, packaging equipment and manipulating mechanisms used to position, hold and transfer products of industry.

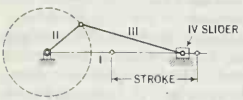

FIG. 4.—SLIDER-CRANK LINKAGE

Some giant linkages have been created, such as in some of the mining equipment of the 19th century. A mine pump in Germany is said to have had a connecting rod over 7,200 ft. long. In 1682 a French fountain display incorporated a linkage 2,000 ft. long. In existence in the mid-20th century was a water wheel 72 ft. in diameter that drove a mine pump on the Isle of Man. The 600-ft.-long connecting rod was disconnected during the 1930s, but the wheel remained in operating condition. Some of the largest linkages continue to be employed in mining, as in the giant shovels used for removing overburden in strip mines.

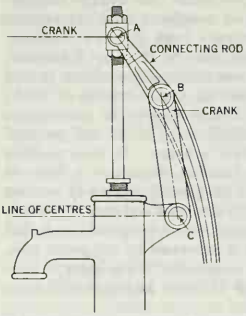

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FIG. 5.—HAND-PUMP LINK MECHANISM

Classification.—Attempts have been made at classification of linkages using rules such as the number of degrees of freedom of the chain. A link with unrestricted motion is said to have six degrees of freedom since it can move in any one of three mutually perpendicular directions in space and can rotate in any one of three mutually perpendicular planes. Such criteria, however, can distinguish between structures and mechanisms in general but may fail for special cases where a point-by-point analysis will be required.

Basic to all linkages are the types of joints or pairs employed. Such pairs may be classified as higher pairs when line or point contact between the members is indicated. Examples of such pairs are ball bearings, cams and flat-face followers, pins in slots and gear teeth. Lower pairs are pairs with geometrically similar areas in contact, such as plain bearings, a piston in a cylinder, and ball and socket joints.

A further description is provided by the terms turning pairs (pin joints, sleeve bearings); sliding pairs (piston in cylinder, gears); and rolling pairs (balls and races in ball bearings, railroad-car wheel on rail). A special pair having relative helical motion is known as a screw pair, as exemplified by the common bolt and nut.

Common Linkages.—The study of linkages generally begins with the analysis of some of the more common types and progresses to the more difficult problems of synthesis. One basic linkage is the four-bar linkage or quadric-crank mechanism (*see* fig. 1). This consists of four links connected by pin joints with one link (I) generally stationary. Link II is usually called a crank, link IV a lever, and link III a coupler. By varying the proportions of the links, various motions are transmitted to link IV as well as to points on link III. Thus, in fig. 1 the crank can make a complete revolution while the lever oscillates as shown by the dotted lines. This linkage can be used as a simple device to translate rotation into oscillation which, with a ratchet linkage, will produce an intermittent motion.

By altering the proportions the drag-link mechanism, fig. 2, may be created. Here links II and IV both rotate completely, II at constant speed and IV with varying speed. This mechanism, when coupled with an additional link V, creates a type of quick-return mechanism commonly used in a Dill slotter, a machine for cut-

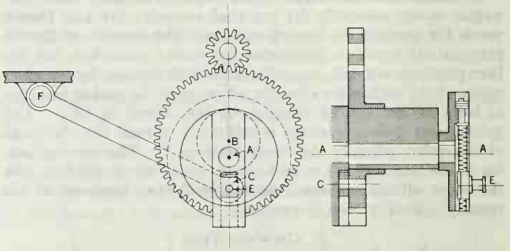

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FIG. 6.—WHITWORTH QUICK-RETURN MECHANISM

ting keyways in shafts. If the links are paired with opposite links of equal length, a parallel linkage is formed such as is used in the cranks and parallel rod of a locomotive or in the universal drafting machine, which is widely used in place of T squares and triangles. The automobile steering mechanism has generally employed a four-bar linkage to obtain the necessary differential motion of the two front wheels. Ideal performance dictates that the two wheels should operate as in fig. 3 in making a turn. Practically, a compromise usually is reached that provides for turning the wheels through unequal angles but does not attain a common centre of curvature at Q for the paths of all four wheels.

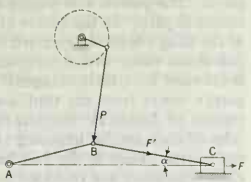

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FIG. 7.—TOGGLE LINKAGE

The idea of inversion is very important in the study of linkages. A mechanism or linkage is said to be inverted when the originally fixed or reference link is permitted to move and a different link is held fast, without changing the basic proportions of the linkage. Such inversion changes the motions of all links relative to a fixed reference system but does not change the motions of the links relative to each other.

A quadric-crank linkage in which the lever, link IV, is permitted to become infinitely long is represented by the slider-crank mechanism, fig. 4. One of the pin joints has thus been replaced by the rectilinear sliding pair. In this form it is the familiar crankshaft, connecting rod, piston and cylinder of the internal-combustion engine, air compressor or refrigerator compressor. Mathematical and graphical techniques have been developed to analyze the motions of this mechanism quickly and accurately.

Several inversions of this interesting and versatile linkage have been put to use. With link IV fixed, the common hand pump, fig. 5, results. By holding stationary the connecting rod, an oscillating piston and cylinder mechanism may be obtained, such as has been used in marine engines. Radial aircraft engines in which the cylinders rotated about a fixed crank were obtained from a fourth inversion of the basic slider-crank linkage at the time of World War I.

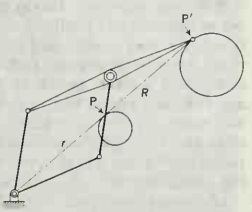
Inversions of the slider crank are frequently combined with additional linkage in modern machinery. The crank shaper, and the Whitworth quick-return mechanism, fig. 6, are devices used in machine tools where a reciprocating motion with controllable unequal times for advance and return strokes of the slider C are desired.

One quite useful variation is the toggle linkage, fig. 7. As the slider C approaches the end of its stroke it is capable of exerting a very large force F with a relatively low force P. By making AB = BC and having F act perpendicular to F', then

$$\frac{F}{P} = \frac{1}{2 \tan \alpha}$$

Stone crushers, presses, clutches, pneumatic riveters use forms of this device.

Straight-Line Linkages.—The production of a straight-line motion in a plane has intrigued the minds of many scientists and engineers in times past. Exact straight-line motions may be obtained by the Scott-Russell's linkage, Hart's straight-line motion, Peaucellier's movement and the pantograph, fig. 8. However, these devices are not widely used since straight-line motions are generally obtained with slides. In special cases where the slide cannot be mounted at the point that is to move in a straight line, these linkages, particularly the Scott-Russell's, or some type of approximate straight-line motion linkage, are used.



FROM J. S. BEGGS, "MECHANISM"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 8.—PANTOGRAPH

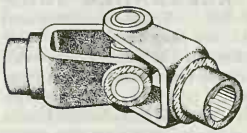
The classical approximate straight-line motion linkages are generally special cases of the four-bar linkage. The best known of these are Watt's, Roberts' and Chebichev's mechanisms. Some giant dock cranes employed for loading ships are examples of the use of the Roberts' approximate straight-line motion.

The pantograph is useful in the redrawing of maps or other figures to a different scale, several arrangements of this linkage being possible. In fig. 8 point P′ will trace the same figure traced by P, but R/r times as large. By joining several such linkages together the common lazy tongs is achieved, a device much used as a telephone support, in toys and in a railroad freight-car unloader.

Steam-engine valve gears, rather complex linkages involving straight-line motions, were developed as the reciprocating steam engine came into use during the 19th century. The Baker valve gear became one of the most popular of these linkages for the steam locomotive.

Space Linkages.—The conic four-bar linkage enables relative spherical motion to take place between the four links. If the axes of the four pin joints are not parallel but have a common intersection at a finite distance the members remain movable. The different forms of plane linkages can be reproduced in the conical form (or space linkage) provided this rule is maintained, with a few modifications to eliminate interference of parts.

One of the most useful of these space linkages is the Hooke's joint or universal joint, fig. 9, used for joining two intersecting shafts. Unfortunately, a varying angular speed ratio results when the joint connects shafts at an angle, though this defect can be minimized by suitable arrangement of two joints and an intermediate section of shafting.



FROM V. L. DOUGHTIE AND W. H. JAMES, "ELEMENTS OF MECHANISM"; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 9.—UNIVERSAL (HOOKE'S) JOINT

Synthesis.—The problem of proportioning a linkage to perform a given function may be relatively difficult when using a combination other than a simple cam and follower (*see* CAM). However, many mechanical computing devices have been developed for specific mathematical operations and are in widespread use throughout industry, performing a great variety of production and control operations. *See* COMPUTING MACHINES, ELECTRONIC; OFFICE MACHINES AND APPLIANCES.

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LINKÖPING, a city of Sweden, the chief town of the *län* (county) of Östergötland, situated on the Stang river near its outflow into Lake Rox, 100 mi. S.W. of Stockholm. Pop. (1960) 65,082.

A bishop's see was established about 1100. At a synod held in 1153 payment of Peter's pence (expenses toward the Holy See) was agreed upon at the instigation of the English legate Nicholas Breakspear, afterward Pope Adrian IV. The coronation of Valdemar, the son of Birger Jarl, took place in the cathedral in 1251. In the reign of Gustavus I Vasa several important diets were held in the town. In 1598 it was the scene of the battle against the Catholic king Sigismund III of Poland, which guarded the Evangelic Lutheran Church in Sweden and secured the Swedish throne for the Vasa dynasty.

The cathedral (*c.* 1100–1499 and restored in the late 19th century) is a great Romanesque and Swedish Gothic building with a magnificent south portal and late Gothic choir; it has an altarpiece by Maerten van Heemskerck (1543) and a modern one by the Norwegian artist Henrik Sörensen (1931). In the church of St. Lars are some paintings by Pehr Hoerberg (1746–1816), the Swedish peasant artist; the remains of an older Roman church are preserved under the church floor.

Other buildings of note are the 13th-century castle (once the episcopal palace, afterward a royal palace rebuilt in the 16th

century but now the residence of the governor of the county) and the old gymnasium founded by Gustavus II Adolphus in 1627. The Lutheran bishop's palace was erected in 1734 on the old site of a Franciscan monastery. There are also noted diocesan and city libraries and a modern museum (1939) with a picture gallery and collections of prehistoric art. Other museums are the Krogsfallsgården with two peasant houses, "Uncle Adam's House" with late 19th-century interiors and the Valla open-air museum with houses from the old city. The Fountain of the Folkungs by Carl Milles (1927), with an equestrian statue of Folke Filbyter, the mythical ancestor of the famous family, is in Stora Torget (the principal square).

Industrial development came with the building of the Göta and Kinda canals and the Stockholm-Malmö railway. The town is a rail junction with aircraft, freight car and automobile industries. Rope, textiles, tobacco and beer are produced. (B. J. C.)

LINLEY, THOMAS (1733–1795), English musician and father of a large family of musicians, was born at Badminton, Gloucestershire, on Jan. 17, 1733. He studied music at Bath, Somerset, and afterward settled there as a singing master and conductor. From 1774 he was engaged in the management of the oratorios performed at Drury Lane theatre, London. He composed or compiled the music for many dramatic pieces played there, including *The Duenna*, by his son-in-law Richard Brinsley Sheridan. In 1777 he was elected a member of the Royal Society of Musicians. He died in London on Nov. 19, 1795.

LINLITHGOW, VICTOR ALEXANDER JOHN HOPE, 2ND MARQUESS OF (1887–1952), British statesman and viceroy of India from 1936 to 1943, was born at Abercorn, West Lothian, Scot., on Sept. 24, 1887. Educated at Eton, he succeeded his father in 1908 and served with distinction on the western front during World War I. He was appointed civil lord of the admiralty in Stanley Baldwin's government in 1922. He gained considerable knowledge of India's problems as chairman of the royal commission on agriculture in India (1926–28) and of the select committee on Indian constitutional reform that culminated in the Government of India act (1935). In 1936 he succeeded Lord Willingdon as viceroy, with the intention of carrying those reforms into effect. Under the act, the provinces were to be governed by ministries responsible to the elected legislatures. The Congress party, with clear majorities in 5 of the 11 provinces, was unwilling to take office without some assurance that the governors would not use their reserve powers to override the ministries. Linlithgow succeeded in overcoming these scruples, and provincial autonomy was soon functioning smoothly, but he failed to secure the consent of the princes, which was necessary for the establishment of the federal structure provided by the act for the central government. As viceroy, he declared war against Germany in Sept. 1939 before consulting the Indian political parties and thus offended the Congress leaders, who called upon their provincial ministries to resign. They also refused Linlithgow's offer of representation in his executive council; he nevertheless enlarged its size and increased the number of Indian members. In Aug. 1942, in spite of the Japanese menace to India, the Congress threatened a mass civil disobedience campaign if independence were not granted at once. Linlithgow immediately interned their leaders. Outbreaks of violence followed but were soon suppressed. Meanwhile, he had done much to mobilize India's resources. He resigned office in 1943. His pronouncements as viceroy were published by the government of India as *Speeches and Statements by the Marquess of Linlithgow* (1945). (*See* also INDIA: *History.*)

After his viceroyalty Linlithgow held various appointments, including the chairmanship of the Midland bank. He died while out shooting on his estate in West Lothian on Jan. 5, 1952.

(KE. A. B.)

LINLITHGOW, a royal burgh (1389) and the county town of West Lothian, Scot., lies on the south side of a loch, 18 mi. W. of Edinburgh by road. Pop. (1961) 4,327. In the 19th century its old-world appearance was much changed by rebuilding, and thereafter by the demolition of other buildings of local architectural merit. The burgh's outstanding feature is the now roofless royal palace, the birthplace of Mary, queen of Scots. This, and the parish kirk of St. Michael, stand together on the rising ground of the promontory which divides the loch into two nearly equal parts. The palace, a favourite abode of the kings of Scotland, is square in plan. In the centre of the inner close stand the remains of the King's fountain ascribed to James V. At each corner of the palace is a tower with a turnpike turret. The northwestern tower is crowned by a little octagonal cap-house known as Queen Margaret's bower from the tradition that it was from there that the consort of James IV watched for his return from Flodden. The original entrance, an imposing architectural feature, is in the eastern quarter, built in the first half of the 15th century; James V closed this entry and provided one in the south quarter. The north quarter, which contained the queen's suite, having become ruinous, was rebuilt for the "homecoming" of James VI (James I of Great Britain) in 1617. The royal apartments, the chapel and the Great hall, otherwise known as the Lyon chamber, were situated on the first floor. The last time the Scottish parliament met in the palace, during the plague in Edinburgh, was in 1646. It was burned in 1746 by Gen. Henry Hawley's dragoons.

The kirk of St. Michael, consecrated in 1242, was restored following a fire in 1424. In the early 19th century the open crown spire was removed from the head of the tower, and thus the building was robbed of a typical Scottish feature. In front of the town hall (1662) is the Cross well, erected in 1807 by a one-handed mason. It is a copy of one made at the Restoration by Robert Myme, the king's master mason, who based his design on the King's fountain within the palace.

Modern industries include paper making, whisky distilling and the manufacture of antibiotics. There is an agricultural market.

About 4 mi. S. by W. lies Torpichen, where the knights of St. John of Jerusalem had the chief Scottish preceptory.

(J. S. RN.)

LINNAEUS, CAROLUS (CARL VON LINNÉ) (1707–1778), Swedish botanist, the first to enunciate the principles for defining genera and species and to adhere to a uniform use of the binomial system for naming plants and animals. He was born on May 23, 1707 at South Råshult, where his father was a curate. His love of flowers developed at an early age, and it is recorded that when only eight years old he was nicknamed "the little botanist." He was educated at Växjö and at the universities of Lund and Uppsala, at which latter he qualified in medicine.

It was when he visited Uppsala that he met the veteran botanist Olaf Celsius, an event that had a profound influence on his subsequent career. He was appointed lecturer in botany in 1730 and two years later explored in Lapland for the Academy of Sciences, the results of his journeyings being published in Amsterdam in 1737 as the *Flora Lapponica* and in English by Sir J. E. Smith as *Lachesis Lapponica* (1811). His reputation was established by this and, even more, by the appearance in 1735 of his *Systema naturae* and of the *Genera Plantarum* two years later, while the *Species Plantarum* did not appear till 1753. (For purposes of nomenclature of flowering plants and ferns the first edition of the *Species Plantarum* has been internationally agreed as the starting point together with the fifth edition of the *Genera Plantarum* published in 1754.)

The *Systema naturae*, which Linnaeus had shown to Jan Fredrik Gronovius in manuscript, so impressed the latter that he published it at his own expense. This system was based mainly on the number of stamens and pistils in the flower and the manner in which, if not free, they were joined together. Although artificial, as Linnaeus himself recognized, such a system had the supreme merit of enabling students rapidly to place a plant in a named category, and that at a period when the richness of the world's vegetation was being discovered at a rate which outstripped more leisurely methods of investigation. So successful was it in practice that its facile application was the greatest obstacle to its replacement by the so-called natural systems that superseded it.

Linnaeus visited England in 1736 where he met Sir Hans Sloane in London, Phillip Miller at Chelsea Physic garden and Dillenius (Johann Jakob Dillenius; *q.v.*) at Oxford. He returned to Holland to complete his work on the famous *Hortus Cliffortianus* and vis-

ited the Jussieu (*q.v.*) family in Paris with whom he became a close friend. A month later he was once again in Sweden and in 1738 settled in Stockholm as a practising physician, in which he attained considerable success. In 1739 he married the daughter of a physician, Sara Moraea, to whom he had been betrothed four years earlier. Two years after his marriage Linnaeus was appointed to the chair of medicine at Uppsala but a year later exchanged this for the chair of botany.

Henceforward his time was taken up by teaching and the preparation of other works. He issued his *Flora Suecica* in 1745 and *Fauna Suecica* in 1746; his two volumes of observations made during journeys in Sweden, *Västgöta resa* (1747) and *Skånska resa* (1751); his *Hortus Upsaliensis* (1748); his *Philosophia Botanica* (1751) and his important *Species Plantarum* (1753), in which the specific names are fully set forth. In 1755 he declined an invitation from the king of Spain to settle in that country with a liberal salary and full liberty of conscience. In 1761 he was granted a patent of nobility, antedated to 1757, from which time he was styled Carl von Linné. To his delight the tea plant was introduced alive into Europe in 1763. An apoplectic attack in 1774 greatly weakened him, and he died on Jan. 10, 1778, at Uppsala, in the cathedral in which he was interred.

Linnaeus delighted in devising classifications, and not only systematized the two kingdoms of living things but even classified the mineral kingdom and drew up a treatise on the kinds of diseases.

Of his 180-odd works those published during his lifetime were enumerated in R. Pulteney's *General View of the Writings of Linnaeus* (1781). An edition of his correspondence appeared at Groningen in 1830. His widow sold his collections and books to Sir J. E. Smith, the first president of the Linnean society of London. When Smith died in 1828 a subscription was raised to purchase the herbarium and library for the society, whose property they remain.

See BIOLOGY: *History: Early Attempts to Classify Living Things;* BOTANY; *see* also references under "Linnaeus, Carolus" in the Index.

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LINNET (*Carduelis cannabina*), a common old world songbird of the finch family (Fringillidae) frequenting Europe and western Asia, where it breeds. Some individuals migrate in winter to Egypt and Ethiopia, while others remain at all seasons in Barbary, as well as in the Canaries and Madeira. Though the fondness of this species for the seeds of flax (*Linum*) has given it its common name in many European languages, it feeds chiefly on the seeds of Compositae (ragweed, sunflower, etc.). The males in spring have a handsome crimson-red breast and crown. The plumage of this small finch varies much with age, sex and season; each phase may have a different common name, such as red linnet, gray linnet. The song is pleasant but apt to be monotonous.

JOHN MARKHAM

LINNET (CARDUELIS CANNABINA) AT NEST WITH YOUNG

The linnet begins to breed in April, the nest being generally placed in a low bush. It is a neat structure of fine twigs, roots or bents, lined with wool or hair. The eggs, four to seven in number, are of a very pale blue marked with reddish or purplish brown. Two broods are raised in a season.

The name mountain linnet is applied to the yellow-billed twite (*C. flavirostris*), of northern Eurasia, which never has crimson on crown or breast. Green linnet is a common name for the greenfinch (*q.v.*). In the United States linnet is a name sometimes given to the house finch (*Carpodacus mexicanus*)—familiar, nesting about houses and a good singer—whose various subspecies range from British Columbia to Baja California and southern Mexico and eastward to the northern plains states; it has been introduced into Hawaii. (G. F. Ss.; X.)

LINOLEUM: *see* FLOOR COVERINGS.

LINSANG (*Prionodon linsang*), a carnivorous mammal of the civet family (Viverridae), found from upper Burma through the Malay archipelago to Borneo and Java. The linsang, about 30 in. long, is slender in build with short legs and a long, banded tail. Its general colour is pale buff, but the forehead and muzzle are brown, and five broad black or brown bands cross the back. Other longitudinal markings occur on neck and sides. *See* CARNIVORE: *Cats and Cat Allies* (*Feloidea*): *Civet Family* (*Viverridae*); CIVET. (J. E. HL.)

LINSEED AND LINSEED OIL. Linseed, an oilseed known also as flaxseed, is the seed of a variety of the common flax, *Linum usitatissimum,* which is cultivated principally in the United States, Canada, the U.S.S.R., India and Argentina for its yield of linseed oil and linseed oil meal. This variety of flax has shorter straw, more branches and more seeds than other varieties that are grown primarily for fibre to be woven into linen. World production of linseed is about 140,000,000 bu. per year; the United States, the Soviet Union and Argentina rank among the leading producers. (*See* also FLAX.)

Linseed is borne in globular capsules, each containing ten long, flat elliptical seeds with slight projections at one end. Sizes vary considerably; typical seeds are about 3–4 mm. long, 2–3 mm. wide and 0.5 mm. thick. Average weights range from 3 to 9 mg. The seeds, usually brown, are smooth and shiny and contain a mucilaginous substance in their outer layer that makes them sticky when wet. Beneath the seed coat is a thick layer of endosperm, inside which the main volume of the seed is occupied by the two cotyledons. Unlike most grasses, mature linseed is devoid of starch granules.

The oil content of the whole seed depends upon several factors, including the type of the linseed, maturity of the seed, locality, soil, temperature, rainfall and other conditions of climate and weather under which the seed is grown. The oil content usually ranges from 33% to 43% in air-dried seed having a moisture content of about 6%.

Linseed oil has a high iodine number (value), which reflects the high degree of unsaturation of its fatty acid radical. The oil is a mixture of the glycerides of linolenic, linoleic, oleic, stearic and palmitic acids. Its high iodine number (usually between 175 and 205, depending on the grade) is due mainly to the linolenic and linoleic acid components. Linseed oil is a golden-yellow, amber or brown liquid that is classified as a drying oil because it thickens and hardens on exposure to air (*see* also OILS, FATS AND WAXES). It has a low melting point (about −20° C.) and is a little more viscous than most vegetable oils. It is used in the manufacture of paints, printing inks, linoleum, varnish and oilcloth.

Linseed oil is prepared commercially in several grades, including raw, refined, boiled and blown. Raw oil is the slowest drying

of all the grades. The refined grade is raw oil from which solid fats, fragments of seeds and other undesirable materials have been removed. Boiled linseed oil dries in less time than either raw or refined oil and exhibits improved drying qualities (*i.e.*, it becomes thicker, denser and darker when dry) as a result of having materials called driers, such as manganese oxide, added while the oil is hot; the name is inaccurate, since the oil is not boiled. The blown grade dries to an even harder film as a result of having air blown through the oil while it is heated to about 125° C.; this grade is used in enamels and interior paints.

Although exposure to air causes the flavour of the seed to deteriorate rapidly, especially if it has been refined and deodorized, linseed was used as food by the ancient Greeks and Romans, and it continues to be used as such in parts of central Europe. In modern times, however, its main food use is as a livestock feed. After the oil is removed from linseed by compression, the remaining meal is heated and pressed into cakes for livestock. Linseed meal contains about 33% protein and is high in minerals, especially calcium and phosphorus. *See* FEEDS, ANIMAL: *Important Concentrate Feeds; see* also references under "Linseed and Linseed Oil" in the Index.

See U.S. Tariff Commission, *Flaxseed and Linseed Oil,* "Industrial Material Series," Report no. M-7 (Nov. 1952); E. W. Eckey, *Vegetable Fats and Oils* (1954). (P. HE.)

LINTH, a river of Switzerland, is one of the tributaries of the Aare (*q.v.*). It rises in the glaciers of the Tödi range and has eroded a deep bed that forms the Linthtal, which comprises the greater part of the canton of Glarus. A little below the town of Glarus the river, keeping its northerly direction, flows across the alluvial plain that it has formed toward the lake of Zürich. In order to regulate the flow of the river over this plain it has been canalized, and dikes protect the riparian lands. These works were begun in 1807, and the first portion of the undertaking was completed in 1811, when it received the name of the Escher canal, the river being thus diverted into the Walensee or lake of Walenstadt. The Walensee is 9 mi. long with an area of 9 sq.mi., an altitude of 1,375 ft. and a maximum depth of 492 ft. The Churfirsten range dominates the northern shore, which is less populated than the southern. The Seez river enters the lake from the east. Wallenstadt is the main town on the lake. The second portion of the Linth, known as the Linth canal, regulated the course of the river between the Walensee and the lake of Zürich and was completed in 1816. Many improvements and extra protective works were carried out after 1816, the date of the completion of the work being 1911. The Linth emerges from the lake of Zürich as the Limmat and, keeping the northwesterly direction, joins the Aare a little way below Brugg and just below the junction of the Reuss with the Aare. The combined length of the Linth-Limmat is 87 mi. (A. F. A. M.)

LINTON, RALPH (1893–1953), U.S. anthropologist, an influential contributor to the development of cultural anthropology, was born into a Quaker family in Philadelphia, Pa., on Feb. 27, 1893. While a student at Swarthmore college (B.A., 1915), he participated in archaeological expeditions to New Mexico, Colorado and Guatemala. Thereafter, he studied at the University of Pennsylvania (M.A., 1916). After serving in the American expeditionary forces as a corporal during World War I, Linton studied briefly at Columbia university and then at Harvard university (Ph.D., 1925). During these student years he continued to engage in archaeological research in New Mexico, Colorado, Ohio and the Marquesas Islands. Linton's experience in the Marquesas Islands turned his attention to ethnology and, during his association with the Field Museum of Natural History (later the Chicago Natural History museum) from 1922 to 1928, he led an expedition to Madagascar (1926) that resulted in his major ethnographic work, *The Tanala, a Hill Tribe of Madagascar* (1933).

Linton was professor at the University of Wisconsin (1928–37), Columbia (1937–46) and Yale (1946–53). His most important theoretical work, *The Study of Man* (1936), was a widely influential synthesis of theories from anthropology, psychology and sociology concerning the nature of human culture. Other major works were *The Cultural Background of Personality* (1945); and *The Tree of Culture* (1955), the fruition of his stimulating lectures on world ethnology at Yale university. His professional honours included the presidency of the American Anthropological association (1946), membership in the National Academy of Sciences, Viking fund medal (1952) and the Huxley memorial medal of the Royal Anthropological institute (1954). He died on Dec. 24, 1953, in New Haven, Conn. (D. B. ST.)

LINTON, WILLIAM JAMES (1812–1898), English wood engraver, author and active Chartist, was born in London on Dec. 7, 1812. He was apprenticed to the engraver, G. W. Bonner, and from an early age contributed engravings to the Royal Academy summer exhibitions and to books and periodicals, working both from his own designs and from those of other artists. He was noted for his skilful exploitation of the "white line." An ardent republican, Linton was politically active in the 1840s and early 1850s, founding a political party and editing a number of radical papers. His second wife, whom he married in 1858, was Eliza Lynn, the novelist, but the marriage was not a success. In 1866 Linton emigrated with his family to the United States. He set up a printing press at New Haven, Conn., where he died on Jan. 1, 1898. Linton wrote poetry, an autobiography (*Memories,* 1895) and books on his craft, among them *The Masters of Wood-Engraving* (1890). (A. Bs.)

LINUM, a genus of plants of the flax family (Linaceae). Of the approximately 200 species of *Linum* found in temperate and subtropical regions, especially the Mediterranean, about 35 are native to North America. Among these are *Linum virginianum* (slender yellow flax), of the eastern states; *L. floridanum* (Florida yellow flax), of the southeastern states; *L. rigidum* (large-flowered yellow flax), of the interior prairie region; *L. lewisii* (wild blue flax), widely distributed from Ontario to Alaska and southward to California and northern Mexico; and *L. californicum* (white-flowered flax), of the coast ranges.

L. grandiflorum (flowering flax), a native of north Africa, with large red flowers, and *L. flavum,* with golden-yellow flowers, native to Europe, are grown as ornamental plants.

There are four species common in the British Isles and western Europe: *L. catharticum* (purging flax), with white flowers; *L. anglicum* (perennial flax); *L. bienne* (narrow-leaved flax); and *L. usitatissimum* (cultivated flax). Flax, the fibre from the stems of the last-named species, is used to produce linen yarn and fabric; the shorter fibres form tow. The seeds yield linseed oil and a meal used as cattle food. *See* FLAX; LINEN MANUFACTURE; LINSEED AND LINSEED OIL.

LINUS, SAINT was, according to Irenaeus, the immediate successor of St. Peter as bishop of Rome. Irenaeus says (in *Against Heresies*) "the blessed Apostles passed on the sacred ministry of the episcopacy to Linus." Linus was in all probability also attested by Hegesippus' list and is mentioned by Eusebius of Caesarea (*Church History*). In the *Book of Popes* (*Liber Pontificalis,* Duchesne edition) Linus comes immediately after St. Peter. This list dates back to primitive Christianity. His feast day is Sept. 23.

See L. R. Loomis and J. T. Shotwell, *Book of the Popes,* Eng. trans. based on Duchesne's work, in "Record of Civilization Series" (1916). (J. M. F. M.)

LINUS (Gr. LINOS), a name abstracted from the ancient ritual cry *ailinos,* the refrain of a dirge. It is at least as old as Homer (*Iliad,* xviii, 570). To account for this lament for Linus, as it was supposed to be, two principal stories were told:

1. According to the Argive story, Linus, child of Apollo and Psamathe, was exposed at birth and was torn in pieces by dogs. In revenge, Apollo sent a *Poine* or avenging spirit, which destroyed the Argive children. The hero Coroebus killed her, and a festival, Arnis, otherwise called Dog-killing day (*kunophontis*), was instituted, in which stray dogs were killed, sacrifice made, and Linus and Psamathe mourned for.

2. In the Theban version, Linus was the son of Urania and Amphimarus, and was a great musician. He invented the Linus song, but was put to death by Apollo for setting up as his rival. A later, half-burlesque story says that he was Hercules' music master, and was killed by his pupil, whom he tried to correct. He

had a cult on Mt. Helicon. Later tradition rationalized him into an ancient poet, prophet or the like.

This and similar figures (Adonis, Maneros, Narcissus) are plausibly explained as originating ultimately in the ceremonial lament for the dead corn spirit.

See Greve in Roscher's *Lexikon* (bibl.); J. G. Frazer, *Golden Bough*, vii, 257.

LINZ, the provincial capital of Oberösterreich (Upper Austria), lies on the Danube 100 mi. W. of Vienna. Pop. (1961) 195,978. The see of a bishop since 1785, it is a cultural centre with schools of art and music, a technical college, a religious seminary, scientific institutes, museums and art galleries, libraries, archives, an opera and theatres. Historic buildings include the castle; the Romanesque church of St. Martin (first mentioned 799); the early baroque town hall; the rectangular architecturally homogeneous main square (13th century) with a monument to the Holy Trinity; the City Parish church (built in the 13th century, remodeled baroque in the 17th century); the old cathedral (late 17th century); and the church of the Minorites (Franciscans) (13th century, remodeled 18th century). Other notable buildings are the 16th-century Landhaus (building of the provincial diet) and monastic churches (Capuchin, Ursuline, Carmelite). In the 19th century Archduke Maximilian d'Este fortified the town with a belt of towers, and the main fort on the Pöstlingberg (1,765 ft.) can be reached by mountain railway (one of the steepest without rack and pinion in Europe).

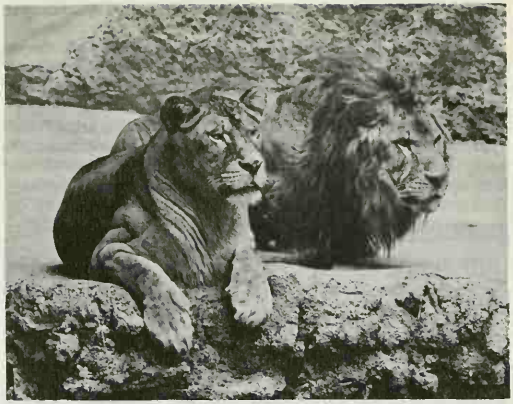
The most direct rail route between the Baltic sea and the Adriatic runs through Linz, and the town's position on the Danube makes possible a flourishing river transit trade. Urfahr, a large suburb on the left bank, is connected with the city by two bridges. After 1938 Linz developed into an important industrial centre with blast furnaces, smelting works, steel factories and a nitrogen fixation plant. War damage necessitated their reconstruction after 1945. The Linz-Donawitz (LD) oxygen-injection steel process is well known. The manufacture of machinery, electrical equipment, textiles and tobacco is also considerable.

Linz grew out of the Roman castle of Lentia (1st century A.D.) and it became an important medieval trading centre. By the 13th century it had all the outward characteristics of a regular city, but no civic rights. It achieved the status of provincial capital during the residence of the emperor Frederick III and was noted for its fairs. By the 18th century it was a city of the nobility, but it temporarily declined in the 19th century. The astronomer Johannes Kepler, the poet Adalbert Stifter and the composer Anton Bruckner all spent part of their working lives in Linz.

(W. F. Ra.)

LION, since the earliest times one of the best-known wild animals, the proverbial "king of beasts." During the Pleistocene period the lion (*Panthera leo*) was distributed over the greater part of Europe, and within the historical period it inhabited north Africa, western Asia and probably Greece. It is now found in most parts of Africa south of the Sahara desert and in Kathiawar in Gujarat state, northwestern India, but is extinct in Iran and Iraq. The lion, tiger, leopard, jaguar, and snow and clouded leopards, generally known as the big cats, make up the genus *Panthera* of the family Felidae, order Carnivora (*see* Carnivore).

The lion is a powerfully built beast of prey with long body, short legs and large, well-developed muscles. It varies considerably in size but averages about 9 ft. 6 in. (including the tail), stands about 3 ft. at the shoulder and weighs 400 to 500 lb. The hair is short and varies greatly in colour from pale sandy to dark tawny; the tuft at the end of the tail is usually darker. The outstanding characteristic of the male, the mane, varies greatly in its development from the entirely maneless condition through a mere fringe of longer hair around the face to the splendid full mane. At its most luxuriant it covers the back of the head, neck and shoulders and is continued on to the throat and chest, where it joins a fringe along the underside of the belly. In some lions the whole of the mane and fringe are very dark, almost black, so that the animal has a majestic and impressive appearance; in others it is lighter, often no darker than the rest of the coat. The reasons for the variation in mane development are unknown; they may be heritable, like the differences in hairiness among human beings. But it has also been suggested that lions living in dense bush country have their manes so thoroughly combed while penetrating among thick thorn scrub that most of the long hair is pulled out. The fact that lions in captivity generally grow much longer and fuller manes than wild lions is quoted in support of this supposition. A newborn lion cub is covered with dark spots on a pale ground colour, but these markings are generally lost with approaching maturity; in some lions, however, the spots are retained on the limbs, under parts and flanks throughout life.



H. ARMSTRONG ROBERTS

FEMALE AND MALE LIONS (PANTHERA LEO)

The lion has no definite breeding season, and cubs may be born at any time of the year; the litter varies from two to four, rarely six (in captivity). In captivity lions often breed every year, but in the wild it is probable that they do not breed more frequently than once in two years. In confinement lions and tigers occasionally interbreed (*see* Tiger). The young are born blind, the eyes opening at the age of about a week; they do not become adult until the permanent canines replace the milk teeth, at the age of about one year. In the wild the lion reaches its prime at about five or six years of age. The life span is not known for lions in the wild, but in captivity they may live 25 years or more.

The well-known roar of the lion is generally given forth when the animals arouse themselves in the evening before a night's hunting and again before lying up at dawn. The old story that the lion lashes himself into fury with the "claw" on his tail before making an attack is only a legend; the claw is usually no more than a small horny scale or spur attached to the skin at the tip of the last vertebra. In addition to the roar, the lion utters many other sounds: coughs, grunts, growls and deep purring noises.

Lions tend to be sociable animals and often live together in parties of a dozen or more, generally comprising several lionesses with their partly grown cubs. A lioness with cubs is often accompanied by a cubless lioness. The lion hunts by night and spends the day lying up in cover or under the shade of trees or rocks. After patiently stalking its prey, the lion makes a lightning-fast charge for the kill. Lions have frequently been seen hunting in company, and it is stated that some will lie in ambush while others of the party drive prey toward them. In Africa lions feed on any animals they can pull down, from the smaller antelopes to the giraffe, although it takes several working together to overcome the larger animals. In the neighbourhood of human settlements lions are sometimes very destructive to stock, showing great cunning in breaking into enclosures and enormous strength in jumping over thick fences with their prey in their jaws.

Lions, like most other potentially dangerous animals, generally avoid man, but they sometimes take to man-eating and may kill large numbers of natives if they are not promptly sought out and killed before man-eating becomes a habit. When brought to bay a lion will often charge his attacker, rushing upon him with great

speed. The lion can inhabit open country with only sparse cover.

See also references under "Lion" in the Index.

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(L. H. M.)

LION FISH (TURKEY FISH), a tropical marine fish (*Pterois volitans*), somewhat poisonous, of very striking appearance: its very high dorsal and large pectoral fins are more or less divided into long, wide-spreading strands that stand out from the body. In each strand is a spine and an associated venom gland. Its body,

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LION FISH (PTEROIS VOLITANS)

up to one foot long, and its fins are patterned with light and dark stripes.

Like the rest of the scorpion fish or rockfish family (Scorpaenidae), the lion fish is sluggish, spending most of its time on the bottom. It is found in the Indian ocean and in the Pacific from the East Indies eastward to Polynesia. Contact with the spines results in a painful wound in man; however, the toxin is not so virulent as that of the related stonefish or poison fish. *See* also SCORPION FISH; FISH.

(J. T. N.; X.)

LIONNE, HUGUES DE (1611–1671), French diplomat and statesman responsible for foreign policy in the first decade of Louis XIV's personal rule, was born at Grenoble in Dauphiné on Oct. 11, 1611. The nephew of Abel Servien, who was employed on diplomatic business by the cardinal de Richelieu until 1636, Lionne early became acquainted with foreign affairs and attracted the notice of Jules Mazarin during a period in Rome from 1636 to 1641. Mazarin intended in 1641 to take him as his secretary to the projected peace congress at Münster, but eventually Lionne was sent instead on a mission to Rome and to Parma. Recalled to Paris when Mazarin became chief minister (1643), Lionne was one of the "underministers" left with the royal government during Mazarin's temporary exile in 1651 (*see* FRONDE). Subsequently he took part in negotiating the League of the Rhine to counteract the Habsburg power in Germany (1658) and the Franco-Spanish peace of the Pyrenees (1659). Louis XIV took him into the upper council as a minister of state in 1661 and caused him to buy the office of secretary of state for foreign affairs in 1663.

A zealous worker with an excellent knowledge of Europe, Lionne has been accused of encouraging the young king's taste for an active foreign policy. He followed the traditional line of antagonism to Spain, together with that of seeking allies in Italy, Switzerland, Savoy and Germany. He tried to strengthen the League of the Rhine by bringing Brandenburg into it (1665) and made a treaty with Trier, Cologne and Mainz (1667) before the War of Devolution. After the peace of Aix-la-Chapelle (1668), the isolation of the Dutch, whom Louis intended to attack next, was prepared by the treaty of Dover with England and by negotiations to ensure the neutrality of Austria and to detach Sweden from the alliance of 1668 with England and Holland. Lionne, however, died in Paris on Sept. 1, 1671, before the conclusion of treaties with Austria and Sweden enabled Louis XIV to begin war in 1672 (*see* DUTCH WARS). Pauline Payen (1630–1704), whom Lionne had married in 1645, became notorious for her amours.

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LIONS, GULF OF (GOLFE DU LION), lies off the Mediterranean coast of France extending from Cap Cerbère to Cap Croisette, south of Marseilles. The sea bed is a gently sloping shelf extending to the 650-ft. line; along its margins are submarine canyons which include the Vallée de Montpellier and Vallée de Nîmes. The mean sea-water temperature varies from 13° C. (55° F.) in winter to 22° C. (71° F.) in summer; salinity averages 37.7 parts per 1,000. The coast bordering the gulf is low lying and fringed by a number of *étangs* (lagoons). In the east the delta of the Rhône river projects southward into the gulf and discoloured water issuing from it can be seen several miles out to sea.

(A. H. W. R.)

LIOTARD, JEAN ÉTIENNE (1702–1789), Swiss painter noted for his pastel portraits, was born at Geneva. He began his studies under Gardelle and Petitot. He went to Paris about 1723, studying under J. B. Massé and F. le Moyne, on whose recommendation he was taken to Naples by the marquis Puysieux. In 1735 he was in Rome, painting the portraits of Pope Clement XII and several cardinals. Three years later he accompanied Lord Duncannon to Constantinople; from there he went to Vienna in 1743 to paint the portraits of Empress Maria Theresa and her family. His eccentric adoption of oriental costume secured him the nickname of "the Turkish painter." He visited England, where he painted the princess of Wales in 1753, and went to Holland in 1756, where, in the following year, he married Marie Fargues. Another visit to England followed in 1772, and in the next two years his name figures among the Royal Academy exhibitors. He returned to his native town in 1776 and died there in 1789.

Liotard was an artist of great versatility, and though his fame depends largely on his graceful and delicate pastel drawings, of which "La Liseuse," the "Chocolate Girl" and "La Belle Lyonnaise" at the Dresden gallery are delightful examples, he achieved distinction by his enamels, copperplate engravings and glass painting. He wrote *Treatise on the Art of Painting*, and was an expert collector of paintings by the old masters. A portrait of the artist is in the Uffizi gallery, Florence, Italy.

LIOUVILLE, JOSEPH (1809–1882), French mathematician known for his work in analysis, the theory of numbers and differential geometry, was born at St. Omer on March 24, 1809. He graduated in 1827 from the École Polytechnique where, in 1833, he became professor. At the early age of 30 he was elected to the Académie des Sciences (Paris), and presently was appointed professor at the Sorbonne and the Collège de France. He founded (1836) and edited the *Journal des Mathématiques Pures et Appliquées*, which did much to raise and maintain the standard of French mathematics throughout the 19th century.

Liouville was a boldly original mathematician. His works, never collected, comprise about 400 memoirs and notes, more than 200 on the theory of numbers alone. In 1832–33, he investigated criteria for the analytic character of integrals of algebraic functions. Liouville was the first, in 1844, to prove the existence of transcendental numbers, and he constructed an infinite class of such numbers. He worked also in differential equations and boundary-value problems. His methods in this department became of capital importance in 20th-century mathematical physics, as well as in the theory of integral equations. In differential geometry, he contributed notably to the theories of applicability of surfaces and conformal transformations. The concept of geodesic curvature was introduced by Liouville. Nearly all of his work on the theory of numbers (1857–82) was published without indication of the means by which he had obtained his striking re-

sults, relating mostly to numerical functions, representation in quadratic forms and general formulas in parity functions. All have since been proved. In analysis, Liouville was the first to deduce the theory of doubly periodic functions from general theorems, including his own, in the theory of analytic functions of a complex variable. He died at Paris on Sept. 8, 1882.
(E. T. B.; O. Oe.)

LIPARI ISLANDS (Isole Eolie; Aeolian Islands), a group of volcanic islands located off the north shore of Sicily, in Messina province. They have a general "Y" shape, the base of the "Y" being the westernmost island, Alicudi, the northern tip being Stromboli and the southern tip being Vulcano. The other major islands are Lipari, Salina, Filicudi and Panarea. Their total land area is 44 sq.mi. and the population (1951) was 14,782. Seismic and volcanic activity has been known since ancient times, and the Greeks believed the islands to be the home of Aeolus, king of the winds, hence the alternate name of the group. There are fumaroles on Lipari and Panarea; Vulcano and Stromboli are active. Pumice is exported from the islands, and the principal agricultural product is heavy malmsey-type wine from Lipari. There is regular steamer service to Milazzo, Messina and Naples.

Excavations in the 20th century have established an uninterrupted archaeological record from the Neolithic period. Ceramics and artifacts have been found, while the volcanic obsidian of the islands has been detected as far as Crete. A feature of archaeological research was substantiation of the legend that Aeolus came from Magna Graecia along the coast of south Italy rather than Sicily. Lipari (pop. [1961] 10,858 [commune]) is the chief town, with the important Aeolian archaeological museum. Panarea has a Bronze Age village; Stromboli's spectacular volcano is a noted tourist attraction.

The Greeks established themselves in the islands in the 6th century B.C. Later there was a Carthaginian naval station, until the Romans took over in 252 B.C. In Roman days, as in the Fascist era, the islands served as a place of banishment for political prisoners. In medieval times they were conquered by the Saracens, who were expelled by the Normans in the 11th century. The islands frequently changed hands during the wars between the Angevins of Naples and the Sicilian kings in the 14th century. Alfonso V of Aragon annexed them to Naples, but Ferdinand II of Aragon finally united them to Sicily in the late 15th century.
(G. Kh.)

LIPCHITZ, JACQUES (1891–), one of the early revolutionaries of modern sculpture because of his participation in Cubism (*q.v.*) and his development of a new language for sculpture that was not based upon anatomy or the outward form of the human body. Born in Druskieniki, Latvia, Aug. 22, 1891, Lipchitz studied and worked in Paris after 1909; by 1941, when he moved to New York, his international reputation was established. His new means of interpreting the human body esthetically and psychologically can be seen in "Man With a Guitar" (1915) and "Prodigal Son" (1931). In his "transparencies" of the 1920s Lipchitz was one of the first sculptors to introduce voids within his sculptured figures. His strongest art deals with tension, as in "Figure" (1926–30), and man's spiritual history, as in "The Virgin of Assy" (1948–54). Lipchitz always stressed the sculptor's transforming manipulation and shaping power.

There is a well-known portrait of Lipchitz and his wife by Amedeo Modigliani (*see* Portrait Painting: *The 20th Century*).

See Henry R. Hope, *The Sculpture of Jacques Lipchitz* (1958); Robert Goldwater, *Lipchitz* (1959). (A. E. El.)

LIPETSK, a town and *oblast* centre of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on either bank of the Voronezh river, a tributary of the Don, where it is crossed by the railway from Orel to Borisoglebsk, 65 mi. N.N.E. of Voronezh city. Pop. (1959) 156,515. The town was founded in 1707 as an iron-working centre by Peter the Great to supply his Don fleet and armies in his Azov campaigns. By the end of the 18th century iron working had ceased, but it was begun again in 1877. There are two metallurgical plants where iron castings and drainage and water pipes are made, and a large tractor factory; radiators, chemicals, foodstuffs and cement are also produced.

Lipetsk *oblast*, formed in 1954 out of parts of Voronezh, Orel, Ryazan and Kursk *oblasts*, covers 9,305 sq.mi. The western part consists of the rolling hills of the Central Russian upland (Srednе-Russkaya Vozvyshennost), while the eastern part lies on the low Oka-Don plain. The Don and Voronezh cross the centre of the *oblast* from north to south. The *oblast* lies in the zone of forest-steppe. Soils are rich chernozems, so that much of the oak forest cover and almost all the grass steppe has been cleared and plowed up until 74% of the surface is now arable. This has resulted in severe gully erosion of the soil and loess subsoil, especially on the Central Russian upland. The climate is modified continental, with January average temperature about −10° C. (14° F.) and July averages about 20° C. (68° F.). Precipitation is about 18 in. a year, but tends to be variable.

The population of the *oblast* in the 1959 census numbered 1,141,567. Only 30% (344,680) were urban dwellers (*cf.* the national figure of 48%); nearly half lived in Lipetsk and a further 77,900 in Yelets. In all there are 8 towns and 3 urban districts. The large rural population reflects the dominance of agriculture. The leading crops are winter rye (a quarter of the arable), spring and winter wheat, maize (corn), oats, sugar beet and potatoes. Sunflowers and hemp are also important. Livestock numbers are low, although pig keeping is significant. There are extensive iron ore deposits in the *oblast*, part of the Kursk Magnetic Anomaly, and during the 1950s these began to be exploited. Apart from Lipetsk there are several small iron-founding centres, but industry in general is concerned with processing agricultural products. (R. A. F.)

LIPIDS: *see* Oils, Fats and Waxes.

LIPMANN, FRITZ ALBERT (1899–), U.S. biochemist, received (with H. A. Krebs) the 1953 Nobel prize for medicine and physiology for his discovery of coenzyme A, a vital catalyst in cellular metabolism. Born in Königsberg, Ger., on June 12, 1899, he studied medicine at the universities of Königsberg, Munich and Berlin (M.D., 1922) and later chemistry (Ph.D., Berlin, 1927). He did early research in cellular metabolism in the laboratory of Otto Meyerhof at Heidelberg (1927–30), and in 1931–32 he worked as a Rockefeller foundation fellow at the Rockefeller institute in New York city. After a short period with Albert Fischer at the Kaiser Wilhelm institute, Berlin, he followed him to Copenhagen, Den., to work on tissue cultures at the newly established Biological Institute of the Carlsberg foundation (1932–39). He joined the faculty of Cornell Medical school (New York city) in 1939 and became a U.S. citizen in 1944. He was head of the biochemical research department, Massachusetts General hospital, Boston (1941–57), and was professor of biological chemistry at Harvard Medical school from 1949 until 1957, when he returned to the Rockefeller institute. He reported the isolation of coenzyme A in 1947 and again in 1950, and announced (with co-operating workers) its structure in 1953. (G. E. Pn.)

LI PO (Li T'ai-po) (701–762), regarded as China's greatest poet, was born in 701 in Szechwan, in the southwest of the empire. He liked to regard himself as belonging to the imperial family, but he in fact belonged to a less exalted though quite distinguished family of the same surname. At the age of 19 he left his home and lived with a Taoist recluse.

A period of wandering followed, after which he married and lived with his wife's family, north of Hankow. He had already begun to write poetry and showed some of it to various officials, in the hope of getting employed as a secretary, but had no success. In 734 he visited a friend at T'ai-yüan in northeast China. Another period of wandering followed, and in 742 he arrived at Ch'ang-an, the capital, no doubt hoping to be given a post at court. He did not, however, receive any official post but was merely accepted into a pool of distinguished poets, who were kept ready at any moment to celebrate the doings of the court in verse. But he disliked the atmosphere of intrigue by which he found himself surrounded, and in the autumn of 744 his wanderings recommenced. It was now that he met the other great poet of the period, Tu Fu (712–770), who was then hardly known, whereas

Li Po's fame was already immense. Tu Fu, it is clear, was completely carried away by the dash and verve of the older poet. Li Po was becoming increasingly wrapped up in Taoism and alchemy, and at about this time was definitely accepted as a Taoist initiate, receiving at the hands of a high Taoist dignitary a diploma of spiritual progress.

In the autumn of 756 Prince Lin, the emperor's 16th son, was given a big command in south China to fight against a rebellion. He was bringing troops down the Yangtze river in transports early in 757 and was halting at Chiu-chiang when he heard that the famous poet Li Po was living in the town. He asked him to come on board, and Li Po became a sort of unofficial poet laureate to the expedition. But shortly afterward the prince was accused of intending to set up an independent kingdom. He was captured by government troops and executed. Li Po was arrested and thrown into prison at Chiu-chiang. In the autumn a high official, ordered to review the sentences passed in connection with the recent troubles, looked into Li Po's case, released him and took him on to his staff as a secretary. However, in the summer of 758 the charge against him was revived, and he was banished to Yeh-lang, on the southwestern fringe of the empire. But before he got there, he benefited by a general amnesty (May 759). He came back to eastern China and died in the house of a relative, at Tang-t'u (about 60 mi. south of Nanking), in 762.

See Shigeyoshi Obata, *The Works of Li Po* (1923); A. Waley, *The Poetry and Career of Li Po, 701–762 A.D.* (1951). (A. D. WA.)

LIPPE, one of the smallest of the former member-states of the German *Reich,* with a territory of 469 sq.mi., and a population of 187,220 in 1939. It extended from the mountains overlooking the east-west bend of the middle Weser river southwestward across the Detmold hills to the Werre basin and then across the high ridge of the Teutoburg forest to the Senne moorland.

The noble lords of Lippe had their original possessions around Lippstadt (on the Lippe river west of Paderborn). From 1190, however, they began to build up a distinct territory to the north and northeast. The towns of Lemgo, Horn, Blomberg and Detmold, founded between 1200 and 1260, became the core of this territory, which until the beginning of the 15th century had expanded southeast over the countship of Schwalenberg and northward over that of Sternberg. Simon V of Lippe (d. 1536) assumed the title of count in 1528. Lutheranism was established in 1538, Calvinism in 1605. The sons of Simon VI (d. 1613) partitioned their inheritance, but from 1709 the senior line of the dynasty, Lippe-Detmold, began to reunite the hereditary possessions—though the line of Alverdissen, which in the 1640s had founded the separate house of Schaumburg-Lippe (*q.v.*), did not lose its last enclave within the Detmold zone until the end of 1838. The heads of Lippe-Detmold were princes from 1720.

Lippe obtained recognition as a sovereign state on entering the Confederation of the Rhine in 1807. A member of the German confederation from 1815, it took Prussia's side in the Seven Weeks' War (1866) and became a member of the North German confederation in 1867 and a federal state of the German empire in 1871. From 1866 it was completely surrounded by Prussian territory. When the senior branch of Lippe-Detmold died out in 1905, the head of the Lippe-Biesterfeld branch succeeded to the principality as Leopold IV. After Leopold's abdication (1918), the state had a democratic constitution under the republican regime until 1933. Under British military government from 1945, Lippe was merged on Jan. 21, 1947, with the *Land* (state) of North Rhine-Westphalia, from 1949 part of the Federal Republic of Germany.

See E. Kittel, *Geschichte des Landes Lippe* (1957). (FH. H.)

LIPPE RIVER, a right-bank tributary of the Rhine in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany, rises near Bad Lippspringe under the western slope of the Teutoburger Wald and, after a course of 147 mi., flows into the Rhine near Wesel. It is navigable, by the aid of 12 locks, downstream from Lippstadt, for boats and barges drawing less than four feet. The Lippe was once used for the transport of coal, timber and agricultural produce to and from Westphalia, but in 1930 it was replaced by a canal that follows its course from the Dortmund-Ems canal to the Rhine. The Lippe supplies water to the canal system of the Ruhr. The canal, which carries 6,000,000 tons of cargo annually, takes the largest barges that use the Dortmund-Ems canal. During the 1960s it was extended beyond the Dortmund-Ems canal toward Hamm. (R. E. DI.)

LIPPI, FILIPPINO (FILIPPO) (*c.* 1457–1504), Italian painter, son of Fra Filippo Lippi (*q.v.*) and the nun Lucrezia Buti, was a follower of his father and of Botticelli. He was born at Prato, probably in 1457. After Fra Filippo Lippi's death, Filippino entered the workshop of Botticelli. By 1473 he had finished his apprenticeship. The style of Filippino's earliest works stems from that of Botticelli; they include Madonnas at Budapest, Berlin and in the National gallery, London, where there is also an "Adoration of the Magi." Filippino's use of line throughout these panels is less sensitive and subtle than Botticelli's. In a group of paintings executed about 1480–85 he develops a harder and more individual style. The most notable of these are altarpieces in S. Michele at Lucca and the Museo di Capodimonte in Naples, and a panel of the "Journey of Tobias" in the Pinacoteca Sabauda, Turin. Despite the lack of dated or documented works, it is clear that by this time Filippino enjoyed a considerable reputation, since he is known to have been employed, along with Botticelli, Perugino and Ghirlandajo, on the frescoed decoration of Lorenzo de' Medici's villa at Spedaletto near Volterra, and at the end of 1482 was commissioned to complete work left unfinished by Perugino in the Palazzo della Signoria in Florence. No trace of either work survives. Soon after (probably 1483–84) he was entrusted with the completion of the frescoes in the Brancacci chapel in the Carmine, which had been left unfinished on Masaccio's death in 1428.

His most popular picture, the beautiful altarpiece of the "Virgin Appearing to St. Bernard" (Badia, Florence), has been variously assigned to the years 1480 and 1486. In April 1487 Filippino Lippi signed a contract for the frescoed decoration of the chapel of Filippo Strozzi in Sta. Maria Novella, Florence. Work on this was delayed by a second commission for a fresco cycle, this time in Rome, where, on the recommendation of Lorenzo de' Medici, Filippino was invited to decorate the Caraffa chapel in Sta. Maria sopra Minerva. Nothing in Filippino's earlier works prepares for the vein of inspiration which he struck in the Caraffa chapel, where the roof is filled with four figures of sibyls, the right wall with frescoes of the "Miracle of the Speaking Crucifix" and the "Triumph of St. Thomas," and the altar wall with a fresco of the "Assumption."

On his return from Rome (probably 1491) Filippino Lippi executed a fresco of the "Sacrifice of Laocoon" for the villa of Lorenzo de' Medici at Poggiò a Cajano, in which some of the decorative expedients used in the Caraffa chapel are again employed, and resumed work in the Strozzi chapel (completed 1502), the frescoes of which look forward to the Tuscan Mannerism of the 16th century. Of the large number of panel paintings produced in this, Filippino's final phase, the most remarkable are an "Adoration of the Magi" in the Uffizi (painted for S. Donato a Scopeto in 1496) and an altarpiece of the "Deposition" commissioned for the high altar of SS. Annunziata in Florence and completed after Filippino's death by Perugino (Uffizi, Florence). Filippino died on April 18, 1504.

See A. Scharf, *Filippino Lippi* (1935); K. Neilson, *Filippino Lippi* (1938). (J. W. P.-H.)

LIPPI, FRA FILIPPO (LIPPO) (1406–1469), one of the best-known and most influential Tuscan painters of the 15th century, was born in Florence in 1406. His father, a butcher, died during Lippi's boyhood, and the boy was given over by his mother to the Carmelite friars of Sta. Maria del Carmine in Florence, where on June 18, 1421, he took his first vows. He is mentioned in 1430 as a painter in the community records, where his name appears in Jan. 1432 for the last time. Filippo Lippi was thus trained as a painter under the shadow of Masaccio's and Masolino's frescoes in the Brancacci chapel in the Carmine. These influences are reflected in what is probably his earliest work, a fresco formerly in the cloister (now transferred to canvas) commemorating the reform of the Carmelite order by Pope Eugenius

NATIONAL GALLERY OF ART, WASHINGTON, D.C., SAMUEL H. KRESS COLLECTION

"MADONNA AND CHILD" BY FRA FILIPPO LIPPI. IN THE NATIONAL GALLERY OF ART, WASHINGTON

IV in Feb. 1432. In the massive forms of the figures in this fresco and in its solidly constructed architecture Lippi reveals his study of Masaccio, though a latent decorative tendency (later to dominate his work) is already evident in the delicate palette and light tonality. At this point Lippi appears to have left Florence, and in the summer of 1434 was employed in S. Antonio at Padua.

His first dated work, a "Madonna" from Tarquinia Corneto, now in the Galleria Nazionale in Rome, belongs to the year 1437. Like the Carmine fresco, the "Madonna" of 1437 is a powerful and uncompromising work. Immediately after it, Lippi seems to have executed what is perhaps his finest and most characteristic panel painting, an altarpiece of the Annunciation in S. Lorenzo in Florence. This combines space structure of great sophistication with the simple emotionalism that ensured him lifelong popularity. On March 8, 1437, Lippi received the commission for an altarpiece for the Barbadori chapel in S. Spirito (now in the Louvre, Paris). Between 1441 and 1447 Lippi painted for the high altar of S. Ambrogio the great altarpiece of the "Coronation of the Virgin," now in the Uffizi. This includes on the right a self-portrait of the painter designated by the words, *Is perfecit opus*.

After about 1445 Lippi seems to have fallen under the influence of Fra Angelico, which is manifest in the relatively simple scheme of a second altarpiece of the "Coronation of the Virgin" painted for the convent of Monte Oliveto at Arezzo after 1444 (Vatican gallery), as well as in a masterly *tondo* of the "Adoration of the Magi" now in the National gallery, Washington. A second circular painting of somewhat later date (probably 1452), showing the Virgin and Child with scenes from the life of St. Anne in the background, exists in the Palazzo Pitti, Florence; in this too the problem of the circular field is solved with consummate mastery. Thereafter Lippi began work on his most ambitious project, the frescoed decoration of the choir of the cathedral at Prato illustrating the life of St. Stephen and that of St. John the Baptist. The commission for these important frescoes was first offered to Fra Angelico and subsequently (1452) to Fra Filippo Lippi. Work on them appears to have continued until 1464. The bottom frescoes on each side of the choir are works of great solemnity and power. In 1466 Lippi commenced his last major work, the frescoes in the apse of the cathedral at Spoleto. Owing to the master's ill health these weak works were executed almost exclusively by members of his studio.

While in Prato Fra Filippo Lippi abducted from the convent of Sta. Margherita (of which he was chaplain) a nun, Lucrezia Buti, who became the mother of the painter Filippino Lippi (*q.v.*) and who, according to Vasari, was depicted by Lippi in certain paintings.

Lippi died at Spoleto on Oct. 9, 1469.

See R. Oertel, *Fra Filippo Lippi* (1942). (J. W. P.-H.)

LIPPMANN, GABRIEL (1845–1921), French physicist, invented the photographic reproduction of colour by what is known as the Lippmann interference process, for which he was awarded the 1908 Nobel prize for physics. He was born on Aug. 16, 1845, at Hollerich in Luxembourg of French parents, who soon after his birth settled in Paris. He was educated at the École normale and the universities of Heidelberg and Berlin, becoming a member of the faculty of sciences in Paris in 1878. The whole of his life was devoted to teaching and research. In 1883 he was appointed professor of physics and was subsequently director of the laboratory for physical research at the Sorbonne, and in the same year he was elected a member of the Paris Academy of Sciences. Of an original and independent mind, he made important contributions to many departments of physics, but especially to electricity, thermodynamics, optics and photochemistry. One of his earliest achievements was the construction of a capillary electrometer of extraordinary sensitivity. The principle of the Lippmann colour process was communicated to the Academy of Sciences in 1891, but it was not until 1908 that he was awarded the Nobel prize for physics for this work. He was president of the Academy of Sciences in 1912, and he was a foreign member of the Royal society of London. He died at sea on July 13, 1921, while returning from a visit to Canada. *See* PHOTOGRAPHY: *Colour Photography.* (W. J. Bp.; X.)

LIPPMANN, WALTER (1889–), U.S. newspaper commentator and author of numerous books on public affairs, was born in New York city, Sept. 23, 1889. He graduated from Harvard in 1910. In writing on public events for more than 50 years thereafter, Lippmann made himself the foremost commentator in the United States and won a world-wide reputation. From the publication of his first book, *A Preface to Politics*, in 1913, it was evident that he had a discerning grasp of political trends at home and abroad, with a capacity to see where these trends were leading. After a brief apprenticeship with Lincoln Steffens on *Everybody's Magazine* and a briefer excursion into practical politics with the Socialist mayor of Schenectady, N.Y., he became one of the founders and associate editor of the *New Republic*. He was one of the brilliant young men who exerted a great influence on Woodrow Wilson, both through the pages of that liberal weekly and in direct consultation with the president. It was at Wilson's request that after wartime service with the U.S. military intelligence Lippmann served as an aide to Col. Edward M. House in Paris and contributed substantially to Wilson's fourteen points and to the concept of the League of Nations. Deeply disillusioned with the outcome of the Versailles conference, Lippmann returned to the U.S. and became editor of the *New York World*. When the *World* was sold, he began to write for the *New York Herald Tribune* an independent commentary that was syndicated to a large number of newspapers at home and abroad. He was twice honoured with the Pulitzer prize, in 1958 and 1962, for his newspaper articles. Among more than a score of published books, his most influential

works have been *Public Opinion* (1927), *A Preface to Morals* (1929) and *The Good Society* (1937). *Essays in the Public Philosophy* (1955) was criticized in some quarters because of its espousal of the concept of natural law as paramount. After 1938 Lippmann lived in Washington, D.C., with his wife, the former Helen Byrne Armstrong. In writing his commentary he traveled widely in the United States and in Europe, Asia and Latin America.

See M. W. Childs and J. B. Reston (eds.), *Walter Lippmann and His Times* (1959); Clinton L. Rossiter and J. Lare, *The Essential Lippmann: a Political Philosophy for Liberal Democracy* (1963).
(M. W. Ch.)

LIPPS, THEODOR (1851–1914), German psychologist and philosopher, was born July 28, 1851, at Wallhalben, and was professor successively at Bonn, Breslau (now Wroclaw) and Munich. His fundamental principles assumed a dependence of consciousness upon the interaction between older experiences retained in a subconscious state and the entering sensations (apperception). Mind, he said, is the sum of these older experiences organized in a unity. The organization controls the course of perceiving, of recall and thinking and of action. Pleasure is harmonious interaction of the old upon the new; displeasure results from conflict of the different elements.

The best-known phase of his theory is his doctrine of *Einfühlung*, defined as projecting one's self into what is seen. One appreciates another's reaction by feeling one's self into the other. In his two-volume *Ästhetik* (1903–06) Lipps makes all artistic appreciation depend upon a similar self-projection into the object. Part of feeling is dependent upon definite induced bodily responses like imitation. A form is beautiful that is obviously adequate to a situation. A lithe but not emaciated human figure is beautiful. A column that is too slight apparently to support a weight put upon it arouses sympathy; it makes the observer strain unduly and so is unpleasant. In an experimental study of optical illusions (*Raumästhetik*, 1897) Lipps suggests that a vertical line is apparently longer than a horizontal one because it induces the observer to stretch up and the movement is assigned to the line. His publications include, in addition to those mentioned, *Grundtatsachen des Seelenlebens* (1883), *Die ethischen Grundfragen, zehn Vorträge*, 2nd ed. (1905), and *Leitfaden der Psychologie*, 3rd ed. (1926). Lipps died at Munich on Oct. 17, 1914. (W. B. Py.)

LIPPSTADT, a town of Germany, which after partition of the nation following World War II was located in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. It is situated on the Lippe, 32 km. (20 mi.) W. of Paderborn by road. Pop. (1961) 37,502. Lying on the slopes of the Teutoburger Wald, Lippstadt is a picturesque town with 12th- and 13th-century churches. The Hotel Köppelmann has a fine rococo hall. There are many fine old half-timbered houses. The moated castles of Overhagen, Eringerfeld, Heringhausen and Körtlinghausen are nearby. Lippstadt is a junction on the railway from the Ruhr to Paderborn and Hanover. The town was founded in 1168 by the lords of Lippe and joined the Hanseatic league in the 13th century. The rights over one-half of the town passed to the counts of the Mark, which in 1614 was incorporated with Brandenburg; in 1850 the prince of Lippe-Detmold sold his share to Prussia.

LIP-READING: *see* Sign Language.

LIPSIUS, JUSTUS (Joest Lips) (1547–1606), Belgian humanist, classical scholar and moral and political theorist, was born at Overijse near Brussels on Oct. 18, 1547. Brought up as a Roman Catholic, he attended the Jesuit college at Cologne and the University of Louvain. Like many savants of his period he lived much abroad. Unsettled political conditions made him leave Belgium in 1571, and about a year later, when he was appointed to the chair of history and philosophy at Jena, he furnished some proof of Protestant convictions. This made him suspect when he returned to his country. He decided to withdraw again and in 1578 accepted the chair of history and law at the new university of Leiden. In 1591, however, he was reconciled to the Catholic Church. He was appointed professor of history and Latin at Louvain (1592). At Leiden he was soon succeeded by J. J. Scaliger (*q.v.*), whose Calvinistic allegiance remained unchanged. Thus Lipsius' Louvain and Scaliger's Leiden became, for a time, rival centres of humane learning. Lipsius died at Louvain on March 23/24, 1606.

Lipsius' first scholarly publication, the *Variae lectiones* of 1569, was in the traditional field of textual criticism. He quickly established himself as the leading editor of Latin prose texts, and his editions of *Tacitus* (first in 1574) and of *Seneca* (1605) were long renowned as models of their kind and are still worthy of attention. Many of his emendations survive in modern editions. Lipsius, too, was a leader in the anti-Ciceronian, stylistic movements of his time. His Latin writing, terse and epigrammatic, owes a large debt to Tacitus. Force of personality and style also distinguish his vast correspondence conducted in the Latin language.

Moreover Lipsius was noted for his antiquarian and historical studies and still more for his essays in moral and political theory. His introduction to Stoic thought of 1604 (for which again Seneca provided the foundation) remained the most intelligent and complete assessment of that philosophy for more than two centuries although it was chiefly Roman, not Greek, Stoicism that inspired it. For him the ancient philosophers and historians were, however, no mere subjects for research: they were guides to practical morality. He considered himself a Stoic, and his interest in Seneca lies at the root of his tract *De constantia* (1584). Similarly, his interest in Tacitus inspired his political theory, the *Politicorum libri sex* of 1589. But it was a Tacitus seen through the Machiavellian spectacles of the time, and it gave rise to the curious, neo-Tacitean doctrine of politics—a characteristic feature of the following 17th century.

Bibliography.—For a list of Lipsius' publications *see* F. van der Haeghen, *Bibliographie Lipsienne*, 3 vol. (1886–88); for his textual criticism *see* C. O. Brink in *Journal of Roman Studies*, vol. 41 (1951). *See* also H. F. Bouchery, *Waarom Justus Lipsius gevierd?* (1949); J. L. Saunders, *Justus Lipsius: the Philosophy of Renaissance Stoicism* (1955); G. Toffanin, *Machiavelli e il Tacitismo* (1921); A. Momigliano, "The First Political Commentary on Tacitus," *Journal of Roman Studies*, vol. 37 (1947). (C. O. Br.)

LIPSIUS, RICHARD ADELBERT (1830–1892), German Protestant theologian, was born at Gera on Feb. 14, 1830. He studied at Leipzig and eventually (1871) settled at Jena as professor of systematic theology. He helped found the Evangelical Protestant Missionary union and the Evangelical alliance and from 1874 took an active part in their management. He died at Jena on Aug. 19, 1892.

Lipsius wrote principally on dogmatics and the history of early Christianity from a liberal standpoint. His chief works are *Philosophie und Religion* (1885) and *Lehrbuch der evangelisch-protestantischen Dogmatik* (1876), in which his systematic doctrines are described. His other works include *Die apokryphen Apostelgeschichten und Apostellegenden*, four volumes (1883–90), dealing with problems in early Christian apocryphal literature; studies in the early history of the papacy; and commentaries on the Epistles to the Galatians, Romans and Philippians.

See A. Neumann, *Grundlagen und Grundzüge der Weltanschauung von R. A. Lipsius* (1896).

LIPTON, SIR THOMAS JOHNSTONE, 1st Bart. (1850–1931), British merchant and yachtsman, equally well known for his success with tea and for the gallant sportsmanship with which he accepted his failures in international yachting, was born at Glasgow, Scot., on May 10, 1850, of Irish parents, who ran a small grocer's shop. He emigrated to the United States in 1865 and held various jobs for five years before returning to Glasgow.

There he opened a small provision shop, was very successful and established shops throughout the United Kingdom. To supply his retail shops on the most favourable terms, he purchased extensive tea, coffee and cocoa plantations in Ceylon and provided his own packing house for hogs in Chicago. He also acquired fruit farms, jam factories, bakeries and bacon-curing establishments in England. In 1898 his business was organized into Lipton, Ltd. He was knighted in 1898 and created a baronet in 1902, taking as his crest two arms holding sprigs of tea and coffee.

He was a keen yachtsman and as a representative of the Royal

Ulster Yacht club made five unsuccessful attempts between 1899 and 1930 to win the America's cup with yachts called "Shamrock" (*see* YACHTING). Lipton won a reputation for being the "world's best loser," and in 1930 he was presented with a gold cup for sportsmanship by a group of Americans. He died in London on Oct. 2, 1931.

See Alec Waugh, *Lipton Story* (1950). (H. J. SG.)

LIQUEFACTION OF GASES: *see* LOW-TEMPERATURE PHYSICS; REFRIGERATION.

LIQUEURS. A liqueur (from the Latin *liquefacere*, "to make liquid") is a spirit which has been sweetened and flavoured with fruit or herbs. The alcoholic content of a liqueur, which is usually high, as well as the medical herbs which it frequently contains, are both agents which have been recognized as curative and digestive since the middle ages. Liqueurs are also often used as a liquid centre for chocolates.

There are three kinds of liqueur: those with one herb predominating in their flavour; those with only one fruit; and those with a mixture of flavouring agents. Kümmel, made from caraway or cumin seeds, and framboise, made from raspberries, are good examples of the first two types, while Bénédictine is made of about 30 different herbs and other ingredients.

There are two main methods of making liqueurs. The first is by distilling all the ingredients together, the resulting distillate being sweetened and sometimes coloured. The second is to add an infusion of herbs, or fruits, to the base spirit; this is the method generally followed as it preserves the freshness, colour and bouquet of the ingredients. The best liqueurs are usually made upon a Cognac base.

It is easy to confuse liqueurs with spirits or with bitters (*q.v.*). When a liqueur is made upon a brandy or gin base it may be sold as a brandy or a gin, such as cherry brandy or sloe gin—but these are liqueurs, since they are sweetened. An unsweetened spirit cannot be called a liqueur; there is, for instance, a genuine unsweetened Hungarian and Yugoslavian brandy called Slivovitz, distilled from plums. Confusion may be deepened when the same name is used for both liqueurs and brandies; there is a sweet apricot brandy—a liqueur—as well as an unsweetened spirit made from apricots, and also known as apricot brandy. While sloe gin is a liqueur, lemon and orange gin are ordinary dry gins, with fruit added for flavouring. Although combined spirits are sometimes referred to as liqueurs, they should not be unless sweetened. Similarly, "liqueur brandy" is a misnomer; the word liqueur only refers here to its use as a *digestif* or to its specially good quality. Bitters can be used as *digestifs* but they are usually *apéritifs*. They differ from liqueurs in that they are only very slightly sweetened, if at all.

The making of liqueurs was practised from earliest times. The writings attributed to Hippocrates say that the ancients distilled herbs and plants, and because certain herbs were noticed to cure illness or to be effective as tonics, liqueur-making had a close association with early medicine and with medieval astrology. The Saxon word "wort" means a plant used for medicine. Certain plants were believed to keep away evil spirits, sometimes if they were merely pinned to a door. The remedies were certainly effective when they were administered; aniseed, caraway seed and mint, for instance, were long known to help digestion. Nicholas Culpepper, a 17th-century writer on medicine, advises "a water distilled from (angelica) root" for the same purpose; angelica is frequently used in liqueurs, together with many other herbs, such as coriander, fennel, wormwood, gentian, amber, hyssop and thyme.

A particular area of the world will often produce a variety of herb or fruit which is best for liqueur-making, and it is there that the industry will be situated. For example, the small apricot that is found in the Île-de-France is the only one that will make abricotine, and the wild blackthorn of Devon and Cornwall makes the best sloe gin. The fruit must always be picked at its ripest, and even slightly blemished fruit discarded.

See also ALCOHOLIC BEVERAGES, DISTILLED; BÉNÉDICTINE, D.O.M.; CHARTREUSE; CRÈME DE MENTHE; KÜMMEL.

See M. I. Fisher, *Liqueurs* (1952). (C. C. H. F.)

LIQUIDAMBAR, a genus of four species of deciduous trees of the witch hazel family (Hamamelidaceae). *Liquidambar styraciflua* (sweet gum; *q.v.*), is North American, the others are Asiatic: *L. orientalis*, of Asia Minor; *L. formosana*, of southern China, Formosa and Indochina; and *L. edentata*, of southeast China. These species yield useful timber and a resin, storax. The leaves are often almost star-shaped, being palmately cut into three to seven lobes, and the flowers are usually unisexual and without petals. The male flowers, each with numerous stamens, are grouped into clusters that terminate the branches; the female flowers, each consisting of a two-celled ovary with two long styles, are in long-stalked solitary heads. The fruit, which consists of many capsules united, is a spiny ball. Several fossil species of *Liquidambar* are known. (J. W. TT.)

LIQUIDATION, a term often used to denote the discharge of a debt or the ascertainment by agreement or litigation of the amount of a previously unliquidated claim. An important specialized legal meaning is the distribution of the assets of an enterprise among its creditors and proprietors. Solvent corporations or unincorporated associations are sometimes wound up. More often than not the assets are liquidated (turned into money) in preference to attempting distribution of the assets in kind. The liquidation of insolvent concerns may take place in receiverships, under general assignments for the benefit of creditors, in bankruptcy, or in the administration of decedents' estates. *See* BANKRUPTCY; COMPANY: *Company Law;* CORPORATION: *Corporation Law;* DEBTOR AND CREDITOR LAW; RECEIVER. (J. A. MACL.)

LIQUID STATE. The states of aggregation of substances are commonly classified as gas, liquid and solid. Elastic solids resist both tensile and shear deformation with stresses proportional to the strains and are therefore capable of supporting shearing stresses at equilibrium. Gases and liquids resist shear deformation only with a stress proportional to the rate of strain and are therefore incapable of supporting shearing stresses at equilibrium. Thus gases and liquids are distinguished from solids by the property of fluidity; *i.e.*, under the action of external forces they flow and adapt their shapes to those of their containers. The mechanical distinction between fluids and solids is not sharp. Numerous substances can be maintained in a metastable state, the glassy state, with mechanical properties intermediate between those of the elastic solid and the viscous fluid. These noncrystalline solids are often unstable with respect to transformation to crystalline phases, but the rate of transformation may be extraordinarily small.

Macroscopic Properties of Liquids at Equilibrium.—As a rule, substances possess only one liquid modification. Exceptions are found in the case of: (1) helium with isotopic mass 4, which possesses two liquid forms; (2) substances that possess optically and mechanically anisotropic liquid crystalline phases as well as a normal liquid phase (*e.g.*, para-azoxyanisole); and (3) substances that can be isolated in pure quantum states (orthohydrogen and parahydrogen).

In general, substances possess one or more crystalline solid phases, some or all of which may be capable of coexistence with the liquid phase. For a one-component system, the conditions under which phases can coexist in contact under conditions of equilibrium are described by a relation between the number of degrees of freedom, f, and the number of phases, ν. Provided (1) that the only external force is a uniform normal pressure, (2) that interphase boundaries are deformable, permeable to all components and heat conducting, and (3) that surface effects are negligible, then $f = 3 - \nu$. The liquid and solid phases can coexist along a continuous locus of temperature and pressure ($\nu = 2$, $f = 1$) but the liquid, solid and gaseous phases can coexist at only one temperature and pressure ($\nu = 3$, $f = 0$). There is experimental evidence that equilibrium between solid and liquid is possible at all temperatures so long as decomposition or ionization does not occur. In contrast, the equilibrium locus between the liquid and gaseous states ($\nu = 2$, $f = 1$) terminates at a critical point. At each temperature below the critical temperature, T_c, there exists a pressure (the vapour pressure) at which the (more dense) liquid phase and the (less dense) vapour phase coexist.

Above the critical temperature there is no distinction between gas and liquid and there exists but a single fluid phase.

The transition from the liquid phase to the gaseous phase occurs discontinuously at that temperature for which the vapour pressure equals the external pressure. The transformation requires the absorption of a quantity of heat per unit mass, L_v, the latent heat of vaporization. The transition from the liquid phase to a crystalline phase occurs at a fixed temperature, determined by the external pressure, and the transformation releases a quantity of heat per unit mass, L_f, the latent heat of fusion. The transformations from the liquid phase are described by the Clapeyron equation relating the external pressure, p, to the temperature of the transition, T, the latent heat of transition, L, and the volume change in the transition, ΔV. The equation is: $\frac{dp}{dT} = \frac{L}{T\Delta V}$. In vaporization, ΔV is greater than zero for all substances, and therefore the boiling point always increases if the external pressure is increased. In fusion, ΔV is usually positive, but exceptions occur. The most notable exception is water, and for this substance there is a range of temperatures in which an increase of the external pressure decreases the freezing temperature. Other substances having this property are bismuth, germanium and antimony.

In contrast to the discontinuous behaviour described for crystalline phases, noncrystalline solids generally do not possess definite transition points but soften gradually to a liquid phase with increasing temperature.

The properties of the region near the critical point are of great interest and are only poorly understood. The best experimental evidence suggests that along the coexistence curve the density varies as $\sqrt[3]{1-\frac{T}{T_c}}$, whereas the classical theory predicts a dependence of the form $\sqrt[2]{1-\frac{T}{T_c}}$.

There exists no simple relationship between the pressure, volume and temperature of a liquid that can describe the entire fluid range. For small temperature and pressure changes from some fixed T_0, p_0, V_0, a simple power series expansion is useful,

$$V = V_0\left[1 + \frac{1}{V_0}\left(\frac{\partial V}{\partial T}\right)_{p_0}(T - T_0) - \frac{1}{V_0}\left(\frac{\partial V}{\partial p}\right)_{T_0}(p - p_0)\right] \quad (1)$$

but this equation of state cannot ordinarily be used if $(p - p_0)$ is greater than 100 atm. and $(T - T_0)$ is greater than 10° C.

Liquids in contact with their own vapours or air possess a surface tension that, unless opposed by external forces, causes the interface to assume the configuration of minimum area. In the absence of gravity and other forces, the stable form of a mass of liquid is spherical. Surfaces between a liquid and a solid or another immiscible liquid are also characterized by interfacial tensions, which determine whether the liquid in question will spread on (wet) the other material.

The electrical properties of liquids are determined by the density of charge carriers. With the exception of liquid metals, molten salts and solutions of salts in ionizing solvents, the electrical conductivities of liquids are small. In molten salts and solutions of salts the current is carried by the ions of the salt, whereas in liquid metals the current is carried by electrons.

When the density of charge carriers is zero, a liquid may still react to an impressed electric field by the rotation of permanent molecular dipoles. The dielectric constants of nonpolar liquids (for which the molecular dipole moment vanishes) are generally in the range of 1.00 to 3.00. Because of the possibility of storage of the field energy by partial alignment of molecular dipoles, the dielectric constants of polar fluids are much larger, of the order of 10 to 100 times those of nonpolar liquids. For example, at 25° C. the dielectric constant of water is 78.54. In general, with the exception of liquid crystalline phases, the electrical properties of liquids are isotropic. In nonpolar liquids the refractive indexes in the visible spectrum do not differ greatly from the square root of the low-frequency dielectric constant, and in polar liquids the refractive indexes in the visible spectrum are of the same magnitude as those of nonpolar liquids.

The absorption spectra of liquids cover the entire electromagnetic spectrum. Dispersion in the radio-frequency region arises from dipolar orientation and depends primarily upon the interaction between molecules. Dispersion in the higher frequency range arises primarily from absorption within one molecule. Although the absorptions in the latter case also occur in the isolated molecule, changes in frequency and intensity, as well as the broadening of the band structure of the vapour spectrum, are observed on account of the perturbing influence of intermolecular forces.

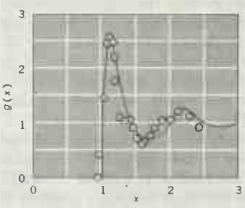
For the entire electromagnetic spectrum the liquid properties can be described by a frequency-dependent dielectric constant, $[\epsilon(\omega)]$, $\epsilon(\omega) = \epsilon'(\omega) + i\epsilon''(\omega)$ with storage of energy characterized by ϵ', dissipation of energy by ϵ'', and with i equal to the imaginary quantity $\sqrt{-1}$. The storage and dissipation terms are related by a general dispersion formula, due to H. A. Kramers and R. Kronig,

$$\epsilon'(\omega) = 1 + \frac{1}{\pi}\rho\int_{-\infty}^{\infty}\frac{\epsilon''(x)}{x-\omega}\,dx$$
$$\epsilon''(\omega) = -\frac{1}{\pi}\rho\int_{-\infty}^{\infty}\frac{\epsilon'(x)-1}{x-\omega}\,dx + \frac{4\pi\sigma}{\omega} \quad (2)$$

with ρ indicating principal part and σ the conductance of the liquid.

Molecular Properties of Liquids at Equilibrium.—The structure of substances on the molecular scale is determined by the balance between the ordering influence of intermolecular forces and the disordering influence of thermal motion. At low temperatures the influence of intermolecular forces predominates to give the completely ordered structural characteristics of the crystalline lattice. At high temperatures the influence of thermal motion predominates to give the random and featureless structure of a gas. The structure of liquids corresponds to a degree of order intermediate between that of the crystalline solid and that of a gas.

The structure of an ideal crystal is described by the theory of space lattices. There exists a fundamental unit of structure composed of a small number of atoms or molecules in a definite geometric configuration. The crystal lattice is built up as a periodic repetition of the fundamental unit in the three directions of space. Real crystals possess various types of disorder such as missing atoms, atoms in positions intermediate between lattice positions, lattice dislocations and mosaic structure as well as thermal disorder associated with lattice vibrations and lattice defects.



FROM J. G. KIRKWOOD, V. A. LEWINSON AND B. J. ADLER, "JOURNAL OF CHEMICAL PHYSICS"

COMPARISON OF THEORETICAL AND EXPERIMENTAL RADIAL DISTRIBUTION FUNCTIONS, OR $g(x)$, FOR LIQUID ARGON AT 91.8° K. AND 1.8 ATMOSPHERES

The points represent experimental data. Solid line represents theoretical function in which λ is a parameter related to the density of the liquid and ϵ is depth of potential energy well. Thus, λ corresponds to a ratio of actual volume to volume of close packing equal to 1.22 and to a temperature such that the depth of the potential well divided by kT is 1.2

When a crystalline solid melts to the liquid state, the long-range order of the crystal is destroyed. However, a residue of local order persists in the liquid state with a range such that the vestigial order becomes imperceptible at distances greater than several molecular diameters. The local order characteristic of the liquid state is described in terms of a pair correlation function, $g_2(R)$ (radial distribution function), defined as the ratio of the average molecular density, $\rho(R)$, at a distance R from an arbitrary molecule to the bulk density, ρ_0, of the liquid: $\rho_2(R) = g_2(R)\rho_0$. When $g_2(R)$ is unity everywhere, the fluid is completely disordered, a structural feature characteristic of dilute gases. De-

partures of $g_2(R)$ from unity measure the local order established by a molecule in the arrangement of its neighbours. For the representative liquid $g_2(R)$ is a curve with a series of rapidly damped maxima and minima (see figure). The positions of the maxima roughly correspond to the first several co-ordination shells of the crystal lattice characteristic of the parent solid. The minima roughly correspond to distances intermediate between the co-ordination shells. The area under a peak of $g_2(R)$ is related to the excess molecular density (relative to the bulk density) and therefore is related to a rough co-ordination number. The radial distribution function specifies only the average local density, from which significant statistical fluctuations must occur as the neighbours of a specified molecule are interchanged with other molecules in the course of thermal motion. Other observable effects of the statistical fluctuations are the diffuse peaks of $g_2(R)$ (as compared with the precise order of a crystal) and the rapid approach of $g_2(R)$ to unity as R increases beyond a few molecular diameters.

The experimental determination of the radial distribution function is based upon the determination of the coherence of waves scattered from different points in the liquid. Since $g_2(R)$ differs from unity for small R only, coherence is only obtained with wave lengths smaller than the range of molecular correlation. Such wave lengths are provided by X-rays and thermal neutrons. A liquid will also scatter visible light. Since the wave length of visible light is very much greater than the range of molecular correlation, only an average over $g_2(R)$ is determined in this wave length region.

If the intensity of scattered radiation making an angle ϑ with the incident radiation is denoted $I(\vartheta)$, then

$$I(\mu) = |f|^2 \left[N + \frac{4\pi N(N-1)}{V} \int_0^\infty (g_2(R) - 1) \frac{\sin \mu R}{\mu R} dR \right]$$
$$\mu = \left(\frac{4\pi}{\lambda}\right) \sin \frac{\vartheta}{2} \tag{3}$$

where f is the scattering form factor of the atoms of which the liquid is composed, λ is the wave length of the radiation and N is the number of molecules in the volume, V, of liquid.

To obtain $g_2(R)$, the integral must be inverted, using the Fourier integral theorem. Lack of data at the extremes of the angular range often introduces errors in the functions deduced from the observed scattering intensities. Small molecular separations affect the scattering at large angles, and vice versa, so that accurate values of $g_2(R)$ for small R, which require $I(\vartheta)$ near $\vartheta = \pi$, are difficult to determine because $I(\vartheta)$ decreases very rapidly as ϑ approaches π.

If the molecules of the liquid interact with a pairwise decomposable potential energy of interaction, $U(R)$, it can be shown that

$$pV = \mathbf{R}T - \frac{2\pi N}{3} \rho_0 \int_0^\infty R^3 \frac{dU}{dR} g_2(R)\, dR \tag{4}$$

$$L = \mathbf{R}T = 2\pi N \rho_0 \int_0^\infty R^2 U(R)\, g_2(R)\, dR \tag{5}$$

where $\mathbf{R}$ is the gas constant with a value of 1.987 kg.cal./mole degree. In molecular units, $\mathbf{R} = N_0 k$ where k is the Boltzmann constant (1.38×10^{-16} erg/molecule-deg.) and N_0 is the Avogadro number (6.02×10^{23} molecules/mole). A molecular theory of liquids requires an interpretation and calculation of $g_2(R)$.

Quasi-crystalline models of local liquid structure may be used to advantage in the interpretation of the radial distribution function. While it is recognized that long-range crystalline order is absent, the local arrangement of the neighbours of each molecule is regarded as a blurred replica of the first several co-ordination shells of a single crystal lattice or of a superposition of several lattice types. The number of neighbours in each diffuse co-ordination shell is estimated as $\int 4\pi R^2 \rho_0 g_2(R) dR$ under the corresponding peak of the radial distribution function. In this way it is inferred that, for example, the local structure of liquid mercury corresponds to an approximately close-packed array of spheres. For the case of water, the liquid is regarded as a three-dimensional net in which each water molecule is linked to four neighbours by hydrogen bonds. By superposing co-ordination structures of β-quartz, tridymite and close-packed types, a synthetic $g_2(R)$ may be constructed that is in substantial agreement with experiment. At low temperatures the β-quartz structure predominates, and at high temperatures the contribution of the close-packed structure increases.

In a similar manner the structure of liquid hydrocarbons is represented as approximating the arrangement realized in the axial close packing of slender rods. The X-ray scattering curves of aliphatic alcohols exhibit inner peaks not observed for the corresponding hydrocarbons. This peak may be qualitatively interpreted if it is assumed that the alcohol molecules are linked in chains by hydrogen bonds between the hydroxyl groups while the aliphatic groups remain approximately close packed as in the corresponding hydrocarbons.

The quasi-crystalline interpretation of the liquid pair correlation function can also be used to advantage in discussing the dielectric constant. When neighbouring molecules are strongly correlated, as for example by the presence of a hydrogen bond, it can be shown that

$$\epsilon'(0) - n^2 = \frac{3\epsilon'(0)}{2\epsilon'(0) + n^2} \cdot \frac{4\pi N}{3kTV} \mu^2 (1 + \Xi < \cos \gamma >) \tag{6}$$

with n the refractive index and where $<\cos \gamma>$ is the average of the cosine of the angle between neighbouring dipoles with electric moment μ and there are Ξ nearest neighbours to any dipole. J. G. Kirkwood has calculated $\epsilon'(0) = 63$ for water at 300° K. whereas the observed value is 78. The predicted temperature dependence of $\epsilon'(0)$ is also in fair agreement with observation. Similar agreement between theory and experiment is obtained when other hydrogen-bonded liquids, such as the alcohols, are considered.

In general, quasi-crystalline models of a liquid are of most use when the correlation between molecules is very strong because of the presence of a specific orientation-dependent force, such as a hydrogen bond. For simple monatomic fluids, quasi-crystalline models are far less useful and often lead to erroneous predictions because of their inherent overestimate of the molecular ordering. For monatomic fluids, $g_2(R)$ computed from a quasi-crystalline model has oscillations above and below the asymptotic value of unity as much as ten molecular diameters from an arbitrary molecule, whereas the observed $g_2(R)$ has reached unity after only three or four molecular diameters.

A different kind of quasi-crystalline model can be used to attempt to understand the properties of liquids. In this model it is supposed that the molecules are located at the points of a hypothetical lattice spanning the liquid volume. Then one molecule is allowed to move away from its lattice point, all other molecules remaining fixed in position. The motion of the wandering molecule is determined by the force field of the neighbouring molecules, which form a cage that prevents the wanderer from straying very far from the initial lattice point. Each molecule is then assumed to behave in the same manner so that the free volume available for the motion of any one molecule is related to the equation of state by

$$p = \mathbf{R}T \left(\frac{\partial \ln V_f}{\partial V}\right)_T - \left(\frac{\partial L}{\partial V}\right)_T \tag{7}$$

with V_f the total free volume of the liquid. This model predicts the energy of the liquid fairly accurately, but the predicted entropy is too small, a reflection of the overestimate of the correlation between molecules.

A much more promising approach to the theory of liquids is through direct calculation of $g_2(R)$ without any appeal to special models. The principal difficulty centres around deriving a closed equation for $g_2(R)$. Because a pair of molecules interacting with third body molecules requires the specification of the molecular

density of triplets of molecules, all rigorous equations for $g_2(R)$ depend upon a knowledge of the three-molecule correlation function. The approximations made in the theory take one of two forms—either the three-body correlation is expressed in terms of two-body correlations (Kirkwood) or an attempt is made to compute certain classes of contributions (by no means all contributions) to $g_2(R)$; the contributions correspond to simple ways in which a third molecule interacts directly or indirectly with a chosen pair of molecules. These contributions can usually be written as a formal series, in principle exact if all terms are evaluated.

Calculations have now been carried out in the case of theories based on both of these two alternatives. A comparison of the theoretical and experimental radial distribution functions is given in the figure for liquid argon at 91.8° K. and 1.8 atm. pressure. In general the theoretical equations of state available predict too large a compressibility. It is likely that the principal source of error is in the approximate relationship assumed to exist between the density of molecular pairs and molecular triplets.

Macroscopic Description of Dissipative Processes.—Dissipative processes arise from the transport of mass, momentum and energy. In each case there exists a phenomenological relationship between a flux and the force that is responsible for the flux. In the cases of energy and mass transport, the Fourier and Fick equations apply,

$$\begin{aligned} \mathbf{q} &= \kappa \nabla T \\ \frac{\partial T}{\partial t} &= \kappa \nabla^2 T \\ \mathbf{J}_m &= D \nabla c \\ \frac{\partial c}{\partial t} &= D \nabla^2 c \end{aligned} \tag{8}$$

with $\mathbf{q}$ and $\mathbf{J}_m$ the energy and mass fluxes, κ and D the coefficients of thermal conductivity and diffusion, and c the concentration of one of the two components in the medium wherein diffusion is occurring. In the case of momentum transport the stress tensor σ and the rate of strain $\dot{\epsilon}$ play primary roles. For a Newtonian fluid the principal shearing stresses are proportional to the corresponding rates of strain and

$$\sigma = [-p + \left(\Phi - \frac{2\eta}{3}\right) \nabla \cdot \mathbf{u}] \mathbf{1} + 2\eta\dot{\epsilon} \tag{9}$$

with Φ and η the coefficients of dilatational and shear viscosity, $\mathbf{u}$ the fluid velocity and $\mathbf{I}$ the unit tensor. The stress law (9) when introduced into the equation of motion of the fluid leads to the Navier-Stokes equation—the starting point for the study of fluid dynamics.

The coefficients κ, D, η and Φ may be determined experimentally by a variety of methods based upon suitable solution of the appropriate differential equation. It is found that all of the transport coefficients vary when the temperature and density of the liquid are varied. It is observed that at constant external pressure D increases exponentially and η decreases exponentially as T is increased. Under the same conditions κ is much less sensitive to changes in temperature than are η and D. The dilatational viscosity, Φ, is partially responsible for the attenuation of sound in a liquid. It has not been measured for simple systems such as liquid argon, krypton, etc. For complex liquids, such as polyhydric alcohols, Φ can be related to the relaxation of the internal motions of molecules in the liquid. For most simple liquids D is of the order of 10^{-5}cm.^{2}/sec., κ of the order of 10^{-4} cal./cm. sec. °C., and η of the order of 5×10^{-3} dyne sec./cm.^{2}. For liquids with extensive hydrogen bonding, such as polyhydric alcohols, η may be very much larger, as it also is for long-chain molecules in general.

The preceding comments refer to the static or steady-state properties of a liquid. Dissipation also accompanies relaxation processes at high frequency. Thus, the imaginary part of the dielectric constant, $i\epsilon''(\omega)$, describes energy loss due to conduction (for which $\epsilon''(\omega) = \frac{4\pi\sigma}{\omega}$, corresponding to ohmic losses, with σ the specific electrical conductivity) as well as losses due to the inability of dipolar molecules to follow the impressed electric field if the frequency becomes much larger than the inverse of the relaxation time for reorientation of the dipole. The relaxation time for reorientation is (approximately) proportional to the viscosity of the liquid.

Molecular Interpretation of Dissipative Processes.—In a dilute gas the transport of mass, momentum and energy occurs by the movement of individual molecules from one region of space where the local variables are c_1, $\mathbf{u}_1$, T_1 to another region of space where the local variables are c_2, $\mathbf{u}_2$, T_2. The transfer requires the actual displacement of molecules. In a crystalline solid the transfer of energy is effected by the lattice vibrations without requiring, on the average, the displacement of any molecules. Also, in the gas a molecule may move freely until it collides with another molecule, but in the solid molecular displacement from one to another lattice site requires imperfections—*i.e.*, vacant lattice sites or dislocations—before motion is possible. In a liquid the motion of a molecule is very complex and has characteristics intermediate between those of the gas and the crystalline solid.

The quasi-crystalline model of a liquid has been extensively used to interpret the relationship between liquid structure and the transfer of mass, momentum and energy. In each case it is assumed that the basic step requires thermal activation, *i.e.*, that an intermediate geometric configuration midway between the initial and final molecular structures exists, and that the ratio of the concentration of such activated states to the concentration of initial states is determined by $\exp\left(-\frac{\Delta G^*}{RT}\right)$ with ΔG^* the free energy of activation. This theory predicts that D and η vary exponentially with temperature, as is observed. The quasi-crystalline theories do not relate the parameters required to calculate D, κ and η to the intermolecular potential or to $g_2(R)$ and therefore are really parametric representations rather than molecular theories. Moreover, they cannot account for the temperature dependence of D and η if the density rather than the pressure is maintained constant.

A better picture of motion in a liquid is provided by a model proposed by M. H. Cohen and D. Turnbull. In this model a molecule can only move if a void of critical size, V^*, opens up adjacent to the molecule. It is supposed that such voids can occur by the occasional random coalescence of the free volume of the liquid. If a is the diameter of a molecule, Cohen and Turnbull show that

$$D = \frac{a}{6}\left(\frac{3kT}{m}\right)^{\frac{1}{2}} e^{-\gamma V^*/V_f} \tag{10}$$

where γ is a numerical constant and m is the mass of the molecule. This equation accurately accounts for the behaviour of complex molecules and provides an interpretation of the fluid behaviour in the glass region where the simple form of the activated state model fails. Equation 10 does not, however, accurately describe the behaviour of simple fluids. For the case of simple molecules the intermolecular repulsive potential rises much less steeply than does the intermolecular repulsive potential of complex molecules, and this difference is one source of the errors inherent in equation 10.

In a liquid any given molecule is in continuous interaction with all its near neighbours. To visualize a typical dynamical event, a pair of molecules may be imagined to have a near-encounter during which strong repulsive forces act. After this repulsion separates the pair, the individual molecules move erratically in the rapidly fluctuating force field generated by the neighbouring molecules. The motion of a molecule in a liquid is therefore analogous, in some ways, to the motion of a massive Brownian particle. In this description of the liquid, the dynamical properties of a molecule are described by a friction constant, $\zeta = kT/D$. The formulation referred to is improved if it is recognized that the motion of a molecule forces a modification of the local structure of the liquid away from the equilibrium structure, but the calculation of nonequilibrium pair correlation functions is extremely difficult. The nonequilibrium pair correlation function also appears in the analysis of the inelastic scattering of neutrons from liquids.

Exact formal relationships for the various transport coefficients of a liquid can be written in terms of an equilibrium average of the autocorrelation functions for certain dynamical variables. A typical result, due to Einstein, is

$$D = \frac{1}{3m^2}\int_0^\infty <\mathbf{p}(t)\cdot\mathbf{p}(t+s)>ds \qquad (11)$$

where the angular brackets refer to an average over the equilibrium ensemble representing the liquid and $\mathbf{p}$ is the momentum of a molecule. Relationships similar in structure to equation 11 have been derived by R. Kubo and H. Mori for the coefficients η, κ and the electrical conductivity, σ.

See also references under "Liquid State" in the Index.

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LIQUORICE: *see* LICORICE.

LIQUOR LAW. The nature and effect of intoxicants are so serious, especially in the case of persons who use them in excess, that a broad range of public regulation has been imposed upon both their manufacture and distribution. User and dealer are thus separately affected, the one by "private" law and the other by "public" law, as has been the case since ancient times. Hammurabi's code, in its provisions respecting drinking places, sought to protect public order first and to regulate price next. In biblical days drunkenness was denounced generally as well as in particular classes such as rulers, priests, women and labourers.

Subsequent legal history endlessly restates, in one form or another, such age-old themes. Courts of justice have fashioned rules of decision for cases in which it appears that use of alcoholic beverages has impaired the legal capacity or responsibility of a party to an act or transaction. The rise of legislation and regulation in the 19th century included the development of a variety of forms for public control of the liquor traffic. In 1890 the supreme court of the United States, in turning aside attacks upon such governmental activity, pronounced there to be "few sources of crime and misery to society equal to the dram shop, where intoxicating liquors . . . are sold indiscriminately to all parties applying" (*Crowley* v. *Christensen*, 137 U.S. 86).

UNITED STATES

Liquor law and regulation in the United States reflects both the peculiarities of the federal system and the practice of the states to place partial control in their local subdivisions. The first of these limits the activities of the national government; the second divides the remaining area of regulation between state and local governments.

Apart from the prohibition era of 1920 to 1933 (*see* PROHIBITION) the main interests of the federal government in liquor production and commerce have been (1) the collection of revenue; and (2) the protection of regulations introduced by the states. But, of these two, taxation of the liquor industry has been its historic preoccupation. Indeed, the first tax on distilled spirits, recommended by Alexander Hamilton and enacted in 1791, provoked armed resistance which tried the resources of the new republic and required it to use troops to keep order and enforce the law (*see* WHISKY INSURRECTION). These revenue-regulation laws have grown until they now comprise about 1,000 sections of the United States code. They place the entire industry under administrative oversight except insofar as brewers, retailers and state-operated stores are left to state law and administration. Gallonage and occupational taxes are imposed, distilled spirits plants and wineries are supervised, and importations are subject to duties or otherwise controlled. Various trade practices are regulated. Further, aside from liquor laws relating to Indians, there are only bits of legislation respecting the use of intoxicating liquors by federal employees and seamen or harbour workers.

In one respect, however, the customary protection of the federal revenue has local effect. As federal, state and local taxes on intoxicating liquors mount under pressures for increases in public funds, illegal manufacture and sale of such beverages without payment of such taxes becomes more profitable; and this incentive swells the ranks of the country's bootleggers. Such activities are violations of many federal laws. Year after year the annual reports of the secretary of the treasury and of the commissioner of internal revenue recite the numbers of arrests made in enforcing these laws. In addition, there are seizures of stills (approximately 10,000 per year), of illicit liquor supplies (hundreds of thousands of gallons), of raw materials for such manufacture (millions of gallons), of vehicles used in such operations (thousands), and of other property so involved (millions of dollars annually). Rewards and paid informers play an important part in these efforts. There is a special program to keep the necessary raw materials, particularly sugar, from bootleggers. It is worthy of note that a rise in the market price of sugar is in itself an effective deterrent to illicit operations. (*See* BOOTLEGGING.)

Otherwise the protective function of federal law rests upon the few pieces of national legislation which, in simple terms, enable states to regulate the whole of the liquor traffic within their borders. The Wilson act of 1890 declares that intoxicating liquors transported into any state are to be subject to the operation and effect of its laws as though originally produced there. The Webb-Kenyon act of 1913 prohibited outright such transportation in violation of any law of such state. Lastly, in the 21st amendment to the federal constitution, by which national prohibition was repealed, a provision was included to the same effect as the Webb-Kenyon act. The result was to elevate the latter's proscription to the status of a constitutional provision of independent operation repealable only by amending the constitution.

State Liquor Law.—Under the federal system the regulation of sales of liquor to consumers and the definition of legal relations affected by intoxication fall primarily within the police powers of the states. All of the states define offenses in which drunkenness or the supplying of liquor to unauthorized persons are material elements. Examples include drunken driving, breach of peace and contributing to the delinquency of a minor. Under certain circumstances, however, intoxication may mitigate criminal liability. Thus, in the United States as in England, most courts recognize that drunkenness may relieve an accused of liability for a crime, provided the defendant was rendered incapable of forming the purpose or possessing the knowledge required to be shown in proving the offense (*see* CRIMINAL LAW). On the other hand, impairment of mental faculties by reason of intoxication generally affords no defense for the civil wrongs such person may commit. Under the stringent dramshop legislation widely adopted in the United States, civil liability for wrongs committed by the intoxicated person or injuries sustained by him may fall on those who sold or supplied such person with liquor. A multitude of other civil consequences are associated with intoxication. Thus the contracts, deeds or will of the intoxicated person may be rendered invalid. Habitual drunkenness may provide his spouse with grounds for divorce, result in the loss of custody of his children or loss of his licence to practise a profession. By the beginning of the 1960s the social problems of alcoholism as manifested in the skid-row areas of large cities produced efforts in some localities to supplement repressive measures by public programs of assistance and therapy.

Much more explicit in form are the state regulations respecting commerce in intoxicating liquors. These systems, based upon legislation rather than the less readily perceptible case-to-case adjudication by courts in private lawsuits, range from outright prohibition or local option (*q.v.*) to various forms of state or local licensing. In between are forms of direct state participation as the sovereign wholesaler or retailer with or without supplementation by private purveyors. Adoption of such a "state store" system without any other form of retailing echoes the theme, popular at the time of the repeal of national prohibition in 1933, that it was the saloon rather than liquor that should be prohibited.

Whatever its plan of regulation, each state has a variety of criminal and civil penalties to enforce its particular system. Each state provides for either state-wide or local administration, by special or ex officio personnel, as well as for taxes, prices, sale

times and limitations upon advertising. Sales to minors are prohibited. About a third of the states maintain state stores for sales to consumers by the package (bottle or more, not for consumption on the premises), or by the drink as well as by package, of some or all types of intoxicating liquors (spirits, wine, beer). A few of these permit no other form of retailing, but most allow sales by the drink by retail licensees such as hotels, clubs and restaurants of some or all such liquors. The other states rely upon licensing alone for both wholesalers and retailers of beverage alcohol. They permit retail sales by the package, or by package or drink, usually the latter combination. (C. McF.)

UNITED KINGDOM

The English System.—The common law of England imposes no control on the keeping of inns, taverns and alehouses apart from the requirement that they shall not constitute a nuisance. Statutory control, however, commenced with the act of 1552, which introduced the system of licensing and brought common ale, or tippling, houses under the vigilance of justices of the peace. The licensing system aimed to suppress drunkenness by limiting the number of public houses and by other controls. A magistrate's certificate was required for the allocation of an excise licence, the sole authority for the sale of liquor.

Control by the lay justices is accordingly the basis of the law and is practically complete except for certain historical exemptions. The Carlisle area in Cumberland is subject to a system of state ownership: no person unless acting on behalf of the secretary of state for home affairs may sell intoxicating liquor by retail or supply it in any licensed premises or registered club. Ancillary functions of the home secretary in this area include the provision and maintenance of hotels and inns where alcoholic liquor is sold.

The main provisions relating to the law of licensing administration were eventually consolidated, and are for the most part to be found in the Licensing act, 1953, as amended and amplified by the Licensing act, 1961, and the Customs and Excise act, 1952. The 1952 act classifies the excise liquor licences that may be authorized under the following heads: (1) manufacturers'; (2) wholesale dealers'; (3) retailers'; (4) occasional; (5) passenger aircraft; (6) passenger vessel; and (7) railway passenger vehicle.

Methods and Conditions of Licensing.—For the purpose of granting a retailers' licence England and Wales are divided into licensing areas comprised of committees of five or five members of the petty sessional division of a county and a borough having a separate commission of the peace. The divisional licensing justices (there must be a quorum of at least three) receive applications for the granting of a new licence, or the renewal or transfer of an old, at their general annual meeting in the first fortnight in February each year, and they are empowered to deal with these applications as they think fit and proper. The meeting of the justices must take place in public. The proceedings are of a quasi-administrative order, the meeting of the justices not constituting a court of summary jurisdiction for licensing purposes. All qualified justices are entitled to sit. The discretion of the justices, although absolute, is required to be exercised judicially. Any person liable to real bias may not sit as a licensing justice and if he does the order may be quashed on that ground. The justices must take into consideration both the character of the application and of the premises. The applicant must not be any sheriff's officer, or a person convicted of felony or certain other offenses, and must be of good repute. The premises must be structurally adapted to the class of licence required and the magistrates may in granting the licence impose conditions as to the alteration of the structure of the premises. No alteration in any on-licensed premises may be made without the consent of the justices. At the hearing any member of the public may be heard in objection to the application provided that such objection is advanced on public grounds. All evidence must be tendered on oath.

The decision of the justices whether to grant the application is by majority vote. Once granted the licence continues in force for a year. The grant of a new licence requires confirmation by the county or borough Confirming and Compensation committee at quarter sessions. In the event of failure to renew an old licence, compensation is payable (after reference has been made to the compensation authority) as calculated on the difference between the value of the premises licensed and unlicensed; such a sum is met out of an "insurance" fund subscribed to by all licence holders.

There is a right of appeal from licensing justices to quarter sessions against the grant or refusal of a licence and from a number of other decisions; under s. 84 of the Magistrates' Court act, 1952, there is a right of appeal from magistrates' courts (as distinct from licensing justices) to quarter sessions in respect of a refusal to issue or renew a club registration certificate and of certain other orders relating to clubs (see *Clubs* below). No appeal is permissible to the superior courts of the country, but the divisional court of the queen's bench division exercises a supervisory jurisdiction over inferior tribunals and can remedy any defects in justice of a fundamental nature which may have been done.

The grant of a justices' licence entitles the holder to an excise licence, the authority for the sale of liquor, but upon forfeiture of the justices' licence the excise licence becomes void. Any person who sells by retail any intoxicating liquor without a justices' licence is liable to a fine of £50 or to imprisonment for one month. The holder of a justices' licence must have his name with the word "licensed" painted on the premises in a conspicuous position.

Under the common law of England the holder of a licence is not under a legal duty to open during the permitted hours, nor to serve all comers unless he be a common innkeeper, in which case he has no right to pick and choose among sober and orderly customers whom he will serve. In general throughout the United Kingdom there is strict supervision of the beverage liquor traffic, and in addition to the penalties under the Licensing act defaulting licensees may be disqualified. Hence it is incumbent on the holder of a licence not to permit drunkenness or any violent, quarrelsome or riotous conduct on the premises; he must not permit them to be the habitual resort of reputed prostitutes, or knowingly harbour thieves or reputed thieves; nor must he allow his house to be used for gaming or betting.

The 1961 act makes a considerable departure from previous legislation by providing that, except on certain specified grounds, licensing justices shall not refuse an application duly made for the grant of a new justices' on-licence or for the renewal of a justices' on-licence in respect of a restaurant licence or for a new type of residential licence, under which proprietors of guesthouses are authorized to supply alcoholic drinks to residents or to private friends being entertained by residents. The 1961 act also goes some way to increase the control of magistrates and the police over the sale and supply of intoxicating liquor in club premises.

Permitted Hours.—The 1961 act fixes the permitted hours during which on-licensed premises may remain open to the public. It is an offense, punishable by £30 fine, for any person to serve to another any intoxicating liquor to be consumed on or off the premises, outside the permitted hours, unless he is resident on the premises or is consuming a drink with a meal ordered within half an hour after the conclusion of the permitted hours, or unless he is a bona-fide friend of the landlord being entertained on the premises at the landlord's own expense. The permitted hours vary slightly as between the metropolis (so defined) and other parts of the country, and as between weekdays and Sundays, Christmas day and Good Friday. The Licensing (Scotland) act, 1962, follows broadly the same lines as the 1961 act for England and Wales.

Protective Provisions.—Under the 1953 act no child under the age of 14 is allowed into any bar. Liquor is not allowed to be sold for consumption on the premises to any person under the age of 18; but if, however, the individual is 16 or over he may take beer, porter, cider or perry with his meal provided that it is consumed in an open part of the premises and not at the bar. A bona-fide error as to the age of the child is a good defense to a charge under this head. By the Children and Young Persons act, 1933, it is an offense for anybody to give intoxicating liquor to any child under the age of five save in a case of medical necessity.

The Licensing act, 1953, makes it an offense to sell liquor otherwise than in a standard imperial measure. Credit sales are forbidden and a customer must pay cash for the drink when it is sold.

Clubs.—Clubs which sell intoxicating liquor come under the

control of the Licensing act, 1953, as amended by the Licensing act, 1961, which requires registration as a condition to the supply or sale of drink. The secretary of a registered club is bound in January of each year to furnish to the clerk of the justices a return containing certain statutory particulars. At the same time he must deliver to the commissioners of customs and excise a statement of purchases of intoxicating liquor during the preceding year. Penalties are imposed for the supplying or keeping of liquor in an unregistered club. Magistrates are empowered if reasonable cause be shown to issue search warrants for the entry into clubs by constables to ensure that the law is not being evaded.

Scotland and Northern Ireland.—A practically parallel method to the system of licensing in force in England and Wales is to be found in Scotland and Northern Ireland. The duties and powers of the Scottish licensing courts are laid down in the Licensing (Scotland) acts, 1903 to 1949. In Ulster control is effected in the main by the Intoxicating Liquor Licensing acts (Northern Ireland), 1923 and 1927.

Rules on Drunkenness.—The Licensing acts control liquor at its source; but other statutory provisions also discourage drunkenness. Underlying the criminal law of the country is the principle expounded by the house of lords in the leading case of *Beard* v. *Director of Public Prosecutions* (1920) A.C. 249, as follows: (1) that insanity whether produced by drunkenness or otherwise is a defense to the crime charged; (2) that evidence of drunkenness which rendered the accused incapable of forming the specific intent essential to constitute the crime should be taken into consideration with the other facts proved in order to determine whether or not he had this intent; and (3) that evidence of drunkenness falling short of a proved incapacity in the accused to form the intent necessary to constitute the crime, and merely establishing that his mind was affected by drink so that he more readily gave way to some violent passion, did not rebut the presumption that a man intended the natural consequences of his acts. In *R.* v. *McCarthy* (1954) 2 A.E.R. 262, it was held by the court of criminal appeal that unless a man is in such a complete and absolute state of intoxication as to make him incapable of forming the intent charged, drunkenness which may lead him to attack another in a manner which no reasonable, sober man would do cannot be pleaded as provocation reducing the crime from murder to manslaughter if death results. In *Broadhurst* v. *the Queen* (P.C. 1964 2 W.L.R. 38) the Judicial Committee of the Privy Council threw more doubt on the applicability of some of the principles adumbrated in Beard's case and Lord Devlin suggested (at L. 52) that the test is simply whether the accused had the capacity at the material time to form the intent.

Drunkenness by the common law of England is not an offense in itself, but by statute drunkenness accompanied by some other action may be. Thus if a person is found drunk in any highway or other public place, whether a building or not, and is incapable of taking care of himself he is liable to be apprehended and on conviction to pay a fine of 10*s*.

Riotous or disorderly behaviour in a public place while drunk is an offense; to be drunk while in charge in a public place of a horse, cattle or a steam engine or in possession of a loaded firearm is likewise an offense. A person may not procure intoxicating liquor for consumption by a drunken person nor aid and abet such a person to obtain it. By s. 287 of the Merchant Shipping act, 1894, it is an offense to be drunk and persist, after being refused admission on that account, in attempting to enter a passenger steamer; it is also an offense, being drunk on board a passenger steamer, to refuse to leave when requested; and the Civil Aviation act, 1949, makes similar provisions for air travel.

Section 6 of the Road Traffic act, 1960, as amended by s. 1 of the Road Traffic act, 1962, and the fifth schedule thereto defines the offenses of and imposes penalties for, respectively, driving or attempting to drive a motor vehicle on a road or other public place when unfit to drive through drink or drugs, and being in charge of a motor vehicle which is on a road or other public place (but not driving the vehicle) when unfit to drive through drink or drugs. Each offense carries substantial penalties, including disqualification from driving, which is obligatory for a period, in the absence of special reasons to the contrary, for the first of these offenses and, in certain circumstances, for the second.

The Inebriates acts, 1879–98, provide for the licensing by local authorities of retreats and reformatories for habitual drunkards. A habitual drunkard is a person who, not being amenable to any jurisdiction in lunacy, is notwithstanding by reason of habitual intemperate drinking of intoxicating liquor at times dangerous to himself or others, or incapable of managing himself or his own affairs. Whether drunkenness is occasional or habitual is a question of fact for the court. A separation order can be made by a court of summary jurisdiction in favour of a wife on the ground that her husband is a habitual drunkard or a drug addict. Any habitual drunkard who is found to be such may upon conviction on indictment of an offense, and if the court be satisfied that the offense was committed under the influence of drink, be ordered by the court to be detained in a reformatory for a period not exceeding three years. (P. B. C.; W. T. Ws.)

COMMONWEALTH OF NATIONS

In Canada liquor legislation was based fundamentally on the licence system of the United Kingdom, but in its development it also followed closely the United States system. Thus, while the provinces had laws of varying stringency, they usually provided for licences modified by local veto. In 1901 the privy council decided the constitutional controversy over the respective powers of the dominion and the provinces; importation and manufacture were to be controlled by the dominion, distribution and sale by the provinces. Exceptions are the Northwest Territories and the Yukon, where retail is controlled by the dominion. Also, the Canada Temperance act is a dominion statute which applies to the whole of Canada.

The Canada Temperance act, 1878 (the Scott act), provided for local option in any city or county on petition of one-fourth of the electors at three-year intervals. Under this act a rapid growth of dry areas in the maritime provinces took place, while in other areas where the Scott act was unpopular dry territory spread under provincial statutes. National prohibition, which received a majority of 13,687 in a total vote of more than 500,000 in an 1898 plebiscite, never gained enough support to secure enactment by the dominion government. After 1901 there was much legislation analogous to the U.S. Wilson and Webb-Kenyon acts (*see* PROHIBITION) to protect dry territory from invasion from surrounding wet areas. Unlike the United States, Canada, in abandoning total prohibition, abandoned also the licence system in favour of state monopoly. The Canada Temperance act, 1952, provided that upon the petition of one-fourth of the electors in any city or county an election must be held and if a majority is in favour part ii of the act takes effect by order in council. This prohibits the sale or keeping for sale of intoxicating liquor in the city or county, and the taking of liquor into it. Liquor purchased outside the city or county for personal use may be delivered to a person at his residence. A petition to revoke part ii results in a vote, and if a majority in favour is obtained a further order in council declares it revoked. Manufacturers' licences are granted to distillers and brewers under the Excise act, 1952. Under the Importation of Intoxicating Liquors act, 1952, the importation of liquor into any province from outside Canada or from another province is prohibited unless consigned to her majesty, the executive government or a government agency vested with the right of dealing in intoxicating liquor. (C. E. Ww.)

In Australia, each of the six states has its own machinery for liquor legislation. The states have a licence court, board or commission to supervise the enactment of laws, to consider applications for new licences and to reduce them. Funds for compensation for licences refused renewal are derived from special taxes, usually assessed on the volume of the liquor trade. Provision is also made for "local option" polls, at varying intervals, when total prohibition may be voted. In Queensland, since the 1958 amendment, 10% of the voters may petition for a poll and overrule the court's decision to grant a licence; in some states the number of licences is fixed, *e.g.*, Queensland, but this is not the case in South Australia or Victoria. Hours of sales vary, as does

the minimum age of being served. Sales are prohibited on Sundays, but bona-fide travelers, *i.e.*, who have traveled a certain distance on the same day, may be served at certain hours.

In New Zealand, the Licensing Control commission (1948) supervises the issue of licences and other legal requirements; licensing committees (representatives of ratepayers) operate in the districts, but their decisions are subject to assent by the electors. District licensing trusts have also operated since 1944, residents of the district electing the trust; in 1949, two previously dry districts voted to have such trusts. Licensing hours are from 9 A.M. to 6 P.M.; no sales are permitted on Sundays, clubs and restaurants having special arrangements.

The 1950s saw in India a great drive to limit, and eventually prohibit, sales of liquor, the campaign being linked with the country's plans for economic development. Under the constitution, each state is empowered to introduce its own laws to effect this. The three states of Madras, Gujarat and Maharashtra had total prohibition by 1960; in others, advertising was being discontinued, sales were being prohibited, or merely discouraged, on certain days and liquor shops were being reduced in number.

(S. McC. L.; X.)

CONTINENTAL EUROPE

Before World War I continental European countries gave little legislative attention to the liquor traffic. It was generally licensed for revenue purposes, but control of beverage alcohol as a means of combating the evils of alcoholism was left to the local authorities and to ordinary police regulation. A strong and growing temperance and total abstinence movement in most countries, wholly individualistic in character, dated from the latter part of the 19th century in the countries of northern Europe, and in some of these countries steps toward liquor control were taken. World War I stimulated liquor control because of the need for food and manpower conservation. In Sweden, liquor rationing, introduced at the end of World War I, was abolished only in 1955. Very stringent laws apply to drivers under influence of alcohol, and a driver is penalized if his blood contains over 0.5% alcohol. Similar legislation applies in Norway. In Denmark, the punishment is 12 months' imprisonment or a fine; in Finland, three years' imprisonment is served and the driving licence withdrawn. In most European countries, including those of eastern Europe, propaganda campaigns have been launched in order to check drinking; and in Poland, since 1956, centres have been established to which people found drunk in the streets are taken, are kept till they become sober and are then required to pay for their accommodation.

Under the basic Licensing act of 1880 France imposed some restrictions on places with on-licences but left their regulation largely to local authorities. Taxation of the trade, then light, was greatly increased. Manufacture and sale of absinthe was prohibited by the act of March 1915, but the act was weakly enforced and there were many equally deleterious substitutes. After World War II both the production and consumption of alcoholic drinks in France went down, but according to some estimates 8,000,000 persons were still engaged either directly or indirectly in the liquor trade in France in 1955. In Nov. 1954 measures were announced for the tightening up of the liquor laws; in an endeavour to combat the national problem of alcoholism, taxes on drinks were to be increased by 20% and stricter penalties were to be imposed for offenses of drunkenness and against the licensing laws. Café proprietors breaking these laws rendered themselves liable to a fine of 1,000,000 fr. or to a term of imprisonment for one year. In 1961, a further law prohibited cafés and other liquor-selling establishments to be situated within certain distances of hospitals and other medical centres.

See also references under "Liquor Laws" in the Index.

(S. McC. L.; W. T. Ws.; P. B. C.; X.)

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LIRA (plural LIRE), the monetary unit of Italy equal to 100 centesimi.

The lira has its origin in the monetary system introduced in Europe by Charlemagne, who based it on the pound (*libra*) of silver. No lira coins were struck during the middle ages and the lira remained strictly a money of account. By the 16th century several of the Italian states actually struck lira coins but they varied considerably in weight. One of the states which used the lira as its monetary unit was the kingdom of Sardinia, and this currency was adopted in all of Italy when it became unified under Sardinian leadership.

In 1862 the lira, which up to then had been divided into 20 solidi, was redefined and the decimal system was introduced. In 1866 Sardinia joined the Latin Monetary union and the value of the lira became equal to the French, Swiss and Belgian francs. Because of the wars of unification Italy had great difficulties in maintaining the value of the lira at par with that of the other currencies of the Latin Monetary union. There were periods of payments restriction, regulated exchanges and other measures infringing upon the freedom of money markets. Budget reforms in the 1880s and a banking reform in 1894, as well as the general improvement in the world economic situation after 1896, contributed to a stabilization of Italy's international accounts around the turn of the century and from 1903 to 1914 the lira showed stability and strength.

As in most other European countries, World War I wrought havoc with the Italian currency, and the effect of World War II was as disastrous. With the devaluation of the British pound in Sept. 1949, the Italian dollar exchange was also affected, and the lira fell from 575 to $1 to 628 to $1. From the later 1950s on the exchange rate remained around 625 lire to U.S. $1. (B. F. H.)

LIRI, a river of central Italy made up of two streams, the Rapido or Gari and the Liri. It is 158 km. (98 mi.) long and has a basin of 4,950 sq.km. (1,911 sq.mi.). The Liri has its sources near Cappadocia in the Simbruini mountains east of Rome, and traverses a long, narrow, scenic valley in its upper course as far as Arce. At the town of Isola del Liri there are two waterfalls. Below Arce the Liri enters its wide lower valley, where it receives the waters of the Sacco, draining the eastern part of the Ciocaria valley, and of the Melfa from the Abruzzi. Near San Giorgio it is joined by the Rapido and there becomes the Garigliano. It then turns southwest and empties into the Tyrrhenian sea near Minturno, forming the boundary between Lazio and Campania in its lower course. During the winter of 1943–44, as part of the Allied drive toward Rome, heavy fighting took place along the Rapido and the Liri, the Allied forces finally crossing in April 1944. (G. KH.)

LISA, MANUEL (1772–1820), pioneer American fur trader on the Missouri river, was born in New Orleans, La., on Sept. 8, 1772, the son of Christopher de Lisa, a native of Spain. He entered the fur trade at St. Louis, Mo., at an early age and soon became one of the leading traders on the upper Mississippi. The Spanish government granted him a monopoly of the trade with the Osage Indians in 1802, but it ended with the transfer of the upper portion of the Louisiana territory to the U.S. in 1804.

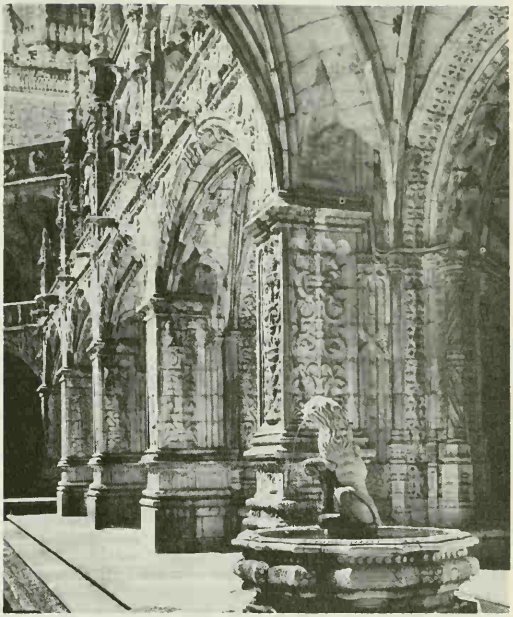
Lisa became associated with a number of successful fur companies, including the St. Louis Missouri Fur company, of which William Clark of the famous Lewis and Clark expedition was resident agent. Lisa himself led a number of expeditions and in

1807 established a trading post at the mouth of the Bighorn river, in what is now the state of Montana. In 1808 he built Ft. Raymond there for trade with the Crow Indians. It was later known as Ft. Manuel and was the first such outpost on the upper Missouri river.

Ft. Manuel was abandoned in 1811. In a famous race that year the river barge of a party led by Lisa overtook, at the Niobrara river, a group of boats sent out by the John Jacob Astor interests. Near what later became the site of Omaha, Neb., Lisa established Ft. Lisa, which from 1813 to 1822 was the most important post on the Missouri, controlling trade with the Omaha, Pawnee, Otoe and other neighbouring Indians. In 1814 William Clark, who had left the fur company and become governor of the Missouri territory, appointed Lisa subagent for the Indian tribes on the Missouri above the mouth of the Kansas river. Lisa died at St. Louis on Aug. 12, 1820.

LISBON (Port. Lisboa), the capital and chief port of Portugal and capital of a district of the same name, stands at the westernmost point of the mainland of Europe, on the right bank of the Tagus (Port. Tejo) near its mouth. Built on the slopes of a range of small hills above the river's mouth and estuary (the former a channel 2 mi. wide and 8 mi. long, and the latter a bay 2 mi. long and 7 mi. broad), the city is one of the most spectacular in Europe, rivaling Naples and Istanbul in its wide views, the distinctive silhouette of its buildings and its enclosed situation. Round its tiled and multicoloured buildings is a belt of vines, parks, gardens and woods, broken by villas, cottages and farms. The entrance to the fine natural harbour is protected by coastal defenses along the river mouth and on the hills behind. The climate, at its best in the autumn, is temperate (average annual temperature 16° C. [60° F.], average rainfall 29.45 in.). Pop. (1960) 802,230.

Its position as the centre of government gives Lisbon the movement and vitality of a great capital. There is, however, a difference in character between its various districts. The oldest part of the city is the Alfama, or eastern district, where narrow, winding streets crowd down to the river between a jumble of houses. Alfama, the starting point of Lisbon's growth, dates from the time when the city spread beyond the walls built by the Visigoths. Its irregular layout on hilly ground, unexpected views and houses which preserve the old architectural types give it a picturesque appearance, particularly attractive to visitors. Above the Alfama towers the castle, Moorish in origin but named after St. George to commemorate the Anglo-Portuguese alliance (1386). In this area is the Sé, the Romanesque-Gothic cathedral, built in 1147 and partially destroyed by earthquakes in 1344, 1531 and 1755. It contains the tomb of St. Vincent, who was accompanied in his search for the "Sacred Headland" by two legendary ravens which form part of the city's coat of arms. The nearby monastery of São Vicente, rebuilt at the end of the 16th century by Filipe Terzi, contains the pantheon of the Portuguese kings. Other notable buildings are the church of Santo António, near the Sé, built in honour of St. Anthony of Lisbon; the ruined 16th-century palace, the Casa dos Bicos; the remains of the Moorish walls; and the façade of the Conceição (formerly Misericórdia) church. Each hill of the line running to the north is crowned by a church or monastery, and on the slopes of São Gens is the district of the Mouraria, the old quarters of the converted Saracens.



J. ALLAN CASH

THE CLOISTERS OF THE MONASTERY OF SAN JERÓNIMOS, LISBON, A FINE EXAMPLE OF THE ARCHITECTURAL STYLE KNOWN AS ARTE MANUELINA WHICH FLOURISHED IN THE EARLY 16TH CENTURY

PAUL ALMASY

THE NATIONAL THEATRE OF DONA MARIA II ON THE NORTH SIDE OF ROSSIO SQUARE

Lisbon's central district, the Baixa, was built after the 1755 earthquake and stretches from the riverbank to the old outskirts in the north. The streets are broad, geometrically aligned and broken by spacious squares, of which the most central is the Terreiro do Paço with its fine equestrian statue (1775) of Joseph I, whence its English name—Black Horse square. This square, planned by Eugénio dos Santos under the orders of the marquis de Pombal as the official entrance to the town, is approached through a triumphal arch. In Rossio square, the converging point of Lisbon's traffic, are two decorative fountains and the Dona Maria II theatre; it is also famous for its black and white mosaic, 100 yd. wide. The Baixa is the centre of Lisbon's commercial life, and in it are concentrated most of the public services.

To the west extend a number of districts, each possessing its own distinctive character, reflecting the epoch in which it was built. The most modern part of the town lies to the north. The expansion of Lisbon in this direction, begun at the end of the 18th century, took on a new impetus when the parts known as the Avenidas Novas were planned after the opening of the Avenida da Liberdade, Lisbon's most famous avenue, in 1880. Forty years later another great expansion took place and entirely new districts were urbanized, absorbing the small villages on the fringe of the town. The transference of various public offices there relieved traffic congestion in the Baixa; there are also such modern buildings as the airport, sports stadiums, hospitals and schools.

Despite the destruction of the great earthquake of 1755, Lisbon

still has many notable old buildings. Besides those already mentioned are the Carmo church, an old 14th-century convent with pointed arches open to the sky; the Estrela Basilica, built at the request of Queen Maria I, the towers and dome of which are visible from all points; the bold Águas Livres aqueduct, built in the time of John V, which brings water from the springs north of the town into a reservoir to supply the public fountains, drinking troughs and domestic services; the 15th-century Jerónimos church, built by order of Manuel I; and the Tower of Belém, built at the same time, which stands like a sentinel at the mouth of the Tagus. The national assembly sits in an old 16th-century Benedictine convent; the same building houses the collection of national archives, called, after its original home, the Torre do Tombo collection. There are two notable palaces, the Ajuda, a richly furnished early 19th-century building, and the palace of Belém at the foot of the Ajuda slopes, the residence of the president.

There are many signs of the close bonds between Portugal and the British Isles—the British have always been the largest foreign colony after the Spaniards, and at one time there was a private quay for British ships. The Corpo Santo monastery was founded in the 17th century by Irish Dominicans; there are a Presbyterian church and an English college and, in the British cemetery, founded in 1717 and planted with cypresses, are buried Henry Fielding, the novelist, and Philip Doddridge, the Nonconformist clergyman.

Many of Lisbon's 18th-century squares contain statues, of which, besides that of Joseph I, the most notable are the Obelisco dos Restauradores, commemorating the campaign which freed Portugal from Spain; the monument to King Peter IV, who gave the country its constitutional charter, in Rossio square; and the monument (20th century) to the marquis de Pombal in the square that bears his name.

In addition to the squares, which give a spaciousness to the central district, there are several parks and gardens. At the northern end of the Avenida da Liberdade is the Parque Eduardo VII, so-called to commemorate Edward VII's visit to the city. Others are the Parque Florestal at Monsanto, planted after the 1920s to protect the town from the prevailing wind; the Campo Grande, a big wooded promenade to the north; the botanical garden at Ajuda; and the zoological garden in the Parque das Laranjeiras.

One of the most interesting of many museums is the Museu dos Coches, in the old royal riding school, which possesses an unrivaled collection of state carriages, coaches, berlins, two-wheeled chaises and 17th-, 18th- and 19th-century sedan chairs. Other museums include those for ancient and modern art, archaeology, ethnology and military objects; and two municipal museums. The university, founded in 1290, was re-established in Lisbon in 1911 and a technical university was founded in 1930.

The surroundings of Lisbon form part of its charm. On both banks of the Tagus are noble country houses set in beautiful gardens. On the north bank, apart from Sintra (*q.v.*), is the 18th-century palace of Queluz, built by a French and a Portuguese architect in the style of Versailles. On the opposite bank is the 16th-century Bacalhoa, famous for its azure tiles. The coastal strip north of the Tagus from Algés to the south of Cape Roca is known as the "Portuguese Riviera" and attracts many visitors. Its centre is Estoril.

Communications, Trade and Industries.—Lisbon has four railway stations; communication with the outlying districts is by electric train. The first section of an underground railway was opened on Dec. 28, 1959, and construction was begun on an extensive system. Four escalators facilitate transportation in the most hilly districts. Between the two banks of the river, which are lined with landing stages, docks and warehouses, there is constant launch and ferry service.

Its position at the westernmost point of Europe has made Lisbon an important port of call. Its airport, Portela de Sacavém, 6½ mi. outside the town, is an intersection point for many world airlines; its estuary and fine natural harbour give anchorage for naval vessels as well as for liners and cargo ships, and it is connected by road and railway with the great European capitals and with the Portuguese hinterland. It is an important transshipping and entrepôt centre, handling about 60% of Portugal's foreign trade. Its exports are chiefly agricultural and forestry produce (olive oil, wine, fruit, cork, timber) and canned fish, especially sardines. The chief imports are coal, raw cotton, mineral oil and cereals. The city's industries include the making of chemicals, textiles, soap, pottery and paper, sugar refining, flour milling and ship repairing.

History.—The origin of Lisbon is clouded by a number of fantastic legends. The derivation of its name from the word *Olisipo* gave rise to the story that it had been founded by Ulysses; it may actually have been Phoenician in origin. During the Roman domination (205 B.C. to the 4th century A.D.) it was elevated to the dignity of a municipium by Julius Caesar and called Felicitas Julia. Occupied by the Alani, the Suebi and the Visigoths in the 5th century, it was captured by the Moors at the beginning of the 8th century and called by them Lixbuna, a name derived from an old *citania* or Roman castle on the summit of the hill on which stands the Castelo de São Jorge. Few traces remain of these successive dominations. Some stones recall Roman theatres, temples and baths; there are traces of the primitive fortifications of the Visigoths as they were modified by later invaders. Of the Moorish domination little is to be seen except the nucleus of the castle, sketches of the "Moorish Wall" and traces of agricultural customs and methods in the surrounding countryside. The city was invaded twice during the Moorish domination—by the Normans in 844 and by Alfonso VI of León in 1093—and in 1147 was captured for Christendom by Afonso Henriques after a siege lasting several months, in which he was helped by a Christian crusade including Normans, Flemish and English. In 1256 Afonso III transferred the seat of his government and court to Lisbon from Coimbra. The town, which had 15,000 inhabitants at the time of the conquest, doubled its population and extended westward. King Diniz founded the university in 1290 (transferred to Coimbra in 1537). After the town had been besieged and burned by the Castilians in 1375, it was strengthened by additional defenses which enabled it to withstand the second Castilian invasion in 1384.

In 1390 Lisbon was made an archbishopric, and in the following centuries its importance grew with the opening of the sea route to India, the discovery of Brazil and the widespread voyages of Portuguese mariners. It became a great commercial port and the centre for the distribution of the riches of the Spanish overseas empire from 1580 to 1640. It was from Lisbon that the Invincible Armada sailed in 1588. The city's political importance was diminished during the union of the Castilian and Portuguese monarchies, but it regained its old splendour under John V.

Because it is built on rocks of Tertiary formation, Lisbon has always been subject to earthquakes, those of the 15th and 16th centuries being notably destructive. On Nov. 1, 1755, it suffered its severest shock; a great part of the town was destroyed and many thousands of people were killed. The tremor was felt throughout Europe. With valuable assistance from other countries, especially England, Portugal's oldest ally, Lisbon was reconstructed under the direction of Manuel da Maia, by order of the marquis de Pombal.

During the late 18th and early 19th centuries, political events hindered Lisbon's progress, particularly the three invasions by Napoleon's troops and the subsequent Peninsular War, in which the two rival factions at court struggled for possession of the throne. In the 20th century there was considerable development, and during World Wars I and II Lisbon was able to offer refuge to about 200,000 foreigners.

LISBOA DISTRICT is part of the province of Estremadura. Its area is 1,066 sq.mi. and its population (1960), 1,382,959. The principal occupations outside the city are agriculture and fishing, with some industries, including ironworks, on the outskirts of the capital.

See also references under "Lisbon" in the Index.

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LISBURN, a market town and urban district of County Antrim, N.Ire., on the Lagan river, 8 mi. S.S.W. of Belfast by road. Pop. (1961) 17,691.

Lisburn is the cathedral city of the Protestant diocese of Connor. The church, built in 1623 in "Plantation Gothic" style, was raised to cathedral status while Jeremy Taylor, the devotional writer, was bishop (1660–67). In 1627 the town was granted by Charles I to Viscount Conway, who built the castle and introduced English and Welsh settlers. The castle was besieged in 1641 during the Irish wars, and was accidentally burned down, along with the rest of the town, in 1707; the grounds are now a public park. The town served as winter quarters for the duke of Schomberg's army in 1689 before the Boyne campaign. The town and district of Lisburn became the centre of the Ulster linen industry when William III invited Samuel-Louis Crommelin and other French Huguenot refugees to settle there and establish it. Flax spinning and linen manufactures are still carried on in Lisburn, and at Lambeg, 1½ mi. toward Belfast, is a linen-bleaching centre and the Linen Research institute. The technical college was once the mansion of Sir Richard Wallace (*q.v.*), whose widow presented to the English nation the Wallace collection in London. Wallace park in Lisburn is named after him. Furniture is made at Lisburn and carpets at Finaghy nearby.

The ruins of Castle Robin, 3 mi. N. of the town, stand on the slopes of White mountain (825 ft.) and date from the 16th century. Lisnagarvey Broadcasting station, the Northern Ireland transmitter of the British Broadcasting corporation, is on Blaris moor, 2 mi. S. of Lisburn. At The Maze, 4 mi. W., is Down Royal racecourse.

LISIEUX, a town of northwestern France, capital of an *arrondissement* in the *département* of Calvados, and also capital of the district known as Pays d'Auge. It lies in the valley of the Touques river, 30 mi. E. of Caen by rail. Pop. (1962) 20,441. Most of the town's industries—brewing, machinery, plywood and condensed milk—are included in the expanded (after Jan. 30, 1960) town area. Trade in cattle, butter, cheese and apples is also carried on.

In the time of Julius Caesar, Lisieux, under the name of Noviomagus, was the capital of the Lexovii. By the 6th century it had become one of the most important towns of Neustria; its bishopric, suppressed in 1802, dated from that period. In 911 it was included in the duchy of Normandy by the treaty of St. Clair-sur-Epte. Civil authority was exercised by the bishops, as counts of the town. In 1136 Geoffrey Plantagenet laid siege to Lisieux, which had taken the side of Stephen of Blois; it fell in 1141. There Thomas (à) Becket took refuge for a time, and some of the vestments used by him are still shown in the hospital chapel. Taken from the English by Philip Augustus, and reunited to France in 1203, the town was a frequent subject of dispute during the Hundred Years' War and later.

Because it was an important road junction, Lisieux was a target for Allied bombs in World War II. It was rebuilt on modern lines, with much wider streets, after the war. Sixteenth-century towers are all that remain of the old fortifications; most of the ancient Norman houses were burned in 1944, and of the church of St. Jacques (late 15th century) only the walls were left. St. Peter's cathedral (12th–16th century), the oldest Gothic cathedral in Normandy, is still standing.

Lisieux has become a world centre of pilgrimages to the shrine of St. Thérèse of the Child Jesus, also known as "the Little Flower of Lisieux" (*see* THÉRÈSE, SAINT). The Basilique, a massive building in the Romano-Byzantine style, dedicated to St. Thérèse, was consecrated in 1937 by Eugenio Cardinal Pacelli, later Pope Pius XII. (C. PN.)

LISKEARD, a market town and municipal borough of Cornwall, Eng., lies 13 mi. E. of Bodmin by road. Pop. (1961) 4,490. Liskeard stands on high (400 ft.) ground 6 mi. from the sea between the deep wooded valleys of the East Looe and Seaton rivers, on the main London to Penzance railway line. The Celtic (Ilys Caer) indicates a seat of jurisdiction (as it still is) and the town was fortified, castle ruins being still visible in the 16th century. William the Conqueror gave the manor to Robert of Mortain, from whom it passed to the earls of Cornwall. Liskeard was the centre of the Cornish kings, the last of whom, King Doniert (died *c.* 900), lived there. Richard, earl of Cornwall, king of the Romans, created it a free borough in 1240, and vested in the burgesses nearly all the rights of a corporate town. The corporation in its modern form dates from 1586. Liskeard was one of the four Cornish stannary (tin-mining) towns. The centre of a large agricultural area, it became known for its cattle fairs, and has two markets each week; the great annual fair of St. Matthew is still held in October. The public library acquired the Leonard Courtney collection of rare Cornish books. (J. H. PR.)

LISLE, ALICE (*c.* 1614–1685), whose trial and execution during the Bloody Assizes of 1685 was perhaps the most scandalous example of the perversions of justice and the savage sentences for which they are notorious, was the daughter and heiress of Sir White Beckenshaw of Ellingham, near Ringwood, Hampshire. She married (1630), as his second wife, John Lisle (d. 1664), who was later one of the judges at the trial of Charles I (1649); he became a member of Oliver Cromwell's house of lords (1657–58), for which reason his wife is sometimes known as Lady Alice Lisle. After her husband's death she lived at Moyles court, near Ringwood.

Alice Lisle was in London during the first days of July 1685, when the rebel army of James Scott, duke of Monmouth, was at Bridgwater. She had always shown sympathy for the dissenting ministers persecuted since the restoration of Charles II and after her return to Moyles court, she agreed (July 20) to shelter John Hickes, a well-known Nonconformist minister. He spent the night of July 25–26 in her house, having brought with him another fugitive, Richard Nelthorpe. Both men had fought for Monmouth at the battle of Sedgemoor (July 6) and Nelthorpe was also under sentence of outlawry. Betrayed by a spying villager, both hostess and fugitives were arrested on July 26. Alice Lisle was tried before Lord Chief Justice Jeffreys at Winchester on Aug. 27, on the capital charge of harbouring Hickes, a traitor. She pleaded that she had no knowledge that Hickes's offense was anything more serious than illegal preaching, that she knew nothing about Nelthorpe (whose name was not included in the indictment but was mentioned to strengthen the crown's case) and that she had no sympathy with the rebellion. Under pressure from Jeffreys the jury reluctantly found her guilty and, the law recognizing no distinction between principals and accessories in treason, she was sentenced to be burned, the penalty at that time prescribed for female traitors. A few days' respite was allowed and James II commuted the sentence to beheading; it was carried out in Winchester market place on Sept. 2, 1685. Many regarded Alice Lisle's death as judicial murder; in 1689 a private act of parliament reversed the attainder consequent upon her conviction on the ground that the prosecution was irregular and the verdict injuriously extorted by the "menaces and violences" of Jeffreys.

LISMORE, an island in the entrance to Loch Linnhe, Argyll, Scot., 5 mi. N.W. of Oban, 9½ mi. long and 1¾ mi. broad. Pop. (1951) 191. It divides the lower end of the loch into two channels, the Lynn of Morvern on the west and the Lynn of Lorn on the east. The name is derived from the Gaelic *lios mòr*, "great garden," from the fertility of the soil. The shallow limestone lochs have an extremely rich vegetation. Several ruined castles stand on the coast, and the highest point is 500 ft. Steamers call at Achnacroish, and there is a ferry to Port Appin. A Columban monastery was founded in Lismore by St. Moluag about 592. About 1200 the see of Argyll was separated from Dunkeld by Bishop John, "the Englishman," and Lismore soon afterward became the seat of the bishop of Argyll. The small cathedral has been restored and is used as the parish church.

The Rev. John Macaulay, grandfather of Lord Macaulay, and the Rev. Donald M'Nicol (1735–1802), who took up the defense of the Highlands against Samuel Johnson, were ministers of Lismore. For the *Book of the Dean of Lismore, see* SCOTTISH LITERATURE.

LISMORE, a city of New South Wales, Austr., situated on the north arm of the Richmond river, 75 mi. from its mouth at Ballina and 20 mi. by land from that town. Pop. (1961) 18,935. Although for many years regarded as the centre of one of the richest dairying districts in New South Wales, the town has gradually developed its secondary industries. Primary industries, in addition

to dairying, are pig and poultry raising; timber cutting; and corn (maize), sugar cane, vegetable, pineapple and banana growing. Secondary industries include engineering and clothing, furniture and boot and shoe manufacturing. In addition to rail transport (to Sydney and Brisbane), there is bus service between all adjoining towns on the far north coast (New South Wales), the tablelands and Brisbane. The city was named after the island of Lismore, Argyll, Scot.

LISMORE (Lios Mór Mochuda), a little market town in County Waterford, Republic of Ireland, 43 mi. W.S.W. of Waterford by rail, is situated on a hill rising steeply from the Blackwater. Pop. (1961) 810. The original name of Lismore was Maghsciath. A monastery founded there by St. Carthagh in 633 became celebrated as a seat of learning. The bishopric, said to have originated with this foundation, was united to that of Waterford in 1363. In the 9th and early 10th centuries the town was repeatedly plundered by the Norsemen, and in 978 the town and abbey were burned by the men of Ossory. Henry II received in Lismore castle the allegiance of the archbishops and bishops of Ireland. The Roman Catholic bishop of Waterford and Lismore has his seat in Waterford city. The Protestant dioceses of Waterford and Lismore were united in 1833 with those of Cashel and Emly, and the bishop of these united sees has his seat in Waterford.

The baronial castle, erected by King John in 1185, was the residence of the bishops till the 14th century. It was besieged in 1641 and 1643, and in 1645 it was partly destroyed by fire but was largely rebuilt in the 19th century. In 1581 the manor was granted to Sir Walter Raleigh and passed from him to Richard Boyle in 1602. Robert Boyle (*q.v.*), the great chemist, was born there in 1627. In 1753 the castle passed by marriage to the duke of Devonshire whose successor still retains it. On the summit of the height is the cathedral of St. Carthagh mostly of the 17th century, with portions probably of the 12th and 13th and considerable additions in the 19th. There is some river trade and the town is the centre of a salmon fishery district.

LISSE, a town in South Holland province, Neth., situated in the centre of the flower fields between Haarlem and Leiden. Pop. (1962 est.) 13,851 (mun.). The chief industry is the growing and exporting of flower bulbs, for which there are research laboratories. A flower exposition covering about 70 ac. is held annually (March until May) at De Keukenhof, a former country estate converted into botanical gardens with hothouses and flower beds surrounded by natural woodland and dunes. Other industries are yacht building and the manufacture of agricultural appliances (including bulb-sorting machinery), wooden crates and flower boxes. Keukenhof castle (built in the 17th century, much restored in the 19th) houses a collection of old paintings and china.

LISSITZKY, EL (Eliezer) (1890–1941), Russian abstract painter, designer and architect, was born in Smolensk, on Nov. 10, 1890. He studied engineering at Darmstadt, Ger., and returned to Russia in 1919, where he painted his first constructivist composition, "Proun No. 1." Marc Chagall then appointed Lissitzky as a teacher of art in Vitebsk. In 1921 he became professor at the state art school in Moscow, but left Russia at the end of the year when the Soviet government turned against modern art. He went to Germany first and later to Switzerland. Between 1925 and 1928 Lissitzky lived in Hanover and on request of the Landesmuseum (directed by Alexander Dorner) designed an "abstract gallery" (destroyed 1936) on entirely original principles. In the U.S. Lissitzky exhibited first in 1924 at the Société Anonyme. He was co-founder of a number of periodicals propagating the most progressive tendencies of the 1920s. In the winter of 1928–29 he returned to Moscow, where he executed his advanced constructivist ideas in official soviet exhibitions and publications for abroad. Lissitzky died in 1941.

His experiments in spatial constructions led him to devise new techniques in exhibiting, printing, photomontage and architecture, which have been of considerable influence in western Europe.

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LI SSU (280?–208 B.C.), Chinese statesman, devoted a lifetime to the task of welding the warring Chinese states of his time into a single centralized bureaucratic empire, applying for this purpose the efficient but ruthless ideas of the totalitarian political philosophy known as Legalism. As minister to the ruler of the state of Ch'in, he saw his goal realized when, in 221 B.C., that monarch completed his conquest of the other Chinese states and assumed the title of Shih Huang Ti, "First Sovereign Emperor."

Li was born a commoner in the state of Ch'u (at the present Shang-ts'ai, southeastern Honan), studied under the Confucian philosopher Hsün-Tzu (*q.v.*), and then (247) entered Ch'in to begin almost 40 years of service under the later first emperor. For most of the radical political and cultural innovations made in the Ch'in empire after 221 (for which *see* Shih Huang Ti), Li, rather than the first emperor, was primarily responsible. Most spectacular (but not most significant) was the "burning of the books" of 213, for which Li has been execrated by later scholars.

Following the first emperor's death in 210, Li became involved in the plot of the eunuch Chao Kao to void the proper succession. In 208 this eunuch turned on Li himself and had him executed at a time when the Ch'in empire was already disintegrating as the result of rebellion. Despite this tragic end to Li and his work he set a lasting imprint on Chinese history in a way that few other men succeeded in doing.

See also China: *History: Ch'in (221–207 B.C.).*

See Derk Bodde, *China's First Unifier, a Study of the Ch'in Dynasty as Seen in the Life of Li Ssu* (1938); also other items listed under Shih Huang Ti. (D. Be.)

LIST, (GEORG) FRIEDRICH (1789–1846), German-American advocate of tariff protection to stimulate national industrial development, was born in industrial Reutlingen, Württemberg, on Aug. 6, 1789. Largely a self-educated man, he advanced rapidly in government service, taught briefly at Tübingen university, then rose to prominence as founder and secretary of an association of middle- and south-German industrialists favouring abolition of the tariff barriers dividing the German states. Exiled to the U.S. in 1825 for his liberal views, List encountered in Philadelphia the Hamiltonian view of national development, the "American System" of Henry Clay and the anti-Ricardianism of Henry Carey. He became editor of a newspaper in Reading, Pa., and took a keen interest in the building of canals and railroads. After becoming a naturalized U.S. citizen he returned to Germany in 1831 and three years later became U.S. consul at Leipzig.

Beginning in 1827 List advanced a qualified version of the classical theory of free trade of Adam Smith and David Ricardo. A national economy in an early state of industrialization requires tariff protection, List argued, and although protectionism entails the loss of certain immediate gains of foreign trade, this loss constitutes the equivalent of an "educational capital" invested in unfolding a nation's productive potentialities. List feared that entrepreneurs in long-established centres of industry would by unfair means of international competition prevent a young country's industrialization, thus: (1) preserving for the old countries not only markets but a flow of cheap raw materials as well; and (2) maintaining the old country's ability to accumulate capital at an accelerating rate, while retarding capital accumulation in underdeveloped areas of the world.

These persuasive arguments for tariff protection ignore the fact that although the nations of the west were politically divided they were the heirs of a basic technology of mechanized production, transportation and communication. This inheritance synchronized their economic development more closely and more harmoniously than List supposed. By contrast, economic nationalism splinters the common market and decimates the common technology. Economic nationalism in backward areas does not induce the growth of capital but disrupts the inflow of needed capital equipment and technical personnel.

The works of List, principally the *National System of Political Economy* (1909; German original, 1841), have the residual value of exposing at its roots the fallacy of generalizing into a plea for economic nationalism the occasionally relevant temporary policy

of protecting "infant industries." List died by his own hand on Nov. 30, 1846, in Kufstein, Aus. After his death he was greatly honoured in Germany, where his early liberal views had made him unpopular during his lifetime.

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LISTA Y ARAGÓN, ALBERTO (1775–1848), Spanish poet, critic and mathematician, the last important writer of the classical period, was born at Triana, a suburb of Seville, on Oct. 15, 1775. As a youth he showed unusual mathematical talent and at the age of 20 he became professor of mathematics in a nautical college in Seville. In 1807 he was appointed to the chair of rhetoric and poetry in the University of Seville. In 1813, during the French invasion, he was exiled to France, where he remained for four years, and on his return to Spain he became editor of the critical review *El Censor*. He was a founder of the Ateneo, the free university of Madrid, and his lectures there were collected under the title *Lecciones de literatura española* (1836). Lista is also remembered for his poems, especially those on sacred themes such as "A la muerte de Jesús" and "La Providencia," and for his mathematical treatise *Tratado de matemáticas puras y mixtas*. He died in Seville on Oct. 5, 1848.

LISTED SECURITIES. The two principal subdivisions of the market for outstanding securities are the securities exchanges and the over-the-counter markets. Listed securities are those that are marketed through the facilities of the exchanges. All other securities are unlisted and most of them are transferred in the over-the-counter markets. (*See* Stock Exchange; Over-the-Counter Market.)

Each securities exchange has its own set of listing requirements, those of the New York Stock exchange being the most comprehensive. A company acquires a listed status by making formal application to the exchange's department of stock list. The formal application is usually preceded by preliminary discussions to discover any obstacles to listing. The company must submit its financial statements and must divulge information concerning its history and business, properties owned, management, capitalization, and business, financial and accounting policies. The company also shows on distribution forms the number of security holders and total number of shares held in each size bracket and also the ten highest holdings of the security. The exchange prefers a wide distribution of stock, with a minimum of 1,500 stockholders. The company must have substantial assets or demonstrated earning power. It must also sign certain listing agreements requiring it to make financial statements available to the public and to perform certain acts considered to be in the interests of security holders.

The application is passed upon first by the department of stock list and then by the board of governors of the exchange. If approved, the exchange certifies this fact to the federal Securities and Exchange commission. The company then files a registration statement with the commission. Normally registration becomes effective 30 days after receipt by the commission of the registration statement and the exchange certification, and trading in the security begins on the effective date.

On the American Stock exchange (formerly the New York Curb exchange) listed and unlisted issues are traded—an exception to the general rule that unlisted issues are traded only in the over-the-counter market. Before 1934 a member of the curb exchange could request the exchange to permit trading in an unlisted issue. This is in contrast to fully listed issues, application for which is made by the issuing company. After 1934 the Securities Exchange act virtually prevented additions of unlisted issues to the stock trading list. Trading in unlisted issues accepted before that date continued but declined in importance. The New York Stock exchange, where all issues are fully listed, is so important relative to the American and other exchanges that the total volume of trading on exchanges in unlisted issues is small. In Oct. 1963, for example, securities sold on that exchange accounted for 84.6% of the market value of security sales on all U.S. exchanges.

The American Stock exchange, the National Stock exchange and other exchanges are less rigid in their requirements than is the New York Stock exchange; they are more willing to list securities of companies in a developmental stage; and most have lower listing fees.

The London Stock exchange publishes an official list of securities admitted to quotation. Companies whose securities are admitted to this list furnish about the same data as in listing on the New York Stock exchange. Financial statements are especially emphasized. A complete record of price movements from day to day is published for securities on this list. There is also published a supplementary list of securities not officially quoted. These securities are of some public interest but the companies have not complied with the rules required for entry on the official list.

When a company's securities are well-known and widely distributed, it may be advantageous to list the security and thus attract the interest of investors who insist upon purchasing only listed securities. The company may find that the price-earnings and price-dividend ratios of outstanding securities are thus increased, and the cost of funds decreased when new issues are sold. On the other hand, listing sometimes involves loss of interest on the part of over-the-counter dealers who have theretofore been making a market for the issue, with resultant decreases in price after listing has occurred.

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LISTER, JOSEPH LISTER, 1st Baron, of Lyme Regis (1827–1912), English surgeon, who opened the modern era of surgery by introducing antiseptic surgery (the use of chemicals to prevent surgical infections), was born at Upton, Essex, on April 5, 1827. His father, Joseph Jackson Lister (1786–1869), perfected the achromatic lens and improved the compound microscope. Joseph Lister received his M.B. at University college, London, in 1852 and in the autumn of 1853 went to Edinburgh, where he became house surgeon to James Syme. In 1856 he married Syme's eldest daughter and soon was made assistant surgeon to the Royal infirmary, where he gave his first lectures on surgery. In the following year he produced his classic paper on "The Early Stages of Inflammation," an investigation in which his interest had already been aroused by his contact with gangrene and pyemia in University college hospital, London. About the same time, he began work on the coagulation of blood, a subject related to the early stages of inflammation.

After his appointment to the chair of surgery at Glasgow in 1860, Lister at first busied himself with his articles on amputation and anesthetics for Timothy Holmes' *A System of Surgery, Theoretical and Practical*. He then resumed his researches on inflammation, which took on a new meaning after his attention was drawn in 1865 to the work of Louis Pasteur (*q.v.*). Pasteur had shown that putrefaction, like other processes he called fermentations, was caused by organisms in the air. Lister at once saw that if putrefaction was caused neither by the spontaneous generation of germs nor by the oxygen in the air—two predominating theories of his day—there was some chance of preventing it. But how were the organisms in the air to be destroyed before they entered the wound? Of three possibilities, filtration, heat and chemical agents, he selected the last for experiment.

The first experiment was made in 1865 upon a compound fracture, the agent used being phenol (carbolic acid). It was applied to the wound undiluted, so as to form a dense crust with the blood. The results, after a first failure, were so satisfactory that Lister wrote two papers, entitled "On a New Method of Treating Compound Fracture, Abscess, etc." and "On the Antiseptic Principle in the Practice of Surgery," for *Lancet* in 1867. However, the caustic property of undiluted phenol made it unsuited for general surgery. It was necessary to mitigate its action by blending it with some inert substance, and the search for such a substance continued for many years. Lister found most satisfactory a mixture of crystallized phenol and shellac, which, when spread on calico and painted with a solution of gutta-percha in benzene, passed

through the gutta-percha without adhering to the skin so firmly as to prevent drainage of pus.

Lister now turned his attention to the arrest of hemorrhage in wounds. It had long been the practice to employ silk or flax threads for tying arteries, long ends being left outside the wound to provide an escape route for the pus. Lister believed that the thread would not cause infection if made antiseptic and might be left with short ends that would become embedded permanently among the tissues of the wound. An extensive series of experiments led him to adopt ultimately (1880) a sulfochromic catgut ligature.

In 1869 Lister succeeded his father-in-law, Syme, in the chair of clinical surgery of Edinburgh. There his chief accomplishments were his researches in bacteriology, his substitution of the dressings of absorbent gauze for the nonabsorbing lac plaster and his attempt to provide a germ-free atmosphere in operating rooms by means of a spray of a 5% aqueous solution of phenol. The irritating properties of this spray soon led to its abandonment and replacement by asepsis, *i.e.*, scrupulous cleanliness of operating room, instruments and personnel, primarily with heat (sterilization).

In 1877 Lister accepted the chair of surgery at King's college, London, which he held for 15 years. While there, the publication of Robert Koch's book on the etiology of infectious diseases led him to experiment with various mercurial preparations as disinfectants. In 1896 he retired from practice but not from scientific study. He was president of the Royal society from 1895 to 1900 and president of the British Association for the Advancement of Science in 1896. In 1883 he was created a baronet and in 1897 was raised to the peerage (the first medical man so honoured) as Baron Lister of Lyme Regis. Among the coronation honours in 1902, he was nominated an original member of the new Order of Merit. He died at Walmer, Kent, on Feb. 10, 1912.

The best monument to Lister is the Lister Institute of Preventive Medicine, London—of which he was one of the founders at its inception as the British Institute of Preventive Medicine in 1891. It was modeled on the Pasteur institute in Paris. Among Lister's contributions to general surgery, R. J. Godlee (see *Bibliography*) mentions his new amputation through the condyles of the femur, his new operation for excision of the wrist joint and for carcinoma of the breast, his improved surgery of the bladder and urethra and his introduction of such instruments as the aortic tourniquet, the wire needle, the ear hook, the sinus forceps, the urethral bougies and the forceps for extracting stones from the prostatic urethra.

See also Antiseptics; Chemotherapy; Medicine and Surgery, History of.

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LISU (Lisaw, Yawyin), a tribe inhabiting the upper Salween valley in northern Burma and parts of the Mekong valley. Reliable census data for the 1960s were not available. They count as one of the Lolo (Yi) peoples, speak a Tibeto-Burman language and are Mongoloid. Like other tribes of the Lolo group, the Lisu migrated southward from the Tibeto-Chinese borderlands apparently under Chinese pressure, and small groups of Lisu spread as far as the Shan states and northern Thailand. The Chinese distinguish between Black Lisu, White Lisu and Flowery Lisu; these terms seem to relate to the degree of assimilation to Chinese culture. In the 1960s the Black Lisu, living highest up in the Salween valley, were least civilized and wore coarse clothes of homespun hemp; the others dressed in colourful and elaborate garments. In all their migrations the Lisu kept to the higher parts of hill ranges, where conditions favour the cultivation of such dry crops as hill rice, maize (corn) and buckwheat on frequently shifted fields worked mainly with hoes. Cattle are kept for the sale of meat only; houses are constructed of wood and bamboo. Dress, ornaments, weapons and implements show the influence of Chinese, as well as Tibetan, culture. Crossbows, with poisoned arrows, and dogs are used for hunting. Little is known of Lisu social organization, except that they are divided into exogamous clans, many of which are named after animals. They worship their ancestors as well as such deities as gods of earth and sky, wind, lightning and forest. Their feasts include dancing to the music of reed pipes, in which both sexes join; marriage is preceded by open courtship. The dead are burned in coffins, and there are detailed instructions regarding the path to the land of the departed ancestors. For three years after the funeral, offerings are regularly made for deceased kinsmen. *See* also Yi.

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(C. v. F.-H.)

LISZT, FRANZ (Ferencz) (1811–1886), Hungarian composer, piano virtuoso and piano teacher, was born on Oct. 22, 1811, at Raiding, near Sopron, Hungary. His father, Adam Liszt, a steward serving the Esterházy family, was Hungarian (according to the son); his mother, Anna Lager, was Austrian. An able amateur pianist, Adam recognized his son's precocious talent and brought it to the attention of his employer and other Hungarian magnates. In 1820, impressed by the young Liszt's playing, a group of noblemen pledged him an annual subsidy, thus enabling the family to move to Vienna, where Franz studied the piano with Karl Czerny and harmony with Antonio Salieri. On April 13, 1823, he played at a concert perhaps attended by Beethoven.

Taken to Paris the same year, he continued to study under Ferdinando Paër and Anton Reicha. His astonishing ability and personal charm made him the darling of society. During the next four years young Liszt and his father traveled in France and made several journeys to England. His repertory included the technically exacting concertos of J. N. Hummel and improvisations on submitted themes. His sensitive nature occasionally allowed him to yield to moodiness and mysticism, and at about this time he had the ambition to become a priest. Exhibited as a second Mozart he was encouraged to compose his youthful works, including a one-act opera, *Don Sanche*, written with the help of Paër and probably Rodolphe Kreutzer and produced at the Paris Opéra on Oct. 17, 1825. In 1827 Adam Liszt died at Boulogne-sur-Mer and his son was thrown upon his own resources. He settled in Paris with his mother, who established a comfortable home, Liszt being obliged to give piano lessons.

Though easily disturbed emotionally, young Liszt had a lively curiosity. He read widely and became interested in the socialist doctrines of Saint Simonism. Between 1830 and 1832 he encountered three figures who strongly influenced his development: Berlioz, Paganini and Chopin. The technical virtuosity of Paganini inspired Liszt's keyboard experiments, and within a short time he had vastly increased the range of his piano technique. Berlioz and Chopin deepened his conceptions of musical expression, eventually leading to the style of his later years.

Closely associated with the romantic authors as well as the musicians of his time, Liszt led an agitated life. In 1834 he formed a liaison with the countess Marie d'Agoult (*q.v.*), who bore him three children within five years. The second child, Cosima, became the wife of Hans von Bülow and later of Wagner (*see* Wagner, Cosima). The attachment lasted for a decade, but its intensity had subsided before the final parting. Ostracized by society, they lived first in Geneva, then briefly in France and later traveled in Italy, where they studied the art and literature of the Renaissance. In the spring of 1838 Liszt gave several concerts in Vienna for the benefit of Hungarian flood victims, setting an example of philanthropic generosity. Supreme as a pianist (he had vanquished his one serious rival, Sigismond Thalberg), he nevertheless found himself encumbered by mistress and children, from whom temporary separations became necessary. From 1839 to 1847 he journeyed all over Europe, exciting extravagant praise and adulation. Besides setting new standards of piano playing he established the vogue of the solo piano recital and also elevated the social position of the performing artist.

Liszt made his last tour as concert pianist in 1847. In Russia he met Princess Carolyne von Sayn Wittgenstein, a woman of cultural and intellectual distinction to whom he was strongly drawn. In 1848 they settled in Weimar, where Liszt held a posi-

tion of great influence. Arranging and conducting concerts and operas in this small German city, he established it as a centre of artistic progress recalling its brilliant period under the influence of Goethe and Schiller. At Weimar he not only wrote and performed his most important orchestral works but also performed many works of other composers. In 1849 he gave *Tannhäuser* there and the following year the first performance of *Lohengrin*. Important works of Berlioz and Schumann were also heard at Weimar, where Schubert's opera *Alfonso und Estrella* received its first performance (1854) as a result of Liszt's initiative.

After 13 years in Weimar the pattern of Liszt's life changed. Resigning his post in 1858 because of reactionary attacks, he remained in the city three more years. Then he followed the princess to Rome, expecting to marry her on his 50th birthday. In 1865, when the plan had failed through the refusal of the church to sanction her divorce, he took minor orders. A withdrawal from the world, however, was far from his thoughts. He resumed his piano classes in Weimar in 1869 and in 1875 became director of the newly opened academy of music in Budapest. For some years he divided his time between the Hungarian capital, Rome and Weimar, winning great admiration and esteem. He died at Bayreuth, July 31, 1886, while attending a Wagner festival.

Liszt's music can be divided into four broad categories: piano, orchestral works, choral works and songs. As a composer of piano music he was a pioneer. His youthful pieces showed talent but his individuality emerged only after he was able to use his transcendental technique creatively. The brilliant scale passages, arpeggios and "blind octaves" of the *Études d'Exécution Transcendantes* were not only intended for virtuoso exhibition; they provided a background of orchestral associations against which the main themes stood out in powerful chords or long, sustained melodies. Other piano works are remarkable for their chromatic harmony while the Sonata shows the use of theme transformation. His melodies and harmonies are often sentimental in character, but he compensates for this by his imagination and his astonishing flashes of originality. His last piano works show an inquiring mind ready to lead music far into the future. The harmonies of "Nuages gris," "La Lugubre Gondole" and the third "Mephisto Waltz" look forward to Debussy and Bartók. In his "Hungarian Rhapsodies" Liszt tried to reflect the soul of his native land. He succeeded admirably, despite the limited knowledge at this time of Hungarian folk music, a fact that caused later generations to judge these works as superficial. He was a supreme transcriber and arranger for the piano of songs, symphonies and operatic extracts, and his numerous arrangements did much to further the cause of the music of Beethoven, Schubert and Berlioz.

His life and work illuminate the romantic musical movement. Influenced by Berlioz' *Symphonie Fantastique,* and developing the 19th-century idea of program music, his orchestral works made a strong pictorial appeal. He was the originator of the symphonic poem, his 13 examples of this form illustrating a dramatic character, the personality of a poet, a myth, a patriotic scene, a scene from nature, a painting and a poem. They can be easily apprehended, however, without the aid of a literary synopsis. The *Faust* (1854–57) and *Dante* (1855–56) symphonies are elaborations of the symphonic poem principle and present Liszt's vision of the three main characters in Goethe's *Faust* and of Dante's *Inferno* and *Purgatorio*.

Among Liszt's choral compositions, which include Masses, psalms and part songs, are two unfortunately neglected oratorios: *Die Legende von der heiligen Elisabeth* (1857–62) and *Christus* (1855–67). The *Via Crucis* (1878–79) is remarkable for its harmonies; *Die Glocken des Strassburger Münsters* (1874) experiments with musical prosody. Liszt's solo songs (about 75) are also little known. Many of them have a simple, lyrical quality; others are boldly dramatic. Among the organ works are the Fantasy and Fugue on *Ad nos, ad salutarem undam* (1850) and the Prelude and Fugue on the letters of Bach's name (1855). These, too, are conceived in a romantic organ style and are notable for their impressive climaxes.

Liszt's collected writings were published in *Gesammelte Schriften,* edited by L. Ramann, six volumes (1880–83). A large number of his letters were published in German in *Liszt's Briefe,* edited by La Mara, eight volumes (1893–1904). Other volumes of Liszt's correspondence were later published in German, French and English.

See also references under "Liszt, Franz" in the Index.

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LISZT, FRANZ VON (1851–1919), German jurist and an outstanding figure in the history of criminal law and criminology. Liszt was born on March 2, 1851, in Vienna, his father being the procurator-general at the Austrian supreme court; an elder cousin was the composer Franz Liszt. After studying at the University of Vienna under Rudolf von Jhering (*q.v.*) and at Göttingen and Heidelberg, Liszt became a professor at Giessen in 1879, moved to Marburg in 1889 and finally to Berlin in 1899, where he remained until his retirement in 1916.

Liszt was distinguished both as a systematic expositor and as a critic of the theory and purpose of the criminal law. As an expositor, his most famous work is *Lehrbuch des deutschen Strafrechts* (1881). The tone of Liszt's critical work was set in his "Marburg program" (*Der Zweckgedanke im Strafrecht,* 1882), in which he applied to criminal law Jhering's insistence on the sociological purpose of law in general. Liszt emphasized the dual aim of the criminal law of protecting society and of providing the maximum of legal certainty, seeking the practical application of these ideas by the inductive methods of the natural sciences. He opposed short prison sentences but favoured the raising of the age of criminal capacity and sentences of fixed duration in special prisons for young offenders; he defended capital punishment and long periods of preventive detention for recidivists.

Of wide culture and international interests, Liszt was a cofounder in 1889 of the *Internationale Kriminalistische Vereinigung,* made an important contribution to comparative criminal law (*Die Strafgesetzgebung der Gegenwart,* 1894–99; *Vergleichende Darstellung des deutschen und ausländischen Strafrechts,* 16 vol., 1904–09) and wrote a leading textbook on international law. Beginning as an admirer of Bismarck, he became a liberal of the left and at the time of his death looked forward to the rebuilding of international co-operation, particularly in the field of criminal science. He died on June 21, 1919, at Seeheim an der Bergstrasse.

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LITANY (Gr. "prayer") in Christian liturgies is a form of alternating prayer in which the minister bids invocations or petitions, to each of which the worshipers answer with short, often repeated responses of a type akin to acclamations. The form probably derives from Jewish synagogue prayers and responsive psalmody; *e.g.,* Ps. cxviii and cxxxvi, and the apocryphal Song of the Three Children. Analogous forms were employed in pagan worship—*cf.* the invocations of Isis (as given in the Oxyrhynchus Papyri), and the prayer taught Licinius' troops at the battle of Campus Ergenus, May 313 (quoted in Lactantius, *De morte pers.,* xlvi). The response *Kyrie eleison* ("Lord, have mercy"), common in Christian litanies, was also a frequent cry of pagan prayer (Epictetus, *Discourses,* ii, 7).

The oldest identifiable Christian litanies stem from Eastern churches of the 4th century. Basil referred to their recent introduction in a letter to the clergy of Neocaesarea. At Antioch, litanies led by a deacon at the dismissal of catechumens and penitents, and at the prayers of the faithful before the offertory, are attested by the Apostolic Constitutions (book viii) and the sermons of John Chrysostom. The customary response was *Kyrie eleison.* These diaconal litanies became a distinctive feature of all Eastern liturgies. The Byzantine liturgies of St. Basil and St. Chrysostom contain seven: at the beginning of the rite, after the Gospel, at the dismissal, before and after the offertory, before the Lord's Prayer and after communion. Chrysostom at Antioch, and

the Gallic pilgrim Etheria in Jerusalem (*c.* 395), have recorded the use of similar litanies also at the daily offices of matins and vespers.

The Western Latin liturgies soon adapted to their use litanies of the Eastern type. A *Deprecatio* ascribed to Pope Gelasius I (492–496) and preserved in the works of Alcuin, was possibly introduced by that pope at the beginning of the Mass. But by the time of Gregory I (590–604), at ordinary Masses, only the *Kyrie eleison* responses, alternating with *Christe eleison*, were in use; and since Gregory's day the full litany form has been lost from the Mass altogether. In the rite of Milan, however, a comparable litany survives at the beginning of the liturgy on the Sundays of Lent. The Gallican Council of Vaison (529) ordered the *Kyrie eleison* to be sung at all Masses and at the offices of matins and vespers, "as is the custom of the apostolic see and also throughout the whole East and the provinces of Italy." The Stowe missal (Irish, 8th century) contains a litany before the Gospel lesson that is undoubtedly borrowed from the East—*cf.* the petition for "the most pious emperors and all the Roman army." St. Benedict in his monastic Rule enjoined a litany at matins and vespers immediately before the concluding Lord's Prayer, and the recital of *Kyrie eleison* at the end of the other daily offices. From the same period, the Gelasian sacramentary directs "*Kyrie eleison* with litany" in all major rites of ordination.

Peculiar to Western custom were litanies sung in procession on special occasions of penitence and fast—adaptations of pagan Ambarvalia (*q.v.*) processions about the land to purify and protect crops. They are first heard of in Gaul *c.* 470, when Bishop Mamertus of Vienne instituted such litany processions on the three days before Ascension day, to invoke the blessing of favourable weather and fruitful seasons. Called rogations, these processions were enjoined upon all Frankish Gaul by the Council of Orléans (511). Some time in the 6th century, the Roman church instituted a similar processional litany (the *litania maior*) on April 25, to replace the pagan Robigalia. The Gallican rogations before Ascension (the *litaniae minores*) were adopted at Rome by Leo III (795–816). In Spain, rogation processions at sowing time were inaugurated in Pentecost week and at the autumn equinox, and also at the beginning of the Gallican Advent season in early November (Council of Gerona, 517; Isidore of Seville, *De officiis*, i, 39–40). The Benedictine missionaries to the Anglo-Saxons entered Canterbury in 597 singing the rogation day litanies (Bede, *Ecclesiastical History*, i, 25); and the English synod of Cloveshoe (747) ordered litanies on April 25 "after the manner of the Roman church" and on the pre-Ascension days "after the manner of our ancestors." (*See* also BOUNDS, BEATING THE; PROCESSION.)

Another type of litany originating in the East was introduced at Rome in the 7th century—one made up of invocations to the Trinity, the angels and the saints—and was combined with the petitionary rogation-type litany. It was employed at processions before papal Masses on Ash Wednesday, the Ember days and four chief festivals of the Virgin Mary. Their development is commonly attributed to a Syrian pope, Sergius I (687–701). The Irish and Anglo-Saxons cultivated this type of litany especially and spread its use in their missions on the continent.

The Roman litany, as it has historically developed, is still sung in procession on Easter Even after the benediction of the font and before Mass. In the breviary of Pius V it is recited after lauds on nonfestal weekdays of Lent, rogation days and April 25. The litany consists of (1) invocations to the Trinity (response: *Kyrie eleison*) and to the angels and saints (response: "Pray for us"); (2) deprecations or prayers for deliverance from all evils, and obsecrations or entreaties by virtue of Christ's atoning work (response: "Deliver us, O Lord"); (3) intercessions (response: "We beseech thee to hear us"); and (4) concluding devotions to Christ as Lamb of God, and the *Kyrie eleison*.

At the Reformation, Martin Luther issued (1529) both Latin and German revisions of the Roman litany, eliminating all invocations of saints. A similar vernacular revision of singular literary finesse, made for the Church of England by Archbishop Thomas Cranmer, was published in 1544. The English litany has been incorporated in all editions of the Book of Common Prayer since 1549. Its traditional use is after Morning Prayer on Sundays, Wednesdays and Fridays; but it is also a common custom in Anglican churches to sing the litany in procession before the Holy Communion and on the rogation days.

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LITCHI (LYCHEE; also spelled lichi, leechee, etc.), the fruit of *Litchi chinensis*, a tree of the family Sapindaceae, believed to be native to southern China and adjacent regions. It has been the favourite fruit of the Cantonese since ancient times; neither the orange nor the peach is held to equal it. Its introduction into the western world, however, came relatively late. It is recorded to have reached Jamaica in 1775.

The first litchi fruits to mature in Florida—where the tree has attained commercial importance—are said to have ripened in 1916. A few trees introduced into California in the 19th century have occasionally produced fruits but, in general, conditions there are apparently unfavourable for their successful establishment. Around the Mediterranean are a few bearing trees; in South Africa a small horticultural industry is based upon litchi production. The tree is cultivated in numerous parts of India and has received horticultural attention in the Hawaiian Islands. Occasional trees are to be seen in tropical America.

The litchi will tolerate about as much cold as the orange. It does not produce good crops in climates which are hot and humid throughout the year. The tree must be subjected to a period of cold weather annually or, failing this, a long dry season. In short, something must discourage vegetative growth and induce flowering. Even at best, the litchi has a strong tendency toward alternate or irregular production.

The tree is a handsome one, developing a compact crown of bright green foliage, beautiful the year round. The leaves are compound, composed of two to four pairs of elliptic to lanceolate leaflets two to three inches long. The flowers, small and inconspicuous, are borne in terminal panicles sometimes a foot in length. The fruits, which are produced in clusters, are oval to round, strawberry-red in colour and an inch or slightly more in diameter. The brittle outer covering encloses white, translucent watery flesh and one large seed. The flavour is subacid, sprightly, delicious, suggesting that of a Muscat grape. The fruit is eaten fresh, canned or dried, as the litchi nut of commerce.

About 50 varieties have been described from southern China, of which No Mai and Haak Ip are considered to be among the best. In Florida the Brewster, from Fukien province in China, has attained commercial importance; Groff, a Hawaiian production, and Bengal, from India (where there are several varieties), are considered excellent. In South Africa the most important commercial litchi is one which had its origin in Mauritius.

The tree is propagated by seed and by air layering. When moved to the permanent orchard, litchi are set 25 to 35 ft. apart. They require very little pruning and no unusual cultural attention, though they should have abundant moisture around the roots most of the time. The trees come into production at three to five years of age. (W. PO.)

LITERARY FORGERY. A forgery is essentially a piece of work created or modified with an intention to deceive. This definition excludes from the category of literary forgeries both the copy made in good faith for purposes of study and the large class of writings that, in the course of their descent from antiquity, have become associated with the name of some great classical author or Father of the Church. A good example is the Pauline commentaries of the heretic Pelagius, which have been transmitted under the name of St. Jerome, one of his most bitter opponents.

Nevertheless, these exclusions made, there remains a heterogeneous collection of forged writings, proceeding from a variety of motives on the part of their authors. Certain broad divisions are possible: works produced to exalt or denigrate some religion, political party or race; works produced pseudonymously by an author who despairs of obtaining recognition under his own name, or who considers that he has been unjustly neglected and takes vicarious pleasure in hearing his forgeries lauded by the very critics

who rejected his genuine writings; forgeries whose motive is financial; and forgeries produced as hoaxes.

Forgery to Further a Cause.—This category includes various pseudonymous apocryphal scriptures (*see* M. R. James, *The Apocryphal New Testament,* 1953); spurious letters, such as those attributed to Pontius Pilate, the creation of which began in the early centuries of the Christian church and has continued to modern times (*see* E. J. Goodspeed, *Strange New Gospels,* pp. 42–62, 1931); or the Epistle of Lentulus, which provides a description of Christ's personal appearance that has inspired many artists. To these may be added the great ecclesiastical forgeries, the Donation of Constantine (*q.v.*) and the False Decretals of Pseudo-Isidore (*see* DECRETALS, FALSE), which powerfully influenced the consolidation of the temporal authority of the popes during the later middle ages. Similar in character are the forged charters that sometimes emanated from medieval monasteries, either to defend a traditional right that had been called into question or, less defensibly, to extend the territorial holdings or the privileges of a religious house (*see* Joan C. Lancaster, "The Coventry Forged Charters," in *Bulletin of the Institute of Historical Research,* xxvii, 1954). In contrast, as an example of forgeries designed to damage the reputation of a religion or a community, may be mentioned the notorious *Protocols of the Learned Elders of Zion,* a fabrication made in tsarist Russia purporting to be evidence of a Jewish conspiracy to obtain world domination, which has been often appealed to by anti-Semitic movements to justify persecution (*see* ANTI-SEMITISM).

Forgery to Gain Recognition.—No forgery of this type is more famous than the "Thomas Rowley" poems of Thomas Chatterton (*q.v.*), which the youthful author attempted to pass off as the work of a medieval cleric. Chatterton, however, enjoys a place in English letters as a creative genius in his own right, and is far removed from the more conventional forger William Ireland (*q.v.*), who cheerfully manufactured Shakespearean documents until nemesis overtook him and the "lost" tragedy *Vortigern* was laughed off the stage at the Drury Lane theatre in 1796. More fortunate was Charles Bertram, who produced an account of Roman Britain by "Richard of Westminster," an imaginary monk whom Bertram's dupe, the eccentric antiquary Dr. William Stukeley, identified with the chronicler Richard of Cirencester, known to have resided at Westminster in the 14th century. The influence of Bertram's forgery (cunningly published in a volume containing the works of two genuine ancient authors, Gildas and Nennius) upon historians of Roman Britain has been enormous, and lasted into the 20th century. Equally effective, though in a somewhat different fashion, were the Ossianic poems of James Macpherson (*q.v.*), which influenced the early period of the Romantic movement. To what degree Macpherson's poems are to be regarded as spurious is not certain. Denounced in his own day, it remains possible that they were, as he claimed, based upon a genuine oral tradition of Scottish Gaelic poetry; but there can be little doubt that they were carefully edited and interpolated by their collector.

Forgery for Financial Gain.—Of all types of forgery, this is the most common, though this fact does not exclude other, less materialistic considerations from the mind of the most venal author. However, in the numerous forged autographs that appear on the market, it is difficult to see any motive but self-enrichment. Little ingenuity is required, apart from a capacity to imitate another's hand and style in a letter, poem or other short document. Occasionally a forger appears with a certain specious glamour like Constantine Simonides (1824–67), the Greek adventurer who varied his trade in perfectly genuine manuscripts with the sale of strange concoctions of his own; or Maj. George de Luna Byron, alias De Gibler, who claimed to be a natural son of the poet Byron by a Spanish countess, and who successfully produced and disposed of large quantities of forgeries ascribed to his alleged father, to Shelley, Keats and others (*see* T. G. Ehrsam, *Major Byron,* 1951). More commonplace is the Edinburgh forger A. H. ("Antique") Smith, who was responsible for forgeries of Robert Burns, Sir Walter Scott, Mary Stuart and other characters from Scottish history—a feat that ultimately earned him 12 months' imprisonment (*see* W. Roughead, *The Riddle of the Ruthvens,* 1936).

More recent and more notorious was the case of the Wise forgeries. Thomas James Wise (1859–1937) was one of the most distinguished private book collectors on either side of the Atlantic, and his Ashley library in London became a place of pilgrimage for scholars from Britain, Europe and the United States. He constantly exposed piracies and forgeries and always denied that he was a dealer. The shock was, accordingly, the greater in 1934 when John W. Carter and Henry Graham Pollard published *An Enquiry Into the Nature of Certain Nineteenth Century Pamphlets,* proving that about 40 or 50 of these, commanding high prices, were forgeries, and that all could be traced back to Wise. Subsequent research has served only to confirm the finding of Carter and Pollard and to convict Wise of other, and more serious, offenses, including the sophistication of many of his own copies of early printed books with leaves stolen from copies in the British museum.

Forgery as a Hoax.—Many persons derive pleasure from the idea of deceiving the expert and making him look foolish. An example of this would be George Psalmanazar (1679?–1763), a Frenchman who went to England, pretending, with great success, to be a native of Formosa, and published a book about that island, which he had never visited. Another case is William Lauder, who attempted to prove Milton guilty of plagiarism by quoting modern Latin poets, into whose works he had interpolated Latin translations from *Paradise Lost.* Less pardonable is the mentality that abuses the faith of simple people by fabricating a document that appears to confirm their religious beliefs, so that disillusionment, when it comes, is the more bitter. This was the case with the so-called *Cidade Calenlixness* or *Dialogue of Jesus and John,* a text allegedly in a papyrus in the British museum, which purports to be a discussion between Jesus and John, strikingly confirming the Christian Scientist teachings of Mary Baker Eddy, but which is actually a conflation of genuine ancient materials and modern fabrications. It has been printed in popular magazines and enjoys a wide circulation, particularly in the United States. More innocent is the forgery made as a joke but taken seriously. An example of this is provided by the "Ern Malley" poems, offered to an Australian magazine in 1944 as the work of a recently dead poet, but actually composed by two young soldiers who wished to ridicule certain aspects of contemporary poetry.

The Detection of Literary Forgeries.—This may be done by scientific examination, by the external criticism of paleography and diplomatic, and by methods of textual criticism.

The scientific examination of the materials of a forged document may demonstrate its spurious character by showing that the parchment, paper or ink cannot belong to the period to which they pretend. However, a skilful forger takes care to secure appropriate materials; and in any case, scientific examination will not avail against the contemporary forger, living in the same age as his victim. Accordingly, other tests must be employed.

Forgeries may be detected by the methods of examination formulated by Jean Mabillon in his great work, *De re diplomatica* (1681), for determining the authenticity of a document by the writing and the style of the terminology. These techniques have developed during three centuries into the modern sciences of paleography and diplomatic (*qq.v.*), by which various scripts and formulas can be assigned to particular ages and localities, and effective comparison can be made between two examples of handwriting purporting to come from the same pen. Thus it is possible to state that a particular document could not have been written at the date that it bears (*see* B. Schofield, "The Lane Bequest," in *British Museum Quarterly,* xi, pp. 73–76, 1937). In dealing with printed texts, analogous methods are employed.

Nevertheless, a forgery may pretend to be no more than a copy of a genuine original. It then becomes necessary to examine the language and style in which it is written and to look for anachronisms or for statements that conflict with known authorities. This is the method of textual criticism brilliantly employed by Richard Bentley (*q.v.*) in his *Dissertation on the Epistles of Phalaris* (1699), which proved that these letters, far from being written by a Sicilian tyrant of the 6th century B.C., were, in fact, the work of a Greek sophist of the 2nd century A.D. Similarly, Sir George

Warner, giving evidence at the trial of A. H. Smith (*see* above), was able to show that several of the forgeries contained errors of dating, quite apart from the fact that Smith's efforts to imitate the writing of many of his subjects were not very convincing.

While the detection of the learned and careful forger may require an expert, the general level of forged literary autographs is a low one, and they can often be detected by anyone taking the trouble to compare them with an authentic example. Many collectors have been deceived by their own credulity, because they wished to believe that they were getting a good bargain and subconsciously suppressed their critical faculty. A classic case is that of the French forger Vrain-Denis Lucas, who sold to Michel Chasles a collection of forgeries including a letter of St. Mary Magdalene, written in French on paper made in France! (*See* M. E. Charavay, *Faux Autographes. Affaire Vrain Lucas*, 1870.) A good knowledge of the general literary and historical background of documents; familiarity with genuine examples of handwriting gained either from facsimiles or, better still, from originals in libraries and museums; and plain common sense are excellent protection against serious deception.

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LITERARY PRIZES. The first known literary prizes were those awarded at the ancient Greek games and festivals (*see* GAMES, CLASSICAL). Although these contests were mainly athletic, the Pythian games, held at Delphi, were derived from an early music festival at which the poet who best sang the praises of Apollo was awarded a money prize and later, after 582 B.C., a crown of sweet laurel (bay). Pericles encouraged music and poetry contests at the Panathenaea, where poets competed for a crown of olive and later for a crown of gold.

The most famous Greek dramatic contest, the Great Dionysia, took place at Athens, and records of tragic contests date from *c.* 534 B.C. (*see* DRAMA: *Greek Drama*). During the 5th century B.C., the three poets chosen to compete each submitted three tragedies and a satyr play. The victors included Aeschylus, Sophocles and Euripides. Comic contests were held primarily at the Lenaea, the winter festival, and the three (later five) competitors each presented one play. At both contests the verdict was given by five judges, chosen by lot, and the winner received a sum of money and a crown of ivy.

In Rome, agones, or contests in the Greek style, were fairly common by the end of the republic. Nero instituted a regular festival, which included competitions in music and eloquence, and the most famous contest was the quadrennial Agon Capitolinus, founded by Domitian in A.D. 86, at which the prize was a crown of oak leaves. At the Agon Quinquatria, dedicated to Athena, the prize, a crown of olive leaves and gold, was awarded yearly. The custom of awarding crowns continued up to the time of Theodosius I (378–395), but the early Christian fathers frowned on its pagan connections, and it was not revived until the time of Frederick I, Holy Roman emperor (*c.* 1123–90). Little is known about how it became general in the Holy Roman empire, but it was current in Germany in the 17th century, when a degree in the "mastership of poetry" was conferred through an imperial patent, in exchange for an oath of loyalty by the recipient, who was also rewarded with a valuable ring.

Petrarch was the only poet to be crowned in Rome during the middle ages. He was invited to be crowned poet laureate by the University of Paris and by the senate in Rome. He accepted the latter invitation and was crowned with olive in the Capitol in April 1341, being also honoured with Roman citizenship.

Modern Prizes. *International.*—The most valued international literary prize is the Nobel prize for literature, first awarded in 1901 under the terms of the will of Alfred Bernhard Nobel (*q.v.*), the Swedish scientist. Like the other Nobel prizes it is not competitive, and the winner receives a gold medal and about £16,000 from the Swedish Academy for the whole body of his work, which must show idealism. A similar organization, the Balzan foundation, was set up at Berne, Switz., in 1961, in accordance with the will of Eugenio Balzan, an Italian journalist, who left a fortune of £8,000,000 to provide annual prizes for peace; literature, philosophy and the arts; and science, technology and medicine, to the total value of £150,000.

The Formentor Literary conference, held on the island of Majorca, is an annual international venture organized by the leading publishers of a number of countries. Each country is represented by a delegation of writers who award the $10,000 Prix des Éditeurs, for the work of an established writer, and the $10,000 Prix Formentor, for the best unpublished novel, which is then published in all the countries participating. The first awards were made in 1961.

Great Britain.—The first English literary prize was the Newdigate, founded by Sir Roger Newdigate (*q.v.*) in 1806, and awarded annually for a poem by an undergraduate of Oxford university. Other British literary prizes are usually administered by the British Academy, the National Book league and various publishers, and include the Foyle prizes for verse (£250) and drama (£100); the Guinness award of £300, £200 and £100 for three poems in English; the W. H. Heinemann Foundation awards, intended to reward the less remunerative forms of literature; and the W. H. Smith annual award of £1,000 for an outstanding contribution to literature. The best-known memorial prizes are the James Tait Black for the year's best novel and biography; the Duff Cooper for an outstanding literary work; the Hawthornden for imaginative prose or verse by a British author under 41 years of age; and the John Llewelyn Rhys for literary work by a British author under 30. The Somerset Maugham trust fund annually awards about £500 to encourage a young writer to travel. Two Library association awards are the Carnegie medal, commemorating Andrew Carnegie (*q.v.*), awarded annually for the most outstanding children's book, and the Kate Greenaway medal for children's book illustrations.

The United States.—Prizes awarded by the American Academy of Arts and Letters include the Award of Merit, consisting of a medal and $1,000, for a novel, poetry or a play, and a gold medal for "special distinction in literature, art or music." Other prizes are offered by publishers, universities and associations; the best known are the Pulitzer prizes, of $500, for fiction, drama, history, biography and poetry reflecting aspects of American life, endowed by the will of Joseph Pulitzer (*q.v.*), and administered by Columbia university. Another well-known award is that given by the New York Drama Critics circle, which each season awards a medal for the best American and the best foreign play produced in New York city. The American Library association awards two prizes for children's books: the John Newbery medal for the best book for children; and the Caldecott medal for the most distinguished picture book for children.

Europe.—The Académie Française awarded its first literary prize for eloquence in 1671. Founded by Jean Louis Guez de Balzac in 1654 but not previously awarded, it took the form of a gold medal. In the same year a gold medal for poetry, founded by Paul Pellisson in honour of Louis XIV, was also awarded. After Pellisson's death the prize was at first paid for by the Académie and later by the bishop of Noyon, but when in 1746 Gaudron left 300 livres for a prize, the three funds were pooled to provide an annual prize for poetry and eloquence alternately. The prize was retained when the Académie was reorganized in 1795, and Napoléon I established prizes for the various classes of the Institut, which included the Académie. Louis XVIII doubled the value of the poetry prize, and in 1860 Napoléon III created a biennial prize for work bringing honour to the nation. On being awarded this prize, Louis Thiers used it to found a triennial prize for an outstanding historical work. Among the most important of the literary prizes awarded by the Académie are the Grand Prix de Littérature and the Prix du Roman.

The Académie Goncourt, founded by the will of Edmond de Goncourt (*see* GONCOURT) and constituted in 1903, offers an annual prize for the best imaginative prose work "exemplifying youth, boldness and talent" which was at first awarded to young writers known to be opposed to the traditions of the Académie Française. Another well-known award is the Prix Fémina, founded in 1904 by a group of French women writers, for the best imaginative work in prose or poetry.

Of more than 100 literary prizes in the Federal Republic of Germany, most are awarded by state or civic authorities. Outstanding are the Büchner Preis, worth 7,000 DM., awarded annually by the Deutsche Akademie für Sprache und Dichtung to German poets and writers, particularly the younger ones; the Fontane Preis, worth 4,000 DM., awarded yearly to writers connected with Berlin; the Friedenspreis der Deutschen Buchhandels or "peace prize," worth 10,000 DM., awarded annually at the Frankfurt book exhibition; and the Preis der Gruppe 47, given for the best unpublished work read at the annual meeting of the group and decided by secret ballot.

Awarded mainly by publishers or foundations, Italian literary prizes are used to publicize otherwise neglected books. The most important are the Premi Viareggio, prizes worth 2,000,000 lire, for fiction, essays and poetry; the Premio Bagutta, which offers 100,000 lire for fiction; the Premi Marzotto, worth 3,000,000 lire, for fiction and poetry; and the Premio Ghianciano, which awards 1,000,000 lire for poetry.

Greece continues its tradition of literary prizes with the Aristeion ton Grammaton, awarded by the Academy of Athens to the author whose work over the four years before the presentation has contributed most to the progress of Greek literature. The Academy also announces occasional specific competitions for drama, bibliography and fiction.

The most important Soviet literary award, the Lenin prize, with a value of 7,500 roubles, is presented annually on April 22, Lenin's birthday. In 1962 the V. Vorouski prize was established for outstanding contributions to journalism.

Until 1962 literary prizes in Poland were distributed by the councils of individual major towns, but thereafter they were brought under the single jurisdiction of the prime minister who has power to make awards of the first grade (50,000 złoty) the second grade (30,000 złoty) or the third grade (20,000 złoty). Czechoslovakia has a similar system of grading for the annual Klement Gottwald state prize, and yearly presentations are also made by the Union of Czechoslovak writers and the "Czechoslovak Writer" publishing house. (J. M. Le.; X.)

LITERATURE (ARTICLES ON). *Encyclopædia Britannica's* articles on national literatures comprise a world-wide survey, discussing the evolution of each literature, the works associated with its historic movements and its recent tendencies. In addition to major outlines such as AMERICAN LITERATURE; DUTCH LITERATURE; ENGLISH LITERATURE; FRENCH LITERATURE; GERMAN LITERATURE; ITALIAN LITERATURE; RUSSIAN LITERATURE; SPANISH LITERATURE; THAI LITERATURE; etc., the literatures of many smaller nations are treated—for example, Bulgarian, Burmese, Ethiopian, Hungarian and Icelandic literature. Portuguese-American and Spanish-American literatures are outlined in IBERO-AMERICAN LITERATURE.

Many authors whose contributions are summarized in the national surveys are discussed also in biographical articles. These range from detailed studies of such world figures as Cervantes, Goethe, Molière and Shakespeare to brief sketches of authors whose work has been nationally treasured but not widely translated. Of related interest are the articles on groups—for example, PRE-RAPHAELITE BROTHERHOOD; BLOOMSBURY GROUP—and the article ROMANTICISM.

PROSE provides cross references to the various articles dealing with prose literature, a form of composition which lagged far behind verse in its development as a literary art. STYLE discusses the leading schools of thought, past and present, as to the qualities that constitute good writing. Related articles include FIGURES OF SPEECH and RHETORIC. The most potent of all influences on English style is discussed in BIBLE, TRANSLATIONS OF.

POETRY discusses the elusive question of what constitutes a poem; a closely related article is POETIC IMAGERY. VERSE describes the patterns of rhythm that enter into the construction of metrical forms. Among supplementary articles are BALLAD; BLANK VERSE; ELEGY; EPIC POETRY; FOLK MUSIC; FOLK SONG, U.S.; METRE; RHYME; SONG, etc.; articles on individual verse forms—for example, BALLADE; RONDEAU; SESTINA; SONNET; TRIOLET; VILLANELLE; articles on types of metrical foot—ANAPEST; DACTYL; IAMB; TROCHEE; and articles on types of metrical line—HEXAMETER; PENTAMETER, etc. For ancient Greek metre *see* PROSODY, CLASSICAL.

NOVEL outlines the history and major variations of this form of storytelling, and the work of the great exponents of each genre. Supplementary articles include PICARESQUE NOVEL, THE; ROMANCE. SHORT STORY traces the origins of the modern short story and its rapid evolution in the 19th and 20th centuries.

DRAMA is devoted primarily to the history of drama as a literary form; for the history of dramatic performance *see* THEATRE. Discussions of drama are included also in the articles on national literatures, and related articles are cited in THEATRE (ARTICLES ON). There are also articles on COMEDY; TRAGEDY; MELODRAMA.

Related to all the foregoing genres are such an article as FOLKLORE; separate articles on many folk and legendary figures important in literature, for example, FAUST; and such articles as ARTHURIAN LEGEND and CHARLEMAGNE LEGENDS.

Major works of literature are discussed in the biography of the author. Works of unknown or multiple authorship are frequently the subject of separate articles; *see*, for example, ANGLO-SAXON CHRONICLE; BEOWULF; REYNARD THE FOX.

BIOGRAPHY describes the world's great works in this field and the varied approaches, from uncritical gossip to Freudian analysis, that have been made to the problem of bringing character into clear focus. A related article is AUTOBIOGRAPHY.

Additional articles on literary genres include CHILDREN'S LITERATURE; ESSAY; HUMOUR; JOURNALISM; LIGHT VERSE; MYSTERY AND DETECTIVE STORIES; ORATORY; PARODY; PASTORAL; PROVERB; RIDDLE; SATIRE; SCIENCE FICTION.

The history and contemporary methods of book publication are discussed in PUBLISHING. Among other articles on media of the printed word are BOOK; LITTLE MAGAZINE; NEWSPAPER; PERIODICAL. Articles of related interest are LITERATURE, SOCIETIES OF and LITERARY PRIZES.

Among the articles in which great literatures of antiquity are described are CLASSICAL SCHOLARSHIP; GREEK LITERATURE; LATIN LITERATURE; SANSKRIT LITERATURE.

BIBLIOGRAPHY discusses the classification of books according to subject matter, locale, era, etc.; the identification of specific printings; and related questions, such as the methods of detection used for the separation of authentic texts from corrupt ones. Articles relevant to this topic include BOOK COLLECTING; ILLUMINATED MANUSCRIPTS; INCUNABULA; INDEX; LIBRARY; LITERARY FORGERY; PALEOGRAPHY; TEXTUAL CRITICISM. Articles on reference works include ATLAS; CONCORDANCE; DICTIONARY; ENCYCLOPAEDIA.

The sections of AESTHETICS dealing with criteria of beauty in literature are supplemented by CRITICISM and DRAMATIC CRITICISM. *See* also AESTHETICS, HISTORY OF.

Important phases of literature that are treated in over-all perspective in the articles cited above are covered in specialized studies in articles cited in HISTORY (ARTICLES ON) and PHILOSOPHY (ARTICLES ON). *See* the Index for more comprehensive lists of articles and sections of articles dealing with each topic.

LITERATURE, SOCIETIES OF. Literary societies may be divided into three main kinds: the academy, established as an arbiter of literary taste and linguistic correctness; the club, a fellowship of authors or patrons to further individual or collective creative work; and the learned society of letters, an organization devoted to literary criticism and scholarship.

Academies.—The academy is best exemplified by the Académie Française founded by Cardinal Richelieu in 1635. Its functions were to include criticism of authors' works (but only at their own request) and the compilation of a French dictionary, together

with the general purposes of establishing canons of literary taste and facilitating the correct growth of the vernacular. Membership has always been limited to 40, and the Académie numbers among its members most notable contemporary men of letters, although this has not always been the case. It also distributes several literary prizes (*q.v.*). A similar function was first performed in Germany by the Fruchtbringende Gesellschaft (1617), and in Spain by the Real Academia Española (1714). Most Italian cities have literary academies, the most important of which are the Accademia della Crusca (1552) of Florence, and the Accademia dell'Arcadia (1690) of Rome.

England had the makings of an academy as early as 1572 when Matthew Parker, archbishop of Canterbury, founded the Assembly of Antiquaries which included William Camden, William Lambard, Sir Robert Cotton and John Stow among its members. Although mainly concerned with history and archaeology this society also published several Anglo-Saxon texts and was the first instance of a society serving the purposes of philological scholarship to an important degree. In 1616–17 Edmund Bolton took a step further and, had his proposal for a formal literary academy not been thwarted by the death of James I, England would have preceded France in establishing an academy claiming royal favour. The establishment of the Académie Française brought a demand for an English equivalent but, although projects came from Thomas Sprat, John Dryden, Daniel Defoe, Joseph Addison, Jonathan Swift and others, none came to fruition. However, the Royal Society of Edinburgh (1783) had a strong "literary class" of which Sir Walter Scott was president from 1820 to 1832.

The British Academy (1901), like the American Academy of Arts and Letters (1904), has never held the same status or claimed the same powers as its French counterpart. It was founded mainly to provide a British representative on the newly formed International Association of Academies. Its literature section comprises 40 members and its *Proceedings,* which began to be published in 1903, include the texts of the lectures which are a regular feature of its activities. (*See* also ACADEMIES.)

Clubs.—Literary clubs have generally been short-lived unions unable to survive the original members or even the original members' personal squabbles. Many of the 18th-century clubs in England, however, made important contributions to literature either by their patronage or by their own discussions and the ideas which arose out of them. The two most important clubs of the former type were the Kit-Kat club, the members of which were active playgoers and patrons of the drama, and were probably responsible for the building of the Haymarket theatre in 1705; and the Brothers club, a Tory group which numbered Swift, John Arbuthnot and Matthew Prior among its members, and interested itself in contemporary letters. Swift often submitted his new publications for criticism at this club, and it is probable that the discussions of the members had a guiding influence on *The Examiner*, the Tory periodical which he edited.

The Whig group which gathered around Addison at Button's coffee house, including Sir Richard Steele, Eustace Budgell, Thomas Tickell and Sir William Davenant, was concerned at its meetings with the correction of verses and the planning of periodical essays. The famous Scriblerus club, which took its name from the name "Martinus Scriblerus" given originally to Swift, had Alexander Pope, John Gay, John Arbuthnot and Thomas Parnell, as well as Swift himself, as its members. As the character of Scriblerus became established, any member wishing to write under a pseudonym could use it, and all works written under this name were directed against false learning. *The Complete Memoirs of Martin Scriblerus* was published in 1741. The main importance of the society, however, was in directing the literary interests of five important writers (Pope, Gay, Arbuthnot, Parnell and Swift) and it seems likely that at least Gay's *Beggar's Opera* and Swift's attack on pseudoscience in the third part of *Gulliver's Travels* were products of its discussions. The Club, later called the Literary club, founded by Dr. Johnson in 1764, was a similar discussion group of eminent literary figures, including Edmund Burke, Oliver Goldsmith, Joseph and Thomas Wharton, Edward Gibbon and James Boswell, which met at the Turk's Head tavern in Soho once a week.

Several similar mutual encouragement societies arose in the United States at the end of the 18th century. In 1793 Elihu Hubbard Smith became the centre of the Friendly club in New York, of which William Dunlap, Noah Webster and C. B. Brown were members. Others were Joseph Dennie's Tuesday club, Peter Irving's Knickerbocker group, whose superficially sophisticated work was criticized by Edgar Allan Poe in his sketches entitled "The Literati of New York," and the Bread and Cheese club which gathered around Fenimore Cooper. At the so-called Transcendental club which met in Ralph Waldo Emerson's home in Concord, Mass., Bronson Alcott, Henry David Thoreau, Margaret Fuller and others discussed philosophy, theology and literature in open forum.

In 17th- and 18th-century France the equivalent of these clubs is to be found in the literary and social *salons* of Mme de Rambouillet, Mme Scarron and others. In England, at least, the club as a literary group declined as a result of the loss of the intimacy of 18th-century society and the gradual divergence of the worlds of letters and fashion. (*See* also CLUB.)

Learned Societies.—The 19th century saw the rise of the learned societies which retained their importance into the 20th century by offering centres for discussion, an organized means of preserving literary monuments and literary knowledge, and an opportunity for scholarly publication. The earliest in England was the Assembly of Antiquaries (1572), mentioned above, which was incorporated as the Society of Antiquaries in 1751. In 1812 there was founded the exclusive Roxburghe club for bibliophiles, each member of which in turn presented a new edition of an old text. Its Scottish equivalent, the Bannantyne club, was founded in 1823 with Sir Walter Scott as its president. The Camden society (1838) also laid the foundations for later research by publishing early texts, including the *Peterborough Chronicle,* the works of Walter Map and the *Ancrene Riwle.* Other important organizations of the type were the Shakespeare society (1840), the New Shakespeare society (1874) and the Percy society (1840). Members of the last included Thomas Wright, Alexander Dyce, John Halliwell and John Payne Collier, and the society was responsible for the publication of the works of Stephen Hawes, John Lydgate and Chaucer as well as editions of many ballads, tracts and interludes. The Philological society (1842) devoted most of its energies to the publication of the *New English Dictionary,* later the *Oxford English Dictionary,* and it was while working at this that F. J. Furnivall realized the need for more editions of Middle English texts, which led him to establish the Early English Text society in 1864.

The Royal Society of Literature of the United Kingdom (1825) was the only 19th-century society in England with royal patronage, but it lacked scholars among its first officers, and ill-defined aims led to the dissipation of its energies on diverse subjects: archaeology, geography, religion and economics. Its chief attempt at a work of value to literature, the publication of a *Biographia Britannica Literaria*, begun in 1842, only reached the second volume.

Modern Societies.—*Great Britain.*—Important societies in the first half of the 20th century included the English association (1906), founded to promote knowledge of English language and literature, which publishes the periodicals *English* and *Essays and Studies* as well as the annual review *The Year's Work in English Studies;* the Poetry society (1906), for the study and appreciation of poetry; and the Malone society (1906), for the study of early English drama. Specialist societies devoting their attention to the life and work of one author include the Francis Bacon society (1886), the Brontë society (1893), the Dickens fellowship (1902), the Kipling society (1927), the Johnson society of London (1928), the Shaw society (1941) and the Conrad society (1951).

The United States.—In the United States the earliest philological society, the American Philological society, was founded in 1868 and devoted its activities to American dialects and spelling reform. It was followed in 1883 by the Modern Language Association of America, best known for its distinguished *Publications,* a periodical collection of literary and linguistic monographs known to scholars by its initials *PMLA*. From this association arose the

Concordance society (1906) which fostered the publication of concordances to the works of such authors as Wordsworth and Gray. The most important U.S. societies concerned with the publication of texts include the Grolier club (1884), which publishes valuable books in fine editions; the Dunlap society (1885), for the preservation and publication of U.S. dramatic writing; and the Augustan Reprint society (1946). As well as the Shakespeare Association of America (1923) there are Shakespeare societies in most of the main cities, and there are also numerous societies devoted to individual authors, many of them American, such as the International Mark Twain society (1936) and the Walt Whitman society (1936).

Europe.—Most European countries have writers' unions, the functions of which include the sponsoring and promotion of members' work, the organization of discussions and cultural exchanges with other countries and often legal representation and financial aid. Eastern European countries in particular, including Poland, Czechoslovakia and the U.S.S.R., cultivate this type of society. Soviet literature is served, in addition, by the Gorki Literary institute and by the Gorki Institute of World Literature attached to the U.S.S.R. Academy of Sciences. In the Netherlands the Maatschappij der Nederlandse Letterkunde (1776) promotes national literature, art and history; Portuguese writers are represented by the Sociedade Portuguesa de Escritores and Belgian authors by the Vereniging van Vlaamse Letterkundigen and the Association des Écrivains Belges de Langue Française.

In addition to these national bodies many countries have a branch of the International P.E.N. club for poets, playwrights, editors, essayists and novelists, which aims to promote free cultural exchange between countries and to defend the right of all writers to freedom of expression.

In France the Académie de Franche-Poésie (1919) comprises an *école de poésie*, a library and a *salon* and supervises the *Oeuvre National des Études Poétiques.* Many other French societies are chiefly important as distributors of valuable and distinguished literary prizes. Among them the exclusive Académie Goncourt, the Académie des Lettres et des Arts and the Académie Montaigne are notable, as well as the Maison de Poésie which owns an extensive library.

An important contribution to Shakespeare studies is made in Germany by the Deutsche Shakespeare-Gesellschaft (1864) which publishes the celebrated *Shakespeare Jahrbuch.* Publication of editions of the work of German authors, and of books and articles about them, is undertaken by such societies as the Hölderlin-Gesellschaft (1943), the Goethe-Gesellschaft (1885) and the Gerhart Hauptmann-Archiv (1949). The appreciation of German literature in general is promoted by the Gesellschaft für Deutsche Literatur (1888), and young authors are encouraged by the annual award made by the society known as the "Gruppe 47" for promising new work.

The Società Nazionale Dante Alighieri (1889) aims to spread Italian language and culture throughout the world and founds and subsidizes schools, libraries, courses, prizes and scholarships as well as publishing *Studi Danteschi.* The Casa di Dante, founded in Rome in 1914, concentrates on research into Dante's life and works, publishes a bibliography entitled *l'Alighieri* and issues the *Lectura Dantis Romana* at intervals. General literature is covered by such organizations as the Società Letteraria at Verona and the Instituto Nazionale del Dramma Italiano in Rome.

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LITHGOW, a city and coal-mining and industrial centre of New South Wales, Austr., situated 3,000 ft. above sea level on the western slopes of the Blue mountains, 92 mi. W. of Sydney by road. Pop. (1961) 14,229. The town lies along the Lithgow valley, overlooked by heavily timbered mountain slopes. The first large-scale slaughtering and chilling works in Australia was built there in 1873, and a successful iron and steelworks, later moved to Port Kembla, was established there in 1875. Lying at the heart of the western coal field, Lithgow is surrounded by mines, including the state coal mine. Its industries include the Australian commonwealth small-arms factory (the largest engineering works in the southern hemisphere), a brickworks and woolen and textile mills. One of the early railway engineering wonders of the world, the famous Zig Zag (after 1910 superseded by a series of tunnels), is near Lithgow and has been preserved.

(R. J. LE.)

LITHIUM, a chemically reactive metallic element which resembles somewhat the other alkali metals, sodium, potassium, rubidium and caesium with which it is classified in group I of the periodic system. However, as the first member of the group, lithium is unique and has certain properties which render it distinct from its congeners and somewhat similar to magnesium and several other metals of group II. For example, lithium is the only element of its group to react with nitrogen to form a nitride, Li_3N, whereas all of the metals of group II undergo a similar reaction. It is also unusual in that it is the lightest of all solid elements and at ordinary temperatures has a higher specific heat than any other substance except water.

TABLE I.—*Uses of Lithium*

Field	Application	Form
Agriculture	Tobacco culture	Lithium carbonate
	Soil moisture retention	
	Fungicides	
Air Conditioning	Moisture absorption	Lithium bromide
	Dehumidification	Lithium chloride
Atomic Energy	Proton production	Lithium metal
	Tritium production	Lithium hydride
	Power development	
	Atomic hydrogen	
Batteries	Primary cells (dry batteries)	Lithium chloride
	Storage batteries (alkaline type)	Lithium hydroxide
Bleaching	Production of solid, soluble, and stable bleaching agents	Lithium hypochlorite Lithium peroxide
Ceramics	Porcelain enamels	Lithium carbonate, manganite, titanate, silicate, zirconate and cobalite
	Ground coats and cover-coats on steel and aluminum for acid resistance, improved bonding, lower firing temperature	Lithium minerals
	Pottery glazes	
	Special glasses	
Chemicals	Production of miscellaneous lithium compounds	Lithium carbonate
	Catalysts	
Gas Purification	Removal of trace impurities in helium, argon, etc.	Lithium metal
	Carbon dioxide removal	Anhydrous lithium hydroxide
Heat Transfer	Stable low melting point Salt mixtures	Lithium nitrate
Iron and Steel	Nodular iron grain refinement in steels	Lithium metal and alloys
	Desulfurization of steel	Lithium carbonate
Nonferrous Metals	Chrome bronzes, high-conductivity copper castings	Magnesium alloys High-purity lithium metal
	Bronze, nickel, silver, monel and precious metal castings	
	Bearing metals	
	Aluminum castings	
	Lithium metal cartridges	
Petroleum	Catalysts	Lithium metal
	Sulfur removal	Lithium hydride
	Lubricants	Lithium hydroxide
	Low-temperature greases	Lithium stearate
Pharmaceuticals	Reagent to produce antihistamines	Lithium amide
	Reagent to produce synthetic vitamins	Lithium metal
Plastics	Stabilizers	Lithium stearate
	Catalysts	Lithium lactate Lithium carbonate
Rescue and Signal Work	Balloon inflation	Lithium hydride
	Flares	Lithium nitrate
Welding	Fluxes for aluminum and magnesium	Lithium chloride Lithium fluoride

Lithium was discovered in 1817 by J. A. Arfvedson in Sweden who, while analyzing the mineral petalite, found that the sodium compounds which he separated were contaminated by an alkali which did not respond to the chemical tests for the only other known alkali, potassium. The name lithium (from the Greek, *lithos,* "stone") was proposed by J. J. Berzelius. It was first isolated in quantity in 1855 by R. Bunsen and A. Matthiessen who electrolyzed fused lithium chloride.

Uses.—Lithium was generally unknown and had few uses for more than a century after its discovery. The United States, the world's largest producer, averaged 290,000 lb. of lithium carbonate (or its equivalent) per year for 1935–39. During World War II a peak of 2,790,000 lb. was reached (1944); this was exceeded in

every year after 1950, reaching more than 30,000,000 lb. per year in the 1960s. The metal has been used as a constituent of certain light metal alloys, with magnesium and aluminum-zinc alloys and in heavy-duty lead bearing alloys. It is used as a degasifier in the production of high-conductivity copper and bronze castings and is also used in the synthesis of vitamin A. Lithium compounds are used in lubricants and ceramics, which consume the largest quantities, and in air conditioning, welding and brazing. Nuclear applications include H-bombs, nuclear power and high-energy fuels.

Occurrence and Production.—It is estimated that lithium constitutes about 0.0065% of the igneous rocks of the earth. Because of its high chemical activity, the element occurs only in combination and its compounds are widely distributed but in small concentrations. Traces of lithium are found in animal tissue, plants (especially tobacco), the soil and a large number of minerals. Small quantities occur in sea water and in some springs. The few minerals which contain lithium in quantities sufficient for commercial extraction are: spodumene $LiAl(SiO_3)_2$, petalite $LiAl(SiO_2)_2(SiO_3)_2$, lepidolite $(Li,K,Na)_2Al_2(F,OH)_2(SiO_3)_3$, amblygonite $LiAl(F,OH)PO_4$ and triphylite $Li(Fe,Mn)PO_4$.

Producing countries of lithium minerals include the United States and Canada, Australia, Argentina and Brazil and a number of countries in Africa (Southern Rhodesia in central Africa, South West Africa, Uganda, Republic of South Africa, Republic of the [former Belgian] Congo and Mozambique [Portuguese East Africa]).

Lithium compounds are separated from the minerals by various methods. Generally, in the case of spodumene, the ore is heated to approximately 1,100° C. to decrepitate the mineral from the γ, or hard form, to the β, or soft form (*see* SPODUMENE). The decrepitated material is ground, mixed with strong H_2SO_4, and heated to 150°–250° C. to render the lithium soluble as a sulfate.

In the second case (petalite) limestone is mixed with the ore or concentrates and heated to approximately 1,100° C. The decrepitated material thus formed with the calcined lime is ground and leached to produce a solution of lithium hydroxide.

Phosphate ores (amblygonite) are treated with strong sulfuric acid recovering the lithium as sulfate and recovering also the phosphorus as a sodium or calcium acid phosphate. The lithium and other soluble sulfates are extracted with water and from the purified solution the crude lithium carbonate is precipitated.

The crude carbonate is converted to the dry anhydrous chloride or bromide, which is separated from the impurities by use of an organic solvent, *e.g.*, amyl alcohol, a mixture of ethyl alcohol and diethyl ether, or pyridine.

Lithium metal is obtained by the electrolysis of a fused lithium chloride and potassium chloride salt mixture containing 40%–50% of lithium chloride. Other methods of reduction have been tried but fused salt electrolysis is the process used commercially.

Properties.—Lithium is a white metal with a silvery lustre which quickly tarnishes when exposed to moist air. Its symbol is Li, atomic number 3, chemical atomic weight 6.939. Two naturally occurring stable isotopes with mass numbers 6 (7.5%) and 7 (92.5%) are known; radioactive isotopes, 8 (half life 0.83 sec.) and 9 (0.17 sec.) have been prepared. It has a hardness of 0.6 on Mohs' scale and is harder than the other alkali metals but softer than lead which it resembles in ductility. The crystal lattice of the metal is of the body-centred cubic structure with the distance of closest approach of the nuclei equal to 3.03 Å (angstrom unit $= 10^{-8}$ cm.). Its spectrum like those of the other alkali metals is comparatively simple and is characterized by a bright-red line (6708 Å) and a fainter orange line (6104 Å).

For additional physical and atomic properties *see* Table II.

Lithium is an active metal and a strong reducing agent, readily giving up its 2s electron to form lithium ion, Li^+. It reacts with water at ordinary temperatures liberating hydrogen and forming a solution of lithium hydroxide, a strong base or alkali. Lithium burns in air forming the oxide, Li_2O; at red heat it unites with hydrogen forming the hydride, LiH; it reacts with the halogens and at higher temperatures with phosphorus, arsenic, antimony, carbon, silicon, sulfur and selenium. It is not as reactive as the other alkali metals but in common with them dissolves in liquid ammonia to give a highly conducting coloured solution. It is thought that the colour is caused by single electrons and electron pairs which are trapped in cavities of the liquid rather than by solvated electrons. The normally stable nuclei of lithium undergo transformations when bombarded with rapidly moving particles: with protons, $Li^6 + H^1 \rightarrow He^4 + He^3$, $Li^7 + H^1 \rightarrow 2He^4$; with deuterons, $Li^7 + H^2 \rightarrow Li^8 + H^1$; with neutrons, $Li^6 + N^1 \rightarrow He^4 + H^3$. In the last reaction, used to prepare tritium, the lithium is bombarded with slow moving neutrons which are produced in a uranium pile (*see* DEUTERIUM AND TRITIUM).

TABLE II.—*Numerical Properties of Lithium*

Electron configuration	$1s^2\ 2s^1$
Density of solid at 20° C., g. per c.c.	0.534
Atomic volume c.c.	12.97
Melting point °C.	186
Boiling point °C.	1317
Ionization potential, volts	5.390
Potential for $Li \rightleftarrows Li^+ + e$ at 25° C., volts	3.045
Heat of hydration of gaseous ions kg.cal. per mole	123
Electronegativity	1.0
Heat of sublimation at 25° C., kg.cal. per mole	36.44
Specific heat at 27° C., cal. per g.	0.81
Metallic radius, Å	1.55
Ionic radius in crystals, Å	0.60

Compounds.—The compounds of lithium are predominantly ionic and their chemical properties are in part those of the lithium ion. This ion, the smallest of the alkali group, attracts an electron more strongly than the others and is more easily reduced to the metal. It also attracts water molecules most strongly with the liberation of a large amount of energy, thereby facilitating the reaction of lithium metal with water. As a result, lithium has a high electrode potential in water solution, greater than that of cesium, instead of the lowest of the group which might be expected from the ionization potential.

Lithium hydride is a white solid with a crystalline structure of the sodium chloride type and a melting point of 688° C. Electrolysis of the fused compound liberates lithium at the cathode and hydrogen at the anode. It is typical of the class of "saltlike" hydrides which are formed by the elements of groups I and II. Lithium aluminum hydride, $LiAlH_4$, and lithium borohydride, $LiBH_4$, in common with lithium hydride are strong reducing agents and react with water to liberate hydrogen and form the metal hydroxides. Lithium aluminum hydride is extensively used as a reducing agent in organic syntheses.

Lithium carbonate, Li_2CO_3, a sparingly soluble salt, is used in the preparation of a number of other lithium compounds, in ceramics for producing glazes and in manufacturing special grades of glass. The bicarbonate, $LiHCO_3$, is soluble in water. Lithium fluoride, LiF, has the highest heat of formation of all of the alkali halides and is one of the most stable compounds known. It is somewhat insoluble and is used in soldering and welding fluxes. The bromide, LiBr, used as a drying agent in air conditioners and the iodide, LiI, used in photography are both soluble. The nitrate, $LiNO_3$, the sulfate, Li_2SO_4, the sulfide, Li_2S, and the perchlorate, $LiClO_4$, are all soluble while the normal phosphate, Li_3PO_4, and the oxalate, $Li_2C_2O_4$, are insoluble.

Organolithium compounds; *e.g.*, butyllithium, C_4H_9Li, and phenyllithium, C_6H_5Li, used for introducing alkyl or aryl groups into organic molecules, are prepared by the reaction of lithium with the appropriate organic halides. The reaction of these organolithium compounds with a variety of other substances is a common preparative procedure, resembling somewhat the methods involving the Grignard reagents (organomagnesium compounds). Organic salts of lithium, the benzoate, citrate, salicylate and the acid tartrate as well as inorganic salts were formerly employed in medicine, some for the elimination of uric acid in the treatment of gout and rheumatic conditions. However, the tolerated dose of lithium cannot form the relatively soluble lithium urate in the presence of the quantities of sodium and potassium normally in the blood serum and accordingly lithium salts have been largely superseded in medicine by other diuretics.

Determination.—Lithium may be identified by the use of a spectroscope or by the red colour it imparts to a flame. It is gravimetrically determined in the presence of the other members

of the group by extraction of the chloride with amyl alcohol. Another procedure involves the use of the flame photometer; a lithium salt solution is fed to a flame, the light passes through a prism and one of the characteristic lines impinges upon a photoelectric cell. *See* also references under "Lithium" in the Index.

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LITHOCARPUS is a genus of about 100 species of evergreen oaklike trees of the beech family (Fagaceae), all native to Asia except one species that is abundant along the coast of Oregon and California. This native species, *L. densiflora* (formerly *Quercus densiflora*), commonly known as tanbark oak or tan oak, is important for its bark, which is used in tanning leather, and for its ornamental value. *See* TANBARK OAK. (J. M. Bl.)

LITHOGRAPH, a planographic print made by a process that relies on the natural antipathy of grease to water. This article considers the lithograph in art; for the commercial printing process *see* LITHOGRAPHY. Lithographs as an art form are printed on specially constructed presses from a drawing, usually on stone (hence the name, from the Greek *lithos*, "stone," and *graphein*, "to write"), but metal plates can also be used. These processes are described in the section on technique, which follows the section on history.

HISTORY

ORIGIN

Lithography is one of the very few graphic mediums that has a recorded origin; it was invented in 1798 by a Bavarian, Aloys Senefelder, who documented his discovery and subsequent experiments in *Vollständiges Lehrbuch der Steindruckerey* (1818; Eng. trans., *A Complete Course of Lithography*). The term *Steindruck* ("stone printing," *i.e.*, lithography) was not Senefelder's original name for the process. Actually the use of stones was incidental to his experiments, which were concerned with what he termed chemical printing; his objective was a cheap form of commercial printing that would enable him to publish his own dramatic productions. According to Senefelder, the use of stone as a printing surface came to him in 1796, when, by force of circumstance, he jotted down a laundry list for his mother with a greasy pencil on a piece of stone. It occurred to him that the markings on the stone could be left in relief if the rest of the surface were etched away. His earliest experiments were from these etched stones, as well as metal plates, printed in relief. Further experimentation led, in two years, to the type of flat-surface printing that is called lithography. By the time his book appeared in 1818, Senefelder had experimented with and described every process in modern lithography.

Senefelder's interest in lithography was a purely commercial one. To this end he accepted an offer from the music publisher Johann Anton André to establish himself at Offenbach and to train persons in the new process. As a result of this kind of partnership, and at André's suggestion, patents were secured in various localities, including London.

19TH CENTURY

Germany.—In Bavaria, under the impetus of Senefelder's press at Munich, commercial lithography proceeded to develop as a reproductive medium; the first important publication was a facsimile edition of Albrecht Dürer's *Missal of Maximilian* in 1808, redrawn on stone by Johann Nepomuk Strixner. Other reproductive lithographs were produced in great quantities by the Quaglios, Karl von Piloty and others.

An abortive attempt to produce an original lithograph was made by the Bavarian count Törring-Seefeld in 1800. His views of the Lake of Wörth, as well as similar attempts by Mitterer and his pupil Angelo Quaglio, failed. E. J. Aurnhammer, a professor at the Gymnasium of Regensburg, sent 12 landscape subjects on stone to Senefelder in 1802 for printing in Munich, but only 6 survived. In the publication *Polyautographische Zeichnungen vorzüglicher Berliner Künstler* of 1804 appeared a lithograph by Johann Gottfried Schadow, who can be credited with being the first German artist of merit to take up lithography. Schadow produced 45 lithographs in all. Another contributor to this publication, as well as its publisher, was the painter Wilhelm Reuter, who had interested himself in the process since 1801. The architect Karl Friedrich Schinkel also made a few lithographs; one of a Gothic church done in 1810 is an exceptionally fine pen lithograph. For the greater part of the 19th century, lithography was not very highly regarded by the most competent artists. However, mention should be made of Joseph Kriehuber, the favourite portraitist of the Vienna school, who drew many of his heads on stone. Adolf von Menzel, also well known as a book illustrator in wood engraving, kept the art alive with competent technical knowledge and accomplished drawing, displaying a special virtuosity with the white scratched-line technique. Toward the end of the century, Hans Thoma took up the medium, experimenting with colour prints and encouraging other artists; and Otto Greiner worked many of his figure studies on stone.

France.—The first attempt at lithography in France was unsuccessfully conducted by Frédéric André, while the earliest effective French trials by Pierre Nolasque Bergeret were published not in France but by an English art dealer, Bell, in 1801. The first lithograph drawn and produced in France is considered to be "Le Mercure" by Bergeret, done in 1804. However, lithography did not receive official recognition until 1809, when the director-general of museums, Vivant Denon, drew a Holy Family at Senefelder's shop in Munich.

Lithography developed in France as in no other country. Gradually taking hold of the imagination of both amateur and professional artists, the new medium appealed as an autographic way to reproduce drawings. Most of the work of the early French lithographers, Carle Vernet, N. T. Charlet, who produced around 1,000 prints, Eugène Lami and Denon, was drawn in simple black lines with a minimum of shading. The painter Eugène Delacroix took up lithography and became a master of the technique; his professional stature added prestige to the new process, by which he produced nearly 100 prints, including illustrations to *Faust, Hamlet* and other dramas. Other outstanding artists of this early period were Eugène Isabey and the immensely influential Théodore Géricault, who lithographed many studies of horses. Pierre Paul Prud'hon, Théodore Chassériau and Auguste Raffet were other significant contributors to the art.

From 1820 to 1863 there appeared a monument to lithographic illustration in the form of Baron I. J. S. Taylor's *Voyages pittoresques et romantiques dans l'ancienne France*, with contributions by Isabey, Géricault, Célestin Nanteuil and many others.

The most prolific figure in 19th-century French lithography was undoubtedly Honoré Daumier, who, between 1830 and his death, in 1879, made nearly 4,000 caricatures. These appeared in the political journals and newspapers of his era and earned him an unshakable place in the great tradition of art and humour. Paul Gavarni followed closely as a chronicler of fashionable Paris.

A decline set in everywhere around mid-century, due not only to excessive commercialization of lithography but also to the newly developed technique of photography and its application to the various reproductive processes. A revival from this setback came about in the decade of the 1870s. Camille Corot began working in the medium in 1871; his work includes 18 pieces. Edgar Degas tried lithography for the first time in 1874; a tireless innovator, he saw in it yet another outlet for his versatile talents. Édouard Manet, whose first work on stone was done in 1862, illustrated Poe's "The Raven" in 1875; Camille Pissarro made his first 12 lithographs in 1874. Rodolphe Bresdin created some lithographs, even transferring some of his etchings to stone. His pupil Odilon Redon practically abandoned painting for lithography from 1883 to 1899, creating eerie and mystical subjects.

Colour lithography, already used by Manet for his plate "Polichinelle" in 1876 and by Jules Chéret, a pioneer of the colour poster, reached its zenith in the 1890s. Henri de Toulouse-Lautrec, a technical innovator, a magnificent poster artist and a

great portrayer of the theatre and the arts of the 19th century, executed his "Moulin Rouge"—his first colour poster—in 1891. To the Impressionists also, colour was all important; Édouard Vuillard was producing such colour masterpieces as his *Douze Lithographies en couleurs* during this decade; and Pierre Bonnard, his *Quelques Aspects de la vie de Paris*. Other powerful artists who turned their hands to lithography in the last quarter of the century were Paul Gauguin, Eugène Carrière, Pierre Puvis de Chavannes and Ignace Fantin-Latour.

England.—Lithography in England received its initial impetus from Senefelder himself and his business associates. In 1800 they went to London to obtain a patent and to arouse interest in the new process. The patent was obtained in 1801; the promotional effort took the form of a publication entitled *Specimens of Polyautography* . . . appearing in 1803. Several well-known artists contributed to this first example of lithographic production in England: Benjamin West, Henry Fuseli and Thomas Stothard among others. West's design of the angel at the tomb of Christ is dated 1801 and may be considered the first lithograph of true merit to have been produced.

Despite this promising start, the English did not seem to take to the new medium very readily. Charles Hullmandel issued a series of *Twenty-four Views of Italy* in 1818 and later, in 1821, brought out 12 designs of *Various Subjects Drawn From Life on Stone* by Géricault, who was in London at the time. James Ward did a series of 14 *Celebrated Horses* in 1823, and Richard Parkes Bonington executed some very accomplished colour lithographs, particularly for Baron Taylor's book. Other English artists, such as Samuel Prout, James Duffield Harding and Thomas Shotter Boys, helped continue the tradition; but the process fell into the general pattern of decline until revived in the latter decades of the century by the American expatriate James Abbott McNeill Whistler. Although his work seems slight—particularly his delicate nudes—his influence was strongly felt, perhaps because his colourful career gave an added interest to anything with which he concerned himself.

Elsewhere in Europe.—Lithography had but one important adherent elsewhere on the continent—the great Spanish painter and etcher Francisco Goya, who drew, in all, 23 lithographs. Among them are four bullfight scenes that are a landmark of technical virtuosity and compositional strength.

United States.—The first lithograph produced by an American was the one mentioned above by West in 1801, for he was actually an American working in England. So far as lithography on the American continent is concerned, however, the introduction of the process to the United States is credited to Bass Otis of Philadelphia, Pa. In 1818 Otis etched on stone a portrait of Abner Kneeland for a frontispiece to a book of sermons by that clergyman. However, a little view of a mill, appearing in the July 1819 issue of the *Analectic Magazine*, is regarded as the first true American lithograph. Rembrandt Peale was among the first artists to employ the medium. Other important early figures were Thomas Doughty; George Lehman, who lithographed scenes in Pennsylvania; J. C. Wild, who executed an important set of Philadelphia views; August Kollner; Christian Schussele, an influential art instructor; Albert Newsam, a deaf-mute artist and lithographer of hundreds of portraits; and M. E. D. Brown.

When reviewing lithography of the 19th century in the U.S., there must be taken into account the tremendous output of the publishers Nathaniel Currier and James Merritt Ives, who produced well over 6,000 lithographs after the designs of such well-known artists as George Inness, A. F. Tait, Louis Maurer, F. F. Palmer, Eastman Johnson and many others (*see* Currier & Ives). The publishing houses of Sarony and Major, and the Kelloggs, were also prolific. Not to be forgotten is Winslow Homer, who made a strong contribution with his *Campaign Sketches* of the American Civil War.

20th Century

The painter-lithographer tradition again declined during the early part of the 20th century. French artists, such as Degas, Paul Signac, Auguste Renoir, Bonnard, Jean Louis Forain, Vuillard, Maurice Denis, T. A. Steinlen and Mary Cassatt, as yet unrecognized in her native America, seemed to be working in isolation so far as their work influenced the medium elsewhere. In England the Senefelder club was formed in 1909 to provide an outlet for artists working in lithography. Augustus John, John Copley, Ethel Gabain, Charles H. Shannon and William Rothenstein were a few who kept the art lively. In Germany the Expressionist school was coming to the fore. Though its work was not immediately understood or appreciated, it gradually received recognition as one of the most powerful molders of 20th-century art. Käthe Kollwitz, the Norwegian Edvard Munch, Lovis Corinth, Max Slevogt, Max Liebermann, E. L. Kirchner, Emil Nolde, Max Beckmann, Ernst Barlach, Oskar Kokoschka, Paul Klee, the American Lyonel Feininger and George Grosz were among the group that challenged the ideal of beauty by rugged emotional display.

In the United States Joseph Pennell, whose work both in the U.S. and England, as well as his book on lithography (1st ed., 1898), made him an important proponent of the medium, led a strong group followed by George Bellows, "Pop" Hart, Bolton Brown, Albert Sterner, Arthur B. Davies, Childe Hassam, Rockwell Kent and Mabel Dwight, as well as Max Kahn, Stow Wengenroth, Benton Spruance, Adolf Dehn, Francis Chapin, George Biddle, William Gropper and Robert Riggs.

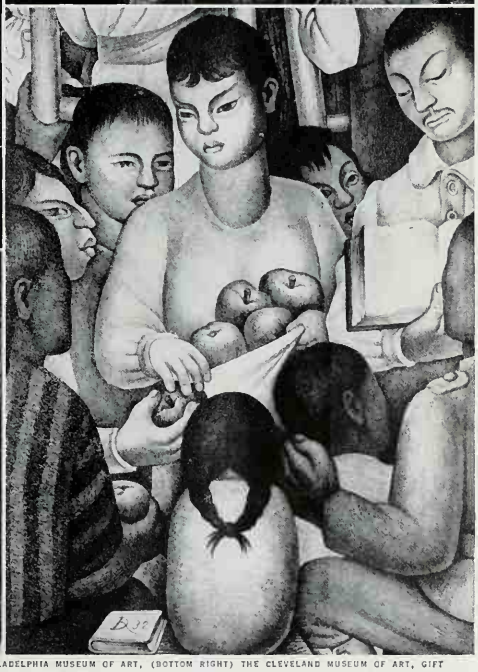
During this century an exciting group of lithographs came from the leading painters of Mexico: José Clemente Orozco, Diego Rivera, David Alfaro Siqueiros, Jean Charlot and Rufino Tamayo. In England, where lithography never was very popular, the names of Graham Sutherland, Henry Moore and Robert Colquhoun stand out.

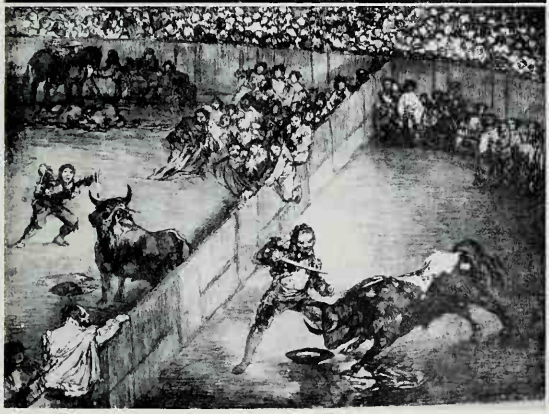
It was from the school of Paris, however, that a vigorous revival of lithography came. To those giants of painting, Henri Matisse, Marc Chagall, Georges Rouault, Fernand Léger, Georges Braque and, above all, Pablo Picasso, with his prodigious output, is owed the tremendous popularity of the medium. Their influence has been international not only in stimulating all the graphic arts but also in freeing them from superficial limitations of size, technique and other preciousness. The colour lithograph, along with other colour-print processes, now rivaled paintings in size and attractiveness.

Printers and Publishers.—It should be remembered that most of the work of the school of Paris came about through the availability of dedicated lithographic printers. In Paris the firms of Fernand Mourlot and "Papa" Desjobert, with their enthusiasm and encouragement, made possible much of mid-20th-century lithography. Their accomplishment, however, is a timeless one, for it has ever been true that the greatest flowerings of lithography have come about as a result of the dedication of a few printers serving many artists—stimulating and easing the way for the production of great lithographs. Senefelder himself spent his life spreading information on the technique that he invented and stimulating production through his ability to print. The names of Bolton Brown, Lawrence Barrett and Lynton Kistler are to be remembered in the U.S.; Thomas R. Way, Whistler's printer in England, and before him, Hullmandel will not be forgotten. In France the names of Clot, Rose Joseph Lemercier, Godefroy Engelmann, Charles Motte, Delpech and Charles Philibert de Lasteyrie du Saillant will be recalled, as well as those of the publishers Ambroise Vollard and David Kanweiler. In Germany Paul Cassirer and the Marées society were important as publishers. (K. McN.)

TECHNIQUE

Lithographs are made as follows: (1) The stone is grained. (2) The outline of the picture to be reproduced is drawn on the stone. (3) The drawing is done with tusche or crayon containing grease. (4) The stone is etched, placed in position on the press bedplate and washed with turpentine, which removes the soap and wax from the tusche or crayon. (5) The stone is dampened and rolled (inked). The drawing on the stone repels the water. The thin film of water on the bare parts, in addition to repelling ink, actually prevents the inked roller from touching those areas of the





BY COURTESY OF (TOP LEFT, TOP RIGHT) LAWRENCE BARRETT, (CENTRE LEFT, BOTTOM LEFT) PHILADELPHIA MUSEUM OF ART, (BOTTOM RIGHT) THE CLEVELAND MUSEUM OF ART, GIFT OF THE PRINT CLUB OF CLEVELAND

19TH- AND 20TH-CENTURY LITHOGRAPHS

Top left: "Angora Cat" by Lawrence Barrett (1897–), U.S. Drawn on stone with dry brush and tusche

Top right: "Girl With a Bouquet" by Peppino Mangravite (1896–), U.S. A combination of scratching, scraping and drawing, with most of the middle tone applied by roller and ink

Centre left: Still life by Pablo Picasso (1881–), Spanish. Crayon drawing with some scratching

Bottom left: "Bull Fight" by Francisco Goya (1746–1828), Spanish. Crayon on stone

Bottom right: "Tree of Life" by Diego Rivera (1886–1957), Mexican.

LITHOGRAPH

BY COURTESY OF (TOP LEFT, BOTTOM LEFT, BOTTOM RIGHT) THE CLEVELAND MUSEUM OF ART, (TOP LEFT) GIFT OF THE PRINT CLUB OF CLEVELAND, (BOTTOM LEFT) GIFT OF RALPH KING, (BOTTOM RIGHT) MR. AND MRS. LEWIS B. WILLIAMS COLLECTION; (TOP RIGHT) THE COLORADO SPRINGS FINE ARTS CENTER

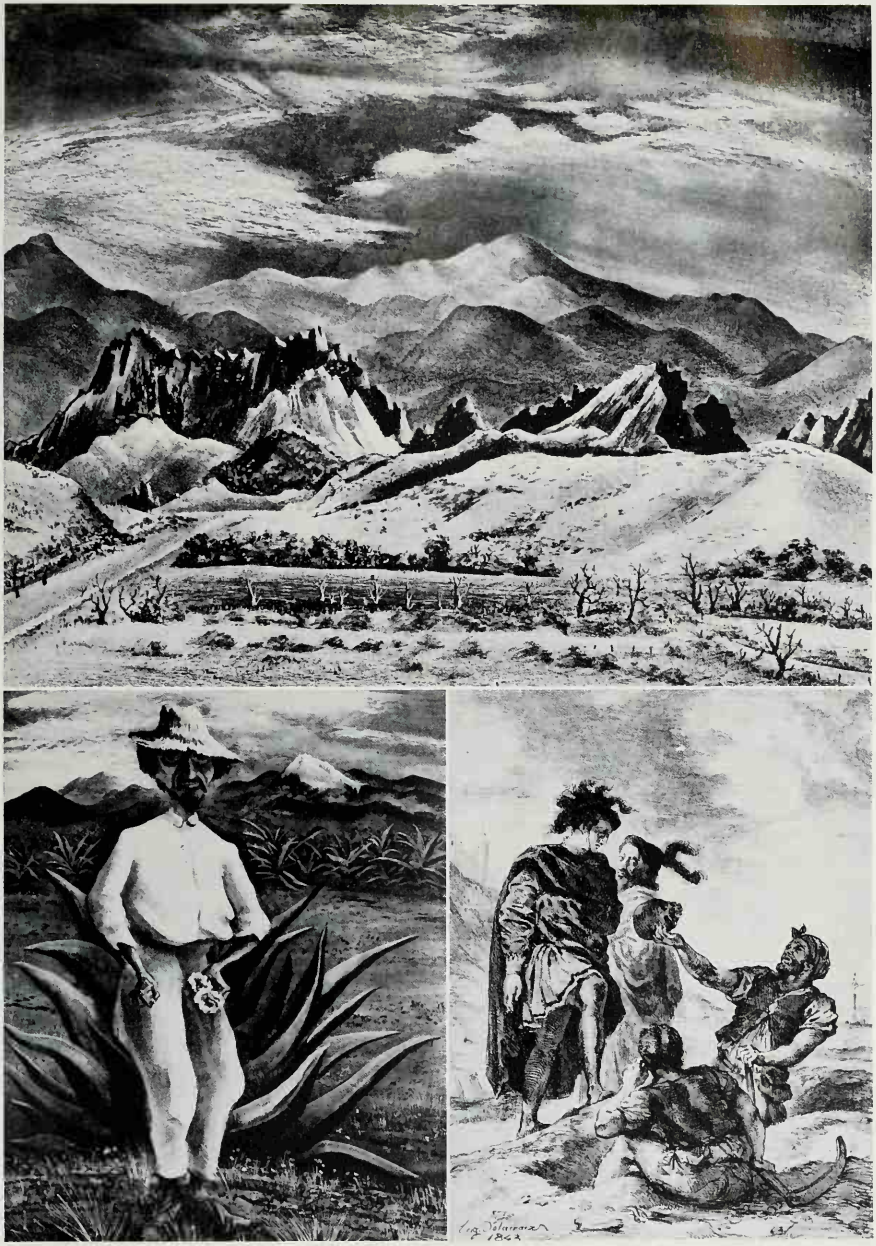
LITHOGRAPH TECHNIQUES

Top left: Self-portrait by Käthe Kollwitz (1867–1945), German. Drawn on paper and transferred to stone

Top right: "Rabbit" by Rico Lebrun (1900–64), U.S. Stone rolled with ink for middle tones. Highlight was scraped out and crayon drawing added

Bottom left: "May Belfort" by Henri de Toulouse Lautrec (1864–1901), French. Crayon drawing with tusche

Bottom right: "Figure in a Doorway" by Thomas Stothard (1755–1834), English. Pen drawing with tusche



BY COURTESY OF (TOP, BOTTOM LEFT) THE COLORADO SPRINGS FINE ARTS CENTER, (BOTTOM RIGHT) PHILADELPHIA MUSEUM OF ART

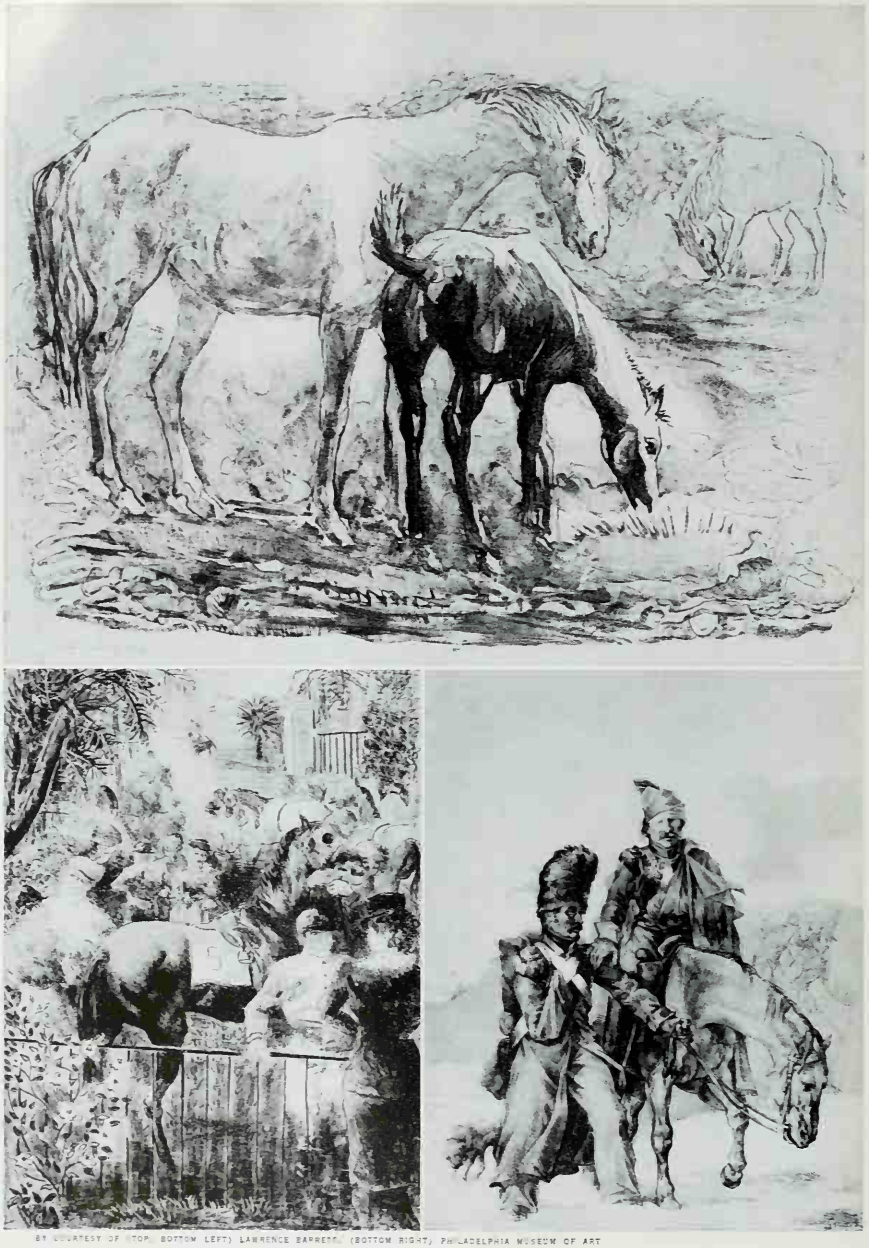
U.S. AND FRENCH LITHOGRAPHS

Top: "The Garden of the Gods" by Adolf Dehn (1895–), U.S. Textural effects in the sky were obtained by rubbing with an ink eraser, in the mountains and rocks by scraping

Bottom left: "The Man From Orizaba" by Dehn. Done on stone with crayons, a piece of felt, a razor blade and eraser

Bottom right: An illustration for an edition of Shakespeare's "Hamlet" by Eugène Delacroix (1798–1863), French. A typical 19th-century use of crayon on stone

LITHOGRAPH



BY COURTESY OF (TOP, BOTTOM LEFT) LAWRENCE BARRETT, (BOTTOM RIGHT) PHILADELPHIA MUSEUM OF ART

LITHOGRAPH STUDIES OF MEN AND HORSES

Top: "Spring" by Lawrence Barrett (1897–), U.S. Lithotint on stone

Bottom left: "Unsaddling Paddock—Hialeah" by Randall Davey (1887–1964), U.S. Crayon with felt rubbing and some scratching and scraping

Bottom right: Book illustration by J. L. Géricault (1791–1824), French. An early lithograph done on stone

stone. Therefore, only those parts of the stone that have been drawn on with the grease material receive the ink, and all bare parts of the stone that have been moistened with water do not take the ink and do not print. It is then covered first with a piece of dampened printing paper, then with backing, which consists of two or three clean blotters, next with the tympan (a piece of hard fibreboard) and printed. The stone is dampened and rolled for each successive print. Hundreds, or thousands if necessary, of prints can be made from a stone or zinc plate. Lithographs can be made in multiple colours by printing with coloured inks, using a separate stone for each colour.

The Stone.—The best lithographic stones come from Solnhofen and Kelheim in Bavaria. Of a form of limestone found deep in the earth, they are of even thickness and perfectly flat. Stones are classified according to colour: blue (hard), blue-gray (medium) and yellow (soft). Blue-gray stones are preferred by artists. Both stones and metal plates must be grained with an abrasive to prepare them for the drawing. Stones are grained by rubbing together in a circular motion two stones with wet carborundum grit between them. Their positions are occasionally reversed, and more grit and water are added until any former design has completely disappeared. The size of the grit determines the texture of the drawing surface. Care must be taken to protect the stone from grease, dandruff, saliva or fly specks. A piece of cloth, tissue or a barrel stave is used as a bridge to prevent the hand from touching the stone while the artist is working on it.

The Drawing.—A nongrease crayon is used to sketch the outline of the drawing on the stone. The drawing should be reversed, since a print comes off the stone as a mirror image of the drawing.

Several drawing techniques are used in making lithographs. Lithographic crayons are supplied in both stick and pencil form in a wide range of grades from no. 0 (very soft) to very hard Copal no. 5. Tusche is supplied in bottles and in stick form. The liquid kind, often called ink, makes solid black areas when applied with a brush, and thin, sensitive lines when applied with a pen. Stick tusche, which must be dissolved in water, is used for wash lithographs called lithotints and for dry-brush lithographs. Smutty, close-grained dark grays are made by rubbing dark areas with a piece of felt or by scraping and shaving with a razor blade. Razor blades are used to soften hard, dark edges and sometimes are used to lighten or scrape out parts and make interesting textures. When a lithograph is to have a solid, dark-gray undertone for the background, such a tone can be laid on the clean, blank stone with a lightly inked composition roller. Parts of the tone can be scraped away or washed out with gasoline to make light areas, and dark areas can be added with tusche and crayon.

Areas can be lightened and textured by laying a piece of tissue paper on the stone and crosshatching over it with a lead pencil or stylus. When the tissue paper is peeled off some of the crayon will adhere to the underside of the paper. Crisp white lines are scratched into dark areas with sharp-pointed tools: razor blade, needle, penknife, etc. The result often resembles a wood engraving. Sharp tools are useful for making dark tones lighter by picking out some of the dots that make up the tone. Small areas can be erased by placing a pinch of carborundum grit or flint on the spot and regrinding with the flat bottom surface of a glass bottle stopper. Striking textural effects are obtained by use of an ink eraser.

To make a lithographic engraving, a fairly soft stone is grained with extra fine carborundum grit or flint. The stone is lightly etched, smoothed with cloth and dried. The drawing is made with a lithographer's engraving needle, which has five facets. Wide shallow lines are made by pulling the needle—not pushing it—to scratch through the gum, barely into the stone. Errors are corrected by applying a thin gum covering, which then can be engraved again. When the engraved drawing is finished, first light machine oil, then lithographic ink, is rubbed in. The printing is done in the usual way, described below.

Lithographic printing is a difficult and complicated operation and is usually done by a professional printer rather than by the artist.

The Etch.—Before printing, lithographs must be etched, to set the drawing to the stone, and cleaned of excess grease that has spread out from the drawings. The etching solution for stones is prepared by pouring a few ounces of gum solution, *i.e.*, about equal parts by volume of water and gum acacia, into a small bowl and adding half a teaspoonful of nitric acid. The gum solution desensitizes the surface not drawn on, decreasing its affinity for grease; the acid eats away any invisible particles of grease that may be on the surface but, when in the correct solution, does not affect the drawing itself, which is protected by the wax in the lithographic crayon. Etching solution is applied to the stone with a large soft brush.

The amount of acid required for the etch solution depends upon many factors, such as room temperature, hardness of the stone, type and age of the drawing and strength of the acid. Often, some parts of the drawing that require a stronger etch than other parts must be gone over with a brush and a stronger solution.

Printing.—Having properly etched the stone, the printer removes the excess gum with a rubber plate scraper and fans it dry. Then he gently rubs it with a damp cloth and a few drops of gum solution. After it has dried, the printer washes off the crayon drawing with turpentine and a soft cloth, leaving the drawing invisible, apparently destroyed; but it is preserved, of course, in the grease still remaining in the pores of the stone. He then rubs ink or asphaltum into the stone. As soon as this has dried, the stone is sponged with water and rolled with a grained roller well charged with lithographic ink. Lithographic ink comes out of pound cans in tarlike chunks; it must be kneaded and thinned with lithographic varnish before using. A small amount is spread onto a slab of stone, and the roller is charged with ink by rolling it briskly over this slab until it produces an audible hissing sound.

A lithograph is printed on a specially constructed press, which has a traveling bedplate that carries the freshly inked stone with dampened paper, backing and tympan under a leather-covered scraper. When the crank is turned, the inked image is rubbed or scraped off the stone onto the paper as it is forced through the press. The scraper is kept well greased to reduce friction. Lithographic presses weigh several hundred pounds.

The first few prints "pulled" (printed) are light, because the stone has absorbed some of the first ink applied. Printing can be interrupted at any time to make corrections. Small areas can be scratched out or lightened with a razor blade and the areas lightly swabbed with a 2% solution of phosphoric acid. When additional work is to be added, the stone must first be counteretched. This is done by inking the stone, dusting it with rosin to dry the ink and washing it with a saturated solution of alum (called counteretch solution). The new work is added and the stone etched again. Then the whole process of preparation and printing is repeated.

If the prints keep getting darker as the edition progresses, the stone must be re-etched. To do this the printer inks it, dusts it, etches it again, washes it out and prints it as before. If the stone is to be put away for future printing, it should be rolled, dusted, etched very lightly and covered with thin paper while wet.

Transferring.—Many print makers prefer to draw lithographs on paper and have a printer transfer the drawing to stone or zinc for printing. Such transfers often require some additional work to be done on the plate or stone, either by the artist or printer before printing. Transfer lithographs are easily identified because their texture is like the paper they were drawn on. Special transfer papers are available, but any thin paper will do. When an artist draws on paper for transfer he does not have to reverse the drawing. The drawing medium must contain grease.

The drawing must be softened by soaking it for a few minutes in a tray filled with a solution of about 30 drops of nitric acid for each quart of water. The stone or plate used for the transfer must be larger than the print, smoothly grained and warmed slightly. The lithographic press is used to transfer a drawing to the stone. In transferring the drawing while still moist, it is placed face down on the stone or plate and covered with aluminum foil, backing and tympan. The press is adjusted and set for extra pressure to make transfers.

The drawing, when transferred to stone or plate, will appear weak, but some of the grease will have penetrated the stone, and the design will come up stronger when it is printed. Transfer lithographs should be lightly etched before printing; otherwise they are printed in the same manner as originals. Sometimes transfer lithographs darken during the printing and must be etched again.

Metal Plates.—Lithographs can be made in the same manner on zinc or aluminum plates, which are bought already grained. Metal plates are preferred by some artists because of their convenience in handling. They are very sensitive to grease and are especially suitable for transfers and for lithotints. The technique for drawing on zinc is the same as for drawing on stone. Textural effects are limited. The metal is hard and cannot be scraped or scratched for corrections.

The process for preparing plates varies slightly from that used for stones. After a zinc or aluminum plate has been drawn upon, it is regummed and dried. Then it is etched, washed out with turpentine and water, rubbed up with asphaltum, washed with water, rolled with ink and printed without being allowed to dry again until the edition has been printed.

The etch solution for zinc plates is about 4 oz. of gum solution and 1 tsp. of chloric acid and 12 drops of phosphoric acid; for an aluminum plate, 4 oz. of gum arabic and 15 or 20 drops of phosphoric acid. Commercial preparations are sold for etching zinc and metal plates.

See ETCHING; *see* also references under "Lithograph" in the Index; and articles on most of the artists mentioned in this article. (L. BA.)

See Felix H. Man, *150 Years of Artists' Lithographs* (1953); J. and E. R. Pennell, *Lithography and Lithographers* (1915).

LITHOGRAPHY is one of the most widely used methods of printing. In its usual commercial or industrial application it is known as offset lithography because the inked image is first printed on a rubber cylinder, which then offsets or transfers the image to paper or other material. The process is also known as photolithography, photo-offset, offset and planography. Because of the flexibility of the rubber cylinder, lithography can be used to print on tin, wood, cloth, leather and rough, as well as smooth, paper. For a discussion of lithography as an art form, *see* LITHOGRAPH.

In lithography the matter to be printed is neither raised above (as in letterpress) nor sunk below (as in intaglio) the surface of the plate but remains on the surface, or plane. For this reason the process is sometimes called planography. Lithography is based upon the principle that grease and water do not mix: ink is deposited on grease-treated printing areas, while the nonprinting parts, which hold water, reject the greasy ink.

Lithography is used mainly to produce printed matter that is required in large quantities; *e.g.*, calendars, greeting cards, bank checks and deposit slips, booklets, letterheads, books, magazines, newspapers, maps, posters, billboards, stamps, labels on tin cans, packaging and other advertising matter. Posters can be lithographed on rotary presses either by offset or by direct printing from the plate. Since most posters require strong colour, direct presses are usually used.

Offset lithography is particularly advantageous in long runs (over 10,000) of large-sized sheets. Only gravure can compete with it in certain types of work. Letterpress plates cannot be made so large as offset plates, while silk-screen and collotype methods are suited, for other reasons, mainly for short press runs. (*See* PRINTING PRESS.)

History.—The lithographic process was invented by Aloys Senefelder (*q.v.*) of Munich, Ger., in 1798. Senefelder had experimented for several years in an effort to discover a cheap method of printing plays and sheet music. In making the first lithographs he used a variety of calcium carbonate stone (limestone) that is found mainly in Bavaria; it has a porous texture that absorbs grease and water. He also suggested the use of grained metal plates, *i.e.*, plates treated so as to give them a granulated surface, but they did not come into general use until the 20th century, when they gradually replaced Bavarian limestone. However, stone is still preferred by artists for making hand-printed lithographs.

Up to 1818, when Senefelder published a technical description of lithography, the process was used sparingly because the procedural techniques were kept secret. Artists in England, France and Germany published work from 1803 on, but the first lithograph in the United States, drawn by Bass Otis, was not published until 1819 (in the *Analectic Magazine*). After 1825 lithography advanced rapidly.

Many firms were established for producing a variety of commercial work and for distributing popular topical, historical and religious subjects to a wide audience. The best known of these publishers was Currier & Ives (*q.v.*) of New York. The firm was founded in 1857, although Nathaniel Currier published work from 1834 on. The lithographs were printed in black ink and were often hand-coloured by an assembly line of women, each of whom applied a separate tint of water colour.

Some good early work was done in colour lithography (using printed colours) by Godefroy Engelmann in 1837 and Thomas S. Boys in 1839, but the method did not come into wide commercial use until 1860. It then became the most popular method of colour reproduction for the remainder of the 19th century. These products were called chromolithographs, chromos or oleographs. They were made by preparing a separate stone by hand methods for each colour (tint) to be used and printing one colour in register over another. Sometimes as many as 30 stones were employed for a single subject.

The steam-driven lithographic press was perfected by Hughes & Kimber of England about 1865 and introduced into the United States in 1866. These presses utilized automatic rollers to moisten and ink the stone, while the paper was pressed into contact by a revolving cylinder. P. S. Duval, writing in the *American Encyclopaedia of Printing* (1871), said that about 450 hand presses and 30 steam presses were in operation in the country at that time. The power press made it possible to print larger stones than ever before, with sizes up to about 44 by 64 in. Although the offset method of printing was first patented by John Strather of England in 1853, the first practical application of this principle came in the 1870s, when rubber offset rollers were used on flat-bed presses for printing on tin and other metals.

The rotary press for lithographic printing came into use in the late 1890s. Lightweight zinc sheets, which could substitute for the heavy stones, were curved around cylinders for rotary printing. Two main cylinders were used, one for carrying the plate and the other for carrying the paper. Early rotary presses could print about 1,100 impressions per hour, about double the performance of the flat-bed power press then in use.

As soon as photography became a practical process in 1839 because of work by Louis J. Daguerre of France and William Henry Fox Talbot of England, efforts were made to adapt it to lithography. Among early experimenters who reproduced line drawings were Joseph Dixon of the United States in 1840 (his technical description, however, was not published until 1854) and Frédéric Zurcher of France in 1842.

Late in 1852 Rose Joseph Lemercier, a Parisian lithographer, together with Charles Barreswil, Nicolas P. Lerebours and Louis Alphonse Davanne, made the first photolithographic half tones (prints in a gradation of tones). They used bitumen of Judea (asphalt) for sensitizing the surface of a grained lithograph stone and developed the image, made through a paper negative, with ether. This slow, expensive and dangerous method was superseded by the albumin process patented by Alphonse Poitevin in 1855; this process, which was essentially the same as the albumin process still used in the early 1960s, employed dichromated solutions of albumin, gum or gelatin as light-sensitive coatings.

In 1857 Eduard I. Asser in Holland invented the phototransfer process, which he patented in England in 1860. In this process a photographic image on sensitized paper is inked and transferred to the printing surface. Henry James of England, in 1859, first used grained zinc to replace stones in making phototransfers. J. W. Osborne of Australia improved the transfer process in 1859 and made it commercially feasible for reproducing engravings, pen

and ink drawings, maps and other line work.

James A. Cutting and Lodowick H. Bradford made the first lithographic half tones in the United States, in 1858. The first use of the half-tone screen in lithography was made by Edward and James Bullock of England in 1866. They employed a glass surface or a translucent paper sprinkled with opaque dots. These produced half-tone prints with a granular texture.

William A. Leggo of Canada made half tones in 1869 through a glass screen coated with darkened collodion and ruled with crossing lines drawn with a diamond point. The resulting prints had a dot structure similar to that made from a modern half-tone screen. (This is composed of two sheets of glass, each covered with fine lines running in a diagonal direction; the sheets of glass are fastened together so that the lines form right angles. The resulting crosslined squares break up a reflected image into dots of varying sizes, depending upon the amount of light that penetrates the transparent squares.)

Offset methods for printing on paper were developed separately in the United States shortly after 1900 by Ira W. Rubel of New Jersey, Alex Sherwood of Illinois and A. W. and Charles Harris of Ohio. Rubel, in collaboration with Sherwood, made the first good press in 1906; this later became the Potter press. The Harris brothers, about one month after the Rubel press appeared on the market, made the first press to be commercially exploited. Many of the initial steps in improving offset lithography were taken by William C. Huebner of the United States, who developed the precision all-metal camera, step-and-repeat machines (widely used to produce multiple images on an offset plate) and plate-coating machines.

The use of colour half tones, which was limited before 1920, expanded rapidly after that date because of the introduction of improved methods of dot etching and improved techniques of registration (superimposing one colour over another). The new etching method permitted better tone control by making it possible to reduce the size of the dots when desired.

Offset presses vary greatly in size. The largest can accommodate sheets as large as 52 by 76 in. and can print up to six colours in a single run. Paper can be fed from a roll (web printing) and cut to the desired size in the press after printing. Usually, however, single sheets are fed in. Some offset presses can print on both sides of the paper simultaneously.

Hand Methods.—The method of preparing stones for hand printing, which is still the lithographic method preferred by artists, has remained substantially unchanged since Senefelder's time. The materials and procedures of the 19th-century lithographer are duplicated in almost every respect by the contemporary hand printer. Three types of stone are used: blue-gray, gray and yellow. The latter, which is very soft, is for coarse work only. The stone is grained to provide an even texture for receiving the drawing. This is done by sprinkling a hard, powdered abrasive, such as flint or carborundum, on the stone, adding water as a lubricant and rubbing with another stone in a flat, rotating motion. After the graining is completed, the drawing is made on the stone or is transferred from a sheet of specially prepared paper. The stone is etched by brushing on a solution of gum arabic (acacia) and nitric acid; the solution also desensitizes the surface to, *i.e.*, lowers its affinity for, grease. Next the stone is rubbed with a solution of gum arabic, the drawing is washed off with turpentine and the stone is rubbed with asphalt (asphaltum) to strengthen the greasy areas. Finally, the stone is coated with water and inked for printing.

The printing is done on a press that exerts a sliding or scraping pressure. The pressure is exerted through a bar of wood that is immovably fixed at the top and is covered at the bottom by a strip of greased leather. The stone to be printed is covered with dampened paper and a flexible backing board and is placed on the press bed, which is then raised by a lever to make firm contact with the scraper. The printer moves the bed horizontally, and the paper is pressed against the inked stone by the sliding pressure of the scraper. When the scraper reaches the end of the stone, the bed is lowered and the backing board and the inked paper are removed.

Types of Plates.—There are four basic types of offset plates: paper, albumin, deep-etch and bimetallic. Copy can be typed directly on special paper for printing on small office-type presses; such plates can produce 5,000 to 10,000 copies under average conditions. The albumin and deep-etch processes, which employ photographic techniques, are for longer runs. Albumin plates can produce up to 25,000 impressions; deep-etch plates are capable of several times this number. Bimetallic plates, which also are made photographically, are extraordinarily durable, being capable of printing more than 1,000,000 impressions. These plates are made from two different metals, one of which holds water and repels grease, while the other, which composes the printing image, attracts greasy ink.

Preparation of Copy and Plates.—Photolithography, since it is a duplicating process, requires material to reproduce. This material, which is known as copy, can consist of typographic matter, water colours, oil paintings, line drawings, hand lettering and photographs, either alone or in combination.

Copy is usually prepared as a paste-up that combines type matter with other line copy (black and white, such as line drawings). The type matter is taken from proofs ("repro proofs") of type that are made on high-quality proof presses especially constructed for reproduction ("repro") purposes. Type matter also may be taken from photocomposition. (*See* TYPESETTING: *Filmsetting.*) If photographs and other tone copy are to be included in the plate, their position and size are indicated on the paste-up by outline. A photographic negative is then made of the paste-up. This can be enlarged or reduced as desired.

A negative of the tone copy (photographs or wash drawings) is made separately in a camera that holds a half-tone screen, which breaks up the tone image into tiny dots. The half-tone negative is cropped to proper size; *i.e.*, the size that fits the space left for it on the paste-up. The line negative and the half-tone negative are "stripped" (fastened) together on a glass-topped layout table over a light. This unit (combination of line and half-tone negatives) is placed on a sheet of paper called "goldenrod" because of its colour; the goldenrod is translucent enough to be seen through on a layout (stripping) table but opaque enough to block light during exposure for platemaking. Openings are cut in the goldenrod paper where the negatives are positioned. The negatives are then fastened in place with opaque cellophane tape. The entire layout, or flat, is now ready for exposure on the thin, light-sensitive, albumin-coated metal plate.

The zinc or aluminum plate is grained or roughened to produce a foundation that will hold the sensitized coating firmly, hold water in the nonprinting parts and prevent the ink from spreading in the printing areas. The usual method of graining is to fasten the plate in a trough, cover it with water and an abrasive, such as sand or carborundum powder, and add a layer of steel marbles. The trough is geared to move horizontally and slightly up and down. This causes the marbles to roll and rub the abrasive into the plate, thus creating a fine, even texture. Plates are sometimes grained by chemicals—a hot solution of a monobasic salt of phosphoric acid, *e.g.*, monobasic sodium phosphate, for zinc and a hot solution of sodium hydroxide or aluminum potassium sulfate for aluminum. Most lithographic printers purchase and use pregrained plates rather than graining their own.

The grained plate is thoroughly washed and then counteretched, usually in a solution of acetic acid or hydrochloric acid. Counteretching removes dirt and metal oxides and sensitizes the plate to, *i.e.*, increases its affinity for, grease. Some shops etch the plate to make it more water receptive. The plate is now coated with a solution of albumin and light-sensitive ammonium dichromate. This operation is carried out on a machine that whirls the plate and spreads the coating evenly. The entire layout, or flat, is placed on the sensitized plate, and both plate and layout are locked in a vacuum frame, from which the air is withdrawn to ensure close contact for sharp photographic printing. The frame is exposed to strong light, usually from an arc lamp, which penetrates the transparent areas of the negative (type, lines and half-tone dots) and hardens the albumin underneath. The albumin under the opaque areas of the negative and the goldenrod paper remains soft and water soluble.

Exposure is often made on a photocomposing, or step-and-repeat, machine. This device produces multiple images of the original subject on one large plate. After an exposure is made, the subject is moved to the next position and again exposed. This procedure is continued as long as desired, or until the entire plate is covered. Since the machine is a precision instrument, with accuracy to one-thousandth of an inch, it is particularly valuable in colour work in which exactness of register is essential. All kinds of copy can be handled by this machine, which also is adaptable to all other photographic printing processes.

The exposed plate is then rubbed with greasy developing ink to strengthen the printing image. After the developing ink is washed off with water, which also removes the soft albumin, the plate is etched with a solution of gum arabic. This desensitizes the bare grained metal to grease and dissolves any albumin that might cling to the edges of the image. Cellulose gum (sodium carboxymethyl-cellulose), which often is substituted for gum arabic, produces a more durable printing surface. The plate is now ready for printing.

Plates made by the deep-etch process can be used for longer runs than plates made by the albumin process. The printing areas of deep-etch plates are slightly below the surface of the plate. These plates, therefore, hold more ink and are less subject to wear. This platemaking method differs slightly from the albumin process. The plate is sensitized in the usual way but in the vacuum frame is exposed behind a positive rather than a negative. It is then developed with a lactic acid solution to remove the unhardened coating. Next it is etched in the image areas to eat away the bare metal; the light-hardened film is not affected. After being washed with anhydrous alcohol to remove the etch, it is dried and covered with lacquer. After being developed in the usual way, the plate is scrubbed with water to remove the light-hardened film that covers the unetched portions. These unetched areas will hold water in printing, while the etched areas will hold the ink.

Printing.—Offset printing is done on a press that is composed, basically, of three rotating cylinders—a plate cylinder, to which the metal plate is fastened; a blanket cylinder covered by a sheet of rubber; and an impression cylinder that presses the paper into contact with the blanket cylinder. The plate cylinder comes in contact first with a series of moistening rollers that deposit a thin film of water in the granulations of the bare metal. A series of inking rollers then passes over the plate. The ink is rejected by the water-holding areas but is accepted by the greasy image, after which it is transferred to the rubber blanket. This inked image (type, drawings, half tones) is then offset to the paper traveling around the impression cylinder.

Decalcomania.—Decalcomanias are designs that are printed on specially prepared paper to form films that can be transferred to any surface. These films, which usually are called decals (transfers), are widely used for decorating and labeling any objects that cannot be run through a press. Decals are made in a variety of ways, depending upon the needs to be served. The regular decal applied to such objects as typewriters and trucks, for example, begins with a sheet of porous paper coated with a solution of starch, albumin and glycerin. The design that will be seen is printed first; several coats of opaque white, which will not be seen after application, are then added; and the decal is finished with a coat of water-soluble glue called "stickative." When the decal is moistened and applied to the object, to which it adheres, the moistened backing paper is removed, and the design becomes permanently affixed. The stickative becomes water resistant soon after application.

Decals applied to windows are printed in reverse order. The layers of opaque white ink are printed first and the design last in order to be seen when in contact with the glass. Decals for china and kitchen ranges are printed with mineral colours and are fired to resist heat.

Office Offset Presses.—Small offset presses, or duplicators, are used in offices, as well as in printing shops. They can print on sheets from 3 by 5 in. to 9¾ by 14 in. at speeds from 3,000 to 6,000 impressions per hour. Paper-base plates, or masters, can be made by typing with a special ribbon or by drawing, writing, tracing or lettering with a special pencil or ink. Corrections can be made with an ordinary eraser. For reproducing photographs, type and illustrations, zinc or aluminum plates are prepared as in the standard commercial offset method. However, these images appear rather gray because they require heavier inking than can be supplied by the duplicator's inking mechanism. The press is especially useful for printing office forms, sales letters and other matter on letterheads. Numerous kinds of paper-base plates have been developed for short or long runs, and plastic plates have come into use.

See also PRINTING: POSTER: *Beginnings of the Modern Poster;* PHOTOENGRAVING; and references under "Lithography" in the Index.

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LITHOPONE, a mixture of barium sulfate, $BaSO_4$, and zinc sulfide, ZnS, in approximately equal molecular proportions used as a white pigment in the manufacture of paints. *See* PAINT: *Pigments.*

LITHUANIA (Lithuanian LIETUVA, Russian LITVA), the largest of the three Baltic republics of the U.S.S.R. It was independent of Russia during 1919–40, after which it became a constituent republic of the Soviet Union (LITOVSKAYA SOVETSKAYA SOTSIALISTICHESKAYA RESPUBLIKA, in Lithuanian LIETUVAS TARYN SOCIALISTINE RESPUBLIKA). It is 25,174 sq.mi. in area, had (1959) 2,711,445 inhabitants, and a density of population of 108 persons per square mile. The capital is Vilnius.

Physical Features.—Lithuania has a coastline on the Baltic about 50 mi. in length, and is bounded on the north and northeast by Latvia, on the southeast by the Belorussian S.S.R. and on the southwest by Poland and the Kaliningrad *oblast* of the Russian S.F.S.R.

The country consists mainly of Devonian rocks in the northeastern half and Cretaceous in the southwestern half. Because of the thick deposits of glacial material in many districts solid geology bears little relationship to relief. The main features of relief are a central lowland, mostly below about 300 ft., drained by the Neman (Nemunas) and its tributaries in the south and by tributaries of the Latvian river Lielupe in the north, and two areas of morainic deposits, the Samogitian hills (Zhmudsk upland) in the northwest, and parts of the Baltic and Belorussian ridges in the southeast, heavily wooded and characterized by numerous small lakes. The lowland extends to the Baltic coast in the west, where the Neman enters the Kurisches Haff (Courland lagoon or Kurski Zaliv), almost cut off from the open sea by a long spit. Sand dunes occur along the shore. Nowhere do the uplands exceed 1,000 ft. above sea level, though several small districts are above 900 ft. and some areas are deeply dissected. In contrast to the broken uplands, parts of the lowland are flat and marshy.

Climate.—Because of its maritime location, Lithuania has a milder climate and is more humid than similar latitudes farther east (54° N.–56½° N.). The mean temperature for January is −5° C. (23° F.) in the central lowlands, but somewhat higher near the coast; the mean July temperature is about 16°–17° C. (62°–63° F.) over most of Lithuania. The coast remains virtually ice free. Mean annual precipitation exceeds 30 in. over much of the lowland.

Vegetation and Animal Life.—The natural vegetation of Lithuania is mixed coniferous and deciduous forest, but most has either been cleared for agriculture or cut for timber. About 23% of the total area is forested, more than two-thirds of it with coniferous species, mainly pine, the remainder deciduous species including

birch, aspen and alder. About 5% of the total area is marsh. Soils are mainly podsolized, but in the north there are some areas in which lime is abundant. Sandy soils of glacial origin are widespread and boulders deposited during the glacial period are an obstacle to farming.

Wild animal life in Lithuania is confined generally to smaller mammals, though wolves are occasionally found. Common fauna include hares, squirrels, foxes, otters and badgers. Birds include grouse and woodcocks, together with herons and cormorants in the coastal districts. In addition to seals, Lithuania has salmon and trout, and cod, plaice and herrings off the coast. (J. P. Co.)

The People.—Lithuanians within and outside Lithuania probably number more than 3,000,000. Jointly with the less numerous Latvians they form the Eastern Balts. They have preserved their language in a very archaic form. They differ anthropologically from the Western Balts. The latter were represented by the now extinct Prussians and Sudovians (Jatvingai or Jatwings), and had a still more archaic anthropological structure, which was closer to peoples of the Neolithic era and consequently also to the Early Germans.

The anthropological changes of the Lithuanians, and of the Eastern Balts in general, were probably caused by the absorption of the remnants of Lappons who were pushed southward by the Baltic Finns. The "Finnoi" located on the Ptolemaic map east of the Vistula, most likely in the middle part of the river basin of the Neman (Nemunas), were probably such a remnant. The Lithuanians are supposed to have originated in the upper part of the Dnieper basin and were presumably derived from the ancient Neurs. According to Herodotus they moved from the borders of the steppes toward the northern forests around 513–512 B.C.

The culture of the Lithuanians developed in the middle ages under the influence of the Russians and, later, under that of the Poles. The great majority of the people are Roman Catholic; there are minorities of Lutherans, Calvinists, Orthodox and Jews.

(*See* also BALTIC LANGUAGES; BALTS; LITHUANIAN LANGUAGE; LITHUANIAN LITERATURE.) (J. Cz.)

Population.—Of the total population of Lithuania (2,711,445 in 1959), 39% (1,046,857) was urban, but although this was a considerable increase over the 23% of urban dwellers in 1939, the average is appreciably lower than that in the U.S.S.R. which was, as a whole, 48%. The density of rural population is highest in the southeast and along the coast, and the largest towns are also in these areas. Vilnius (236,078) and Kaunas (214,348) are the largest, while Klaipeda (89,923, formerly Memel) is the principal seaport. Siauliai (59,722) in the north is the only other town with more than 50,000 people. In 1959, 79.3% of the total population of the republic consisted of Lithuanians, 8.5% of Russians and 8.5% of Poles, and there were small numbers of Belorussians, Jews and Ukrainians. (J. P. Co.)

History.—The Lithuanians belong to the Baltic group of nations, which included also the Old Prussians to the west and the Latvians to the north (*see* BALTS). In the 13th century A.D. the Old Prussians were defeated and partly exterminated by the German Knights of the Teutonic Order (*q.v.*), and Latvian Livonia was conquered by the Knights of the Sword, who in 1237 joined the Teutonic Order. The Lithuanians, however, resisted the German pressure, though Samogitia (Lith. Zemaitija), lying between Prussia and Livonia, was an object of German covetousness. To counteract the German threat, the Lithuanian tribes before the middle of the 13th century united under Mindaugas. Until then Lithuania was ruled by a confederation of the most powerful chieftains. He and his family were baptized in 1251; and two years later, in his capital (probably at Kernave on the Neris), he was crowned the first and only king in Lithuanian history by the authority of Pope Innocent IV. Mindaugas and his two sons were assassinated in 1263 and Lithuania remained officially pagan.

Traidenis, ruler of Lithuania from 1270 to 1282, was probably the founder of the dynasty known as that of Gediminas (*q.v.*), who began to rule in 1315. Though already under Mindaugas, shortly after the destruction of Kievan Russia by the Tatars, Lithuania had begun to expand eastward and southward to the lands inhabited by Belorussians, it was Gediminas who really built the empire later known as historic (as opposed to ethnic) Lithuania. He made Vilnius the capital, as his letters of 1323 show. When he died in 1341, Lithuania's frontiers extended across the upper Dvina in the northeast, to the Dnieper in the southeast and to the Pripet marshes in the south. The warlike but small Lithuanian nation could not colonize this vast territory, but maintained control over it because the ruling class had shown an undoubted political talent and a spirit of religious toleration.

Gediminas divided his empire among his seven sons. Soon, however, only two remained to continue their father's policy of expansion: Algirdas, with Vilnius as his capital, succeeded to the title of grand prince and undertook the defense of Lithuania against the Tatars and Muscovy; and Kestutis, with his seat at Trakai, reigned over ethnic Lithuania and defended it against the Teutonic Order. When Algirdas died in 1377 he left to his son Jogaila (Jagiello) an empire including Kiev, which had come under Lithuanian suzerainty in 1362; but Kestutis drove Jogaila from Vilnius in 1381 and proclaimed himself grand prince of Lithuania. Jogaila however captured Kestutis and his son Vytautas in 1382, and Kestutis died in prison; but Vytautas escaped and found sanctuary in the territory of the Teutonic Order. The German danger had become moreover especially serious because the knights had taken Kaunas in 1362, and Jogaila had promised them the whole of Samogitia to the Dubysa river in 1382. His Orthodox elder brothers tried therefore to convince him that Lithuania's interests lay in alliance with Muscovy and accession to the Orthodox Church, but his pagan younger brothers recommended a pro-Polish policy with acceptance of Roman Catholicism.

Polish-Lithuanian Union.—On Aug. 14, 1385, at Kriavas (Krewo), Jogaila concluded with Polish ambassadors an agreement that he would forever unite Lithuania and Kievan Russia with the Polish crown if he could marry the 12-year-old Queen Jadwiga of Poland and become king of Poland himself. He went to Cracow, was baptized on Feb. 15, 1386, receiving the name Wladyslaw, married Jadwiga and, on March 4, was crowned king of Poland.

The Lithuanians outside the German-devastated Samogitia were baptized in 1387, and Jogaila granted the newly baptized boyars or gentry great privileges. In 1392 a reconciliation took place between Jogaila and Vytautas, who became lieutenant governor of Lithuania. A great warrior, Vytautas dreamed of conquering Moscow and destroying the Golden Horde. In 1398, to consolidate his rear, he confirmed the cession of Samogitia to the Teutonic Order; but on Aug. 12, 1399, on the Vorskla river, he suffered a defeat at the hands of the Tatars. His eastern dream having vanished, Vytautas became more inclined to accept Jogaila's policy of turning in concert against the Teutonic Order.

In 1401 new Polish-Lithuanian agreements were concluded at Vilnius and confirmed at Radom between Jogaila and Vytautas. The Lithuanian boyars promised that in the event of Vytautas' death they would recognize the king of Poland as the grand prince of Lithuania, while the Polish nobility accorded to Vytautas the title of grand prince of Lithuania and declared that if Jogaila died without an heir they would not elect a new king without consulting the Lithuanians. Almost immediately after these agreements, Vytautas supported the revolt of the Samogitians against the German rule. The knights replied with a military expedition against the grand principality. As the Poles and the Lithuanians were not yet in a position to risk a major war, Samogitia had once more to be abandoned (1404). Five years later, however, a new Lithuanian rebellion was in progress. The Order accused Vytautas of treachery and asked the Poles whether they would assist the Lithuanians again. In reply the grand master of the Order, Ulrich von Jungingen, was informed of the absolute solidarity between the two nations. War was inevitable.

The claim of the Teutonic Order to be combating Polish-Lithuanian "pagans" deceived many a western European knight into moving east to save Christianity, but in the decisive battle of Grunwald (Tannenberg), on July 15, 1410, the Polish-Lithuanian forces inflicted a crushing defeat on the Order. German supremacy in the Baltic countries was broken, though the first peace

treaty of Torun (Thorn), concluded on Feb. 1, 1411, was a moderate one. Samogitia returned to Lithuania until the death of Jogaila and Vytautas. On Sept. 27, 1422, however, the Order was forced to agree that Samogitia, by then Christian, was Lithuanian forever.

In the meantime, at Horodlo, on Oct. 2, 1413, a new pact of union was concluded between Poland and Lithuania. The principles of the union remained unchanged, but the autonomy of the grand principality was made permanent: after Vytautas' death the king of Poland would appoint another grand prince in agreement with the representatives of both countries. Vytautas died on Oct. 27, 1430, and Jogaila on May 31, 1434, but the latter was survived by the two sons he had by his fourth wife, Zofia (Sophia) of Alsenai (Holszanska), a Lithuanian princess whom he had married in 1422. His second son, Casimir IV (1447–92), king of Poland and grand prince of Lithuania, continued the struggle against the Teutonic Order and his efforts were crowned by the second treaty of Torun (Oct. 14, 1466) when the Order had to restore Pomorze (Pomerania) to Poland. After the death of Casimir a crisis arose in Polish-Lithuanian relations because the Lithuanian boyars elected Casimir's son Alexander as grand prince, while the Poles chose his brother John Albert. The Polish-Lithuanian personal union lapsed, but, on the death of John Albert in 1501, the Lithuanians insisted that their grand prince should be king of Poland too.

The Poles agreed and the senates of the two countries decided at Piotrkow that thenceforth the king of Poland should always be grand prince of Lithuania. The Teutonic Order was no longer a menace, but in the east there appeared another and greater danger. Ivan III, the grand prince of Muscovy, in 1480 assumed the title of sovereign of all Russia; and the major part of historic Lithuania was Belorussian-speaking. Belorussian was the language in which was written the statute of the grand principality adopted in 1529 (revised in 1566 and 1588).

On July 1, 1569, at Lublin, a common Polish-Lithuanian *sejm* or parliament transformed the personal union into a real one. In the course of the ensuing two centuries both the Lithuanian and Belorussian nobilities of historic Lithuania became polonized, but the two peasantries continued to use their own languages. On the eve of the second partition of Poland, the grand principality of Lithuania covered an area of 120,500 sq.mi. with a population (1791 est.) of about 3,850,000. There were about 1,420,000 Belorussians, 1,005,000 Poles, 770,000 Lithuanians, 385,000 Jews, 140,000 Russians, 95,000 Latvians (in Latgale), 30,000 Germans and 5,000 Karaims (Karaites). From the point of view of religion this population comprised 1,500,000 Uniates, 1,470,000 Roman Catholics, 250,000 Orthodox, 140,000 Raskolniki (dissidents from the Orthodox Church), 60,000 Protestants, 385,000 Jews, 40,000 Muslims (Polish or Belorussian-speaking Tatars) and 5,000 Karaims. (*See* also POLAND: *History*.)

Russian Rule.—While at the first (1772) and the second (1793) partitions of Poland only the Belorussian lands of the grand principality of Lithuania were annexed by Russia, at the third partition (1795) ethnic Lithuania suffered the same fate, the only exception being the province of Suvalkai (Suwalki), the northern part of which was Lithuanian-speaking, which became part of the kingdom of Prussia. In 1806 Suwalki was incorporated into the duchy of Warsaw, which in 1815 was annexed by Russia. The congress of Vienna added to the style of the Russian emperors the titles of king of Poland and grand prince of Lithuania.

Under Russian rule historic Lithuania comprised six provinces: Vilnius (Vilna in Russian), Kaunas (Kovno), Grodno, Minsk, Mogilev and Vitebsk, with a governor general residing at Vilnius. When the Poles rose against Russia in 1830–31 the insurrection extended to the Lithuanian provinces before it was suppressed. The Polish rising of 1863 also spread into Lithuania and its repression there was particularly severe, 180 insurgents being hanged and 9,000 deported to Siberia.

On March 25, 1839, the Uniates were forced to join the Orthodox Church and the next year the Lithuanian statute was replaced by Russian codes. The tsarist government treated the "Territory of the Northwest"—as historic Lithuania was called after 1832—as an integral part of Russia. From 1864 to 1905 the policy of russification extended to every domain of public life. It was forbidden to publish newspapers, periodicals or books in Polish or Belorussian, while books in Lithuanian could be printed if the Russian alphabet was used. Russian was the only language of teaching in the schools. The Roman Catholic religion was persecuted.

The Lithuanian people resisted russification because they remained faithful to ancient language and traditions and to their religion. By abolishing the serfdom of peasants throughout the empire in 1861, the tsarist government hoped that in the lands inhabited by non-Russian populations a wedge would be introduced between the peasants and the gentry and that the former, by acquiring the right to be proprietors, would be more easily russified. The Russians hoped that such a process would be easier in Lithuania proper where the landlords were mainly Poles. It was a miscalculation. Besides the clergy, a new Lithuanian intelligentsia of peasant origin began to emerge in the 1880s. In 1883 Jonas Basanavicius (1851–1927), a country doctor, launched the first Lithuanian periodical, *Aušra* ("Dawn"), published at Tilsit (then in East Prussia) and smuggled into Lithuania. *Aušra* was suppressed three years later, but in 1889 was replaced by *Varpas* ("Bell"), edited by Vincas Kudirka (1858–99), which continued to appear until 1904.

When the manifesto of Oct. 30, 1905, granted freedom of speech to the peoples of the Russian empire, two daily newspapers appeared at Vilnius, one Polish (*Kurjer Litewski*) and one Lithuanian (*Vilniaus Zinios*). On Dec. 4–5, 1905, a congress of about 2,000 delegates was held in Vilnius. The congress demanded territorial autonomy for Lithuania with a democratically elected *seimas*. The frontiers of the national Lithuanian state were to be drawn according to the freely expressed wish of the peoples concerned. Soon afterward the teaching of the Lithuanian language in schools was permitted.

Independence Attained.—During World War I the Germans occupied a great part of historic Lithuania. On Sept. 18, 1915, the German armies entered Vilnius. The German government authorized the gathering at Vilnius, on Sept. 18–22, 1917, of a congress of 214 Lithuanian delegates and the election of the 20-member *Lietuvos taryba* or council of Lithuania. The congress called for an independent Lithuanian state within the ethnic frontiers and with Vilnius as capital. As the leaders of the *taryba* (Antanas Smetona [*q.v.*], Steponas Kairys, Jurgis Saulys and others) rejected all idea of union or federation with Poland, the local Poles refused to co-operate with the *taryba*. On Feb. 16, 1918, the *taryba* proclaimed an independent Lithuanian state and the dissolution of all political connections that had existed with other nations. Germany recognized this on March 24 with the proviso of a "perpetual alliance" of Lithuania with the *Reich*. On July 11 the crown of Lithuania was offered to the Roman Catholic duke of Urach, Wilhelm von Württemberg, but the offer was withdrawn on Nov. 2, and the final solution of the question of the form of government was referred to the constituent assembly. Meanwhile, the supreme power was vested in a three-man presidium (Smetona, the Rev. Justinas Staugaitis and S. Silingas) which on Nov. 5 designated Augustinas Voldemaras (1883–1955) as prime minister of independent Lithuania. He formed a government on Nov. 11, 1918.

Lithuania was still under German occupation, but when the German troops had evacuated Vilnius, the city was entered on Jan. 5, 1919, by the Red army and a Communist Lithuania government, appointed by the All-Russian Central Executive committee on Dec. 23, 1918, was installed. It was headed by Vincas Mickevicius-Kapsukas (1880–1935). The Voldemaras government moved to Kaunas which, on Jan. 17, however, was also occupied by the Red army. The Germans remained in western Lithuania, which from the end of October to Dec. 15, 1919, was controlled by the German army under Rüdiger von der Goltz.

The Polish-Lithuanian Dispute.—Jozef Pilsudski, the head of the restored Polish state, proposed two alternatives for Lithuania. Either an independent state might be set up within purely ethnographic frontiers, that is, without Vilnius and its region, which was

largely Polish, or a larger state including Vilnius; but in the latter case some sort of a federal link with Poland would be indispensable. On April 20, 1919, the Polish army led by Pilsudski took Vilnius from the Red army, which enabled the Lithuanians to re-enter Kaunas. In the following summer the Polish forces moved to the Dvina river in the north and to the Berezina in the east. Against Lithuania they occupied the demarcation line fixed by the Inter-Allied committee presided over by Marshal F. Foch. This "Foch" line, adopted by the Supreme council on July 27, 1919, ran to the west of the Grodno-Vilnius-Daugavpils railways and more or less coincided with the eastern ethnic frontier of Lithuania. On July 12, 1920, when the Polish army was retreating, the Kaunas government concluded in Moscow a peace treaty by which the Soviet Union "ceded" to Lithuania not only Vilnius, but also Lida and Grodno. After Pilsudski's final victory, the Red army, which occupied Vilnius on July 14, left it on Aug. 26 while the Lithuanian army entered the city. On Sept. 5, 1920, the Warsaw government appealed to the League of Nations. A Polish-Lithuanian conference met at Suvalkai and a partial armistice was signed on Oct. 7. Nevertheless Pilsudski ordered Gen. Lucjan (Lucien) Zeligowski to seize Vilnius, and this was done on Oct. 9. Zeligowski set up a government of central Lithuania. A new armistice, restoring the Foch line, was signed on Nov. 29, 1920.

Meanwhile the council of the League of Nations had made many attempts to settle the Polish-Lithuanian dispute. The last of the series was a Polish-Lithuanian conference which opened in Brussels on April 20, 1921, at which a plan for a Lithuania composed of two cantons, Kaunas and Vilnius, each with separate self-government, and federated with Poland, was recommended. But the Lithuanians wanted Vilnius without any ties with Poland. Zeligowski then ordered elections to be held in central Lithuania on Jan. 8, 1922, to a special diet of 106 members which would decide the future of the area in dispute; 55% of the inhabitants took part in the poll in Vilnius city and 65% in the province. On Feb. 20, 1922, the diet voted for the incorporation of the province with Poland. However, under the treaty of Versailles, the principal Allied powers had to determine the Polish frontiers that remained undefined. In the Polish-Soviet peace treaty signed at Riga (March 18, 1921), the Soviet government had declared its disinterestedness in the Polish-Lithuanian dispute. The council of the League of Nations, on Feb. 3, 1923, adopted a final resolution fixing a Polish-Lithuanian line of demarcation almost identical with the Foch line, leaving the decision as to the frontier to the Conference of Ambassadors in Paris. On March 15, 1923, the Conference of Ambassadors recognized the line of Feb. 3 as the final frontier between the two states. Lithuania, however, refused to accept this decision.

Foreign and Domestic Relations, 1919–39.—Lithuania was received into the membership of the League of Nations on Sept. 22, 1921. On Sept. 28, 1926, a Soviet-Lithuanian treaty of nonaggression was signed in Moscow. On Sept. 12, 1934, at Geneva, a treaty of good will and co-operation was concluded by Lithuania, Latvia and Estonia. Lithuania's relations with Germany were jeopardized by Nazi propaganda in the Klaipeda (Memel) territory.

In March 1935, at a trial of Klaipeda Nazis, most of the accused were found guilty of high treason. On March 17, 1938, Poland demanded of Lithuania the immediate opening of the frontier, acceptance of the cession of Vilnius and the establishment of normal diplomatic relations. Lithuania yielded to these demands. In February and May 1938 the Lithuanian government released the convicted Nazis and in October abolished martial law in the Klaipeda territory. On Dec. 11, at the election of the Klaipeda *Landtag*, the Nazis won 25 seats out of a total of 29. On March 21, 1939, Lithuania was presented with another ultimatum which meant the loss of its only port.

On April 4, 1919, Smetona became provisional president of the republic and Mykolas Slezevicius (1882–1939), a Democratic leader, succeeded Voldemaras as prime minister. On May 15, 1920, the newly elected constituent assembly met at Kaunas and its right-centre majority elected as president Aleksandras Stulginskis, the leader of the Farmers' union. On Aug. 1, 1922, a democratic constitution was adopted providing for a *seimas* of 80 elected for three years by proportional representation. As the *seimas* elected on Nov. 12, 1922, had no clear-cut majority, it was dissolved and a new election on June 5, 1923, restored the right-centre majority. The election of May 8–10, 1926, gave a majority to the left-wing parties. On June 7, 1926, Kazys (Casmir) Grinius, leader of the Peasant Populist party, was elected president while Slezevicius became prime minister. However, in the night of Dec. 16–17, 1926, a *coup d'état* took place in Kaunas. It was prepared by the army and backed by the small Nationalist party with the consent of the Christian Democratic party. Grinius resigned and Smetona was elected president; Voldemaras was again prime minister. On May 15, 1928, Voldemaras issued a new constitution which was to be submitted to a national referendum within ten years; but on Sept. 19, 1929, he was forced to resign and his Fascist organization, the Iron Wolf, was dissolved. The Nationalist party was then in full control. Voldemaras, attempting to regain power in 1934, was arrested and imprisoned for high treason committed with German support, but was granted an amnesty in 1938. The period of 1927–38 was that of restricted democracy. A new constitution, adopted on Feb. 12, 1938, was to provide the basis for a return to parliamentary institutions. A coalition government was formed with the inclusion of the Christian Democrats and Liberals, first between March 30, 1939, and Nov. 22, 1939, with Gen. J. Cernius as prime minister, and next with Antanas Merkys, but it had not enough time to reorganize the republic on a more solid basis.

Independence Lost.—A secret protocol to the German-Soviet treaty of nonaggression of Aug. 23, 1939, stipulated that in the event of a territorial and political rearrangement in the areas belonging to the Baltic states, the northern boundary of Lithuania should represent "the boundary of the sphere of influence of Germany and the U.S.S.R." When they began World War II the Germans made frantic efforts to induce Lithuania to attack Poland so that the former might thus become their ally and protégé. Lithuania chose to remain neutral and the secret protocol to the German-Soviet treaty of Sept. 28, 1939, revised the previous agreement by deciding that the territory of Lithuania fell within the sphere of influence of the U.S.S.R.

First Soviet Occupation.—On Oct. 10, 1939, a mutual assistance treaty was signed in Moscow, in accordance with which Lithuania was compelled to admit Soviet garrisons and to grant air bases. The Vilnius area was given to Lithuania, but was limited to 3,680 sq.mi. with a population of 549,000. (The province of Vilnius "ceded" by the U.S.S.R. in 1920 had measured about 12,450 sq.mi. and had a population of 1,275,000.) On June 15, 1940, however, Lithuania was confronted with an ultimatum demanding immediate formation of a "friendly" government. On the same day the country was occupied by the Soviet army. Smetona fled to Germany and later left for the United States. Merkys, Stulginskis and many other Lithuanian leaders were arrested and deported to Siberia. An obscure journalist, Justas Paleckis, became premier. A rigged election of July 14–15 produced a so-called people's *seimas* which, on July 21, unanimously requested the incorporation of Lithuania in the Soviet Union. On Aug. 3, 1940, the Moscow supreme soviet readily acceded to the request and Lithuania was declared a constituent republic of the U.S.S.R. In the night of June 14–15 next year 30,455 members of the Lithuanian intelligentsia (members of the national guard, civil servants, etc.) were deported to Siberia. Including other deportees and about 5,000 political prisoners executed at the time of the hasty departure of the Soviet forces, the country suffered during the first Soviet occupation a loss of about 45,000 people.

German Occupation.—A few days after the German attack on the Soviet Union (June 22, 1941) the whole of Lithuania was in German hands. On July 17, 1941, Hitler announced the creation of the "Ostland" province including the three Baltic states and Belorussia. The commissioner general for Lithuania was Adrian von Renteln who, on Aug. 5, dissolved the new Lithuanian government formed on June 23 on a basis of a broad national coalition. The Germans took over the co-operatives, corporations, banks, better farms and homes. A policy of German colonization was inaugurated and by July 1943 about 4,700 German families were

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SECTION OF THE VILIYA (NERIS) RIVER EMBANKMENT, VILNIUS, CAPITAL OF LITHUANIA

settled in Lithuania. The Germans executed almost all Lithuanian Jews. In April 1943, the Germans attempted a compulsory mobilization in the Baltic states, but in Lithuania the youth went into hiding. In March and April 1943, hundreds of leading Lithuanians were arrested and sent to concentration camps, where many died from hunger or tortures. At the same time Germany resolved to destroy Lithuania's cultural wealth. The universities and other institutions of higher learning were closed.

Second Soviet Occupation.—Vilnius was taken by the Soviet army on July 13, 1944, and Lithuania was again under Soviet occupation by the middle of October. The villages and cities suffered widespread devastation and massacres. All non-Communist organizations were immediately dissolved. The period of methodical sovietization and russification started. Fleeing before the Soviet armies, about 80,000 Lithuanians reached the western zones of Germany, but about 60,000 were rounded up in the eastern zone and sent to Siberia. In Lithuania, during 1945–46, about 145,000 Lithuanians were removed from their native land. The third mass deportation, ordered in connection with the forced collectivization of agriculture, took place on March 24–27, 1949, when about 60,000 Lithuanians were sent to northern Russia or Siberia. From 1945 to about 1953 hundreds of thousands of young Lithuanian men and women took refuge in the forests. In the first years of Soviet occupation the rural life was under partisan rule. There were many armed clashes between Lithuanian partisans and Communists until they were stopped by Soviet military and secret police forces. From 1944 Moscow systematically pursued the transfer of the Russian population on a large scale, particularly in the Vilnius and Klaipeda areas.

After the reconquest of Lithuania by the Soviet army Paleckis became chairman of the presidium of the supreme soviet and Mechislovas Gedvilas became prime minister; the latter was dropped in Jan. 1956 and replaced by Motejus Sumauskas. Antanas Snieckus was appointed first secretary of the Lithuanian Communist party. Founded in Vilnius in Oct. 1918, accepted as a component part of the Communist Party of the Soviet Union in Oct. 1940, the Lithuanian party, according to Soviet sources, had claimed more than 50,000 members in the early 1960s.

About 80,000 Lithuanians fled to Germany before the return of the Soviet forces. It was estimated that between 1945 and 1948 about 205,000 Lithuanians had been deported to Russia, but after 1954 many were allowed to return to their homeland.

The Roman Catholic Church had been left relatively free up to the end of 1946, but early in 1947 a wave of persecution began. According to an official Vatican source, by July 1950, out of 1,332 clergy left free until 1947, about 1,000 had been arrested and deported to Russia. Among them were Msgr. Pranas Ramanauskas, bishop of Telsiai, and Msgr. Teofilis Matulionis, bishop of Kaisiadorys; they were permitted to return to Lithuania to die there in 1959 and 1961 respectively. The only bishop left in the country by 1953 was Msgr. Kazimieras Paltarokas, bishop of Panevezys, who also administered the diocese of Vilnius; he died in 1958. He was succeeded by Msgr. Julijonas Steponavicius who, however, was arrested in 1961. Although divided into six dioceses, Lithuania had only one clerical seminary in Kaunas with about 50 seminarists.

The annexation of Lithuania by the Soviet Union is not recognized by the United States and western countries as a whole have not accorded *de jure* recognition. (K. Sm.; Ma. G.)

Administration.—Unlike the larger Soviet republics Lithuania is not divided administratively into *oblasts* but directly into 62 rayons. The supreme soviet, elected in 1959, comprises 209 deputies. In the early 1960s there were more than 4,250 primary, secondary and special schools with about 450,000 pupils. There were also 41 technical as well as 9 teacher training and 3 commercial schools. Places of higher education include 76 technical colleges, the Vilnius V. Kapsukas State university (founded 1579), the Lithuanian Academy of Sciences (1941) and pedagogical, music and art institutes. (X.)

The Economy.—In spite of steps to industrialize the republic, the economy remains predominantly agricultural. By the early 1960s the sown area exceeded 2,700,000 ha. (6,600,000 ac.) or more than 40% of the total area and this was being increased by the drainage of marshes. The principal types of cultivation are cereals, (44% of all sown area), fodder crops (40%) and potatoes (10%). Flax is the chief special crop of the region, and a little sugar beet is also grown. Rye is the principal cereal, followed by barley; wheat accounts for only about one-tenth of the cereal acreage. Perennial grasses occupy more than half of the land under fodder. Livestock farming makes up an appreciable part of the value of farm output. There is a much higher proportion of cows among the total head of cattle than in the U.S.S.R. as a whole and the emphasis is therefore clearly on dairying rather than meat production, though the republic also has a surplus of meat. There are more than 1,000,000 pigs, and sheep and poultry are also raised.

Industry in Lithuania lacks a basis of energy and mineral raw materials. Peat is the chief local source of fuel. Little hydroelectricity is produced, and coal and oil products have to be brought in from outside. A pipeline for natural gas from Dashava in the Ukraine reached Vilnius in Aug. 1961 and a branch line was to feed the thermal power plant at Elektrenai between Vilnius and Kaunas. At that time there was little heavy industry in Lithuania. Metallurgical and chemical industries were little developed. Production of timber, paper and cement is roughly adequate for local needs. The main branches of industry are textiles and engineering. Cotton, woolen and linen yarn and cloth are all produced, but Lithuania accounts for only 1%–2% of the Soviet total of these. The manufacture of machine tools is the principal branch of engineering represented in Lithuania, and in the early 1960s the republic accounted for about 6% of the national total. Other items manufactured include turbines, electrical apparatus, ships, cranes and precision instruments. Vilnius is the principal engineering centre but all the other large centres have some specialist engineering. Kaunas (woolen and silk) and Klaipeda (cotton) specialize in textiles, and linen goods are manufactured in several smaller centres. Vilnius, Kaunas and Klaipeda together account for 70% of all industrial production.

The republic is nearly self-supporting in food products, and it has a surplus of dairy products and flax. This surplus is offset by its deficiency in sources of energy and industrial raw materials, for which it depends on other regions of the U.S.S.R.

Lithuania has an adequate network of railways (1,290 mi.), and Vilnius and Klaipeda are important junctions. The road system is also of good quality by Soviet standards, the total length being 22,200 mi., of which 6,300 have a hard surface. The Neman is navigable for its whole length in Lithuania, but is frozen from early December to early March. Klaipeda is the chief port, and benefits from being ice free, in contrast to Soviet ports farther north in the Baltic. It is both a commercial and a fishing port. There is an airport at Vilnius.

See also references under "Lithuania" in the Index.

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(K. Sm.; Ma. G.)

LITHUANIAN LANGUAGE. The Lithuanian language, spoken by over 3,000,000 people, primarily in Lithuania, but also by numerous emigrants in the U.S., Canada, South America, Australia and Siberia, belongs to the Baltic branch of the Indo-European family. It did not become an official administrative language until 1918.

History.—Although not officially recognized, a literary language had been in existence since the 16th century. The earliest Lithuanian text, which is also the earliest Lithuanian document, is a translation of a Polish Protestant Catechism (1547) by Mosvydas (Mosvidius or Mažvydas, d. 1563). All Lithuanian writings of the 16th century are of religious character. The most important for the study of the language is the *Postilė* of 1599 by Mikalojus Daukša (1527–1613). The language differs in many respects from modern Lithuanian: longer endings (especially in the dative plural), a directive and an adessive case, strong Slavonic influence in vocabulary and syntax, differences in accentuation. Essentially the same characteristics are found in the language of the first half of the 17th century as represented by K. Širvydas (1579–1631), the first Lithuanian lexicographer.

The Lithuanian literary language, from its beginning through the 19th century, is not uniform, but is based on the dialects of the various authors. The dialects are divided into two main groups, Low Lithuanian or Shamaitish (sometimes called Samogitian) and High Lithuanian or Aukshtaitish. High Lithuanian is more archaic. Modern standard Lithuanian is based on the southern subdivision of the West High-Lithuanian branch, which is also the language of the Prussian Lithuanian pastor-poet Kristijonas Donelaitis (1714–80). In the 19th century, however, three literary languages were competing for recognition: (1) a Low-Lithuanian form, mainly represented by Dionyzas Poška (1757–1830), Simanas Stanevičia (1799–1848), Simanas Daukantas (1793–1864), and Bishop Matthew Valančius (1801–75); (2) the East High-Lithuanian poetic language of Bishop Anton Baranauskas (1835–1902); and (3) the West High-Lithuanian language used in various underground publications as well as in East Prussia. The dialect used by Donalaitis was elevated to a standard language for all of Prussian Lithuania by the grammarian and lexicographer Friedrich Kurschat (1806–84) whose work was seconded by G. H. F. Nesselmann (1811–81) and August Schleicher (1821–68). In the 1880s, Jonas Jablonskis (1861–1930), born in Suvalku Naumiestis (not far from the former Russian-German border), became interested in his own native language while studying at the University of Moscow under F. Fortunatov (1848–1914), and began to study it with the help of Kurschat's and Schleicher's grammars. Jablonskis became the "father of the modern Lithuanian standard language," based on his own dialect.

Characteristics.—Lithuanian is highly inflected, with eight cases: nominative (*miẽstas* "city"), genitive (*miẽsto*), dative (*miẽstui*), accusative (*miẽstą*), vocative (*miẽste*), instrumental (*miestù*), locative (*miestè*), illative (*miẽstan* "into the city"). In the modern standard language there are also remnants of a directive case (*galóp* "toward the end") and an adessive case (*Dievíẽp* "with God"), both of which occur regularly in the texts of the 16th and 17th centuries. There are three numbers: singular, plural and dual (the latter optional). In the nominative singular the nouns, which are grouped into five declensions, have one of the following endings: *-as, -is, -ys, -a, -ė, -i, -us, -uo.* There are regularly two grammatical genders (masculine and feminine) with some traces of the Indo-European neuter in the adjective. No article is used with nouns. Adjectives appear in two forms: indefinite and definite. While otherwise very conservative, the language is unexpectedly progressive in the formation of the comparative and superlative degrees of the adjectives and adverbs, there being no irregular comparison. The illative, directive and adessive cases are innovations which did not exist in the Indo-European parent language. While the Old Lithuanian (16th century) locative plural in *-su* is apparently inherited from Indo-European, the modern locative plural in *-se* is a former illative; *i.e.*, the accusative case extended by means of a postposition.

The inherited verbal system is simplified to some extent. There are only four simple tenses: present, future (formed with *-s-*), preterite or past, and imperfect or habitual preterite. Each of these tenses forms only an indicative. There is only one subjunctive (derived from the infinitive) for all tenses. The imperative is formed from the infinitive and the infinitive ends always in *-ti* (*vẽti* "go," *dúoti* "give," *darýti* "do," *dirbti* "work," etc.). Lithuanian, like Sanskrit, is rich in participles. There are two sets of participles (active and passive) for the present, future, and preterite; the imperfect has only an active participle. The passive participles are used in the formation of the passive voice. Like Russian and Polish, Lithuanian makes a rigid distinction between durative and perfective aspects, but it differs by not using the perfective aspect as a substitute for the future tense. The reflexive verb is highly developed. While in the main the Lithuanian verb continues the Primitive Indo-European *ō*-conjugation (thematic verbs), there are some traces of the *mi*-conjugation (nonthematic verbs). As in declension, there are three numbers also in conjugation (dual optional). On the other hand, there is only one form for the third person of the three numbers in each of the tenses.

Lithuanian is extremely rich in diminutives and endearing forms which are derived from nouns and adjectives alike. Diminutive nouns may express either smallness or affection or even contempt, while diminutive adjectives express intensification of the meaning. The strong emotional appeal of the diminutives supplies the language with effective poetic expressions and gives the Lithuanian folk songs their appeal. The vocabulary is immensely rich, abounding in onomatopoetic formations. The language is possessed of a continually productive creative power; no dictionary can ever include all Lithuanian words.

The word accent is free. It is not indicated in the orthography, except in grammars and texts especially prepared for students. There is no general rule fixing the accent; nor does the main stress always remain on the same syllable throughout the whole paradigm. Furthermore dialects vary widely in their accentual systems. The standard accent of every Lithuanian word, with all indications necessary to ascertain its shifts in various paradigms, is given in the Lithuanian-German dictionary (see *Bibliography,* below).

Lithuanian is written in the Latin alphabet with 32 letters, some of which are conventional letters supplied with diacritic signs. All consonants, except *j* (= *y* as in "you"), have a hard or velar and a soft or palatalized pronunciation. There are roughly 11 different vowels (monophthongs), 6 short and 5 long, all of them clear cut without any diphthongization. There are also the diphthongs *ai, au, ei, ui, ie, uo,* and the combinations (treated as diphthongs) *al, ar, am, an, el, er, em, en, il, ir, im, in, ul, ur, um, un.*

See also BALTIC LANGUAGES.

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LITHUANIAN LITERATURE. In the grand principality of Lithuania, which stretched in the 14th and 15th centuries from the Baltic to the Black sea, the official language was Belorussian and later Latin. In the 16th century the temporary spread of Protestantism, and thereafter the Counter Reformation, led to the writing of religious works in the vernacular. Lithuanian literature may be divided into four periods.

Early Period.—The first known Lithuanian printed book is the Catechism of M. Mažvydas (1547). Later there appeared the religious writings of J. Bretkūnas or J. Bretke (1535–1602). In 1701 the New Testament was published, and, in 1727, the entire Scriptures. Until 1700 books were mostly of a religious character. Among publications outside this category, the first Lithuanian dictionary, K. Širvydas' *Dictionarium trium linguarum* (1629), is noteworthy. To this period belong 85 authors and 70 publications, but these are now more of linguistic than strictly literary interest.

18th Century.—The 18th century produced more books of secular tendency, including grammars, dictionaries and the first collections of folk songs. The most significant work of the period was the poem of Kristijonas Donelaitis (*q.v.*), called "The Four Seasons"; it is written in hexameters, shows German influence and depicts village life throughout the year. The 18th century gave Lithuanian literature 61 authors and 198 printed publications.

19th Century.—New trends appeared in the 19th century. During its first half a national literary movement was fostered, mostly by graduates of Vilnius university; there was greater effort to create a Lithuanian literary language and, partly under the influence of romanticism, interest arose in the early history of Lithuania. Thus, alongside the patriotic poetry of Simanas Stanevičia (1799–1848) and Dionyzas Poška (1757–1830), the first attempts to write Lithuanian history were made by Simanas Daukantas (1793–1864). Among many other writers, the Rev. A. Strazdas-Strazdelis (1763–1833) is memorable as the author of religious and secular songs. Throughout there appears a surge of western influence, in the wake of the French Revolution.

This renaissance was continued by Bishop M. Valančius (1801–75), noted for religious and educational works and for imaginative prose on a more ambitious scale; further by Bishop A. Baranauskas (1835–1902), a poet whose greatest work is "Anykščių Šilelis" (1858–59; Eng. trans., *The Forest of Anyksciai*, 1956). In 1864 the Russian authorities forbade the printing of Lithuanian writings in Latin characters. Henceforth for 40 years books and periodicals were printed in so-called Lithuania Minor or Prussian Lithuania, then under German rule, and were smuggled across the frontier. The literature of this era seeks to revive the national consciousness and to rally the Lithuanians against the political control of Russia and the cultural influence of Poland.

The first modern Lithuanian periodical, *Aušra* ("Dawn"), founded in 1883 by Jonas Basanavičius (*q.v.*) and printed in Lithuania Minor, has given its name to the literature of the ensuing generation. Thus, Basanavičius, famous as a collector of folklore and as a publicist, is commemorated as the "father of the Lithuanian national movement." Vincas Kudirka (1858–99) was a leading publicist and short-story writer; one of his poems became the national anthem of Independent Lithuania. The Rev. J. Mačiulis, who wrote under the pen name Maironis (*q.v.*), the most famous Lithuanian poet, noted both for dramatic and lyric poetry, has been called "the poet-prophet of the Lithuanian renaissance." Other distinguished names of the era are V. Storasta-Vydūnas (1868–1953), born in Lithuania Minor, philosopher, poet and dramatist; J. Biliūnas (1879–1907), a short-story writer of singular sensitivity; and the Rev. J. Tumas-Vaižgantas (1869–1933), a publicist and literary critic. Women writers included J. Žymantienė-Žemaite (1845–1921), the most famous short-story writer of the period; S. Pšibilauskienė-Lazdynų Pelėda (1867–1926), writer of novels and short stories; and M. Pečkauskaitė-Šatrijos Ragana (1878–1930), who achieved a new perfection in the art of the short story.

20th Century.—In 1904 the prohibition of Lithuanian books in Latin characters was repealed and in 1918 the Lithuanians regained independence. Lithuanian writers continued the work of developing national culture, and in time more sophistication appeared in the works of younger authors.

V. Krėvė-Mickevičius (*q.v.*), the novelist and dramatist, was regarded by some as the greatest of Lithuanian writers. J. Baltrušaitis (1873–1944) achieved distinction as a lyrical poet in Lithuanian and in Russian. Other prominent names of the age were V. Putinas-Mykolaitis (b. 1893), novelist, dramatist and pioneer of the modern Lithuanian romance; B. Sruoga (1896–1947) and K. Binkis (1893–1942), both poets and dramatists; J. Savickis (1891–1952), novelist and short-story writer; F. Kirša (b. 1891), poet; P. Vaičiūnas (1890–1959), dramatist; I. Šeinius (1889–1959), novelist and short-story writer; and S. Čiurlionienė (1886–1958), novelist and dramatist.

The leading poet of the younger generation was B. Brazdžionis. Others were S. Neris (1904–1945), J. Aistis-Aleksandravičius, A. Miškinis, H. Radauskas, K. Grigaitytė, and G. Tulauskaitė.

The aesthetic moment was notable in the prose of A. Vaičiulaitis, and a highly individual and decorative style characterized that of N. Mazalaitė. Among other prose writers of note were the novelists J. Grušas, J. Jankus, V. Alantas, L. Dovydėnas, P. Orintaitė, the historical novelist F. Neveravičius, the literary critic B. Babrauskas and many others.

When Lithuania, in 1940 and again in 1944, was occupied by the Soviet Union, the writers remaining in the country were compelled to follow the line dictated to them by the Communists. Those working in the free world, about 100 in number, tried to further the development of the national literature. New modes of expression were successfully attempted in the philosophical poetry of A. Nyka-Niliūnas, in the idyls of J. Mekas and in the novels of M. Katiliškis.

Lithuania has a rich folklore, and, on the whole, the genres most favoured by Lithuanian writers have been the short story and the lyric, with their roots in the folk tale and the folk song.

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LITKE, FYODOR PETROVICH, Count (1797–1882), Russian arctic explorer, geographer and naval officer whose influence on Russian science, geography in particular, was very great, was born on Sept. 28, 1797, in St. Petersburg. His grandfather (who spelled his name Lütke) had emigrated from Germany. In 1812 Litke joined the imperial navy and took part in a voyage around the world under V. M. Golovnin in 1817–19. During the four summers 1821–24 Litke commanded an arctic expedition which mapped the west coast of Novaya Zemlya and studied the adjacent southeastern part of the Barents sea. In 1826–29 he went around the world again, this time in command of a scientific expedition in the sloop "Senyavin," and made important surveys and collections in the Bering strait region and the western Pacific (Bonin and Caroline Islands). From 1832 to 1848 he was tutor to Tsar Nicholas I's second son Constantine. Litke was one of the founders of the Russian Geographical society in 1845 and was at its head from that time until 1873, with the exception of the seven years 1850–57 when he was admiral in command of the ports of Revel (Tallinn) and Kronstadt. He was president (1864–81) of the Imperial Academy of Sciences, taking particular interest in astronomy and magnetism. He wrote a large volume on each of his two major expeditions, and many scientific papers. The Geographical society instituted a Litke medal upon his retirement. He died on Oct. 20, 1882. (T. E. A.)

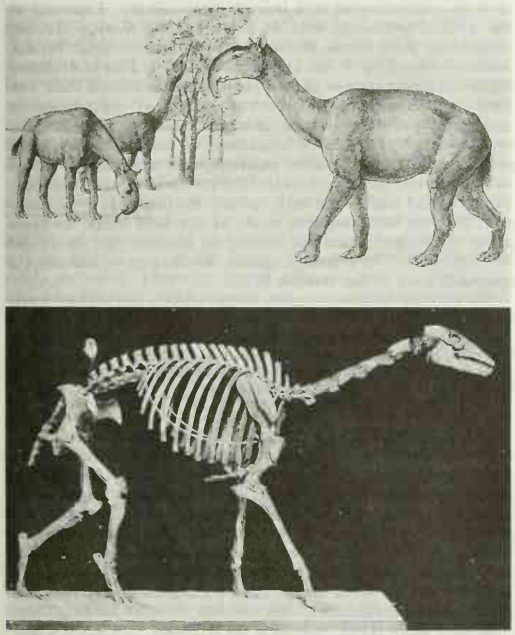
LITMUS, a mixture of dyes, the chief constituents of which are azolitmin and erythrolitmin. It is the oldest and most commonly used acid-base indicator. In an acid solution the dye turns red and in a basic solution it turns blue. Litmus was originally

prepared by the action of air, ammonia and an alkali carbonate on certain species of lichens (*Lecanora tartarea* and *Roccella tinctoria*) found in the Netherlands. It can be synthesized directly from β-orcinol. Litmus is usually used in the form known as litmus paper, an absorbent paper impregnated with the dye. When moistened with the solution under test, the paper changes colour. An alcoholic solution of litmus is sometimes used. A few drops added to the solution under test causes the whole solution to turn colour upon neutralization. *See* also INDICATOR, CHEMICAL.

LITOPTERN, any of the herbivorous, hoofed mammals (ungulates) of the order Litopterna, an extinct group confined to South America during the long period of isolation of that continent from all others. Litopterns, derived from the most primitive hoofed mammals, the condylarths, were abundant from the Paleocene to the Pliocene epochs (about 70,000,000 to 2,000,000 years ago) and finally became extinct during the Pleistocene (about 1,000,000 years ago). They were represented very early by two distinct families, Proterotheriidae and Macraucheniidae.

Early proterotheriids were barely distinguishable from condylarths. By the Miocene epoch (about 25,000,000 years ago) the feet in some genera showed a remarkable specialization, the number of toes having been reduced from five to three and even to one. The foot of *Thoatherium* closely resembled that of the present day horse, but had progressed even further in the reduction of the lateral digits. Conservative members of this family persisted into the Pliocene, the time of extinction of this branch of the litopterns.

The Macraucheniidae reached a three-toed condition early in their history, but did not progress beyond this stage. The teeth of macraucheniids, in contrast to those of proterotheriids, develop high crowns with complex patterns of crests and ridges in the molars. The last genus known, *Macrauchenia,* was probably somewhat camellike in size and appearance. The skull was marked by a reduction of the nasal bones and development of a short proboscis. The neck and limbs were long, the body and tail short. Remains were first brought to light in Patagonia by Charles Darwin, and since his discovery, numerous specimens, including complete skeletons, have been found in the pampean deposits of Argentina.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

RESTORATION DRAWING (ABOVE) AND SKELETON CAST (BELOW) OF MACRAUCHENIA, A GENUS OF THE EXTINCT ORDER OF HOOFED MAMMALS, LITOPTERNA

During the late Pliocene and the Pleistocene a land corridor developed between North and South America, permitting invasion of the southern continent by herbivores and carnivores from the north. Concurrently some South American mammals pushed northward, but many of the once highly successful groups, such as the litopterns, already somewhat impoverished, were unable to survive the competition with their North American adaptive counterparts. Among the casualties was *Macrauchenia,* whose extinction marked the end of the once abundant litopterns. *See* also UNGULATA; PALEONTOLOGY.

See A. S. Romer, *Vertebrate Paleontology* (1945); W. B. Scott, *A History of Land Mammals in the Western Hemisphere,* rev. ed. (1937). (E. C. O.)

LITOTES, a rhetorical figure in which emphasis is secured for a statement by turning it into a denial of the contrary, *e.g.,* "a citizen of no mean city," *i.e.,* a citizen of a famous city. *See* FIGURES OF SPEECH: *Figures for Emphasis.* (G. W. A.)

LITTLE ENTENTE, a mutual defense arrangement among Czechoslovakia, Yugoslavia and Rumania during the period between World Wars I and II. It was directed against German and Magyar dominance in the Danubian area and toward protection of the freedom and territorial acquisitions won by the member states in 1918. It was based upon the treaty of Aug. 14, 1920, concluded at Belgrade between Yugoslavia and Czechoslovakia, joined by Rumania in treaties with Czechoslovakia on April 23 and with Yugoslavia on June 7, 1921. By a treaty of Aug. 31, 1922, the three states undertook broader obligations of economic and political co-operation and by that of May 21, 1929, they agreed that the renewal of the treaty of alliance should be automatic at the end of each five-year period. At the same time they signed a treaty for the peaceful settlement of their differences in accord with the League of Nations model treaty of conciliation and arbitration of 1928.

Fascist Italy had been an enemy of the little entente from the beginning but the advent of Adolf Hitler to power in Germany on Jan. 30, 1933, challenged the whole structure of central Europe. On Feb. 16, 1933, the little entente states strengthened their bonds against this menace. Under the able leadership of Edvard Benes, Nicolae Titulescu and Bogoljub Jevtic, as well as King Alexander of Yugoslavia, a veritable, if short-lived, diplomatic federation was constituted. The new pact created a permanent council composed of the three foreign ministers or their delegates to meet three times a year and to direct a common policy. A permanent secretariat was established, one section of which was to function at Geneva, the seat of the League of Nations.

The little entente took a lead in urging effective sanctions against Japan from 1931 to 1933 and successfully protested against Mussolini's proposal in March 1933 of a four-power pact to revise treaties without consultation with the smaller states of Europe in substitution of the League's processes. Though signed in June 1933 by Italy, Germany, Great Britain and France this project was not implemented. On July 4, 1933, the little entente signed a nonaggression agreement with the U.S.S.R.; on Feb. 9, 1934, Yugoslavia and Rumania joined Turkey and Greece to form the Balkan entente (*q.v.*); and on May 16, 1935, Czechoslovakia, motivated by the Nazi menace, signed an alliance with the U.S.S.R., following the French-Soviet alliance by two weeks. From its first meeting at Prague in Jan. 1934, the economic council of the little entente laid foundations for closer economic collaboration among the three countries, attempting to include in this work Austria and Hungary.

The assassination of King Alexander of Yugoslavia and Jean Louis Barthou, foreign minister of France, at Marseilles on Oct. 9, 1934, weakened the little entente. Prince Paul, the regent of Yugoslavia, supported Milan Stojadinovic, who dominated the country as premier from 1935 to 1939, in a policy of rapprochement toward Italy, Bulgaria and Germany, thus striking at the vitals of both the little entente and the Balkan entente. The vacillating foreign policy of France and the division between France and Brit-

ain in respect to Italy and Germany further weakened the little entente. At the Bratislava conference of Sept. 1936, Yugoslavia seemed determined to follow an independent policy and the council of the little entente virtually acknowledged the right of each of the member states to do so. The last conference of the council was held at Yugoslavia on Aug. 21, 1938. An unsuccessful attempt was made to conciliate Hungary by an offer of equality in armaments in return for the promise of a peaceful policy. Despite the reluctance of the Stojadinovic government, both Yugoslavia and Rumania, at the time of the Munich crisis, in accordance with the terms of their alliance, warned Hungary not to attack Czechoslovakia. But with the appeasing attitude of Great Britain and France, there was little question of the outcome. The Munich accord of Sept. 30, 1938, permitted Germany to annex the Sudeten area of Czechoslovakia, and destroyed the little entente by destroying Czechoslovakia, the keystone of the system. (Q. W.)

LITTLEHAMPTON, a seaport, seaside resort and urban district in the Arundel and Shoreham parliamentary division of West Sussex, Eng., at the mouth of the Arun, 14 mi. E.S.E. of Chichester by road. Pop. (1961) 15,647. Backed by the South Downs and with long sandy beaches, it caters to many vacationists every year and also has a harbour, accessible in good weather, with a small domestic and foreign trade. Timber, granite and fertilizers are imported and grain for seed is exported. Lifeboats are made in the local boatyards.

LITTLE MAGAZINE, the term applied to a certain kind of periodical published from 1890 through much of the 20th century. Little magazines flourished in the United States and England, though French writers (especially the *symboliste* poets and critics, 1880–*c.* 1900) often had access to a similar type of publication and German literature of the 1920s was also indebted to them. The name, probably derived by analogy from "little theatre," signifies most of all a nonprofessional and noncommercial manner of editing, managing and financing. A composite description of the little magazines' motives for existing and of their careers would most usefully take this form: a little magazine usually begins with the object of publishing literary work of some artistic merit which is unacceptable to commercial magazines for any one or all of three reasons—the writer is unknown and therefore not a good risk; the work itself is unconventional or experimental in form; or it violates one of several popular notions of polite moral, social or aesthetic behaviour. In addition, several little magazines were employed as direct forums for the advancement of entirely new ideas in literature such as those of the *symbolistes* of France and the imagists of the United States and England, or of social and political perspectives on a culture as in the leftist magazines of the 1930s in the United States and England.

As a consequence of these peculiarities, little magazines were frequently in the advance guard of modern literature. They lacked both the financial stability and the restrictive editorial controls of established commercial magazines and were likely for both reasons to take risks and make bold moves beyond the limits set by public taste at any given time. Frequently the little magazines advanced new developments in literature which were subsequently assimilated by a culture, the time lag usually being about two decades. Foremost in the ranks of such sponsorship of literature were *Poetry: a Magazine of Verse* (1912), especially in its early years under the vigorous guidance of Harriet Monroe; the more erratic and often more sensational *Little Review* (1914–29) of Margaret Anderson; a group of English magazines in the second decade of the 20th century, of which the *Egoist* (1914–19) and *Blast* (1914–15) were most conspicuous; and Eugene Jolas' *transition* (1927–38). In all but the last of these, a major guiding spirit was the U.S. poet and critic, Ezra Pound; he served as "foreign correspondent" of both *Poetry* and the *Little Review,* maneuvered the *Egoist* from its earlier beginnings as a feminist magazine (*The New Freewoman,* 1913) to the status of an *avant garde* literary review, and with Wyndham Lewis jointly sponsored the two issues of *Blast.* In this case, the little magazines showed the stamp of a single vigorous personality; similar strong and dedicated figures in little magazine history were the U.S. poet, William Carlos Williams (whose name appears in scores of little magazines, in one capacity or another); the British critic and novelist, Ford Madox (Hueffer) Ford, editor of the *Transatlantic Review* (1924–25) and contributor to many others; and Gustave Kahn, a minor French poet but a very active editor associated with several French *symboliste* periodicals.

From the point of view of the writer, the little magazines rendered two essential services: their pages were accessible to him when he was still unknown, and they conducted campaigns designed to publicize and broadcast reputations in foreign countries. Both of these services persisted throughout little magazine history, though the stress upon them varied in the several stages of that history.

There were four principal periods in the general history of little magazines. In the first, from 1890 to about 1915, French magazines served mainly to establish and explain a literary movement; British and U.S. magazines, to disseminate information about and encourage acceptance of continental European literature and culture. In the second stage, 1915–30, when other magazines, especially in the United States, were in the vanguard of almost every variation of modern literature, a conspicuous feature was the expatriate magazine, published usually in France but occasionally elsewhere in Europe by young U.S. and British critics and writers. The major emphasis in this period was upon literary and aesthetic form and theory and the publication of fresh and original work, such as that of Ernest Hemingway (in the *Little Review, Poetry, This Quarter* and elsewhere), T. S. Eliot (in *Poetry,* the *Egoist, Blast*), James Joyce (in the *Egoist,* the *Little Review, transition*), and many others. The third stage, the 1930s, saw the beginnings of many leftist magazines, started with specific doctrinal commitments which were often subjected to considerable editorial change in the career of the magazine. *Partisan Review* (1934) was perhaps the best-known example of these in the U.S., as was the *Left Review* (1934–38) in England.

The fourth period of little magazine history began about 1940. One of the conspicuous features of this period was the critical review supported and sustained by a group of critics, who were in most cases attached to a university or college. Examples of this kind of periodical were, in the U.S., *The Kenyon Review,* founded by John Crowe Ransom in 1939, and in Great Britain, *Scrutiny,* edited by F. R. Leavis (1932–53). This and related kinds of support such as that of publishers maintaining their own reviews or miscellanies, represented a form of institutionalism which was radically different from the more spontaneous and erratic nature of the little magazines of earlier years. These magazines generally favoured criticism over creation and tended to stabilize and slow the growth of experiment in new literature. In the second half of the 20th century the prospects were, however, that the little magazine might at any time break out from newly established limits and recover at least in part its earlier freedom, if only as a protest against the dangers of too strict a standardization of the creative life.

See also the articles on most of the editors and writers mentioned above.

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(F. J. HN.)

LITTLE ROCK, the largest city and capital of Arkansas, U.S., the seat of Pulaski county, is on the south bank of the Arkansas river near the centre of the state at a dividing line between the mountains and the plains. It is the principal centre of commerce and manufacturing for the region. The population was 102,213 in 1950, and 107,813 in 1960. The population of the Little Rock–North Little Rock standard metropolitan statistical area (Pulaski county) was 156,085 in 1940; 196,685 in 1950; and 242,980 in 1960. (For comparative population figures *see* table in ARKANSAS: *Population.*)

Bernard de la Harpe, exploring the Arkansas in 1722, saw two conspicuous rock formations on the river banks, which he named *La Petite Roche* and *La Grande Roche* (or *Le Rocher Français*). Near the smaller rock was a settlement of Quapaw Indians, and La

Harpe made this his trading post. In later years, the "little rock" became the abutment for a railway bridge. The "big rock," on the North Little Rock side of the river and two miles upstream from the smaller formation, was the site of an army post and later became the location of a veterans administration hospital. In 1812 William Lewis, a hunter and trapper, built his home at the "little rock." In 1819 Arkansas became a territory with its capital at Arkansas Post. The site of Little Rock was surveyed in 1821, and the territorial capital was moved there the same year. Little Rock was incorporated as a town in 1831 and chartered as a city in 1836. A board-manager form of municipal government was adopted in 1957.

Little Rock was strongly anti-Union at the outbreak of the American Civil War, and the U.S. arsenal which had been strengthened by the federal government was seized by state authorities Feb. 8, 1861. In Sept. 1863, Gen. Frederick Steele's Union troops occupied the city, and a pro-Union government was set up. In the 1880s Little Rock became an important communication centre with the expansion of the state railways, and began to develop commercially and industrially. Industry in the greater metropolitan area experienced a marked and diversified growth in the 1940s mainly because of the proximity of raw materials and an adequate labour supply, and in the 1960s included cottonseed, wood products, light bulbs, roofing granules, watches and clocks, electric motors, nonwoven fabrics and food products. There are large railroad shops across the river, and bauxite mines just outside the city. The surrounding agricultural region produces large crops of cotton, alfalfa, potatoes, rice, fruits and vegetables. Within a short distance are vast stands of high grade timber and large deposits of coal, oil and natural gas. Other mineral resources in the region are marble, clay, flint, granite and barite.

Little Rock is noted for its three capitols, one of which served the territorial government. The meeting place of the territorial legislature between 1821 and 1836 is preserved in the Territorial Restoration, along with a block of buildings of the period, including the first print shop of the *Arkansas Gazette*, one of the first newspapers to be published west of the Mississippi. The Old state house, the capitol from 1836 until 1912, is a remarkable work of ante-bellum architecture. It is on the site of an Indian burial ground and has a commanding view of the Arkansas river. The Territorial Restoration and the Old state house, containing interesting authentic furnishings, are open to the public. The present state capitol is on a knoll near the business district and is flanked by other governmental buildings. It is of Arkansas marble and is patterned after the capitol at Washington, D.C.

Several state institutions are located at Little Rock, including the main branch of the state mental hospital, the schools for the blind and deaf; also medical units, a graduate centre and graduate institute of technology of the University of Arkansas. Other educational institutions include Little Rock university (1927), privately endowed; Philander Smith college (1868), a Methodist school for Negroes; the Arkansas Law school (1916), a private institution; St. John's seminary (1930), Roman Catholic; Arkansas Baptist college, for Negroes (1884); and Shorter college (established as Bethel institute in 1886), an African Methodist Episcopal school for Negroes at North Little Rock. Little Rock's Robinson Memorial auditorium houses a convention hall, lecture hall, committee rooms and a music hall seating 3,000 persons.

The metropolitan area has several parks, including MacArthur park, which surrounds the birthplace of Gen. Douglas MacArthur and is the former site of an army post at which the general's father was stationed. The 36 ac. of shaded grounds include a museum of natural history, a band shell and a museum of fine arts. The 200-ac. War Memorial park has a zoo, a swimming pool, a golf course, an archery range, an amusement park, a baseball park and the War Memorial stadium. The Arkansas Livestock show grounds at Little Rock is centred about the T. H. Barton coliseum. The Governor's mansion, at the opposite end of Center street from the Old state house, is a stately structure completed in 1950. The Georgian colonial two-story brick executive mansion is on a 6.25-ac. plot. The Albert Pike Memorial temple, state headquarters for Freemasonry, is a magnificent block-long structure in the downtown area. Adams field, the municipal airport, is one mile from the main street. Veterans', Roman Catholic and Baptist hospitals are in the area. Camp Pike of World War I, renamed Camp Joseph T. Robinson in the 1940s, was an important military training centre. In the mid-1950s, the Little Rock air force base was built near Jacksonville.

Bishops of the Roman Catholic (St. Andrew's cathedral), Protestant Episcopal (Trinity cathedral), Methodist and African Methodist Episcopal churches maintain residence at Little Rock, and several other denominations have state headquarters and churches there.

From Sept. 1957 the city was the focus of world attention. The immediate issue was the right of nine Negro children to attend Central high school under a gradual desegregation plan adopted by the city school board, in accordance with the 1954 decision of the U.S. supreme court holding racial segregation in public schools as unconstitutional. Their attendance set off a series of legal battles and one of the 20th century's great tests of power between the federal and a state government. Gov. Orval E. Faubus ordered state militia to prevent Negroes from attending the school, but the state was enjoined from interfering by Pres. Dwight D. Eisenhower, who sent federal troops to maintain order throughout the year 1957–58. After various legal maneuvers, the city's public high schools were closed during the following school year, but were reopened in Aug. 1959 with several Negroes in attendance at Central and Hall high schools. City police dispersed a small mob of whites at Central on opening day, and token integration was accomplished without further incident. (K. W. P.)

LITTLE THEATRE MOVEMENT: *see* THEATRE: *United States: Community Theatre.*

LITTLETON, SIR THOMAS (*c.* 1407–1481), English judge, best known as the author of *Littleton on Tenures*, was born, it is supposed, at Frankley House, Worcestershire, perhaps in 1407, and certainly not later than 1422. He is said by Sir Edward Coke to have "attended one of the universities." He was probably a member of the Inner Temple where he lectured on the statute *De Donis Conditionalibus* (1285), which established the law of entail (*q.v.*). He appears to have been recorder of Coventry in 1450; he became sergeant-at-law in 1453 and was afterward a justice of assize on the northern circuit. In 1466 he was made a judge of the common pleas and in 1475 a knight of the Bath. He died, according to the inscription on his tomb in Worcester cathedral, on Aug. 23, 1481.

Littleton wrote his *Tenures*, a brief text on property, the first of the classical texts on English law not written in Latin and uninfluenced by Roman law, probably after his appointment to the common pleas, for the instruction of his son, Richard. It soon became the most celebrated treatise on English law and was acclaimed by Sir Edward Coke "the most perfect and absolute book that was ever written in any human science." Composed in law French, the *Tenures* was principally a scientific account of the English land law of the middle ages unmodified either by the doctrines of the chancellors, such as uses, or by later common-law innovations, such as contingent remainders and conveyances barring entails. Intended as a first book in law, it served countless generations of lawyers not only in England but also in America both before and after the Revolution.

The edition by Lettou and Machlinia of 1481 or 1482 was the earliest treatise on English law ever printed and among the first ten books to be published in London. An English translation by William Rastell appeared early in the 16th century. The division of the text into sections dates from the edition of William West (1581). The most famous form of the *Tenures* was Sir Edward Coke's *First Institute*, known as *Coke Upon Littleton*, the first edition of which appeared in 1628.

See E. Wambaugh, *Littleton's Tenures in English* (1903); W. S. Holdsworth, *History of English Law*, vol. 2, pp. 571–590 (1936). (S. Tr.)

LITTLE TURTLE (*c.* 1752–1812), American Indian chief of the Miami tribe, who became a popular hero among the settlers, was born in a village (later named after him) on the Eel river near Fort Wayne, Ind. Noted for military prowess and oratorical

ability, Little Turtle was one of the most important Indian leaders in the Northwest Territory. On Nov. 4, 1791, he led the Indians to a crushing victory on the Wabash river over federal troops under the command of Gen. Arthur St. Clair. In 1795, after the defeat of the Indians by Gen. Anthony Wayne at Fort Recovery and Fallen Timbers, Little Turtle, who was not in command at the latter battle, signed the treaty of Greenville, by which the Indians ceded to the United States much of Ohio and parts of Illinois, Indiana and Michigan. Thereafter he was a strong advocate of peace, and he successfully resisted the efforts of the Shawnee chief Tecumseh to induce the Miami to join his confederacy. He subsequently signed other treaties with the United States before his death at Fort Wayne on July 14, 1812.

LITTRÉ, MAXIMILIEN PAUL ÉMILE (1801–1881), French philologist and positivist philosopher, whose dictionary is one of the outstanding lexicographic accomplishments of all time, was born at Paris on Feb. 1, 1801. He was educated at the Lycée Louis-le-Grand, where he made friends with Louis Hachette and Eugène Burnouf. He then studied the English and German languages, and classical Sanskrit literature and philology. Littré intended to become a doctor, and had completed his studies when his father's death in 1827 made it necessary for him to begin earning money. He began to teach classics, and in 1835 became a regular contributor to the *National*, and eventually director of the paper. In 1839 appeared the first volume of his edition (completed 1862) of the works of Hippocrates, which secured his election the same year into the Académie des Inscriptions et Belles-Lettres. He also became a friend of Auguste Comte and popularized his ideas.

About 1844 he started working on his great *Dictionnaire de la langue française*. In the Revolution of July 1848 he took part in the repression of the extreme republican party in June 1849. His essays, contributed during this period to the *National*, were collected together and published under the title of *Conservation, révolution et positivisme* in 1852, and show a thorough acceptance of Comte's doctrines. Later he differed with Comte's more mystic ideas, but he concealed his differences. After Comte's death in 1858 Littré felt free to publish his own ideas in his *Paroles de la philosophie positive* (1859), and at still greater length in his work in *Auguste Comte et la philosophie positive* (1863).

About 1863, after completing his Hippocrates and his Pliny, he set to work in earnest on his French dictionary. In the same year he was proposed for the Académie Française, but rejected, because of the opposition of Msgr. Dupanloup, bishop of Orléans, who denounced him as the chief of the French materialists. He also at this time started with G. Wyrouboff the *Philosophie Positive*, a review which was to embody the views of modern positivists. Literary work absorbed him until the overthrow of the empire compelled him to take a part in politics. He felt himself too old to undergo the privations of the siege of Paris, and retired with his family to Brittany, from which he was summoned by Léon Gambetta to Bordeaux, to lecture on history; and then to the senate to which he had been elected by the Seine *département*. In Dec. 1871 he was elected a member of the Académie in spite of the opposition of Dupanloup, who resigned rather than receive him.

Littré's dictionary was completed in 1873. An authoritative interpretation is given of the use of each word, based on the various meanings the word had held in the past. He died in Paris on June 2, 1881.

LITURGICAL MOVEMENT, ROMAN CATHOLIC. The 20th-century liturgical movement in the Roman Catholic Church embraces all the efforts to promote better understanding of Christian worship by clergy and laity and more active congregational participation in worship. Though such efforts have their roots in the 19th century, they are ordinarily dated from the pontificate of Pope Pius X (1903–14). While the movement is principally educational, it also extends to the revision or reform of liturgical services in order to achieve sincere and intelligent corporate worship by the laity. It is closely related to developments in biblical, catechetical, and ecumenical studies, as well as to the fuller role increasingly played by the laity in the Roman Catholic Church.

The English-speaking world was little affected by the movement until the 1920s, and even then the influence was limited. Its chief organ in English is the monthly *Worship* (originally *Orate Fratres*, from 1926); the principal organization in the English-speaking world is the Liturgical Conference (Washington, D.C.).

Official recognition of the development was first given by Pius X, who urged congregational participation in the sung liturgy and initiated several reforms: improvement of liturgical music, especially plainchant; daily communion and communion for young children; correction of the church calendar; and reform of the daily prayer or office. Little further official reform was introduced until the program was taken up again by Pius XII, but the popular movement had spread widely by then, largely through distribution of translations of the Roman missal for congregational use, the practice of dialogue Mass, and educational efforts aimed at a sounder spirituality based upon the Eucharist, understood as the action of the whole community of worshippers, and the other sacraments.

Pius XII encouraged the various levels of the liturgical movement, first by doctrinal pronouncements (encyclical on the church, the Mystical Body of Christ, 1943; encyclical on the liturgy; international congress on pastoral liturgy, Assisi, 1956), then by beginning a complete reform of rites through a special commission (1948). The chief reforms included evening Mass and a mitigated fast before communion, partial use of the vernacular languages in sacramental rites, the complete revision of the Holy Week services, and a provisional simplification of the church calendar and office. He also gave the strongest official impetus to congregational participation in the Mass and other services.

Pope John XXIII took up this movement by personal example and proposed that the second Council of the Vatican determine the general principles of liturgical reform. This was done in the council's first enactment, the Constitution on the Sacred Liturgy (promulgated Dec. 4, 1963), which insisted upon the universal need for promoting liturgical understanding and participation and also gave norms for revision of rites. Implementation of this constitution is the work of a commission named in January 1964 by Pope Paul VI for the whole Roman liturgy, but regional adaptations according to cultural traditions were to be accomplished by conferences or assemblies of bishops for their respective territories. The most striking reforms include the restoration of the cup to the laity on certain occasions and the introduction of the vernacular languages into services.

Summing up the findings of the popular liturgical movement, the second Vatican Council directed that the forms of worship should better express the communitarian nature of the liturgy, should take full advantage of the liturgy's didactic value (especially by simplicity and clarity of rites and by a fresh emphasis upon the place of the Bible in worship), and should remain open to development and regional adaptation in harmony with differing cultural and religious traditions.

See also LITURGY: *Latin Eucharistic Rites: The Community's Part in the Mass.*

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LITURGY, in the widest use of the term, refers to the public worship of the Christian church as expressed in formulas, rites and ceremonies. It is easier to trace the semantics of the word than to circumscribe the living limits of the thing called liturgy, as is particularly evident in the 20th century during the debates concerned with the liturgical movement. The encyclical *Mediator dei* of Pius XII (1947) equated liturgy with the priesthood of Christ as exercised by the church chiefly through the sacraments,

the sacramentals and the divine office. Christian liturgy, particularly its most important part, the mystery of the Eucharist, has taken different forms from the earliest period; the principle from which the differentiation sprang was originally neither linguistic nor dogmatic (as it became in the West at the Reformation) but geographical, as in the case of the great division into Eastern and Western rites.

This article deals, in necessarily summary fashion, first with the eucharistic rites of the Eastern churches and with the variants of the Latin Mass, then with the other sacraments and the sacramentals and finally with liturgical services in Protestant churches. It does not deal with the theology of the Eucharist, for which *see* EUCHARIST. (P. MU.)

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I. EASTERN EUCHARISTIC RITES

Liturgy is the title most commonly used in the West to designate the eucharistic rite of the Eastern churches. The names these churches themselves apply to their celebration of the Eucharist represent three concepts: a holy and public function (*leitourgia*, Byzantine), sanctification or consecration (*qudasha*, Nestorians and Malabar Christians; *aghiasmos*, Copts; *qedeshe*, Ethiopians) and oblation or sacrifice (*badarak*, Armenians; *qurbana*, Syrians and Maronites). In this part of the article, for simplicity's sake, the word liturgy is used throughout.

A. History

1. Development.—It took many centuries for the Eastern liturgies to reach their present state. After free improvisation in the first three centuries, written formularies brought stability to the basic structure, though creative activity and borrowing by one rite from another never entirely ceased. By the 7th century the main types were fixed, but development within each liturgy still remained possible.

The Christian liturgy has a double origin: the sabbath service of the Jewish synagogue, composed chiefly of readings from Scripture, and the special institution of Jesus Christ at the Last Supper when he blessed bread and wine and gave them to his disciples, saying that they were his body broken for remission of sins and his blood shed for the salvation of the world. Serious disadvantages were caused by the linking of this double rite of benediction and communion to an actual meal (*see* I Cor. xi, 17–34), and before the end of the 1st century the Eucharist was separated from the meal and was soon attached to the synagogue service that the Christians held on Sunday morning, as Pliny the Younger remarks in his 96th letter to Trajan.

For a long period there was a clear distinction between these two parts, which were known to have a different origin and aim. Justin Martyr's first *Apologia* (*c.* 150) and Hippolytus' *Apostolic Tradition* (*c.* 217) show that the first part was omitted after the conferring of baptism or of holy orders; as late as the 6th century in a number of Palestinian monasteries the Armenian, Georgian and Syrian monks had their Bible lections each in their own language and in their own chapel before joining the Greeks in the main church for the celebration of the Eucharist.

2. Sources.—From the 4th century onward various sources give information about the liturgies of the different churches:

a. Actual formularies, such as the "Clementine" liturgy in the eighth book of the Apostolic Constitutions, the *Euchologion* of Serapion of Thmuis, the Greek liturgies of St. James, St. Mark, St. Basil and St. John Chrysostom, the Nestorian liturgy of the apostles Addai and Mari, the anaphora of the Der Balizeh papyrus.

b. The commentaries of Cyril of Jerusalem in his fifth mystagogical homily; of Theodore of Mopsuestia in his two last catechetical homilies; the interpretation of the *Testamentum Domini* and of the second book of the Apostolic Constitutions.

c. Scattered references in the writings of the Church Fathers and the canons of church councils.

Beginning with the 6th century, the most important sources for the historical study of the liturgies are the following: (1) for the Byzantine rite, the works of Maximus the Confessor, the canons of the Trullan council and the short commentary attributed to Germanus of Constantinople; (2) for the Syrian rite, the *Ecclesiastical Hierarchy* of Dionysius the Areopagite, the letter of Jacob of Edessa to the priest Thomas and the commentaries of George, bishop of the Arabs, of Moses bar-Kepha and of Jacob bar-Salibi; (3) for the Chaldaean rite, the 21st, 22nd and perhaps also the 17th homilies of Narsai of Nisibis, the canons of Isho'yabh I, the constitution of Isho'yabh III, the commentaries of Abraham bar-Lipheh and of Pseudo-George of Arbela and the "Questions and Answers" of Isho'yabh IV; (4) for the Egyptian rite, the 97th, 98th and 99th Arabic canons of St. Basil, the Arabic version of the *Testamentum Domini* and the *Euchologion* of the White Monastery in Egypt.

Later developments are the Byzantine proscomidia (the ritual preparation of the bread and wine) in the 12th century, new Syrian anaphoras composed up till the 15th century, and in the 18th century a new Maronite anaphora. As in other fields, here too the invention of printing had a stabilizing influence on liturgical formularies, rubrics and prayers.

B. Structure

The three original parts of the liturgy—Bible lections, consecration of bread and wine and communion of the consecrated elements—were increased, by the 4th century at the earliest, by two further actions: the ritual placing of the gifts on the altar before the great eucharistic prayer, and, after it, the fraction of the bread, the consignations, the commixture, the Lord's Prayer and the exclamation "Holy things for those that are holy" (*Sancta sanctis*). Finally, a preliminary office was everywhere added. An analysis of these six parts will show the ways in which the various rites differ.

1. Preliminary Office.—The Byzantine liturgy begins in silence, behind the closed doors of the iconostasis (chancel screen), with the preparation of the oblations on the side altar (prothesis); after covering them with a veil the priest censes them and says an offertory prayer over them. The deacon leaves the sanctuary

to cense the whole church and then invites the faithful to prayer. After this the choir sings three psalms with antiphons.

The Armenian liturgy, on the other hand, begins with a solemn hymn, during which the clergy go in procession to the sanctuary. After certain prayers the curtain is drawn across and then opened again after the preparation of the oblation. As in the Byzantine liturgy, the church is censed and a psalm is sung.

In the Nestorian rite the gifts are prepared before the faithful enter the church, and the service begins with the recitation of a *marmitha* (a division of the psalter, generally three psalms). During the singing of the *onitha* (anthem) of the sanctuary the bishop used formerly to enter and take his place with his clergy at the ambo in the centre of the church; there he placed incense in the censer, and the censing took place during the hymn "Thee, O Saviour of the world, we thank."

In the Syrian and Maronite rites the psalm singing takes place at the *sedro*, which includes an introductory prayer of praise, the chief prayer indicating the theme of the little office, a hymn of four strophes and a prayer for the acceptance of the incense; there is usually a censing. In addition, this little office is repeated; the preparation of gifts and the offertory prayer is joined to the first, and the censing to the second.

In the Coptic rite the priest says the Lord's Prayer with the faithful before entering the sanctuary, where he prepares the altar and then takes a piece of bread, which he wraps in a cloth and holds in his hands while walking round the altar three times, accompanied by the deacon carrying the wine. The priest then blesses the gifts, places them on the altar and says the offertory prayer over them. Next, he turns to the faithful and pronounces a formula of absolution from their sins. Finally he performs the censing, which is a long ceremony. The absence of psalm singing is striking here.

The Ethiopian rite, which is basically the same as the Coptic, begins with a ceremonial entry in which a deacon carries on his head a basket of bread from which the priest will choose the loaf for the Eucharist.

As the foregoing indicates, this preliminary part of the rite, which originally consisted only of psalm singing, was gradually enlarged, chiefly by the preparation of the offering and by the general censing.

2. Biblical Lections.—The second part of the liturgy is much simpler and more uniform. In the Byzantine and Armenian rites the little entrance with the Gospel book takes place first, corresponding to the entry of the bishop into the sanctuary. In the Nestorian rite the bishop goes to the ambo before the censing; in the other rites there is no trace of a similar ritual entry.

All rites include the *Trisagion*, the solemn threefold acclamation "Holy God, holy mighty, holy immortal," addressed by the Byzantines and the Nestorians to the Holy Trinity, by the Monophysite Armenians, Syrians, Copts and Ethiopians to Christ. The Monophysites add the words that caused so much controversy: "Who wast crucified for us." The acclamation concludes with the prayer "Have mercy upon us."

All the rites have at least two lections, one from the Pauline Epistles, the other from the Gospels. The Armenians, like the Byzantines up to the 8th century, add an Old Testament lection before the others. The Syrians sometimes have three Old Testament lections, the Nestorians regularly two (from the Law and the Prophets), while the Copts and the Ethiopians take their four lections from the New Testament (Pauline Epistles, Catholic Epistles, Acts of the Apostles, Gospels), sung toward the four points of the compass. The Gospel lection is plainly the most solemn one, preceded as it is by chants, censing and a procession.

The Armenians sing the Creed immediately after the Gospel. In all the rites the deacon invites the faithful to pray for the needs of all; for penitents, catechumens and the faithful.

3. Placing of the Gifts on the Altar.—The part of the liturgy that runs from this prayer to the beginning of the anaphora is less uniform, though containing elements common to all the rites. The Byzantines and Armenians first bring the gifts ceremonially to the altar in what is called the great entrance, with mention of the intentions for which the gifts are offered. Meanwhile the choir sings the cherubic hymn ("We who in a mystery represent the Cherubim . . ."), which ends during the placing of the gifts on the altar, where they are censed. The Nestorians also take the gifts to the altar but with less ceremony; then follows an offertory prayer. From the procession of the gifts the Syrians have retained the processional hymn and the censing; the Maronites have kept the mention of intentions and the censing, which in fact takes place during the Creed. The Copts and Ethiopians omit this action, for they have already placed the gifts on the altar during the preliminary part of the liturgy.

It is worth noting the way in which the Nestorian and the Malabar priest approaches the sanctuary and the altar: as he comes toward the altar he makes three deep obeisances, and when he has reached it he kisses it three times—in the centre, at the right-hand corner and at the left-hand corner.

All rites contain the washing of the hands of the celebrant, the singing of the creed and the kiss of peace, but the order varies. The Nestorians retain also a prayer by the deacon, which, with its lists of names, recalls the diptychs recited in the early church at this point of the liturgy.

All rites also contain the following two actions before the great eucharistic prayer: the removal of the veil covering the gifts and the deacon's request to the faithful to stand upright, for the priest is about to begin the sacrifice.

4. The Anaphora.—The central part of the liturgy is sometimes called the anaphora (literally "offering"). It is easy to detect, beneath the later additions overlying its basic structure, the early parts that form it and that make it a logical whole, at least in the most widespread type, which is the Antiochene. This type lies behind the two Byzantine anaphoras, the Armenian anaphora, about 80 Syrian and Maronite anaphoras, the two Coptic anaphoras of St. Basil and of St. Gregory, and several Ethiopian anaphoras. After the introductory dialogue ("Lift up your hearts . . ."), the priest says a prayer, which can be called theological insofar as it praises and thanks God as the Creator of the universe and, in particular, of man; the prayer begins after the song of the angels: "Holy, Holy, Holy . . ." (the *Sanctus*), which the priest takes up, this time to exalt the work of redemption accomplished by the incarnate Word. This prayer, which can be called Christological in that it sometimes refers to incidents in the life of Jesus Christ, continues, often by a natural transition, with an account of the Last Supper. Here the priest repeats the words of Christ, in his name, with the intention of fulfilling his command "Do this in remembrance of me." Then comes the anamnesis ("memorial"; I Cor. xi, 24 f.), which recalls the death and resurrection of Christ and concludes with a formula of oblation whereby the actual bread and wine over which thanks have been given are offered to God. The Syrians, however, end with an insistent prayer for mercy. After thus offering these gifts, the priest asks the Father to send his Holy Spirit upon them so that, sanctified and changed by the Spirit into the body and blood of Christ, they may purify those who are going to communicate and make them enter into the communion of the Holy Spirit and into possession of the kingdom of heaven. This part is called the epiklesis. The great eucharistic prayer then continues by entering upon its longest part—the many intercessory requests for the saints, the living and the dead. The anaphora ends with a doxology.

Besides the Antiochene there are two other types of anaphora: the Nestorian and the Egyptian. The former is represented by the anaphoras of the apostles Addai and Mari, of Theodore of Mopsuestia and of Nestorius, as well as by the Maronite anaphora of St. Peter, which is today reduced to a Mass of the Presanctified. This type, which begins with the usual dialogue, continues with the theological prayer and after the *Sanctus* with the Christological prayer: the account of the Last Supper follows, then the anamnesis (where it exists), the intercessions, the epiklesis and the doxology.

The Egyptian type, known chiefly through the Coptic anaphora of St. Cyril, which is a slightly developed translation of the Greek anaphora of St. Mark, places the prayers of intercession between the theological prayer and the introduction to the *Sanctus;* further, the prayer after the *Sanctus* is not Christological but is a

rudimentary epiklesis; this does not prevent another epiklesis from appearing further on. The Egyptian type alone has the whole anaphora sung by the priest, although in the other rites the priest says most of the prayers in a low voice while the choir sings; in all rites, however, the actual words of institution are said out loud, and the faithful respond with "Amen."

Thus the three types of anaphora, as far as their main elements are concerned, differ chiefly in the position of the prayer of intercession. A point worth noting is the trinitarian form of the Eastern anaphora—the theological prayer, the Christological prayer and the epiklesis of the Holy Spirit—which appears very clearly in the Antiochene type.

5. Between Anaphora and Communion.—The part of the liturgy between the end of the anaphora and the communion looks forward to the latter. After a benediction and a litany, which is found in many rites, the Syrians and the Nestorians have the "manual rites," *i.e.*, the fraction (breaking of the bread), the intinction (dipping the bread into the wine), the consignations (marking with the sign of the cross) and the commixture; the fraction and the other actions are performed for the sake of the commixture. The commixture, in fact, confirms that the body and the blood, present in the two separate kinds of bread and wine, belong to the one person of Jesus Christ. The Maronites, though keeping the prayer accompanying the fraction at this point, perform all the manual acts after the *Sancta sanctis*.

A series of prayers always occur in the same order: prayer before the Lord's Prayer, the Lord's Prayer itself, the embolism (*i.e.*, expansion of the two last clauses of the Lord's Prayer), a prayer of inclination (*i.e.*, said while all the heads are bowed) and finally the *Sancta sanctis* uttered at the elevation (lacking in the Nestorian rite) of the consecrated elements. The Byzantine, Armenian and Maronite rites place the manual acts after this series of prayers. The Coptic and Ethiopian rites have the fraction before this central series and the manual acts after it.

Each rite here has its own individual features. After the commixture in the Byzantine rite a little warm water is poured into the chalice; this *zeon* indicates the warmth of faith and of the Holy Spirit. The Armenians add to the elevation a ceremonial exposition of the body and blood of Christ. The Nestorians and the Malabars have the prayer of pardon before the Lord's Prayer, and the Malabars since the 16th century have placed the account of the Last Supper with the words of Christ at the beginning of the fraction. The Copts and Ethiopians have an absolution before the *Sancta sanctis* and immediately before the communion a magnificent profession of faith (*homologia*) in Christ.

6. Communion.—The last part of the liturgy is on the whole uniform in character. In all rites there are prayers preparing the priest and his deacon for communion while the choir sings. The faithful communicate by receiving, often in a spoon, a piece of bread dipped in the wine, save for the Copts and Ethiopians, who receive the bread and then the wine separately. What remains after communion is placed on the altar of the prothesis to be consumed after the service, or on the altar itself, in which case it is consumed immediately, and the ablution of the sacred vessels follows.

Thanks are given by a chant from the faithful, a litany from the deacon and a prayer from the priest. The concluding benediction and dismissal of the faithful immediately bring the liturgy to an end. In several rites the blessed bread (eulogia, antidoron) is distributed to the departing congregation, and the priest leaves the altar where he has celebrated the eucharistic sacrifice.

(A. M. Ra.)

II. LATIN EUCHARISTIC RITES

Latin eucharistic rites may be divided into two groups: the Roman rite, which is that in almost universal use; and the others, whether obsolete or still extant. For a detailed exposition of the Roman rite, including its music, *see* Mass.

A. The Modern Roman Rite

1. Origin.—The uniform rite imposed in the 16th century on the Roman Catholic Church (with only a few exceptions) is called the Roman rite. There are no detailed reports of the work of the commission that produced the *Missale Romanum*, promulgated on July 14, 1570, by Pius V, but modern scholars have traced the evolution of the greatest of the Western eucharistic rites, or, to give it its common name, the Mass, through four significant turning points: (*a*) About A.D. 370 the changeover from Greek to Latin as the language of the Roman liturgy was complete. (*b*) About A.D. 600 there was a thoroughgoing reform by Gregory I the Great, aimed above all at clarifying the condition of the sacramentary (the celebrant's Mass book). (*c*) About A.D. 950 reverse currents of influence from Germany began to influence the Roman Mass; these were Gallicanizing and newly created trends carried southward by the Frankish *ordines romani* (*q.v.*), and above all by the 10th-century Romano-Germanic pontifical from Mainz. (*d*) After A.D. 1000 this mixed development came to a close under Gregory VII and Innocent III; abbreviated liturgical books were drawn up for the Roman curia, and their use was spread everywhere by the friars.

The growing importance of Rome after the 5th century, when the pope became the only civil as well as religious authority in the city, led to the gradual increase of the influence of the local rite that developed there. The chief agents in its diffusion were the pilgrims to Rome, the Benedictine abbeys and the political power of the Carolingians. The "Roman" Mass, then, of the *Missale Romanum*, the standard rite in modern times, is composite both in its texts and its ceremonies and, broadly speaking, has been static—as a liturgy—since the 16th century. It is not the business of this article to discuss how suitable this rite is today as a world-wide (not merely Latin or European) liturgy, but it is possible, in the light of modern liturgical experiences and studies, to discuss its strength and weakness as a eucharistic rite.

2. Liturgical Structure.—As a liturgy, the Mass has a fourfold structure: (*a*) the communion of the Word of the Lord; (*b*) the offertory of the bread and wine; (*c*) the sacrifice; (*d*) the communion of the body and blood of the Lord.

Communion of the Word of the Lord.—This part is mainly scriptural, since all the readings are taken from Scripture, and the chants are almost without exception centos of scriptural passages. Critical studies of the lectionary (*q.v.*) have established the fact of a thematic unity in the readings for the greater feasts, whereas the readings for the seasons were originally chosen on a system of selection of continuous passages from the Bible. In the latter case, therefore, the aim was to unify not the parts of the same Mass but the Masses of a season. The hazards of time have altered the original arrangements in many details but have left this basic structure untouched. It would be artificial then to look for any one exclusive theme in the texts of a Mass that is the result of the latter system (the *lectio continua*).

The collect figures in this part of the rite as the first of the three symmetrical priestly prayers that close off three parts in the Mass: entrance, offertory and communion. These tightly packed Latin prayers are the despair of translators and commentators: their rich theological content can be rendered in English only at much greater length, and even then it is difficult for a listener really to grasp their full message.

The general decree *Rubricarum instructum* (1960) of the Congregation of Rites approved a new Code of Rubrics, which provided for a homily after the Gospel. To be liturgically appropriate, such a homily should arise naturally out of the texts of the liturgy of the day or out of the general liturgical context. In practice, however, this is often not feasible, since many dioceses use a prescribed course of systematic instruction, drawn up not on the liturgical lectionary but on a general catechetical basis. This course, though originally intended by Pope St. Pius X to be distinct from the homily, has in many dioceses taken the place of the liturgical homily at most Sunday Masses.

Offertory.—The offertory may be analyzed into four elements: (*a*) the bringing up to the altar of the Hosts and the wine; (*b*) their preparation as the matter of the sacrifice; (*c*) the offering of these *oblata;* (*d*) certain accompanying prayers. The third element, the offering of the bread and wine at this point of the Mass, calls for some theological comment. In the two earliest

witnesses to the Roman offertory (Justin and Hippolytus) there is no mention of a ritualization of the offertory; it is an action of simple practical utility by the deacons, without any external participation on the part of the faithful. Gradually, however, the faithful began to want to have some external part in presenting these offerings, and this was managed in one of two ways: either each member of the congregation came up to the altar and handed his loaf of bread and flask of wine to the clergy, or the latter came down into the nave to receive the offerings. There is no detailed information about the performance of either method, but the practice was established in Hippo (St. Augustine's episcopal see), Milan and Rome in the 4th century.

Some efforts have been made in the modern liturgical renewal to restore the offertory procession at Mass, but although this may be desirable as an external manifestation of the people's share in Mass, sometimes it has been misunderstood and has given a false emphasis as to who and what is offered up at Mass. The Mass is the renewal (though not the multiplication) of Calvary, and its central truth is that Christ in it offers himself to the Father. Bernard Capelle, in his *A New Light on the Mass* (Clonmore & Reynolds Ltd., Dublin; 2nd ed., 1961), points out:

> From the spiritual point of view there are not many hosts, but one, one single bread as at the Last Supper, and *it is offered by all.* This bread is Christ, it is not ourselves and our life. The great spiritual value of the gesture of oblation by the faithful consists in the desire which it shows *to offer up Christ* individually and collectively, to offer the unique Victim by a movement of supplication on the part of the creature, powerless, needy and sinful, who has nothing to offer to God to glorify Him, and to obtain grace and pardon, except Jesus Christ. Understood in this way, the action of placing the host on the paten is full of spiritual significance, and it brings out the role played by the priest, stressing the fact that he is the representative of the assembled officers for this essential act of presenting Christ to God. This does not exclude . . . the implication of complete submission of each individual, which is '. . . inherent in every sacrifice. But we must not confine the significance of the gesture to that, nor declare that it is that directly. There is a hierarchy to be observed, and the distance between the two intentions is infinite. . . . Taken in the wrong sense, the offertory procession may be gravely prejudicial to the true understanding of the Mass.

The idea stressed by some liturgiologists that bread and wine, being the products of man's labour, are symbols of his life and activity, and as such are offered up at this point of the Mass, seems to give the initiative in offering to man's work, not to God's gift. Undoubtedly, man's work has a share in producing the bread and wine, but it is subordinate to the double gift from God: the gifts of nature (wheat and grapes, bread and wine), which are offered up to him, and which by the power of his grace are changed into heavenly gifts.

The secret, the concluding (silent) prayer of the offertory, usually presents the bread and wine as gifts from God in the order of nature, offered back to God by the church (with reference to the assembly gathered at Mass), but the bread and wine, by and large in the secrets, are seen in anticipation as Christ's own offering that will be brought about in them by the *veneranda commercia*, the "sacred exchange" of earthly for heavenly gifts.

Sacrifice.—In the Roman Mass the sacrifice is celebrated chiefly in the part that today is called the preface and canon. Here one is confronted immediately by a liturgical fact—the silent canon—to which Catholics have grown so accustomed that it does not seem to them to call for comment. This custom of saying the canon in silence was introduced in different places over a long period of time, as congregations gradually lost the sense, vividly present in the early church, that they had an integral part to play in the corporate worship of the Mass. The silent canon, which had become universal in the Western church by the 16th century, was in fact made obligatory for the Roman rite by Pope Pius V's approval of the Roman missal of 1570.

It may be debated whether this silence is a strength or a weakness. The unmistakable cessation of all the familiar sounds in a congregation, which marks the moment of consecration, no doubt enhances the sense of mystery at the supreme moment of the eucharistic celebration. But considered in itself, apart from the Reformation controversies and in the light of the renewal of community values in worship, it seems to be a weakness to have the great thanksgiving and consecratory prayer so performed that it does not come to the assembled faithful through the obvious human medium of hearing. It may be noted, however, that the *Instruction on Participation in the Mass* (1958) encourages (or rather inculcates) a sacred silence from the consecration to the *Pater noster.*

As a literary composition the canon is one continuous whole, couched in the noble liturgical Latin of the 4th century, and apart from one or two passages it is neither obscure nor complicated. The central portion is the scriptural narrative of the institution of the Eucharist, in which there is a deliberate symmetry of details between the two consecrations that is not found in the New Testament accounts of the Last Supper. The leading themes of the canon are contained in the "primary" passages, three of which precede and four of which follow the institution narrative. *Te igitur, Hanc igitur, Quam oblationem* are all prayers of offering. The group of four that follows the second consecration—*Unde et memores, Supra quae, Supplices te rogamus* and *Per ipsum*—is the richest in the canon, turning on the pivotal ideas of offering and remembrance. The "secondary" passages are five in all, two before and three after the consecration: The memento of the living and the *Infra actionem* before; the memento of the dead, *Nobis quoque* and *Per quem* after.

The basic religious fact in the canon is the sacrificial renewal of what Jesus did at the Last Supper; this is achieved by the words and gestures during the institution narrative, which in turn is set in a great thanksgiving prayer, beginning with the dialogue with which the preface opens, and ending with the great doxology: "Through Him, and with Him, and in Him, is to Thee, O God the Father Almighty, in the unity of the Holy Ghost, all honour, all glory, world without end."

The Communion of the Body and Blood of the Lord.—This is celebrated in the Roman rite after the canon. In the present rite, the faithful receive only under the form of bread; they come in procession to the altar rails, kneel down and receive the Host on the tongue, where it is placed by the priest. In 1962 the second Vatican council discussed the desirability of restoring, at least on certain occasions, the practice of communion under both kinds.

The postcommunion prayers are a rich repository of eucharistic faith and devotion. Prescholastic in composition, they emphasize the sacramental nature of Christ's presence rather than the fact of his presence; they stress the operative nature of that presence, not only in the sacrament but as an abiding influence in life; they bind communion as closely as possible to the mystery of the Mass.

3. The Community's Part in the Mass.—Attendance at Sunday Mass is obligatory for practising Catholics, and the ratio of worshipers to the total Catholic population is usually taken as the index of the vitality of local church life. But it may be questioned how far Catholic congregations really take part, as communities, in Masses they attend. The restoration of frequent and even daily communion under Pope St. Pius X at the beginning of the 20th century antedated the modern liturgical movement with its insistence on community participation. (*See* also LITURGICAL MOVEMENT, ROMAN CATHOLIC.) When in addition to physical presence at Mass there is added the practice of frequent communion, good people are often puzzled to know what more they are expected to do at Mass.

The *Instruction on Sacred Music and Liturgy* (1958) states as a basic principle: "Of its nature, the Mass requires that all present should participate in it, in their specific measure." This document codifies and authorizes at universal level practices of community celebration of Mass, which were unevenly distributed over the church according to the vigour or feebleness of the liturgical renewal in the different countries.

The lowest place on a list of forms of celebration rated according to community participation is what the Germans call *stille Messe*—a misnomer, in fact, since no Mass is fully silent. However, as a broad title, it may be applied to that form of celebration where the priest "says" Mass and is answered by the acolytes from within the sanctuary area, but where the general congregation, from beginning to end, do not say or sing anything. They do, however, fulfill the basic community requirements of being physically present and of performing certain gestures or postures in common;

e.g., rising for the Gospel, kneeling during the canon, going in procession to Holy Communion. In addition, of course, there is internal participation by each person present, to the best of his own ability.

The next highest place on the list is taken by the Mass in which the people "raise their voices in prayers and chants *in common*," even if these do not happen to be the liturgical texts of the Mass that is being celebrated.

A third form is "dialogue Mass," which, taking low Mass as the norm, allows the people to answer liturgically to the celebrating priest. There are four graded levels of participation possible in this form: (*a*) "if the people make the easier liturgical responses to the celebrant" (the acclamations such as *Et cum spiritu tuo*); (*b*) when the faithful also say the responses, which according to the rubrics are to be recited by the server, and, if Holy Communion be distributed within the Mass, say also the triple *Domine, non sum dignus;* (*c*) when the people recite aloud, in addition, with the celebrant, certain parts of the ordinary of the Mass—*Gloria in excelsis Deo, Credo, Sanctus-Benedictus, Agnus Dei;* (*d*) when the faithful say also with the celebrant parts from the proper of the Mass: introit, gradual, offertory and communion antiphons.

The nobler form of eucharistic celebration according to the instruction, which here echoes tradition, is solemn Mass; provision is made for graded participation by the faithful in the singing (no mention is made of their partaking in the ceremonies, which all take place in the sanctuary). Three levels of participation are apportioned according to their musical difficulty: the acclamations, the ordinary of the Mass and the proper of the Mass. The same norms are applicable to sung Mass, where there is a celebrating priest but no deacon or subdeacon.

4. Liturgical Language.—Any attempt at promoting community participation in the Roman rite today comes up against the problem of liturgical language. Latin is the language of the Roman liturgy; and whereas considerable incorporation of the vernacular into noneucharistic rites took place after the issue of bilingual rituals in 1947, nothing comparable was done for the Mass, though the case for the vernacular has been ardently, if not always prudently, championed on the continent of Europe, particularly since World War II. It should be noted that Latin is not exclusively the liturgical language for Mass, for the instruction of 1958 allows the use of the vernacular in the following instances:

(i) during low Mass, if it is customary, to add prayers or popular chants to the direct participation by the recitation in Latin of the correct liturgical texts; (ii) during low Mass—independently of any direct participation of the people—for common prayers and chants, provided these are in keeping with the different parts of the Mass; (iii) for the reading by a lector of the epistle and gospel.

It is not oversimplifying the issue in the debate to say that those who defend Latin are concerned for the visible unity of the worldwide church today and the historical unity with a centuries-old tradition, while those who favour a vernacular Mass do so in order to promote the active community participation of the faithful. The debaters often overlook a still more basic fact that, in liturgy, language is only a medium for a message whose biblical and spiritual content is often more remote than a dead language from modern man. A great renewal, lying at a deeper level than language, is needed here.

The debate on liturgical language held during the second session of the second Vatican council issued in a compromise, as may be seen in the relevant passages of the Constitution on Sacred Liturgy promulgated on Dec. 4, 1963. Latin is maintained as the liturgical language of the "Latin" rites, but for pastoral reasons greater scope is allowed in the use of vernacular(s) than hitherto (Constitution, No. 36, 1 and 2). The supplanting of Latin by the vernacular is permitted at three points of the Mass: the readings; the "Prayer of the Faithful"; those items of the liturgy which pertain to the people, as distinct from those said or sung by the priest (Constitution, No. 54). It should be noted that the "Prayer of the Faithful"—to take place after the Gospel with its homily—is a restoration by the council of a practice long obsolete. The constitution also allows for "a more extended use of the mother tongue within the Mass" appearing desirable in some parts of the world (Constitution No. 54) and provides the steps by which it may be brought about (No. 40). A new departure in ecclesiastical procedure is to be seen in the application of this constitution: the executive power for enforcing the constitution is vested in the various national episcopal conferences.

5. Roman Rite and Paschal Mystery.—A highly significant renewal in the Roman rite is the restored order for Holy Week promoted by the decree *Maxima redemptionis* (Nov. 16, 1955). This not only restored the services to the time of the day corresponding to the biblical events (evening Mass on Holy Thursday, afternoon ceremony on Good Friday, midnight vigil on Holy Saturday) but emphasized the meaning of the rites as saving mysteries (not merely as historical souvenirs) by subordinating all the other rites to that of the Easter vigil. Particular care was taken to provide for participation by the people and to eliminate useless doubling of readings, prayers and roles.

The new calendar clearly marked the primary importance of the temporal cycle in the liturgical year and the place of Sunday in the week. Both these facts reinforced the importance of Easter and of the paschal nature of every Mass.

6. Roman Rite and Modern Church Architecture.—Many thousands of new and restored churches have been built all over the Catholic world in the mid-20th century (*see* RELIGIOUS ARCHITECTURE). Those that are most successful liturgically have been those that provide for active community celebration, with the faithful well deployed round a sacrificial altar in a setting redolent of the paschal mystery. The altar should represent the place of encounter of God with man in Christ; it is the focal point of the church, and nothing should distract from its importance. Since the priest is the human mediator for the people to God, there should be the maximum contact between him and the congregation. This ideal of community participation was successfully realized in a church designed by Dominikus Böhm at Ringenberg, in Germany, in 1935. Here the people sit on three sides of a free-standing altar, and the sanctuary is almost entirely surrounded by a communion rail. Other modern churches that satisfy the demands of the liturgy are the church of Basel-Riehen in Switzerland, designed by Fritz Metzger in 1950, and the church of St. Joseph, Haslach, in Germany, designed by Hans Schädel in 1958.

But in bringing to the fore the principle of the people's share in the celebration of the Eucharist the architect must not lose sight of a complementary principle: the hierarchical nature of the liturgical assembly, whereby the distinction between the sacerdotal space (the sanctuary) and the congregational space (the nave) must be made manifest in the interior design of the church.

In modern church architecture, the position of the baptistery assumes considerable importance. Since baptism is the sacrament of entry into the Mystical Body, it is fitting that the baptistery be located in a prominent position near the entrance of the church. Good church architecture should respect the hierarchy of sacred values: side altars should be erected only where strictly necessary, objects of devotion should not be multiplied and, in general, the furnishing should be dignified and restrained. The pulpit should be situated in the sanctuary area of the church, not in the nave; in this way the preaching of the Word is seen to be an integral part of the liturgy of the Mass. (P. MU.)

B. Other Latin Eucharistic Rites

Thanks to the tenacious conservatism of certain ecclesiastical provinces and religious orders, something of the rich diversity of liturgical practice that was once a feature of the Western, no less than the Eastern, Church has been maintained to the present day. A proviso in the bull *Quo primum tempore* of Pope St. Pius V (which made the missal of 1570 the exemplar for the whole West) saved from extinction the rites of those religious orders and dioceses where a continuous liturgical tradition of at least 200 years had been maintained. In modern times the church not merely tolerates these traditional rites: it takes positive steps to ensure their continuity.

There is no space to treat here the great Western liturgies that have disappeared in the course of the centuries, except for the most

important of them, the old Gallican rite, which existed until the end of the 8th century, when it was abolished by order of Charlemagne and replaced by the Roman. The other rites treated below are still in limited use.

1. The Gallican Rite.—It would be unwise to generalize about the liturgy of early Christian Gaul, since there was considerable diversity of practice from province to province and even among local churches. Moreover, it is known only at a late stage of its development (end of the 7th century) when it had become strongly marked by Spanish influence. The liturgical sources from which a reconstruction of the ancient Mass *ordo* can be attempted were nearly all compiled in Burgundy. The chief of these sources is a detailed exposition of the Mass rite contained in two letters of the Pseudo-Germanus (*c.* 800).

As to the origin of this rite there is still disagreement among scholars. It is certain, however, that it could not have been simply an importation from the East. It is clear from the little that is known of its development that the numerous Eastern elements were introduced only in the final stages of its formation.

The chief characteristic of the Gallican Mass rite was that, unlike the Roman Mass with its fixed canon, it provided a complete new prayer formulary for each feast of the calendar. The eucharistic prayer was thus made up of a series (more or less stable) of variable prayers grouped round the words of institution. In marked contrast, too, with the restrained Roman rite was the prolixity of the prayers and the dramatic quality of the ceremony.

The pattern of the Mass *ordo* may be summarized as follows: A series of chants, including *Trisagion, Kyrie eleison* and the canticle *Benedictus,* preceded the readings. There were three readings: the first taken from the Old Testament Prophets, the second from the Pauline Epistles or Acts and the third from the Gospel. This last, which had the character of a triumphal procession, was surrounded with magnificent ceremonial. After the homily the deacon chanted prayers for the people, using a form of diaconal litany that was common in the East. The offertory rite also included a splendid and majestic procession in which the sacred ministers carried the oblations to the altar during a chant known as the *Sonus.* It is noteworthy, however, that the faithful had no part in this ritual offering. Their gifts of bread and wine must have been left at the sacristy before the celebration of Mass. Two other points of difference from Roman practice deserve mention: the memento of the dead was inserted before the offering of the *oblata,* whereas in the Roman rite it comes after the consecration; and the kiss of peace was given before the beginning of the eucharistic prayer, not before communion as in the Roman Mass.

As stated above, the Gallican rite had no fixed canon. The eucharistic prayer opened with the *Contestatio,* a prayer corresponding to the Roman preface. This was followed by a short prayer, the *Collectio post sanctus.* The words of institution were probably said in a low voice: the actual formula used has not been preserved in the manuscripts. The prayer *Post secreta,* which followed, did service both as an anamnesis and an epiklesis. The rite of the fraction of the Host was carried out according to an intricate symbolism: the earlier practice was to arrange the particles in the form of a cross. The *Pater noster* was inserted after the fraction (another divergence with Rome, where it comes immediately after the conclusion of the canon). As was the custom in all the Western rites up to the end of the 4th century, a special blessing of the people preceded the distribution of Holy Communion. The sacrament was for a long time received under both kinds, the men receiving the Host in bare hands, the women in veiled hands. Two short prayers of thanksgiving, the *Post eucharistiam* and *Collectio,* followed. The deacon then dismissed the people, and the ceremony was concluded.

2. The Old Spanish or Mozarabic Rite.—This rite is known, although less appropriately, as Mozarabic (from *musta'rib,* meaning under Arab influence) because it lasted longest in the provinces dominated by the Muslims. Its liturgy, in its essentials, was drawn up and unified before the Moorish invasion of 711; *i.e.,* during the Visigothic period. In 1085 the rite was suppressed under Pope Gregory VII and was replaced by that of Rome, diffused especially by the Benedictine monks of Cluny. An attempt to restore the traditional rite was made by Francisco Cardinal Jiménez de Cisneros, archbishop of Toledo, who commissioned the publication of a missal incorporating the Mozarabic Mass rite (1500). The rite is maintained only in a chapel of the cathedral of Toledo, where it is carried out daily by six chaplains.

The Mozarabic rite presents the closest affinity with the Gallican rite, upon which it exerted a considerable influence. As performed today, it contains many elements that are very late additions. The essentials of the ancient tradition, nonetheless, have been faithfully preserved.

There are normally three lessons at Mass, from the Old Testament, the Epistles or Acts, and the Gospels. During Lent and on fast days there are four lessons, the extra one being chosen from the Old Testament. The offertory prayers are borrowings from the Roman liturgy. The bread and wine are offered separately, but before offering the chalice the celebrant takes it in his hand and blesses it. The offering of bread and wine by the people, which formed part of the old Mozarabic rite, has disappeared from the Mass. As in the Gallican rite there is no fixed canon or eucharistic prayer; instead there are a series of seven variable prayers. It is in this central portion of the Mass that the Mozarabic rite has best preserved its identity; as early as the 7th century St. Isidore commented on these seven prayers.

A commemoration both of the living and the dead has its place after the offertory. The eucharistic prayer begins with the *Illatio* (Gallican *Contestatio,* Roman preface). For the consecration of the bread and wine the Roman formula is used. On certain days the creed is chanted immediately before the fraction of the Host. The latter rite has retained its ancient symbolism—division of the Host into nine particles arranged in cross form, each particle representing a mystery in the life of Christ. The *Pater noster* is said by the celebrant alone, but the people answer, "Amen," after each petition. The commixture comes after the *Pater noster* and embolism and is thus separated from the fraction. There is a threefold blessing of the people before communion. The Mass concludes with a short thanksgiving prayer followed by the dismissal.

3. The Ambrosian Rite.—The name is derived from St. Ambrose, 4th-century bishop of Milan, where this rite is practised. It is also known as the Milanese rite. The problem of the origin of this rite has not been finally resolved. The theory of L. Duchesne that the Gallican rite originated in Milan, whose bishops had borrowed it from the East, has now little support among scholars. It is not clear whether it should be classified with the Gallican or with the Roman type.

The framework of the liturgy is probably Roman. St. Ambrose in his treatise *De sacramentis* maintains that he followed the Roman rite while tolerating a number of local usages and traditions. It is now believed that in certain of its features the Ambrosian rite has preserved a more ancient form of the Roman Mass *ordo* than that found in the official Roman liturgy. The Mass also contains a number of Gallican usages: it is possible that these were introduced into the rite during the exile of the Milanese bishops at Genoa (570–641). The system of readings corresponds with the Gallican, and there are some Eastern features.

Although the Milanese rite has been progressively romanized, it has never lost its identity. St. Charles Borromeo, 16th-century archbishop of Milan, was its most vigorous champion. In 1902 a typical edition of the missal was published, which is that in use today. The following are the chief individual features of this rite that differentiate it from the Roman: (*a*) three readings (the first normally from the Old Testament); (*b*) after having greeted the people with *Dominus vobiscum* before the offertory, the priest says the *oratio super sindonem,* a prayer that may once have formed part of the Roman Mass formulary; (*c*) survival of the old Roman offertory procession, in which the offerings of bread and wine are presented by two old men (the *vecchioni*); (*d*) the creed placed after the offertory; (*e*) a number of textual variants in the canon of the Mass; (*f*) the celebrant washes his hands before the consecration; (*g*) the fraction preceding the Lord's Prayer and accompanied by a chant called *Confractorium;* (*h*)

after the embolism the priest greets the people with the blessing *Pax et communicatio;* (*i*) no *Agnus dei* except in requiem Masses; (*j*) a special formula for the distribution of communion; (*k*) a threefold *Kyrie* before the final blessing.

4. The Rite of Lyons.—This is no longer held to be a survival of the old Gallican liturgy; on the contrary, it is simply a variant of the Roman rite that, in some respects, is "more Roman than that of Rome." It represents the Roman liturgy at a certain stage of its development and took shape during the episcopacy of Leidrade (798–814). This bishop, by order of Charlemagne, undertook the reform of the liturgy in his see, modeling it on that of the palatine court at Aachen; *i.e.*, on the Roman-Carolingian liturgy as then fully evolved and established. Thanks to the tenacity of the chapter of the primatial church, this new rite remained intact throughout the middle ages, indeed for nearly 1,000 years. With the appearance of the reformed Roman missal (1570), certain modifications were introduced to bring the Mass rite into line with the new legislation, but nothing of importance was sacrificed. It was not until the troubled years of the 18th century that the survival of the Lyons rite was seriously threatened. For a while the missal was suppressed and a neo-Gallican one placed in its stead. After a prolonged struggle the independence of the rite was finally secured when, in 1903, the Congregation of Rites approved a new edition of the Lyons missal, which, while not reflecting the full riches of the traditional liturgy, nonetheless embodied some of its most characteristic features.

The peculiar splendour of this rite is best manifested at a pontifical Mass. No fewer than 36 persons take part in the solemn entry; apart from the celebrant there are six priests in chasuble, seven deacons, seven subdeacons and seven acolytes. The Lyons missal contains a good number of proper sequences, pontifical blessings and prefaces for various feasts. On one day in the year, Holy Thursday, the bishop concelebrates (*i.e.*, celebrates simultaneously) with his priests.

5. The Rite of Braga.—The archdiocese of Braga in the north of Portugal has, in spite of many vicissitudes, preserved its own form of liturgy. It is not, however, an antique rite but dates only from the beginning of the 12th century, when the reforming bishop Gerald (1096–1108) enforced the observance of the Roman liturgy in his see. This new rite, which supplanted the Mozarabic liturgy used until then throughout the entire peninsula, was thus a variant of the Roman rite; apart from such particularities as the preparation of the *oblata* before the offertory and the addition of some proper prayers, it differs from the Roman Mass rite only in points of detail.

6. The Monastic Rites.—Five religious orders, Carthusians, Cistercians, Premonstratensians, Carmelites and Dominicans, preserve their distinctive rites, which, in the case of the Mass, are variants of the Roman rite, sharing many features and reflecting the usage of the period and country (mainly France) in which the orders were founded in the 11th–13th centuries. A certain austerity of expression characterizes the spirit of these rites, in particular that of the Carthusians, which has remained unchanged for centuries; *e.g.*, there is no elevation of the chalice at the consecration.

Comparison of these rites with the Roman Mass reveals the following general characteristics: the prayers at the foot of the altar are much shorter than in the Roman rite; in most of these rites the chalice is prepared before Mass (or during the gradual if it is a high Mass); at the offertory the Host and chalice are offered together; in some of these rites the celebrant is directed to extend his arms in the form of a cross during the canon of the Mass or at the *Unde et memores.* (V. R.)

III. OTHER EASTERN RITES

Space forbids the inclusion here of reference to other than Orthodox Eastern liturgical functions, so those of the lesser Eastern churches are omitted. The Orthodox Eastern Church has never been so rigid in the number of the sacraments as the Latin West, though since the 17th century it has agreed that there are seven; *i.e.*, baptism, chrismation, the Eucharist (described above), penance, anointing of the sick, marriage and holy orders.

1. Baptism and Chrismation.—After a preliminary rite including exorcisms, the candidate's renunciation of the Devil and his profession of faith, baptism proper begins with a litany, followed by the priest's blessing of the water and the oil. He then anoints the candidate on all his members, making the sign of the cross, before immersing him three times in the water with the words "N, the servant of the Lord, is baptized, in the name of the Father, amen, and of the Son, amen, and of the Holy Spirit, amen." After a prayer, the chrismation follows; this is performed on the candidate's members with myrrh previously consecrated by the primate of the national church, together with some of its other bishops. While chrismating, the priest says, "The seal of the gift of the Holy Spirit, amen." Biblical readings end the ceremony.

2. Penance.—Penance takes place in church, but the Orthodox use no confessionals. The penitent confesses his sins in the presence of the priest, who asks God to forgive them. In the Russian church since the 18th century, after a deprecatory prayer offered by the priest, the priest pronounces the absolution in the first person, but in the Greek church the formula is: "May God forgive you through me, a sinner." The priest may also impose a penance and give spiritual advice.

3. Anointing of the Sick.—The sacrament of anointing the sick begins with hymns and a litany, followed by the blessing of the oil and biblical lections. The priest then anoints the sick person, with prayers for his bodily and spiritual recovery. Further lections and prayers follow.

4. Marriage.—The marriage rite begins with a litany and two short prayers, followed by the exchange of rings (betrothal). In the second part of the service (crowning), the marriage proper, there is again a litany, and long prayers asking that this marriage may be blessed as various marriages of the Old Testament were blessed, and the couple preserved as certain Old Testament characters were preserved in danger. Then the priest places crowns above the heads of the couple in the name of the Father and of the Son and of the Holy Spirit, asking God to crown them with glory and honour. Bible readings, a litany, drinking out of a common cup, a procession round a lectern on which lies a Gospel book, hymns and prayers conclude the ceremony. In the case of a second or third marriage (a fourth being forbidden altogether), the betrothal consists of penitentiary prayers, and the crowning is omitted.

5. Holy Orders.—Ordinations take place during the liturgy, but no more than one candidate may be ordained at one liturgy to each grade of the ministry. The subdeacon who is to be made deacon goes three times round the holy table and is then marked three times with the sign of the cross by the bishop, who next commands him to be vested. He then faces the altar and kneels before the bishop, who places his right hand on his head, saying, "The grace of God that fosters the weak and fills up what is lacking chooses N, the reverent subdeacon, to be deacon. Let us therefore pray for him, that the grace of the Holy Spirit may come upon him." The bishop crosses him again three times and prays that God will give him the grace that he gave to Stephen, the first martyr. After a litany has been sung and the bishop has recited another prayer, still keeping his hand over the new deacon's head, the latter is vested with the orarion (stole) over the left shoulder, greeted with the threefold cry of *axios* ("he is worthy") and given the liturgical fan (ripidion). A parallel ceremony is used by the bishop when he ordains a priest, and by three bishops when consecrating a bishop.

6. Other Rites.—Besides the sacraments the *Euchologion* of the Orthodox Church contains many rites of blessing and prayers for various occasions. For the divine office *see* HOURS, CANONICAL. *See* also ORTHODOX EASTERN CHURCH: *Worship.* (A. BL.)

IV. OTHER LATIN RITES

1. Baptism.—In the early church, the principal components of the ritual of baptism were the rite of washing, normally by total immersion, and a profession of faith on the part of the candidate. Hippolytus of Rome, in his *Apostolic Tradition* (*c.* A.D. 217), gives a detailed description of the ritual of baptism in which this pro-

fession of faith (in the three Persons of the Trinity) formed an essential part of the sacrament. Since about the 8th century the formula of baptism in the Roman rite has lost the character of a dialogue and is simply declarative: "I baptize you in the name of the Father and of the Son and of the Holy Spirit." This formula, which accompanies the pouring of water over the head of the child or adult, is preceded by a series of prayers and exorcisms, a renunciation of Satan and, finally, an anointing with oil of catechumens. The greater part of this preliminary ritual is a survival of the ancient Roman scrutinies, those rites that marked the final stage of the catechumenate and whose object was to weaken Satan's power. When, by the 11th century, it became customary to baptize infants immediately after birth, the exorcisms were annexed to the sacrament itself. For pastoral reasons the Sacred Congregation of Rites in 1962 promulgated a new *ordo* for the baptism of adults in which the ancient ritual of the catechumenate was restored. The conferring of the six preparatory rites of baptism is made to correspond with the various stages of instruction through which the catechumen must pass.

Having been purified in the waters of baptism, the neophyte is anointed with sacred chrism as a symbol of his configuration to *Christos,* God's "Anointed One." Finally, he is given a white garment and a lighted candle, both symbols of the grace he has received, which it will be his duty to preserve until the day of Christ's return.

2. Confirmation.—The Acts of the Apostles (viii, 14–17; xix, 6) indicates the basic rite of this sacrament: it consists essentially in the laying on of hands with prayer. The Roman liturgy has added little to the primitive rite. First the bishop stretches his hands over the candidates while saying a prayer that calls down upon them the seven gifts of the Holy Spirit. Then he deals with each candidate separately, laying his hand on the person's head while, at the same time, anointing the forehead with chrism in the sign of the cross and saying the sacramental formula: "I confirm you with the chrism of salvation, in the name of the Father and of the Son and of the Holy Spirit." Then he gently strikes the cheek of the confirmed person: this latter rite is probably a corruption of the kiss of peace, since it is accompanied by the greeting "Peace be with you." According to the ruling of canon law (canon 788), the conferring of this sacrament should normally be deferred until a child has reached the age of about seven. But the practice, which obtains in some countries, of postponing confirmation until long after the reception of first communion is contrary to liturgical tradition and to the true purpose of this sacrament; for confirmation, being the complement of baptism, is by its nature oriented toward the Eucharist.

3. Penance.—In its ritual and discipline this sacrament has, in the course of the centuries, been subject to considerable development. The chief difference between the modern practice of penance and that of the early Roman church (especially of the 3rd and 4th centuries) is the public character of the latter. The actual revelation of sins (to the bishop or his representative) was always a secret affair; but, according to the older discipline, the penitent made public satisfaction for the sins confessed and was assigned to the rank of penitents. Only at the completion of his penance—usually long and arduous—could he receive sacramental absolution and be restored to communion with the church. The faithful had recourse to this sacrament only for grave and manifest sins.

The practice of private penance seems to have originated in the monastic communities of early medieval Ireland. Already in the 9th century the modern discipline of penance was known and practised: confession of sins to a priest, the imposition of a suitable penance and the conferring of absolution all within a single judicial process. Since about the 16th century the rite of penance takes place inside a confessional where the priest is seated behind a grille. When the penitent has confessed his sins, the confessor offers him such direction of conscience as he deems necessary and imposes an appropriate penance—usually in the form of prayers to be said. He then absolves the penitent in the name of the Holy Trinity.

4. Anointing of the Sick.—Scriptural evidence for the rite of anointing is furnished in the Epistle of St. James (v, 14–16). There are two major periods in the history of this sacrament: that before and that after A.D. 800. It is clear that in the first period anointing was regarded primarily as a sacrament of the sick. Of the three effects of the sacrament—bodily health, spiritual well-being and forgiveness of sins—the early liturgical texts place bodily health first in order. From about A.D. 800 onward, as the rite of anointing becomes increasingly organized, the practice of reserving the sacrament to those in danger of death is gradually established. The association of anointing with deathbed penance had the consequence that this sacrament was held to be a last pardon accorded by the church to the dying.

According to the present-day ritual of the sacrament, the priest anoints the eyes, ears, nose, mouth, hands and feet of the sick person, using a specially blessed oil (*oleum infirmorum*). While anointing with the sign of the cross the various parts of the body, he utters the formula: "Through this holy anointing and by his most tender mercy may the Lord pardon you for whatever offenses you have committed through . . ." (here the particular sense or member is specified). The three prayers that follow the anointing are urgent petitions for bodily recovery.

5. Holy Orders.—This is the sacrament that confers upon a man an altogether unique participation in Christ's priesthood. It has three degrees: the episcopate, the priesthood and the diaconate. The subdiaconate, although included among the major orders, is not a sacrament; like the minor orders, of which there are four, it was instituted by the church to fulfill a particular liturgical need. The four minor orders, which existed in Rome as early as the 3rd century, are acolyte, exorcist, lector and doorkeeper. Before being eligible for any ordination, it is necessary for the candidate to receive the tonsure, a rite that raises a layman to the status of cleric.

The laying on of hands forms an essential rite in the conferring of the sacrament of holy orders. In episcopal ordination this is performed by the three consecrating bishops; in priestly ordination, by the bishop and the assisting priests; in ordination to the diaconate, by the bishop alone. In this particular rite the Roman liturgy has faithfully preserved the prescriptions of Hippolytus' *Apostolic Tradition.*

In 1947 the Holy See issued the apostolic constitution *Sacramentum ordinis,* which decides what constitutes the matter and form, *i.e.,* the elements necessary for validity, of the sacraments of holy orders. In ordination to the priesthood it is the laying on of hands by the bishop, together with the solemn preface that follows, that constitutes the matter and form. Other rites, such as the clothing with sacred vestments, the anointing of hands, the handing over of the chalice and paten, are all of late origin. They are, nonetheless, expressive symbols of the spiritual powers conferred by the sacrament and, in particular, of the priest's dedication to the service of the altar.

6. Matrimony.—The marriage rite, in its essentials, is one of great simplicity. The sacrament is constituted by an official contract: the mutual exchange of consent of the partners. It is the latter who are the ministers of the sacrament; the priest blesses it. Clandestine marriages are no longer tolerated since the Council of Trent decreed that the marriage must be contracted in the presence of the parish priest and at least two witnesses.

The marriage rite, which varies in details according to the legitimate traditions of each country and diocese, has the following general characteristics: First there is the essential rite of the exchange of consent, which takes the form of a dialogue between the priest and the partners. This is followed by the blessing of the ring, which the man places on the finger of his bride as a sign of lifelong fidelity. The priest then blesses the couple. The nuptial Mass, although in practice frequently omitted, should follow. A special Mass formula is provided for this. At the end of the Lord's Prayer the celebrant blesses the bride, exhorting her to model her life on the example set by the great women of the Old Testament. At the end of Mass, using a shorter formula, he blesses the newly wedded couple, praying that they may see "their children's children even unto the third and fourth generations."

7. Vernacular Rituals.—After the publication of the papal encyclical *Mediator Dei* in 1947, the vernacular was introduced

extensively into the administration of the sacraments (though Latin was retained for the essential form, as well as for the blessings and exorcisms), and many bilingual rituals were printed. These new rituals were compiled at the request of the national hierarchies in order to facilitate the participation of the faithful in the sacramental rites. Some of these national rituals, in particular the German *Collectio rituum* (1950), contain many traditional, national elements that do not figure in the Roman rite itself. At the second session of the second Vatican council (1963), it was decided to replace Latin entirely by the vernacular in the administration of the sacraments.

8. Rites Other Than Sacraments.—The sacraments described above, of which the Eucharist is the centre, are the kernel of the Christian liturgy but do not constitute the whole of it. In addition there are the sacramentals, a name given to the other rites and ceremonies of the church, such as blessings, exorcisms and processions; to these may be added the rites of Christian death and burial and a number of set forms of prayers, such as litanies, for use on various occasions. The Code of Canon Law defines sacramentals as "things or actions by which the church, in a certain imitation of the sacraments, is accustomed to obtain by her own prayer certain effects, chiefly spiritual" (canon 1144).

For the divine office, *see* HOURS, CANONICAL.

Blessings and Consecrations.—Blessings are of two kinds: constitutive and invocative. Constitutive blessings impart to the recipient (person or object) a certain sacred quality that withdraws it from the sphere of the profane. Invocative blessings do not alter the condition of the recipient: in their administration the minister prays that a particular spiritual or corporal effect be granted.

Constitutive blessings are not easily distinguishable from consecrations. Indeed, before the 12th century the terms *benedicere* and *consecrare* were synonymous. Both effect a certain dedication of the object to divine service. Rites of consecration, however, normally include an anointing with chrism, which invests the action with particular solemnity and indicates a more intense petition on the part of the church. Consecrations and constitutive blessings can be conferred on persons or things. The former include clerical tonsure and minor orders, the blessing of abbots and abbesses, the blessing and consecration of virgins. Things and places blessed and consecrated include churches, altars, altar stones, sacred vessels and vestments, cemeteries and bells; also such common elements as water, salt, oil and ashes.

Consecrations can be validly administered only by bishops, unless priests are given the required faculty by law or by apostolic indult. The blessings contained in the pontifical are reserved to bishops. Some of these, *e.g.*, the blessing of bells, are found also, in a somewhat different form, in the *Ritual:* these latter may be employed by simple priests who possess the required delegation. The priest is the ordinary minister of all the other blessings in the *Ritual*, some of which are reserved to the members of various religious orders.

The *Roman Ritual* (1952) contains 177 blessings, whereas the *Ritual* of Paul V (1614) contained only 29. It was mainly in the 19th century that the number of formulas was increased; the many new blessings that were then composed show the desire of the church to sanctify the inventions of the scientific age. Not all the blessings of the *Ritual* are of equal importance. Some, because of their intimate connection with a particular sacrament, deserve to be considered apart: thus the blessing of sick persons is rightly regarded as an extension of the sacrament of anointing. The blessing of water is particularly important, because the sprinkling with holy water accompanies all the blessings of the *Ritual*. The formula of the *Ritual* defines the effects of this sacramental as purification, bodily and spiritual health and, especially, protection against the attacks of Satan. Certain uses of holy water, *e.g.*, the rite of aspersion before Sunday Mass, symbolically recall the sacrament of baptism.

From the earliest times the church linked its blessings with the Eucharist, the sacrament in which natural products receive their supreme hallowing. The early Roman sacramentaries refer to the blessing of various commodities before the final doxology of the canon; and even to the present time the blessing of the oil of the sick on Holy Thursday takes place at this point of the Mass. As in the Eucharist the priest consecrates by giving thanks, so in its traditional sense the term *benedicere* implies at once the giving of thanks and the invocation of a divine blessing. This eucharistic motif is clearly revealed in the great traditional blessings of the church, whose very form is that of a Mass preface.

Other Rites and Prayers.—Included among the major sacramentals of the church are the rites of exorcism. An extensive use is made of these in the sacrament of baptism, as well as in many liturgical blessings. In cases of certain diabolical possession, the church makes use of a special formula contained in the *Ritual*, entitled "The rite of exorcizing persons possessed by the demon." The components of this rite, which can be administered only by a priest having express jurisdiction from the local bishop, include prayers, readings from the Gospels, the exorcisms proper (commanding the unclean spirit to depart) and, finally, a series of Psalms expressive of the afflicted person's distress.

The church's attitude to death is well expressed by the prayers and rites surrounding Christian death and burial: it is one of sorrow and compunction on the one hand, and serene hope and confidence, founded on the merits of the Saviour, on the other. Over the dying person is said the *Commendatio animae*, a formula that begins with a litany and continues with prayers that God and the heavenly host may joyfully receive the dying soul. The burial service has several parts. First, the priest goes to the house of the deceased to receive the body, which is then brought in procession to the church. As it is carried into the church, the *Subvenite* is sung: "Come to his (her) assistance, ye saints of God, meet him (her) ye angels of the Lord, receiving his (her) soul, offering it in the sight of the Most High." The most important ceremonies take place inside the church, where the body is placed before the sanctuary with the feet toward the altar. The office of the dead, consisting of matins and lauds, may or may not be celebrated, according to national or diocesan custom. This is followed by the celebration of requiem Mass, which includes the chant of the sequence *Dies irae*. At the conclusion of the Mass, the priest proceeds to the coffin and there performs the ceremony of the absolution, beseeching God to pardon the sins of the deceased. The body is then carried from the church to the chant of the *In paradisum:* "May the angels lead thee into paradise. . . ." At the graveside the canticle of Zacharias (Luke i, 68–79) is sung with its responsory, "I am the resurrection and the life. . . ." The coffin is then sprinkled with holy water, versicles and prayers follow and, in conclusion, the priest blesses the body with the sign of the cross.

The church has always attached importance to processions, a form of prayer that facilitates the participation of the faithful. There are processions for different occasions; *e.g.*, in time of war or famine, to obtain favourable weather. Especially important are those that occur annually and whose purpose is to obtain God's blessing on the fields and the fruits of the earth; these are the greater litanies (April 25) and the lesser litanies or rogation days (occurring on the three days preceding the Ascension). Although several of the great liturgical processions are marked by a penitential character, some, such as those of Palm Sunday and Corpus Christi, have the joyful mood of triumphal marches. During the processions litanies are sung, a form of prayer in which the priest, deacon or chanters intone short petitions to which the congregation makes the responses.

The breviary, missal and *Ritual* contain other forms of prayer, such as the priest's preparation for Mass and thanksgiving after Mass, prayers while vesting and prayers before going on a journey.

(P. MU.)

V. PROTESTANT LITURGIES

A. LUTHERAN CHURCH

The Lutheran reformers of the 16th century had a strong sense of unbroken community with the medieval and the primitive church—hence their reluctance to innovate in liturgical practice. The reforms they actually introduced reflect both this sense of linkage with the past and their specific theological concerns in this area: the communication of the Holy Spirit and of "forgiveness of

sins, life and salvation" (Luther's Small Catechism) through the Gospel proclaimed by the church's ministry and through the sacraments; the fundamental role of Christ's incarnation, atonement and exaltation for the faith of the church and of the individual; the identity of faith and worship; and man's obligation to respond sacrificially to every communication of divine grace.

They made a distinction between those elements in worship that the New Testament commanded and those that the church had instituted or that had grown up through custom. What the New Testament neither commanded nor forbade was to them an adiaphoron, an indifferent matter; with reference to such "ecclesiastical rites," the Augsburg Confession (*q.v.*), the basic Lutheran creed, declared that "those should be kept which can be observed without sin and which contribute to peace and good order in the church" (xv, 1), so long as it is clear that they are not essential and do not assuage God's wrath or earn merit.

Martin Luther devised two experimental adaptations of the medieval Mass—the Latin "Form of the Mass and Communion" (1523) and the vernacular "German Mass" (1526)—which exerted considerable influence on the orders of service.

The normal 16th-century Lutheran Sunday and festal service (with seasonal and regional variations) consisted of introit, *Kyrie, Gloria in excelsis,* salutation, collect, Epistle, gradual and Alleluia verse, Gospel, Nicene Creed, sermon, offertory, great intercession, preface, *Sanctus* and *Benedictus qui venit,* words of institution, Our Father, *Pax Domini, Agnus Dei,* communion, postcommunion, *Benedicamus,* blessing. The celebrant and his assistant ministers wore the traditional eucharistic vestments, sang the service to the traditional chants and ministered before altars with the traditional ornaments. In the cities, the service was largely in Latin, interspersed with vernacular hymns; in the villages the service was in the vernacular throughout. The distinctive difference between this rite and the pre-Reformation Mass lay in the regular preaching of a sermon; the administration of Holy Communion to lay communicants under the form of both the consecrated Host and the consecrated wine at every Mass (although the actual number of communicants at any service seems to have been relatively small for at least a generation); elimination of all terminology that implied that the Mass is an expiatory sacrifice; discontinuance of private Masses without communicants and of the cult of the reserved sacrament; more extensive use of the vernacular (especially in hymns); and the reduction of the church year to Sundays and the major feasts and seasons commemorating events in the life of Christ, with very few commemorations of individual postbiblical saints.

Baptism was administered to infants in church as soon after birth as possible, though rarely during the service, by immersion or by pouring, with many of the old ceremonies (for example, exorcisms, signing with the cross, procession to the font, giving of the baptismal candle and robe, sponsors); adult baptisms were, in the circumstances, rare. The clergy heard the confessions of penitents individually and pronounced holy absolution privately. Where monastic communities accepted the Reformation, the divine office continued to be said in modified form; in the parishes and in schools, a morning office (based on monastic matins, with elements of lauds and prime) and an evening office (based on monastic vespers, with elements of compline) were not uncommon. The sick and the dying were provided for normally by the Holy Communion celebrated at the bedside; extreme unction disappeared. With the perpetuation of the apostolic succession a political impossibility, ordinators were of necessity local pastors. In a few Lutheran territories confirmation survived in a variety of modifications; the present Lutheran practice of confirming adolescents dates largely from the late 17th century. The *benedictio sacerdotalis* (priestly blessing) of marriages continued.

This situation perpetuated itself in broad outlines for over two centuries. The transition of some Lutheran princes and cities (Anhalt, the Palatinate, Brandenburg, Bremen, for instance) to the Reformed religion led to a variety of compromises, although in some cases it stiffened the determination of the Lutherans to retain their distinctive ceremonies, such as bowing the head at the name of Jesus, chanting the lessons and the prayers, lighted candles, exorcisms at baptism, plainsong and polyphonic music, and the historic vestments. The upheavals of the Thirty Years' War, the political vicissitudes of the Lutheran territories, the individualistic influence of Pietism (*q.v.*), the pragmatic approach of rationalism and the Enlightenment, and the increasing power throughout the Holy Roman empire of the rulers of Brandenburg-Prussia and their determination to enforce a union of their Lutheran and Reformed subjects contributed to a gradual loss of the Lutheran liturgical heritage. The 19th century saw accompanying the confessional revival a liturgical revival, associated with the names of, among others, Theodor Kliefoth, August Vilmar and Wilhelm Loehe; this revival, which is still moving toward its climax, has resulted in the increasingly general restoration of practices that had survived only locally and in some cases had fallen into complete disuse.

Outside the Holy Roman empire, the Lutheran minority churches in Poland, Slovakia, Hungary and Rumania were in general somewhat more tenacious of their heritage. The Lutheran churches in France and Holland quite early assimilated to a Reformed liturgical pattern. The Lutheran folk churches of Denmark, Norway, Iceland and Greenland retained their episcopal structure (though not the apostolic succession), which made possible greater liturgical continuity. The Lutheran folk church of Sweden has its own liturgical history. Strong political pressures from both the Roman Catholic and the Reformed side evoked the conscious resistance of the Lutheran prelates (who stand in the apostolic succession), clergy and people; on balance, Sweden has been liturgically the most conservative Lutheran country on the European continent.

The situation in the homeland at the time of emigration largely determined developments in the political or ecclesiastical colonies. Thus, Finland, Estonia, Latvia and the 17th- and 18th-century colonies on the Delaware consistently mirrored the Swedish situation. Parallels existed in the case of the Danish colonies (including the Virgin Islands), the German settlements in Russia and the missions that European Lutheran churches and missionary societies established throughout the world.

Communities established by European Lutheran immigrants and refugees in the United States, the Commonwealth of Nations (especially Canada and Australia) and Latin America similarly reflected the liturgical situation in the homeland at the time of departure. Due to geographic and political isolation, the immigrants tended to perpetuate their distinctive practices while gradually accommodating them to one another and adapting them to new conditions.

At first each group tended merely to translate its rite into English with limited adaptation. The 19th-century liturgical revival led in 1888 to the drafting of the intersynodical Common Service, which revived the 16th-century rite in substantially the form described above, plus a preliminary office of preparation. Generally adopted by American Lutherans during the next two generations, it underlies the rites contained in the two service books of which one or the other is used by almost all English-speaking Lutherans, the Lutheran Liturgy (1941) of the Evangelical Lutheran Synodical conference and the Service Book and Hymnal (1958). The latter is noteworthy for its introduction of an Eastern Orthodox type of litany as an alternative to the *Kyrie* and of a eucharistic prayer as an alternative to the consecration of the eucharistic elements merely by the words of institution. The Spanish Lutheran rite is substantially identical with that of the Service Book and Hymnal.

Lutheran liturgical practice still varies widely in detail from parish to parish, and there is still considerable resistance to certain aspects of the liturgical movement in many places. But the trend is toward more frequent celebration and reception of Holy Communion; liturgical preaching; more universal use of the prescribed rites; the restoration of the historic vestments; greater employment of the Old Testament in the service; the revival of private confession and individual absolution in forms appropriate to contemporary needs; better church music; and the expression of the historic meanings of worship in language relevant to the 20th century.

B. Presbyterian and Reformed Churches

Presbyterian and Reformed worship varies in its details but not in spirit from church body to church body and from country to country.

Integral to and dominating the classical Reformed idea of worship is the Word of God contained in the Old and New Testaments. Lessons from both testaments are a prominent part of every service. The psalter also plays a large part, especially in the Scottish tradition, which for more than three centuries has had a fine metrical version of the Psalms set to sturdy tunes. Ideally the sermon is an extension of the Word of God and an exposition of Holy Scripture, the showing forth of Jesus Christ crucified and risen, that he may be worshiped, adored and served.

The Swiss reformers broke more radically with the past than did Luther and his colleagues. Huldreich Zwingli, who espoused a purely symbolic view of Holy Communion, abolished ecclesiastical vestments, the traditional Epistles and Gospels, instrumental music and chant, and private confession and absolution. Whereas the Lutherans had undertaken to reform the medieval Mass, Zwingli did away with it and substituted for it a very simple form of preaching service. From 1525 on, the Lord's Supper was to be celebrated only on the Thursday and Friday before Easter and on Easter itself, for a different group in the congregation each time.

In Geneva, Guillaume Farel helped shape the tradition of that community by observing communion three times a year. Although John Calvin was, if anything, even more insistent upon primitive simplicity than Zwingli, both his eucharistic doctrine and his ideal of eucharistic practice were notably higher. After the Zürich agreement (*Consensus Tigurinus;* 1549) Calvin's eucharistic doctrine became dominant nearly everywhere in the Reformed community; but when he attempted to introduce a weekly (or at least monthly) celebration of communion into Geneva, the town council demurred, and Calvin had to content himself with four communion Sundays a year. This became more or less normative for Reformed worship. The Westminster Directory of Public Worship, approved 1645, called for Holy Communion to be "frequently celebrated," but the injunction seems not to have been obeyed.

The English-speaking Reformed communities in Great Britain derive the basic structure of their worship from the order drafted by Jan Laski, the younger, in 1550 for the Dutch refugees in England.

Traditionally, the emphasis in the Reformed churches is on Sunday—which Reformed divines from the late 16th century on regarded as a divine institution replacing the Old Testament sabbath for Christians—with relatively little concern for an ordered church year or for the great traditional festivals.

Beginning in the last quarter of the 19th century a worship revival stirred the Reformed churches and culminated in an impressive roster of new orders of service that reflect sound liturgical scholarship—among them the Book of Common Order of the Church of Scotland (1940), the Book of Common Worship of the Presbyterian Church in the U.S.A. (1946; in process of revision for the United Presbyterian Church in the U.S.A.), the Geneva Liturgy (1946) and the Liturgy of the Reformed Church in France (1955). (*See* also Common Order, Book of.) During this period the number of celebrations of Holy Communion has increased beyond the statutory four occasions; monthly (and here and there even weekly) communion services are not unheard of. Nor is it without significance that the first international and interdenominational liturgical quarterly, *Studia Liturgica,* was begun by a Netherlands Reformed minister, Wiebe Vos, in 1962.

The order of service is still highly flexible. One recommended order in the Book of Common Worship consists of the invitation "Let us worship God," a hymn, a call to worship, an act of adoration, a confession of sins and an assurance of pardon, a portion of the psalter with *Gloria Patri,* two Scripture lessons with a hymn or anthem between them, the Apostles' or Nicene Creed, a hymn or anthem, "prayers of thanksgiving, supplication, intercession and Communion of Saints," the Lord's Prayer, the offering, a prayer of dedication, a hymn, a sermon, a closing hymn and the blessing. An order for Holy Communion adds the collect for purity and the decalogue or *Kyrie* before the confession; calls for the *Gloria in excelsis,* the *Te Deum* or another canticle after the assurance of pardon; prescribes an Epistle and Gospel, the latter preceded and followed by the traditional acclamations, and, after the offering, the invitation to communion, a hymn, the words of institution as a warrant, the setting apart of the elements, the preface, *Sanctus,* a eucharistic prayer, the Lord's Prayer, the words of institution, *Agnus Dei,* the distribution, a prayer of thanksgiving and the blessing.

C. Other Protestant Bodies

Methodism began as a movement within the Anglican Church; and though schism ultimately occurred, John Wesley nonetheless commended to his American followers an abridged version of the Anglican Book of Common Prayer under the name of Sunday Service for the Methodists. The American church's organizing conference adopted it in 1784; and though it never came into general use, its orders for the administration of the Lord's Supper and baptism went over into the Methodist Discipline. The conditions under which early Methodism developed, especially in the United States, demanded simple services and spontaneous worship, consisting of song, prayer, Scripture readings and preaching, to which were added the Lord's Prayer, the doxology and the apostolic blessing. The worship revival that began in the 1920s has had a profound effect upon Methodism. The services of many churches became more formal, more and more clergymen turned to the Book of Common Prayer for inspiration and example, and more stress began to be laid, especially in urban communities, on the aesthetic side of public worship. Holy Communion came to be celebrated more frequently; a monthly service is normal. An energetic though numerically small group of clergymen and laymen who called themselves the Brotherhood (later Order) of St. Luke diligently fostered the liturgical idea from 1946. The Methodist Church's Book of Worship is an important and ambitious document, notably because of the wide variety of public services that it provides.

Complete spontaneity of worship is part of the tradition of large numbers of Christians, including the Baptists; the bodies that prefer the designation "Christian" (the Churches of Christ and the Disciples of Christ), called into being by the 19th-century restoration movement, which had as its ideal a return to 1st-century Christian practice; the Mennonites, who stand in a direct line of descent from the radical "left wing of the Reformation"; and the Holiness and Pentecostal bodies, which grew out of Methodism. In these bodies, too, in varying degrees, closer and more frequent contact with other Christians has raised the question if and to what extent they will allow the worship revival to affect their own services. Some have resolutely resisted any accommodation to what they regard as formalism and a quenching of the Spirit; others have found values in the worship revival that they have gratefully incorporated into their own practice without any sense of having violated cherished convictions. These bodies are generally "gathered" churches with authority vested in the local congregation. Local and regional patterns may be traced both in spontaneous worship and in adopting of features of the worship revival, but generalizations are impossible.

Special interest attaches to the worship of the union churches. The United Church of Canada produced an interesting and thoroughly historical liturgy in 1932. The Church of South India has a liturgy whose basic structure reflects the practice of the uniting denominations, with a considerable number of alternatives in both rite and ceremony from other traditions; thus it provides unity in variety rather than uniformity. The United Church of Christ, whose book of worship was in preparation in the early 1960s, unites the traditions of the (German) Reformed Church in the United States, which gave Christendom such distinguished liturgiologists as the Mercersburg movement theologians Philip Schaff and John Williamson Nevin; of the (German) Evangelical (Lutheran) Synod of North America, which preserved the surviving remnants of many Lutheran liturgical practices; of the "Christian" component of the Congregational Christian merger, with its restoration

movement approach; and of Congregationalism, with its wide variety in worship, from the stark simplicity associated with New England meetinghouses to a serious concern with liturgy at its highest levels.

The Moravian Church (Unitas Fratrum), whose history goes back to 1457, combines in its worship liturgical elements and a large measure of freedom in prayer. It produced a distinctive Hymnal and Liturgies in 1924.

The worship of the Society of Friends (Quakers) is wholly unstructured. The participants in the service gather, wait expectantly on God in silence and minister to one another in words of exhortation and uttered prayer under what they regard as the constraining and restraining influence of the Holy Spirit.

For the forms of worship of the churches of the Anglican Communion, *see* COMMON PRAYER, BOOK OF; ENGLAND, CHURCH OF; and PROTESTANT EPISCOPAL CHURCH, THE.

See also VESTMENTS, ECCLESIASTICAL; CHURCH MUSIC; CHURCH YEAR; HYMN; also references under "Liturgy" in the Index. (A. C. PN.)

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LITURGY, JEWISH. The liturgy of the synagogue, as embodied in its Book of Prayer (Heb. *Siddur*), is grounded in one of the liturgical prayers of the Bible, Neh. ix, 5–37, two features of which it adopted: (1) the pattern, namely, praise of God or laudation prior to petition or supplication for one's needs; and (2) the threefold praise of God for having created the world, for having chosen Abraham and his descendants as his particular people, and for having liberated the Israelites of old from servitude in Egypt. Though thus rooted in the Bible, the liturgy of the synagogue, it must be remembered, is the product of postbiblical, or rabbinic, Judaism.

WEEKDAY SERVICES

Corresponding to the time-honoured practice of daily prayer in the morning, afternoon and evening, the Book of Prayer comprises services for these three periods of the day. The weekday morning service is composed of three major units: the recital of the Shema (*q.v.*) with its attendant prayers; the Amidah; and the Torah (Pentateuch, *i.e.,* the first five books of the Bible) service, limited to Mondays and Thursdays.

The recital of the Shema consists in the reading of three selections from the Torah in the order given: Deut. vi, 4–9 and xi, 13–21, and Num. xv, 37–41. The designation "Shema" derives from the opening word of the first verse, Deut. vi, 4: "Hear [Shema], O Israel." The term "the Shema" and the expression "the recital of the Shema" signify "[the reading of] the three given excerpts from the Pentateuch." While the latter are not prayers, they are enclosed within a framework of prayers, essentially of praise.

The name of the second major unit, Amidah, is descriptive of the standing posture of the worshiper (Heb. *amad,* "to stand"). The Amidah is a collection of 19 prayers characterized by a blending of supplication with laudation.

At the core of the third unit, the Torah service, is the reading from a scroll of the Torah which, when not in use, is enshrined in the chest known as the Ark (*q.v.*).

The Shema.—The time for the recital of the Shema was determined by the words in the first two selections, namely, "when you lie down, and when you rise," which suggested evening and morning. The Shema, accordingly, is an integral part of both evening and morning worship. In the latter, two prayers precede the Shema and one follows it; these prayers have their counterparts in the evening service. Though the texts of the evening prayers differ from those in the morning service, the contents of both groups revolve about the tripartite praise of God, in keeping with the precedent of Neh. ix. Furthermore, though originally designed to be prayers of praise exclusively, in the course of time supplications were introduced into both groups. Basically, nevertheless, they remain prayers of laudation, each concluding with the formula of praise: "Praised art thou, O Lord."

The morning and evening recital of the Shema serves three distinct purposes: as a profession of faith; as a symbolic equivalent of devotion to the study of the Torah; and as a declaration of allegiance to the kingship of God and his kingdom. These functions are indicated in the second prayer preceding the Shema of the morning service.

Profession of Faith.—First and foremost, the first verse of the Shema, "Hear, O Israel: The Lord our God is one Lord" (or ". . . the Lord our God, the Lord is One"), constitutes the worshiper's affirmation of faith, and the words "proclaim thy unity" in the prayer reflect this purpose.

Devotion to Torah Study.—The second purpose is expressed in the following petition: "O put it into our hearts to . . . *learn and teach . . . to do* and to fulfil . . . all the words of instruction in thy Torah." The italicized words allude to a rabbinic observation that the first selection of the Shema focuses on learning the Torah; the second, on teaching it; and the third, on doing or observing its precepts. Underlying this progression leading to a climax—learning, teaching, doing—is the thought that study of the Torah and the teaching thereof are not a form of intellectual exercise but a regimen of training in character building and ethical behaviour.

More on the second purpose of the Shema is mirrored in the statement "we will meditate on them day and night" (in the second prayer prior to the Shema of the evening service), a statement reminiscent of Josh. i, 8: "You shall meditate on it [the Torah] day and night, that you may be careful to do according to all that is written in it." The rabbis understood this verse as declaring that it is every man's paramount duty to devote night and day to the study of the Torah, to the end that he may order his life in keeping with its teachings. The implementation of this duty, however, interfered with earning a livelihood. Hence, the rabbis resolved the problem by ordaining that, in order to discharge his religious obligation, a person should recite the Shema morning and evening; and this act was to be regarded as though he had read the entire Torah or as if he had toiled in its study day and night. Thus the Shema became a substitute for Torah study, or, to be exact, the minimum requirement for the observance of the precept of Torah study; and as a token of Torah study, it served to keep alive the ideal of learning in the consciousness of every adherent of the faith. Furthermore, by identifying the reading of the Torah selections with Torah study, the liturgy made study an integral part of worship. As a result, study of Torah is a form of worship, on a par with prayers of praise and of supplication.

Allegiance to God the Sovereign.—The third function of the Shema adds a new dimension by envisaging the opening verse as a declaration of allegiance to the kingship or kingdom of God, or to both. When, under Roman domination, the vassal state of Judaea was subject to an emperor who made claims to partial divinity, its spiritual leaders were keenly aware of the danger that emperor worship could undermine monotheism, the central doctrine of Judaism. In protest, therefore, they ordained that twice daily it devolved upon every Jew, while reciting the first verse of the Shema, "to accept or take upon himself the yoke of the kingship and kingdom of God." Continuing to serve as an affirmation of God's sole unity, the verse "Hear, O Israel: The Lord our God is one Lord" began to be viewed also as a declaration of God's sole sovereignty. And since no mention is made of God as king in the Shema, a response, not derived from the Bible but borrowed from the usage of the Temple of Jerusalem, was to be recited directly after "Hear, O Israel," etc.: "Praised be his name, whose glorious *kingdom* is for ever and ever."

The emphasis on the concept of submission to the yoke of the kingship and kingdom of God is extended to the prayers accompanying the morning recital of the Shema. The first pre-Shema prayer extols God primarily as creator of the terrestrial world. But an insertion portrays him as creator of the celestial world as well, in which the angels "take upon themselves the yoke of the kingdom of God" by exclaiming: "Holy, holy, holy is the Lord of hosts" (Isa. vi, 3). In an interpolation in the second pre-Shema prayer the worshiper petitions for the return of the exiles to the Holy Land, which, in rabbinic thought, is a precondition for the ultimate establishment of God's kingdom on earth. And the post-Shema prayer recalls how the worshiper's forebears concluded their song of triumph over their Egyptian foes with a proclamation of God's kingship: "The Lord will reign for ever and ever" (Ex. xv, 18).

Similar references to God's kingship and kingdom also occur in the first pre-Shema prayer and in that immediately following the Shema of the evening service.

Variations.—The above paragraphs describe the traditional, or Orthodox, morning and evening recital of the Shema with its attendant prayers. The (Conservative) *Weekday Prayer Book* exhibits no divergencies from this pattern. The (Reform) *Union Prayerbook for Jewish Worship* deletes the second Torah selection of the Shema and retains only a short fragment of the third. Moreover, in its morning service the Reform liturgy eliminates the angelology and the reference to Zion in the first pre-Shema prayer and the supplication for the return of the dispersed to Palestine in the second. Virtually no deviations are discernible in the two pre-Shema prayers of the Reform evening service.

The Amidah.—The Amidah is central to morning, afternoon and evening worship. Rabbinic tradition divides it into three parts: the first, a triad of prayers of praise; the second, a group of 13 prayers of petition; and the third, a triad of prayers of praise or thanksgiving. This tradition is tenable insofar as the tripartite division of the Amidah and the characterization of its 13 intermediate prayers are concerned, but not as regards the nature of the first three and last three prayers.

First and Last Triads.—It has been shown by M. Liber that the opening triad of prayers is independent of the others and, what is more, is as much supplicatory as the intermediate group. The first three prayers constitute a "Messianic drama," in which the worshiper petitions for "the coming of the Messiah, the resurrection of the dead, [and] the establishment of the Kingdom of God" (*Jewish Quarterly Review*, vol. xl, pp. 333–343).

As for the closing triad of prayers, it is, as Liber observes, descriptive of "the final and public acts of the daily Temple worship." The supplicatory nature of the first and third prayers of this group is evident from their current texts, which are petitions for the restoration of the cult of animal sacrifices in the Jerusalem Temple and for peace to Israel. The second prayer is composed in part of an acknowledgment of divine providence and in part of thanksgiving for God's blessings.

In sum, the first group of prayers of the Amidah and most of the third belong, like the middle one, to the category of supplications. At the same time, each of the 19 prayers concludes with the formula of praise: "Praised art thou, O Lord." Hence, all but one of the Amidah prayers are a blend of supplication and laudation, with the former as the dominant element.

Central Section.—The intermediate section of the Amidah is composed of supplications which, like the first, focus on the future, for the aim of the recitation of the Amidah was that the worshiper in his petitions should voice his hopes and aspirations for his people, its land and the Jerusalem Temple, before offering any personal prayer his heart might prompt. The place for private prayer was either after the conclusion of the Amidah or within the framework of specified prayers in it.

The intermediate section of the Amidah is, as it were, a mes-

sianic drama in 13 acts. It commences with a prayer for "knowledge, understanding and discernment" which, from the rabbinic point of view, are the three indispensable attributes to make Israel aware of its sins that cause the delay in the inauguration of the golden age. Awareness will lead to repentance, followed by God's pardon. At this stage Israel is ready for redemption. Next, the healing of the sick and physically handicapped and the restoration of Palestine's soil to its pristine state must take place, for these, as the rabbis viewed it, are the prerequisites for the gathering of the dispersed back to their homeland. The return of the scattered ones of Israel will then be followed by the reappearance of judges of integrity and the establishment of the kingdom of God. For the latter will be founded on the principles of justice and righteousness, and the judges will be the human agents to execute the will of the divine king and judge. Two tasks must be accomplished by this ideal world order: the suppression of all subversive forces that delayed its consummation and the vindication of all whose faith in God was ever firm and constant. The final phase in the unfolding of the divine plan will be reached with the rebuilding of Jerusalem, capital of the kingdom, and the restoration of the Davidic dynasty.

Variations.—In the opening triad of prayers of the Amidah the Hebrew text of the Reform liturgy substitutes "redemption" for "redeemer," that is, the messianic era for a personal Messiah. Furthermore, it eliminates the doctrine of the bodily resurrection of the dead, replacing it by the immortality of the soul. The Conservative version, on the other hand, while retaining the traditional Hebrew text, in its English paraphrase alters "who revivest the dead" to "Master over life and death." The Reform prayer book includes only 5 of the 13 prayers in the intermediate section of the Amidah, which remains intact in the Conservative ritual. The five retained by the Reform liturgy admit of personal application, being the prayers for knowledge, repentance, divine forgiveness, healing of the sick and divine receptiveness to prayer. As for the closing triad of prayers, both the Reform and Conservative liturgies expunge the reference to the restoration of the Temple cult of animal sacrifices, the former further deleting the theme of the return of God's presence to Zion. Finally, the Reform version does not confine the prayer for peace to Israel but extends it to all God-fearing people.

Torah Service.—Central to the third principal part of the traditional, or Orthodox, weekday liturgy, the Torah service, are short readings from the Torah scroll during morning worship on Mondays and Thursdays, as well as during the afternoon service on sabbaths. While Conservative practice follows tradition, the *Union Prayerbook* of the Reform congregations prescribes a Torah service on sabbath afternoons and a "Reading from Scripture," from the Torah scroll or the pulpit Bible, on weekdays other than Mondays and Tuesdays. One usage, however, is common to Orthodox, Reform and Conservative rituals: the prayers of praise, one preceding and the other following, a reading from the Torah, which extol God as giver of the Torah "of truth" in token of his choice of Israel, in whom he "implanted everlasting life."

SABBATHS, FESTIVALS AND SOLEMN DAYS

Common Liturgical Elements.—The three major units of the weekday liturgy are also basic to worship on sabbaths; on the three festivals of Passover, the Feast of Weeks or Pentecost and the Feast of Booths or Tabernacles; and on the solemn days (in popular parlance: high holy days or high holidays) of New Year and the Day of Atonement. There are differences, however. The prayers accompanying the morning and evening recital of the Shema on sabbaths exhibit several additions and other minor modifications. Particularly striking is the sharp contrast between the weekday and nonweekday Amidahs and the Torah services. The two Amidah categories have only one element in common, namely, the opening and closing triads of prayers. Beyond this, however, the nonweekday Amidahs appear in an entirely different form, having a total of 7 instead of 19 prayers. In lieu of the middle 13 prayers of the weekday liturgy, only 1 prayer constitutes the intermediate section. Moreover, a second Amidah, of seven prayers, is added to the morning service on sabbaths, festivals and solemn days. It bears the name *Musaf*, which means "Additional Amidah," and is, as specified in its intermediate part, in remembrance of the additional sacrifice offered in the Jerusalem Temple on sabbaths, festivals and solemn days. Following this historical reminiscence, the worshiper petitions for the privilege of actively participating some day in the restored Temple cult of animal sacrifices. The New Year Additional Amidah, unlike the other nonweekday Amidahs, comprises nine instead of seven prayers.

In the Orthodox ritual the Additional Amidahs remain unaltered; the Reform liturgy dispenses with them, viewing them as irrelevant in modern times; while the Conservative position is to preserve them as a historic memory but not as a petition for the restoration of the sacrificial cult.

Readings from the Prophets as well as from the Pentateuch are a characteristic feature of the morning service on sabbaths, festivals and solemn days, as well as of the afternoon service on the Day of Atonement. In Orthodox and Conservative practice the Torah lections during the sabbath morning service are extensive; in the Reform liturgy they are abbreviated. Two more points need to be noted regarding Reform usage: first, a Torah service is indicated in the *Union Prayerbook* in the sabbath evening service; second, the reading supplementing that from the Torah during morning worship on sabbaths, festivals and solemn days is not limited to the Prophets but is extended to include lections from the Hagiographa as well.

What distinguishes the nonweekday Amidahs from the weekday Amidah is the former's intermediate section; and the uniqueness of the nonweekday Torah service inheres in the supplementary reading from the Prophets, accompanied, like a lection from the Torah, by prayers preceding and following it. The key to a comprehension of the nature of the intermediate section of the nonweekday Amidahs and of the final prayer after the reading from the Prophets is the phrase *Mikra Kodesh*, derived from the festival calendar in Lev. xxiii, and rendered in English Bibles by "a holy convocation" or "a sacred gathering" or "a religious assembly." *Mikra Kodesh*, however, admits of two more equally valid significations: (1) "a proclamation of the sanctity [of the day]"; and (2) "a reading from sacred writings." The latter connotation is obviously discernible in the practice of reading from the Torah and the Prophets, while the former underlies the liturgy's conception of the sabbath, festivals and solemn days as occasions whose sacred character is to be proclaimed.

The proclamation is made in the home and in the synagogue. On the eve of the sabbath, the festivals and the New Year the Jew in his home declares the sanctity of the day to his family circle before the meal is served by means of the Kiddush prayer over a goblet of wine (*see* KIDDUSH AND HABDALAH). And during worship in the synagogue he likewise proclaims the sacred character of those days in conjunction with two of the major units of the liturgy, the intermediate part of the Amidahs (the Hebrew technical term for which, like Kiddush, also signifies "a declaration of the sanctity of the day") and after the conclusion of the reading from the Torah and the Prophets. Common to Kiddush, the intermediate section of the Amidahs and the last of the prayers following the lection from the Prophets are a statement that God gave the particular day to Israel, or bequeathed it as an inheritance, and the eulogy "Praised art thou, O Lord, who hallowest," etc. Reflected in the statement and the eulogy is the thought that the proclamation by the individual of the God-given sacred character of the day is bound to have a hallowing effect upon his life.

Prior to the introduction of the Additional Amidah, morning worship on sabbaths, festivals and solemn days was highlighted by the recital of the Shema with its attendant prayers, the (one) Amidah and the readings from the Torah and the Prophets. After the lesson from the Prophets, therefore, the service came to a close. The Hebrew term for the prophetic reading, Haftarah (*q.v.*), attests to this fact, for it denotes "dismissal [time]"; which is to say, that after the completion of the lection from the Prophets the dismissal of the congregation followed. The

Haftarahs were drawn in the main from the consolatory prophecies in the Major and Minor Prophets, which tended to have an uplifting effect on the mood of the worshiper. And the prayers accompanying the Haftarah were the final prayers of the day's service which, though pronounced by the reader of the prophetic lesson, voiced the sentiments of the congregation as a whole.

What was uppermost in the minds and hearts of attendants at the service as it neared completion? The prayers enclosing the Haftarah provide the answer to this question. In the pre-Haftarah prayer the congregation's attention is directed to the prophets from whose works a lesson is about to be read, as well as to the Torah lection that preceded. Reference to the latter was designed to stress the primacy of the Torah. Since the classical prophets served as God's spokesmen, their utterances were inevitably true. With firm faith, therefore, in the truth of the words spoken by the prophets, the congregation listens to the prophetic selection. The post-Haftarah prayers open with the observation that the prophetic pronouncements contain divine promises. As such they are bound to be fulfilled. In a spirit of perfect trust in God's faithfulness to his promises, the worshiper pleads that God may speedily fulfil those promises the prophets made in his name that pertain to the restoration of Zion-Jerusalem, the advent of the prophet Elijah, precursor of the Messiah, and the assumption by the Davidic dynasty of its messianic role. Whereupon a closing prayer follows, in which praise and thanksgiving are extended to God for the spiritual benefits derived from attendance at the service, namely, the privilege of the worship experience, the enlightenment gained from the Torah lesson, the inspiration drawn from the prophetic reading, and the hallowing influence of the particular festive or solemn day. And interwoven with this closing prayer is the declaration of the sacred character of the day given by God for the purpose of enhancing and ennobling the life of every member of the household of Israel.

The reading of a passage from the Torah and of the Haftarah with their attendant prayers is the prerogative of a boy on the sabbath nearest his 13th birthday, when as a Bar Mitzvah (*q.v.*) he avows his readiness faithfully to discharge the duties and obligations incumbent upon him as an adherent of the Jewish religion. The Bar Mitzvah rite is observed in all Orthodox and Conservative houses of worship as well as in a number of Reform synagogues. The latter, however, employ an abridged version of the post-Haftarah prayers.

Sabbaths.—In the sabbath evening service the recital of the Shema with its attendant prayers is preceded by a section named "Welcoming the Sabbath," which the school of Jewish mystics in Safad (Safed), Palestine, originated in the 16th century. It consists of a number of Psalms and a poem commencing with *Lekha Dodi* ("Come, beloved Israel, to greet the sabbath"). The home ritual of Kiddush over a goblet of wine is likewise part of the synagogue evening service on sabbaths (and on the festivals and New Year). In a prayer of the sabbath morning service, joy in the awaited kingdom of God is said to be in store for those who by their observance of the sabbath experience the spiritual delights (Heb. *oneg*) it yields. This concept inspires the *Oneg Shabbat* gatherings on sabbaths in Orthodox, Reform and Conservative synagogues—gatherings devoted to the discussion of timely topics of religious import and to the singing of Hebrew melodies.

Festivals.—Before the Torah service on the festivals, *Hallel* (*i.e.*, Ps. cxiii–cxviii) is recited, followed by the reading of a biblical book: the Song of Songs during Passover; Ruth during the Feast of Weeks; and Ecclesiastes during the Feast of Booths. Shortly after the Haftarah with its prayers, a memorial service (Heb. *yizkor*), devoted to recalling the souls of the departed, is added during the three festivals. Unique to Passover is its home ritual of the Haggadah, *i.e.*, the narration of the events surrounding the emancipation of ancient Israel from slavery in Egypt. In the synagogue, a prayer for dew (*tal*), symbolic of God's reviving power, is included during Passover, and a prayer for rain (*geshem*), symbol of prosperity, during the Feast of Booths. In Reform and Conservative synagogues, the Feast of Weeks, commemorating the giving of the Torah to Israel on Mt. Sinai, is marked by confirmation exercises for boys and girls. While the Bar Mitzvah rite is for boys at the age of 13, the confirmation service is designed for children of both sexes past that age.

Solemn Days.—Characteristic of the Orthodox and Conservative liturgies of the solemn days of New Year and the Day of Atonement is the vast quantity of religious poetry known as *piyyut*, which is intertwined with the prayers enclosing the Shema and with the Amidahs (*see* HEBREW LITERATURE). The Reform ritual reduces *piyyut* to a minimum, confining it principally to Atonement Day.

A unique element in the New Year liturgy is the prayers in connection with the sounding of the ram's horn (*shofar*), which blend the universalistic and particularistic aspects of Judaism. On the side of the former, the hope is expressed in mankind's ultimate recognition of God as supreme sovereign of the universe. Moreover, New Year is envisioned (1) as the anniversary of the creation of the world, specifically, of the completion of creation or of the beginning of the existence of the world inhabited by man; and (2) as a day of judgment on which, on the basis of his evaluation of their actions and thoughts, God determines the fate of all individuals and all nations. On the particularistic side, the focus is on the revelation on Mt. Sinai to the accompaniment of the *shofar* and on the aspiration for the clarion call of "the great *shofar*" to herald the ingathering of all Jewish exiles to the Holy Land—the precondition for the advent of God's kingdom. The Reform liturgy accords sole prominence to the universalistic component of Judaism by declaring it to be Israel's task, as bearers of the Torah, to proclaim its teachings to all men, so that "all dwellers on earth shall hearken unto the sound of the Shofar, and shall worship as one brotherhood."

The Day of Atonement is ushered in with the threefold rendition of Kol Nidre (*q.v.*) prior to the evening service. Part of the Amidahs of the Day of Atonement is the collective confession of sins and the penitential prayers. A memorial service follows the morning reading of the Torah and Haftarah in the Orthodox and Conservative liturgies, and the afternoon service in the Reform rite. Enclosed within the Additional Amidah are two historical compositions: the order of the service by the high priest in the Jerusalem Temple on the Day of Atonement and the (legendary) account of the Ten Martyrs executed by the Romans during their occupation of Judaea. Also unique to Atonement Day is the *Ne'ilah* or closing service.

Minor Festivals.—Purim and Hanukkah have no independent liturgies. Purim is marked by the reading of the Book of Esther, an insertion in the weekday Amidah stating the basis of its observance, and a Torah service. The eight days of Hanukkah are celebrated in the home by the lighting of candles. Singular to its observance in the synagogue are the recitation of *Hallel*, a Torah service and an insertion in the Amidah furnishing the historical background of the festival (the rededication of the Temple).

Kaddish.—In the course of every synagogue prayer service every day of the year, Kaddish (*q.v.*) is recited. Originally a prayer subsequent to a period of study in the Hebrew classics, it in time was assigned its present place in various parts of the traditional liturgy, and is otherwise also employed as the prayer pronounced by those who mourn the death of loved ones.

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(L. J. Li.)

LITVINOV, MAKSIM MAKSIMOVICH (1876–1951), Soviet diplomat who was commissar for foreign affairs from 1930 to 1939, was born in Bialystok in Poland on July 17, 1876, of Jewish middle-class parents. His real name was Meir Walach. He received a high-school education and early in his life, while serving in the army, became involved in Marxist politics. In 1898 he joined the Russian Social Democratic Workers' party in Kiev. As a result of his revolutionary activities he was arrested in 1901 but escaped and in 1902 fled abroad to Great Britain, where he lived almost continuously until 1918. In 1915 he married Ivy Low, daughter of Sir Sidney Low, a British historian. He joined the Bolshevik faction of the Social Democratic party and took an active part in its work abroad. After the Bolshevik seizure of power in Nov. 1917, Litvinov was appointed diplomatic representative of the Soviet government in London, though that government had not been recognized by the British. It was later alleged that he had not kept his agreement to refrain from engaging in propaganda activities, and in Oct. 1918 he was arrested. He was released in Jan. 1919 in exchange for the release of Robert Bruce Lockhart and other British subjects resident in Russia. On his return to Russia in 1919 he joined the staff of the commissariat for foreign affairs, of which in 1921 he was made deputy commissar. He remained in this field for the remainder of his active life.

Litvinov represented the Soviet government at the Genoa and Hague conferences, 1922; and between 1927 and 1930 he led the Soviet delegation to the preparatory commission for the Geneva disarmament conference. On July 21, 1930, he was made commissar for foreign affairs. He was the principal Soviet delegate to the League of Nations disarmament conference at Geneva in 1932 and led his country's delegation to the World Economic conference in London in 1933. He won considerable fame for his advocacy at the League of various sweeping plans for disarmament, which he put forward in the name of the Soviet government. He first used the phrase that "peace is indivisible." Among his other achievements was the successful conduct of negotiations for establishing relations between the U.S.S.R. and the U.S. in 1934.

Litvinov was credited with a sincere desire to promote understanding between the U.S.S.R. and the western powers and with a genuine fear of the aggressive intentions of Nazi Germany. In Sept. 1938, when Germany was pressing Czechoslovakia to cede the Sudeten territories, Litvinov declared his country's readiness to give Czechoslovakia effective assistance if France would do the same. It was his opposition to German ambitions, and his Jewish parentage, that accounted for his removal from the post of foreign commissar on May 3, 1939, on the eve of the reorientation of Soviet foreign policy toward collaboration with Germany.

After the German invasion of the U.S.S.R., Litvinov returned to public life, this time as ambassador to the United States (Nov. 6, 1941). He retained this post until Aug. 21, 1943, when he returned to Moscow as deputy commissar for foreign affairs. He continued throughout World War II to play an active, if not a prominent, part in the conduct of Soviet foreign policy, especially as far as relations with the western powers were concerned. He went into retirement on Aug. 25, 1946, and died in Moscow on Dec. 31, 1951. He was accorded a state funeral. (D. Fd.)

LIU-CHOU (Liuchow), a city in central northern Kwangsi Chuang Autonomous Region, China. Pop. (1953) 158,800. Until 1937 it was called Maping. An important U.S. advance air base was located there during World War II. The city is located 300 mi. northwest of Canton on the Liu Chiang, which drains southeastern Kweichow, and is at the head of year-round junk navigation, and steam launch navigation in the summer. Liu-chou is an important transportation centre for roads and railroad lines leading north into Hunan, northwest into Kweichow, and south toward Vietnam. Coal is mined, and lumber produced, to the northwest. The city, in the early 1960s, was developing into a regional centre of light industry, with the beginnings of heavy industry, and was growing rapidly in population. (J. E. Sr.)

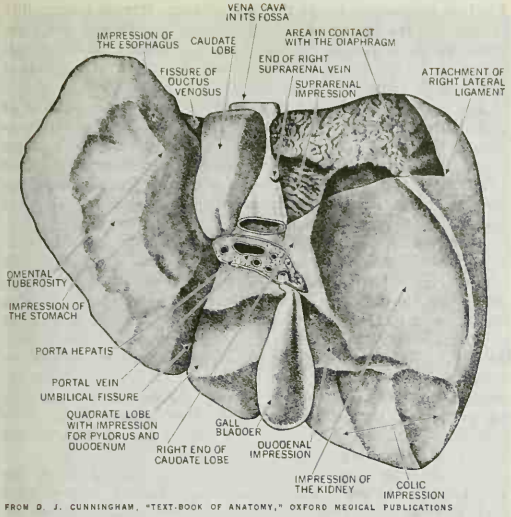
LIUDOLFING, a German dynasty whose members rose from leadership in the duchy of Saxony during the Carolingian period to reign as German kings from 919 to 1024, thus constituting what is generally known as the Saxon dynasty (*see* Germany: *History*). The founder of the house was the count Liudolf, who energetically defended Saxony against the Danes and Slavs and who is accorded the title of duke (*dux*) by contemporary chroniclers. On his death (866), Liudolf's political power passed to his sons Bruno (d. 880) and Otto (d. 912). Otto withstood attacks by the Hungarians, extended his authority over Thuringia south of Ostphalia (908) and, after the death of the last Carolingian king (Louis the Child) in 911, assumed the ducal title. Though Otto was now the most powerful prince in Germany, the duke of Franconia was in 911 elected king as Conrad I instead of him; but after Conrad's death (918), Otto's son became German king as Henry I in 919 (*see* Henry). Thereafter Henry's descendants Otto I, Otto II, Otto III (*qq.v.*) and Henry II were kings successively until 1024. Otto I, however, in 961(?) granted the duchy of Saxony to the margrave Hermann Billung, thus breaking the dynasty's link with its original seat. Otto I's brother Henry was duke of Bavaria (*q.v.*), being succeeded in 955 by his son Henry II the Wrangler (d. 995), father of the German king Henry II. The Liudolfing dukes of Swabia (*q.v.*) were Otto I's son and grandson, Liudolf (d. 957) and Otto (d. 982). (C.-E. P.)

LIUDPRAND (Liutprand, Luitprand) (*c.* 922–*c.* 972), Italian chronicler, whose works are a major source for the history of Italy and Germany in the 10th century. Of noble Lombard family, he joined King Hugh's retinue as a page; after Hugh's fall (947) he entered the service of King Berengar who sent him on an embassy to Constantinople (949). Having quarreled with Berengar on his return, he found refuge at the court of Otto I, where he rose to a prominent position. Otto made him bishop of Cremona in about 961, and in the following year he was present at Otto's imperial coronation. Having become one of the king's principal diplomatists, he went in 968 on another embassy to Constantinople, to demand the hand of a Greek princess for the future Otto II. He died probably in 972.

A Lombard patriot and enemy of Berengar, Liudprand became a loyal adherent of Otto I; and his writings are coloured by his political enmities and loyalties, as well as by his personal prejudices, as for instance against the Greeks. While his *Antapodosis*, an account of events from 888 to 949, is directed against Berengar and Willa, his *Historia Ottonis* is meant to justify the emperor's ecclesiastical policy; and his *Relatio de legatione Constantinopolitana* may have been intended to serve as political propaganda for the resumption of the war against the Byzantines. But despite their strongly polemical and often biased character, his works are among the most valuable historical sources for the history of Italy and the empire during his time. Liudprand knew Greek and had a considerable knowledge of Roman literature; and his works constitute an important document of contemporary classical learning. The most recent edition of Liudprand's works is by J. Becker, in *Monumenta Germaniae Historica in usum scholarum,* 3rd ed. (1915); Eng. trans. by F. A. Wright (1930).

See W. Wattenbach-R. Holtzmann, *Deutschlands Geschichtsquellen im Mittelalter. Deutsche Kaiserzeit,* I, 2 (1948); M. Lintzel, *Studien über Liutprand von Cremona* (1933). (N. R.)

LIU SHAO-CH'I (1898–), president of the People's Republic of China and a leading theoretician of the Chinese Communist party, was born of poor peasant parents in Ning-hsiang district, Hunan province, probably in 1898, though some sources give 1905. Liu attended middle school in Ch'ang-sha and studied in Shanghai and at the Peking university. He joined the Communist party in 1921 and became a labour organizer in Shanghai. In 1921 he was sent to the Far Eastern university in Moscow. The next year he returned as a labour organizer in coal-mining districts along the Kiangsi-Hunan border. In 1927 he was elected to the central committee of the Communist party. After a second sojourn in Moscow, he began organizational work in the Kiangsi Soviet and was later commissar of the New Fourth army. He was elected to the Politburo in 1942 and later served in other high offices. His theoretical essays became standard texts in Communist China. In 1949 Liu was made vice-chairman of the central government council in Peking. On April 27, 1959, he succeeded Mao Tse-tung as chairman (president) of the People's Republic of China. (R. C. N.)



FROM D. J. CUNNINGHAM, "TEXT-BOOK OF ANATOMY," OXFORD MEDICAL PUBLICATIONS

FIG. 1.—POSTERIOR SURFACE OF THE LIVER

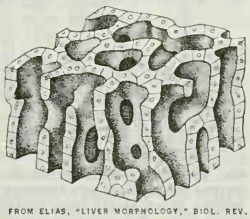
LIVER (HEPAR). The liver is a gland, the largest in the body. It is located in the upper right part of the abdominal cavity. It is rather soft, so that the surrounding organs push in its surface, but as soon as the living liver is taken out of its position, as during surgery, the depressions disappear. Its weight of approximately 1.5 kg. (3.3 lb.) represents about one-fiftieth of the total body weight. The liver has many different functions, each of which is based on its strategic location in the blood stream. It is a filter and clearing station that purifies blood; a storage place for food, particularly for sugar and vitamins; a producer of proteins of various kinds and of antibodies; and a gland that aids in digestion and acts as a remover of waste. All vertebrate animals and only vertebrate animals possess a liver.

Animal liver in man's diet is an important source of protein and fat and vitamins, especially of vitamins A, D, E and vitamin B complex. Because of its high content of iron, copper and particularly of vitamin B_{12} it is useful in the dietary control of certain kinds of anemia.

Functions.—The liver is a mass of cells through which the stream of venous blood flows as it returns from the intestine to the heart. As the blood passes through the wall of the gut, foodstuffs and occasionally poisonous substances are added to it. Laden with these materials, the blood passes immediately through the liver, which acts as a filter, removing noxious substances, destroying or inactivating poisons by chemical means and removing bacteria.

The liver also acts as a storehouse, taking nutritional material from the blood and storing it for future use. Among the stored substances is sugar, which is taken from the blood under the influence of the hormone insulin (*q.v.*), produced in the pancreas. The sugar is converted into storable glycogen, which remains in the liver cells until it is needed for energy production, at which time it is reconverted into sugar under the influence of another pancreatic hormone, glucagon.

Fat, vitamins and other foodstuffs also are stored in the liver cells. Purification and storage are by no means the only functions of the liver. As the blood flows through it, the liver adds to the blood plasma proteins, among which albumin, fibrinogen, globulins, prothrombin and heparin are important. The liver also adds antibodies to the blood, which counteract disease-producing poisons (toxins) produced by bacteria. Thus it is a part of the defense system of the body.



FROM ELIAS, "LIVER MORPHOLOGY," BIOL. REV. 30, CAMBRIDGE UNIVERSITY PRESS (1955)

FIG. 2.—PORTION OF THE LIVER MURALIUM AND LABYRINTH

Not only does the liver receive materials from the intestine via the blood stream, but it also is connected with the intestine by a system of tubes through which a stream of bile flows from the liver into the gut. Bile is a green liquid, secreted by the liver, that contains many different substances, among them bile acids, which aid in fat digestion, and bile salts, which help in the absorption of fat and fat soluble substances such as vitamins A, D, K and E. Many red blood cells are destroyed in the bone marrow, spleen and liver. Hemoglobin, which gives these blood cells their red colour, is thus released and flows freely in the blood. The liver picks up this dye and transforms it into bilirubin (a reddish pigment) and biliverdin (a greenish pigment), which flow with the bile into the intestine and are responsible for the brown colour of the feces. Waste products of the body activity, such as urea and uric acid, are excreted by the liver through the bile stream. Cholesterol also is eliminated from the liver through the bile, but most of it is reabsorbed by the intestine and thus is not lost.

Embryological Development.—Developmentally, the liver is the successor of the yolk sac of lower vertebrates. Its development is best exemplified in the amphibians. The female frog produces eggs in her ovaries. In these eggs, a great amount of nutritive material (fat, protein and sugar) called yolk is deposited.

The egg is laid in the water, and an embryo, then a young larva and later a tadpole develop from it. The yolk is activated and put at the disposal of the developing organism. Most of the cells that contain yolk are located in the belly of the embryo, just behind the newly formed heart. Hollow spaces develop in the mass of yolk cells. These spaces enlarge and become connected with each other and with the heart, and blood cells develop in them. Thus, through these primitive blood vessels in the yolk sac, the nourishing substances that are liberated from the stored yolk come into the blood and, by way of the heart, are pumped into all parts of the larva. Meanwhile, the intestine develops. Blood vessels grow from the main artery toward and around the intestine and from there toward the yolk sac. These blood vessels hook up with the network of blood vessels in the yolk sac.

Gradually, the cells in that region are depleted of yolk. At about the time the yolk has been used up, the mouth of the young tadpole opens, and it begins to eat. The food that it eats is digested in the gut, and through the wall of the gut penetrates into the blood vessels connected with the vessels in the former yolk sac. These vessels are surrounded by the cells that formerly contained the yolk. They are now empty and ready to store food again, but they are no longer yolk cells. They have become liver cells and can perform all the functions that liver cells must perform.

What were formerly yolk vessels are now called liver sinusoids. The yolk sac has become a liver. Since the liver produces bile, which must flow into the intestine, some liver cells arrange themselves so that they form the wall of a system of tubes, called bile ducts.

The main bile duct into which they all converge is termed the common bile duct. This common bile duct grows until it reaches the intestine and opens into it.

In man the development is quite different. The human embryo develops in the uterus, where it receives nourishment from the blood of the mother, and therefore the human egg contains almost no yolk. However, since man descended from lower vertebrates, the early human embryo has a yolk sac. This yolk sac is empty; yet, as if it were to remind us of our lower vertebrate ancestry, a dense net of blood vessels (the vitelline vessels) develops in its wall. A little later is developed a second system of blood vessels (the umbilical vessels), which brings nourishment from the uterus. The vitelline and umbilical veins join just behind the heart and enter into the heart together. From the fork of their junction a network of blood capillaries grows into a mass

of embryonic connective tissue (called septum transversum). This capillary network has an outlet into the heart.

Many cells detach themselves from a ventral outpocketing of the wall of the primitive gut at its anterior junction with the yolk sac. Others detach themselves simultaneously from the lining (mesothelium) of the body cavity. These cells from both sources (entodermal and mesodermal) migrate into the spaces between the vitelline-umbilical capillaries in the septum transversum and surround the capillaries completely. They become liver cells.

Immediately they assume the primary function of liver cells—that is, storage of food that is brought to them from the uterus through the umbilical veins. The bile ducts develop from liver cells and join in the common bile duct, which in turn joins the intestine.

In the chick the liver arises from tubular extensions of the gut wall. Unfortunately this exceptional type of development has become the basis for standard descriptions of liver development in textbooks.

The liver of the embryo has the additional function of producing blood cells, a function that in the adult is carried on by the bone marrow.

Among vertebrate animals, 20 different modes of liver development have been found. But regardless of the method by which the liver develops, the end result is always the same. It is as if several houses were to be built according to the same floor plan and elevations, but with different building materials and methods of construction. At the end, each house is wallpapered inside and covered with stucco externally so that they all look alike, and no one except a construction expert can tell how each house was built.

This observation is contradictory to the biogenetic law of Johannes P. Müller and Ernst Haeckel and to the laws of embryogenesis of Karl Ernst von Baer, which tell us that the embryos of various species are alike, but that the adults differ. Although there is much truth in these "laws," the comparative embryology of the liver shows that they are by no means universal.

The livers of embryos of various species are extremely different, while the livers of adult vertebrates are in essence all alike.

Structure.—G. G. Simpson, in *The Meaning of Evolution,* has explained that if an organ shows great variations in adults from species to species, that organ must be adequate but it cannot be perfect. But if an organ is of equal construction throughout the entire range of its occurrence, then that organ must be perfect. Any divergent construction would be inadequate, and a better construction would be impossible. How, then, is this perfect liver built that can perform so many different tasks? Its construction is extremely simple, yet almost nothing was known about its microscopic structure prior to 1949 and almost nothing was known about its gross anatomy before 1952.

The liver of every vertebrate animal (including man) is a continuous mass of cells tunneled by a maze of connected cylindrical spaces in which a network of specialized blood capillaries is suspended. One should imagine the liver to be a huge building with a maze of crooked hallways and long, narrow, crooked rooms. Neighbouring rooms (the lacunae hepatis) are openly connected with each other, forming a three-dimensional labyrinth (the labyrinthus hepatis). The walls between them are built not of stones but of liver (hepatic) cells. In lower vertebrates these walls (laminae hepatis) are two cells thick, while in songbirds and mammals, including man, they are only one cell thick. Such a system of connected walls is known as a muralium (from *murus,* "stone wall").

The liver of lower vertebrates, since its laminae are two cells thick, is a muralium duplex; that of higher vertebrates is a muralium simplex. The hepatic cells that compose the liver walls are connected, as the electron microscope shows, by little pegs that fit into depressions of neighbouring cells exactly in the manner of snap fasteners.

Between adjacent liver cells are minute tubes, the bile canaliculi, so small that they can rarely be seen in the light microscope. Electron microscopy shows that protoplasmic threads (microvilli) project into the bile canaliculi. The bile canaliculi together form networks of polygonal meshes, each surrounding an individual hepatic cell. Each liver cell possesses one, two or three spherical nuclei, each containing a nucleolus.

The size and number of the nuclei depend on the volume of each individual cell; this volume, in turn, depends on the location of the cell in the muralium. The hepatic cell also contains many mitochondria and piles of double membranes composed chiefly of ribonucleic acid. On the side toward the lacunae, the liver cells are studded with fingerlike and leaflike projections visible only by electron microscopy.

In the lacunae are suspended specialized capillaries, the successors of the yolk vessels, known as sinusoids. These sinusoids are lined by flat cells, called Kupffer cells after their discoverer, which have the ability to engulf and digest (phagocytize) particles of dirt, worn-out blood cells and bacteria. Until 1957 the Kupffer cells were believed to form an uninterrupted lining of the sinusoids. Electron microscopy, however, shows that there are spaces between them and pores in them through which liquid can pass directly from the blood stream to come into immediate contact with the myriads of submicroscopically small projections of the liver cells that pervade the narrow space (Disse space) between the solid part of the liver cells and the Kupffer cells.

The numerous functions of the liver are all carried out by the Kupffer cells and the hepatic (liver) cells. Much is known about their structure, but it appears that the more details are learned, the less is understood about their astonishing variety of function.

Gross Anatomy.—The liver receives its chief blood supply from the intestinal capillaries that converge to form the mesenteric veins. These, together with a vein from the spleen and a few small veins from the stomach, converge into a short but thick vessel called the portal vein. This is so named because it enters the liver at its "door" (porta hepatis). This door is a deep and broad

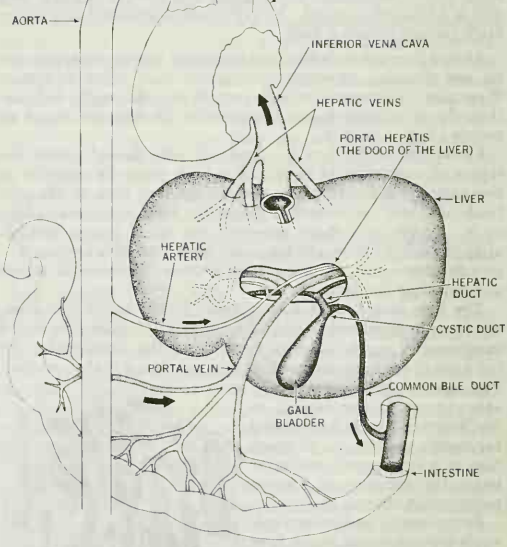


FIG. 3.—PORTA HEPATIS, THROUGH WHICH PORTAL VEIN AND HEPATIC ARTERY ENTER LIVER AND THROUGH WHICH BILE DUCTS LEAVE IT. PORTAL VENOUS BLOOD COMES FROM INTESTINE; HEPATIC ARTERIAL BLOOD COMES FROM THE AORTA. BILE FLOWS THROUGH COMMON BILE DUCT INTO INTESTINE. BLOOD, AFTER PASSING THROUGH THE LIVER, FLOWS THROUGH HEPATIC VEINS AND INFERIOR VENA CAVA BACK INTO THE HEART

BY COURTESY OF A. J. LADMAN

FIG. 4.—ELECTRON MICROGRAPH (ABOUT 12,000×) OF HUMAN LIVER, SHOWING AN ERYTHROCYTE (E) OCCUPYING MOST OF THE SINUSOIDAL SPACE (S). FAT GLOBULES IN SINUSOID AND IN KUPFFER CELL (K) (UPPER LEFT) REPRESENT AN ADMINISTERED RETICULOENDOTHELIAL TEST EMULSION. SPHERICAL MITOCHONDRIA (M) AND DARK PARTICLES OF GLYCOGEN (G) ARE SHOWN IN PARENCHYMAL CELLS (RIGHT). AT LOWER CENTRE IS PART OF A FAT-STORAGE CELL OF ITO (FSC)

depression in the postero-inferior (dorso-caudal) surface of the liver. The portal vein divides, in the porta hepatis, into a left and a right trunk, from which a number of branches (rami venae portae) arise. These branches were unknown to anatomists in 1952, although Francis Glisson had described them in all detail in 1654, but in 1952 an accident led to their rediscovery.

The liver acts upon the portal venous blood, as noted above. But for all this work, the liver needs energy, which it must derive from the combination of carbon (contained in foodstuffs) with oxygen.

Oxygen is provided by a relatively small artery, the hepatic artery, the smaller branches of which accompany the rami venae portae. The branches of both the portal vein and the hepatic artery empty into the sinusoids.

Blood flows through the sinusoids into tributaries of the hepatic veins. The latter empty into the inferior vena cava, which returns the blood to the right atrium of the heart.

The porta hepatis is not only the entrance door for portal and arterial blood but also the exit for bile. The minute bile canaliculi converge inside the liver into ductules (little tubes), small ducts, large ducts, and then into ducts so thick that they can be seen with the naked eye. These ducts run along the portal vein branches, but the bile in them flows in the direction opposed to that of the blood flow. The bile ducts of ever-increasing calibre finally converge in the porta hepatis into the hepatic duct.

Outside the liver, the hepatic duct divides into two large branches. One of them, the cystic duct, ends in a large sac, the gall bladder. The internal lining of the gall bladder is thrown into many folds whereby its surface is increased. The cells lining it bear many tiny projections (microvilli). The gall bladder serves for short-term storage of bile, and at the same time it takes (through the microvilli) water out of the bile, making the bile more concentrated. If this concentration is carried to excess, gallstones consisting chiefly of cholesterol are formed. The other branch of the hepatic duct is the common bile duct. This duct leads into the upper part of the small intestine, the duodenum. At its exit, the common bile duct is guarded by a ring muscle, the sphincter of Oddi. Some animals, such as the horse, do not possess a gall bladder, a fact showing that the gall bladder is not necessary for life.

See DIGESTION; GALL BLADDER; METABOLISM, DISEASES OF; NUTRITION; *see* also references under "Liver" in the Index.

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LIVERMORE, MARY ASHTON (née RICE) (1820–1905), U.S. feminist and reformer, was born in Boston, Mass., Dec. 19, 1820. She taught in neighbouring Charlestown and briefly in a plantation school in Virginia. Returning to Massachusetts she worked vigorously for the abolition of slavery, for temperance and for social reform. With Daniel Parker Livermore, Universalist clergyman and editor, whom she married in 1845, she cooperated in liberal enterprises for 50 years. During the American Civil War, representing the U.S. Sanitary commission, she served in hospitals and behind battlefields and sponsored the Northwestern Sanitary fair in Chicago. Convinced by her war experiences that for status and self-expression women required the ballot, she wrote and lectured extensively for 30 years in the United States and Britain advocating suffrage, education and remunerative employment for women. Dynamic, eloquent and devout, she maintained wide acquaintance and correspondence with persons in all walks of life. With Frances E. Willard she produced a biographical directory of American women and with Elizabeth Cady Stanton and Susan B. Anthony a history of woman suffrage. Her individual publications comprise articles and several books including *The Children's Army* (1844), *My Story of the War* (1888) and *The Story of My Life* (1897). She died at Melrose, Mass., May 23, 1905. (EA. C.)

LIVERPOOL, CHARLES JENKINSON, 1ST EARL OF (1727–1808), English statesman, was born at Winchester on April 26, 1727, the eldest son of Col. Charles Jenkinson. He was educated at Charterhouse school and University college, Oxford, and became private secretary to Lord Bute, the favourite of George III, in 1760. Jenkinson was elected member of parliament for Cockermouth in 1763 and was appointed undersecretary of state in 1761. Promoted joint secretary of the treasury in 1763, he became leader of the "king's friends" in the commons after the retirement of Bute from active politics. During the next 20 years he held a series of minor offices: at the admiralty and treasury (1766–73); vice-treasurer for Ireland (1773); master of the mint (1775–78); and secretary at war (1778–82). In 1786 he became chancellor of the duchy of Lancaster and president of the reconstituted board of trade and was created Baron Hawkesbury. An able administrator, he entered the cabinet in 1791 and was created earl of Liverpool in 1796. Although too ill to attend cabinet meetings after 1801 he retained his cabinet seat and his office at the board of trade until May 1804, but resigned the chancellorship of the duchy in Nov. 1803. He died in London on Dec. 17, 1808.

(A. AL.)

LIVERPOOL, ROBERT BANKS JENKINSON, 2ND EARL OF (1770–1828), Tory prime minister of England from 1812 to 1827, was born on June 7, 1770, the eldest son of the 1st earl, and was educated at Charterhouse school and Christ Church, Oxford. During his grand tour he witnessed the fall of the Bastille (July 14, 1789), and in 1790 was elected, while still under 21, member of parliament for Lord Lonsdale's borough of Appleby. His early speeches established his reputation and launched him on a long and successful public career, serving under William Pitt the Younger as a commissioner of the India board (1793–96) and master of the mint (1799–1801). As foreign secretary under Henry Addington (afterward Viscount Sidmouth) from 1801 to 1804, he negotiated the peace of Amiens and was in the cabinet with his father. He was created Baron Hawkesbury in 1803, a title he had borne by courtesy since 1796. A misfit at the foreign office, he became home secretary in Pitt's last cabinet (1804–06) but refused the premiership when Pitt died. He was again home secretary (1807–09) under the duke of Portland and secretary for

war and the colonies (1809–12) under Spencer Perceval. For a politician he was singularly modest and unambitious, knowing his own limitations. He did not accept the premiership in June 1812 until he realized that, without him, the Tory party would break up. He then hoped to discover a brilliant man whom he could train as his successor, saying that he would be very willing to resign in favour of another Pitt.

Liverpool's great administrative experience, ability as a speaker and knowledge of financial matters were outstanding, but it was his remarkable prudence, businesslike habits, tact and discretion which enabled him to perfect himself in the art of keeping together a cabinet and party deeply divided on such fundamental questions as Catholic emancipation, the corn laws, free trade and liberal and nationalist movements abroad. His name tended to fall into obscurity after his death because in the cabinet he was overshadowed by George Canning and to a lesser extent by Lord Castlereagh. In describing him as the "arch mediocrity" Benjamin Disraeli did him less than justice. By restoring the gold standard in 1819 he once more put the currency on a sound basis and during his premiership administrative reform both in church and state made great headway. Unlike Pitt and his successors he refused to buy seats in parliament with the promise of peerages. Liverpool initiated the practice of making all ecclesiastical appointments subject to merit and suitability irrespective of influence: a policy continued and consolidated by Sir Robert Peel in the 1840s. This high-mindedness was the result of his strong evangelicalism. Liverpool died in London on Dec. 4, 1828, having lived in retirement since Feb. 1827 when a paralytic stroke put an end to his political life. Though twice married, the 2nd earl had no children and the earldom and barony passed to his half brother, Charles, who died in 1851.

See C. D. Yonge, *Life and Administration of the 2nd Earl of Liverpool,* 3 vol. (1868); W. R. Brock, *Lord Liverpool and Liberal Toryism, 1820 to 1827* (1941). (A. AL.)

LIVERPOOL, a city and a county and parliamentary borough in Lancashire, Eng., the second largest seaport of Great Britain, lies 202 mi. N.W. of London by road, on the right bank of the estuary of the Mersey, the centre of the city being about 3 mi. from the open Irish sea. On the north the city is partly bounded by the borough of Bootle, along the shore of which the line of docks is continued. Pop. (1961) 747,490.

The form of the city is that of an irregular semicircle, the base line formed by the docks and quays extending about 9 mi. along the northeastern bank of the estuary, the latter varying in breadth from 1 to 2 mi. The city lies on a continuous slope of sandstone varying in gradient toward the river. The old borough, which lay between the pool (now filled in) and the river, was a medieval pattern of narrow alleys, and during the 16th and 17th centuries it was affected several times by plague. When the town spread up the slopes beyond the pool, conditions improved.

The city is broadly zoned as follows: lying along the river's edge are the docks and quays, together with the ancillary warehousing and other port facilities, as well as a variety of industrial plants closely associated with the import and export of merchandise. The commercial shopping area forms the centre of the semicircle and occupies broadly the site of medieval Liverpool. Round the city centre are the older suburban residential and industrial districts, the nuclei of which are the original outlying villages, which were absorbed by boundary extensions. Beyond these and up to the city boundary are the 20th-century private and municipal residential areas, with generous parks and open spaces. Sefton, Walton Hall and Newsham parks, of 269, 130 and 147 ac., respectively, are but three of the many parks in the city, which has 2,300 ac. of recreation space within its boundary. The Otterspool Riverside promenade by the Mersey is 20 ft. wide and overlooks the Welsh hills. At Aintree, 5 mi. N., is the racecourse where the Grand National is held annually in March.

As a major British port, Liverpool was a target for German aerial bombardment during World War II and sustained considerable damage, not only to commerce and industry but also in its residential areas; 6,500 dwellings were totally destroyed, and more than 125,000 damaged.

History.—During the 8th century, colonies of Norsemen settled on both sides of the Mersey. After the Conquest the site of Liverpool formed part of the fief granted by the Conqueror to Roger de Poictou. Although Liverpool is not named in the Domesday Book, it is believed to have been one of the six berewicks, or subordinate manors, dependent on the manor of West Derby therein mentioned, and cultivated by 53 villeins (peasants), 62 bordars (day labourers), 3 plowmen, 6 herdsmen, 1 horseman, 2 bondmen and 3 bondwomen. After various forfeitures and regrants from the crown, it was handed over by Henry II to his falconer Warine. In a deed executed about 1191 by John, earl of Morton (afterward King John), who was then lord of the honour of Lancaster, in which he confirms Henry Fitzwarine in the possession of Liverpool, the name of the town first occurs. Probably its most plausible derivation is from the Norse *Hlithar-pollr,* "the pool of the slopes." Another possible derivation is from the provincial English *lever,* the yellow flag or rush, O.E. *laefer,* any rush-like or sword-bladed plant. (*See* the *New English Dictionary, s.v.* "Levers.") Yet another derivation could be from the Anglo-Saxon *lither,* meaning "lower," and pool. The grant on which the city's coat of arms is based is the mythical "liver" bird, but in origin this bird was probably the eagle of St. John, King John having granted Liverpool its first charter in 1207.

Besides his honour of Lancaster, Prince John possessed also the lordship of Ireland, and he therefore needed a port where men and supplies could be shipped. Into the tidal waters of the Mersey a small stream ran, forming a pool at its mouth. This pool could provide harbourage for the largest vessels of those days and lay conveniently near to the castle of West Derby. After his accession to the throne, John repurchased the manor from Fitzwarine, giving him other lands in exchange. On Aug. 28, 1207, he issued letters patent granting Liverpool the same status as any other free borough upon the sea and invited his subjects to take up "burgages," or allotments, in the new town, which was built along the brow of the hill on which Castle street and the town hall are erected. The high cross stood near the present town hall, and there the main line of street was intersected by another line extending from the riverside to the Townsend bridge, which crossed the pool where the end of Dale street now is. Considerable use was made of Liverpool in the 13th century for shipping stores and reinforcements to Ireland and Wales. In 1229 a charter was granted by Henry III confirming in detail that previously granted by his father, making Liverpool a free borough forever, and authorizing the formation of a merchants' guild. Several charters were granted until the reign of William III and Mary II, whose charter was that under which the town was governed until the Municipal Corporations act of 1835. In 1880, when the diocese of Liverpool was created, the borough was transformed into a city by royal charter. In 1888 it became a county borough, and in 1893 the style and dignity of lord mayor was conferred on its chief magistrate. The city council consists of 40 aldermen and 120 councilors.

Liverpool sent two representatives to parliament in 1296 and again in 1307. The next time it sent members was in 1547. From 1588 to 1592 the borough was represented by Francis Bacon. Since 1951 Liverpool has returned nine members to parliament: for Edge Hill, Exchange, Garston, Kirkdale, Scotland, Toxteth Park, Walton-on-the-Hill, Wavertree and West Derby.

Under the Municipal Corporations act of 1835, the boundaries of the original borough were extended, and there were several extensions afterward. In 1932 was added the township of Speke, where the municipal airport was established.

The crown revenues from rents and the royal customs were leased from time to time to the corporation or to private persons. The first lease was from Henry III in 1229, and in the same year the borough, with all its appurtenances, was bestowed with other lands on Ranulf, earl of Chester, from whom it passed to the earl of Derby, who seems to have built Liverpool castle between 1232 and 1237. The lands of his grandson, Robert de Ferrers, were confiscated in 1266 when Liverpool passed to Edmund, earl of Lancaster.

The corporation of Liverpool has possessed from a very early

period considerable landed property, the first grant having been made by Thomas, earl of Lancaster, in 1309. This land was originally of value only as a source of turf for firing, but in modern times it has become a profitable building site. A large proportion of the southern district is held in freehold by the corporation and leased to tenants for terms of 75 years, renewable on a fixed scale of fines. Liverpool again became the property of the crown when Henry IV inherited it from his father, John of Gaunt. In 1628 Charles I sold Liverpool to certain merchants of London, who in 1635 reconveyed the crown rights, including the fee-farm rent of £14 6*s.* 8*d.*, to Sir Richard Molyneux, then Viscount Molyneux of Maryborough, for the sum of £450. In 1672 all these rights and interests were acquired by the corporation and in 1777 converted into a perpetuity. With the growth of commerce these dues increased enormously and became a cause of complaint to those with shipping interests. An act of 1857 transferred the dues to a new body of dock trustees on payment of £1,500,000, largely applied to liquidate the corporation's bonded debt. In 1858 the trustees were constituted as the Mersey Docks and Harbour board.

During the Civil War the town was fortified and garrisoned by parliament. It sustained three sieges and in 1644 fell to Prince Rupert.

Liverpool's trade developed slowly. From £10 per annum at the beginning of the 13th century, the crown revenues had increased toward the end of the 14th century to £38, after which they declined. The Black Death, about 1360, killed a large part of the population. The Wars of the Roses in the 15th century retarded progress for at least a century, during which period the crown revenues were finally leased at £14 6*s.* 8*d.*, and they continued at this figure until the sale by Charles I. It is, however, not safe to conclude that the reduced fee-farm rent represents an equivalent decline in prosperity; the privileges conferred by the various leases differed widely and may account for much of the apparent discrepancy. The true rise of the commerce of Liverpool dates from the Restoration. Down to that period its population probably never exceeded about 1,000. Its trade was chiefly with Ireland, France and Spain, exporting fish and wool to the continent and importing wines, iron and other commodities. The rise of the manufacturing industry of south Lancashire and the opening of the American and West Indian trade gave the first impulse to the progress that has continued. By the end of the 17th century the population had increased to 5,000. In 1699 the borough was constituted a parish distinct from Walton. The small existing harbour was found insufficient, and in 1709 Thomas Steers constructed a wet dock with floodgates impounding the water, so as to keep the vessels floating during the recess of the tide.

About that time the Liverpool merchants entered on the slave trade, into which they were led by their connection with the West Indies. In 1700 the "Liverpool Merchant" carried 200 Negroes from Africa to Barbados; in 1730, encouraged by parliament, Liverpool went heartily into the new trade. In 1751, 53 ships sailed from Liverpool for Africa. The ships sailed first to the west coast of Africa, where they shipped the slaves, and thence to the West Indies, where the slaves were sold and the proceeds brought home in cargoes of sugar and rum. By the end of the century five-sixths of the African trade centred on Liverpool. Just before its abolition in 1807, the number of Liverpool ships engaged in slave traffic was 185, carrying 49,213 slaves a year. Another branch of maritime enterprise that attracted the attention of the merchants of Liverpool was privateering, which, during the latter half of the 18th century, was a favourite investment.

The abolition of the slave trade did not bring to Liverpool the ruin that had been prophesied, and trade with the fast-developing North American continent was further increased by the introduction of steam-driven ships in the early 19th century. The reformed town council, after a few years of acute political dissension, displayed a pioneering spirit in the field of public health, encouraged to do so, no doubt, by the problems arising from the mass immigration from Ireland after the famines of the 1840s. Liverpool appointed W. Duncan the first medical officer of health in 1846. As the town became more wealthy, there was increased interest in cultural affairs. In 1849 the Philharmonic hall was opened, and in 1852 Liverpool acquired one of the first public libraries in the country. A museum was provided by Sir William Brown in 1860 (primarily to house the natural history collection left to the citizens of Liverpool by the 13th earl of Derby) and an art gallery (opened in 1877) by Sir Andrew Walker. In 1855 the *Liverpool Daily Post* began publication, and in 1879 the *Liverpool Echo* was started as an evening newspaper.

In the 20th century the opening of the Queensway road tunnel (1934) greatly increased the flow of traffic through Liverpool on a north-south axis and brought the residential and industrial areas of Cheshire and Staffordshire into closer touch with Liverpool and southwest Lancashire. After World War II large blitzed areas in the centre of the city had to be cleared, but it was not until 1952 that the major tasks of central redevelopment could be undertaken. In 1963 a new plan was proposed to rebuild the centre. Large suburban estates had also been developed at Norris Green, Dovecot, Speke, Kirkby, Croxteth, Gateacre and Childwall.

The original supply of water was from wells in the Triassic sandstone. In 1847 an act was passed under which works were constructed and extended later at Rivington, about 25 mi. distant. The vast increase of population led to further requirements, and in 1880 another act gave power to impound the waters of the Vyrnwy, a tributary of the Severn. These works were completed in 1892 and a second pipeline added in 1905. The capacity of the Vyrnwy reservoir is 13,125,000,000 gal. and the catchment area 23,150 ac. in extent. The water from Lake Vyrnwy is conveyed to the city through four main pipelines. In 1957 a new reservoir with a capacity of 16,400,000,000 gal. was authorized at Tryweryn, near Bala in north Wales, its water to be fed into the river Dee and drawn off into the Liverpool supply at Huntington, near Chester.

Architectural Features.—Although the city possesses many buildings of considerable architectural merit, the development of the commercial and shopping centre on the site of the medieval town has obliterated practically all traces of the earlier buildings. The town hall, opened in 1754 and designed by John Wood of Bath, is of particular merit; it is a rectangular building in the Corinthian style, surmounted by a dome that was added after a disastrous fire in 1795. The old Bluecoat hospital (1717), a Queen Anne group built round a courtyard off Church street, is a fine example of its period; the interior suffered considerable damage in World War II but was later rebuilt. Fine examples of 19th-century domestic architecture are to be found in Rodney street and in the Abercromby square area round the university. These dwellings were formerly the residences of Liverpool merchants. Outstanding among many buildings in the Classic Revival style is St. George's hall, designed by Harvey Lonsdale Elmes and completed in 1854. This imposing building, in addition to providing a large public hall, also houses the assize and crown courts and is surrounded by open spaces and gardens sufficiently extensive to enable its splendid classic proportions to be appreciated. After the death of Elmes in 1847, the building was completed by Charles Robert Cockerell, who also designed other important buildings in the city. Adjacent to St. George's hall is the impressive group of buildings in William Brown street, comprising the Technical college, the City museum, the Central library and the Walker Art gallery.

Of the many modern buildings of architectural merit, the most famous are the Anglican and Roman Catholic cathedrals (*see* below) and the three buildings overlooking the river at the pierhead: the Royal Liver building, the Cunard building and the offices of the Mersey Docks and Harbour board. The Philharmonic hall, replacing the old one that had been burned down, was opened in 1939. It is a finely proportioned concert hall with excellent acoustics for orchestral concerts and its own Philharmonic orchestra.

Ecclesiastical Architecture.—Prior to 1699 Liverpool came within the parish of Walton-on-the-Hill, but in that year the chapel of ease of Our Lady and St. Nicholas at the pierhead separated from its parent to become the first parish church. A second church, that of St. Peter, erected by the corporation, was founded and these two, with a number of subsequent churches, served until the increasing population made the establishment of a see of Liver-

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LIVERPOOL CATHEDRAL ON ST. JAMES'S MOUNT, BEGUN IN 1904

pool imperative. A public subscription was launched, which realized £100,000, and as a result the see was formed in 1880, with the parish church of St. Peter serving as procathedral. The see is comprised of 223 parishes. Warrington is a bishopric suffragan.

The building of the Anglican cathedral on St. James's mount was begun in 1904 when the foundation stone was laid by Edward VII. The architect, Sir Giles Gilbert Scott, has taken full advantage of the excellent site, and the cathedral is the most important 20th-century addition to the city's sky line. The building is designed in the Gothic style and is built of red sandstone with copper roof. The Lady chapel was consecrated in 1910 and the choir, east transepts and chapter-house in 1924. The organ, dedicated in 1926, is one of the largest in the country (5 manuals, 10,925 pipes). The interior height of the cathedral is 116 ft. and the ultimate length 619 ft. The space beneath the massive central tower is the largest unsupported space known in Gothic architecture.

The Roman Catholic archdiocese of Liverpool embraces the old hundreds of West Derby, Leyland and the Isle of Man. It was formed as a bishopric in 1850, raised to an archbishopric in 1911 and embraces 196 parishes. The parish church of St. Nicholas, Copperas hill, serves as procathedral.

The construction of the Roman Catholic cathedral of Christ the King on Mount Pleasant, to the design of Sir Edwin Landseer Lutyens, was begun in 1933. The original designs were substantially modified and the size reduced by more than one-third. In 1956 it was realized that even the modified designs were impracticable, and an entirely new approach was made. A public competition calling for designs for a new cathedral from architects in the commonwealth countries was won by Frederick Gibberd. The new cathedral was being built in the 1960s.

The Arts and Education.—The free library, museum and gallery of arts, established and managed by the city council, was originated in 1852. The Derby museum, containing the natural history collections of Edward Smith, the 13th earl, was presented by his son. The Mayer museum of historical antiquities and art was contributed by Joseph Mayer (1803–86), a Liverpool goldsmith, who presented his collections to the city in 1867. The museum was wholly destroyed during World War II (in 1941), but most of the valuable collections had been removed to safety; the museum was being rebuilt in the early 1960s. Sir Andrew Walker (1824–93) erected in 1877 the art gallery that bears his name; large additions were made in 1884, the cost being again defrayed by Sir Andrew Walker. The permanent collection of paintings includes the William Roscoe collection of old masters and the bequest (1923 and 1927) of James Smith of Blundellsands of 28 pictures by George Frederic Watts, 4 sculptures by Auguste Rodin, many etchings and engravings by Albrecht Dürer, Sir Francis Seymour Haden and James Abbott McNeill Whistler, together with a large number of modern works, British and foreign. The Picton library, with a circular reading room, was built by the corporation and opened in 1879. It includes the Hornby library of fine art books, prints and bindings; the technical library, used by industrialists and scientists; the international library, on the history, language, etc., of foreign countries; the art library; the record office; and the local history department. The Brown library was the first and was erected by Sir William Brown; it was bombed in 1941 and has been rebuilt. A commercial library contains information for merchants and businessmen.

The city has two theatres in addition to the Playhouse repertory theatre, which is the oldest repertory company in the country.

The local education authority maintains primary, secondary, county and special schools, as well as colleges for technology, commerce, art, building, crafts and catering and a nautical catering school. Voluntary schools provided by foundations include Roman Catholic, Church of England, and Hebrew schools.

The University.—University college, Liverpool, founded by the citizens of Liverpool, received its charter of incorporation in 1881. Three years later it was accepted as a member of the federal Victoria university, and at the same time the Royal Infirmary Medical school, which had been established since 1844, became a member of the college. By 1900 there was a staff of 25 professors and 60 lecturers, and a student body of nearly 600. On the dissolution of the Victoria university, a royal charter, granted in 1903, established the University of Liverpool. Degrees in engineering were instituted and, later, degrees in architecture; in 1904 the New Veterinary college of Edinburgh was transferred to Liverpool, and a chair of veterinary medicine and surgery was founded. After World War I, development was rapid. Between 1920 and 1939 many new buildings and extensions were constructed, including the Jane Herdman Memorial Geology laboratories (1929), the Leverhulme building of the school of architecture (1933), an extension to the students' union (1935), the Harold Cohen library (1938) and Derby hall, a hall of residence for men students (1938). In 1942 a veterinary field station was opened at Willaston, Wirral, thus continuing the development of a science with which the university has always been prominently associated.

The extension of university education since World War II has brought an increase in staff, students and accommodation; new halls of residence have been built and the old halls extended. The number of chairs in the university is 59, and the faculties are those of arts (responsible for degrees in commerce, architecture and civic design, as well as for degrees in arts); science, including a department of oceanography with the only chair in oceanography in the commonwealth, which works in close conjunction with the marine biological station maintained at Port Erin (Isle of Man) and with the Liverpool Observatory and Tidal institute; medicine, including the school of dental surgery; law; engineering; and veterinary science. The Liverpool School of Tropical Medicine, though separately incorporated, is governed by a committee representative of the university and the merchants and shipowners of Liverpool; and its students take the university postgraduate diploma in tropical medicine and hygiene. Many departments of the university have been entirely rebuilt since World War II.

In 1948 a plan for the development of the university was published, and the city council reserved a site in its own redevelopment plan for the purpose, with Abercromby square as its approximate centre. The university's jubilee was celebrated in May 1953.

Docks, Railways and Roads.—The docks of the port of Liverpool on both sides of the Mersey are owned and managed by the Mersey Docks and Harbour board (constituted in 1858). On the Liverpool side they extend along the estuary 6½ mi., of which 1¼ mi. is in the borough of Bootle. The Garston docks, six miles above Liverpool, are also within the city boundary. The Birkenhead docks have not such a frontage but extend a long way inland. The water area of the Liverpool docks and basins is 460 ac., with a lineal quayage of nearly 28 mi. Birkenhead docks contain a water area of about 181¼ ac., with a lineal quayage of 9¾ mi. The

system of enclosed docks was begun by the corporation in 1709. The Gladstone docks, opened in 1927, are among the best equipped in the world. The sill is 20 ft. below datum level, the entrance is 130 ft. wide and the area with branch docks is nearly 54 ac. A fine graving dock is part of the system. Down to 1843 the docks were confined to the Liverpool side of the Mersey. In 1843 a plan for docks in Birkenhead was carried through, proved unsuccessful, and was acquired in 1855 by Liverpool. The Birkenhead docks were for many years only partially used but are now an important centre for corn milling, the importation of cattle and export trade to the east.

The first portion of the great landing stage, known as the George's Landing stage, was constructed in 1847. This was 500 ft. long. In 1857 the Prince's Landing stage, 1,000 ft. long, was built 500 ft. to the north of the George's stage. In 1874 the intervening space was filled up and the George's stage reconstructed, but it was destroyed by fire and had to be reconstructed a second time. In 1896 it was extended farther north, and its length is now 2,534 ft. and its breadth 80 ft. It is supported on floating iron pontoons (about 200) connected with the river wall by ten bridges, besides a floating bridge for heavy traffic 550 ft. in length and 35 ft. in width. The southern half is devoted to the traffic of the Mersey ferries, of which there are three—New Brighton, Seacombe and Birkenhead. The northern half is used by ocean-going steamers and their tenders. The warehouses for storing produce form a prominent feature in the commercial part of the city. In addition to general produce warehouses, grain warehouses have been constructed by the dock board at Liverpool and Birkenhead, with machinery for discharging, elevating, distributing, drying and delivering. Warehouses for the storage of tobacco and wool have also been built by the board. The Stanley tobacco warehouse is the largest of its kind in the world, the area of its 14 floors being about 36 ac.

The dock board was the first harbour authority to introduce wireless telegraphy as a guide to shipping (1911), and in 1948 the first port radar station was built to serve as a navigational aid to shipping using the Mersey. The Waterloo river entrance lock was opened in 1949, and in 1962 the Canada-Langton river entrance was reconstructed. The whole of the North docks in Liverpool are now accessible to vessels at all stages of the tide. The new Tranmere oil jetty provides for the discharge of large tankers.

There are four terminal passenger stations in Liverpool. They are: Lime street, Exchange, Central and Riverside. Connection with Birkenhead is effected by the old Mersey tunnel (opened 1886) and by the Queensway road tunnel opened in 1934. (*See* BIRKENHEAD; TUNNEL.) In 1895 the Riverside station at the Prince's dock was completed by the Mersey Docks and Harbour board, giving direct access from the landing stage to the railway system.

Plans to reorientate traffic in the central area of the city were approved in 1963. These included a new inner motorway to relieve congestion in the city itself and a second Mersey tunnel to alleviate the pressure on the existing one.

Trade and Commerce.—The port is the traditional centre of business life in Liverpool and the adjoining districts that go to make up Merseyside. It is second only to London among British "general" ports, with extensive passenger interests to add to its handling of materials and goods of virtually every type. The total tonnage of these in an average year is of the order of 23,000,000, carried in about 32,000 seagoing vessels.

The commerce of Liverpool, channeled through its port, has a main emphasis on North and South America, western Africa, the Mediterranean countries, the Indian subcontinent and Australasia —a very large proportion of the trading world. The main imports are of raw materials and commodities (in excess of 14,000,000 tons in the mid-1960s, including bulk oil) for use or manufacture in and round Liverpool or in the upcountry areas of industry that it serves. From these areas, principally of Lancashire, the Midlands and west Yorkshire, come in return the chief exports of Liverpool —iron and steel, machinery and manufactured goods of all types from the heaviest products to pottery, textiles and fine goods, compiling a list as long as the concerns of British overseas trade. The export tonnage exceeds 4,000,000.

The port is the hub of the wheel of Merseyside, and in that hub are the ships, the building and fitting of ships, and the manning, victualing and servicing of ships that are known throughout the world. Packed round that hub are major facilities of banking and insurance, of warehousing and of every branch of commercial life, and industries to process imported materials are located as close as possible to the quays. Merseyside has the largest flour-milling centre in Europe, its sugar and oil refineries are well known, oilseed crushing is a substantial industry and biscuit (cookie), confectionery, rubber and soap factories, somewhat farther from the main port area but well within local boundaries, are also important.

In the late 1920s this picture, with some modifications, would have represented the sum of Liverpool's commerce and industry. But the trade recession that paralyzed the world then had a particularly serious effect on Liverpool, dependent as it was on a maximum passage of the world's goods and, at the worst of the recession, more than 100,000 of Liverpool's citizens were unemployed. To ensure against a repetition of this, by spreading the risk over as wide and productive a field as possible, the Liverpool City corporation took special statutory powers (in 1936), which have since been imitated by many other authorities, both central and municipal—powers to bring work to the worker by means of special facilities, of finance, siting and construction, made available to manufacturing industry. The corporation's industrial estates at Speke, Kirkby and Aintree cover a total acreage of 2,741, and each is on a principal approach to the city from its inland areas of chief contact. The effect, when allied to the efforts of the state since World War II and of private enterprise throughout, has been to add a third partner, manufacture, to the older and better-known interests of Liverpool's life. There are now large factories for electrical and electronic apparatus, diesel engines, jet engines, tires and heavy chemicals. Other products include antibiotics, clocks, scientific instruments, pharmaceuticals and matches. The social process involved of converting a measurable part of a dockside population, accustomed for many generations to casual labour, into an industrial population, working regularly, has been both interesting and successful.

As a result, Merseyside's working population has an infinitely greater industrial element than its grandfathers would have believed possible. The port and all to do with it remains the largest employer of that labour, followed by light engineering, chemicals and pharmaceuticals, food and foodstuffs, the services of commerce and inland transport and a very large number of smaller activities, each substantial in itself and completing the composition of an area that has at least taken definite steps in the direction of economic balance.

See also references under "Liverpool" in the Index.

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(T. AR.)

LIVERWORTS, small, chiefly prostrate nonvascular plants, constitute two classes of the Bryophyta (*q.v.*), to which also belong the mosses. The liverworts differ from the mosses principally in the structure of the spore-bearing plants (sporophytes), described below. All mosses are leafy, but some of the liverworts lack leaves or, if leafy, are usually flatter than the majority of mosses. The leafless forms may be ribbonlike or otherwise flattened and ruffled, but most liverworts have leaflike appendages on the stems.

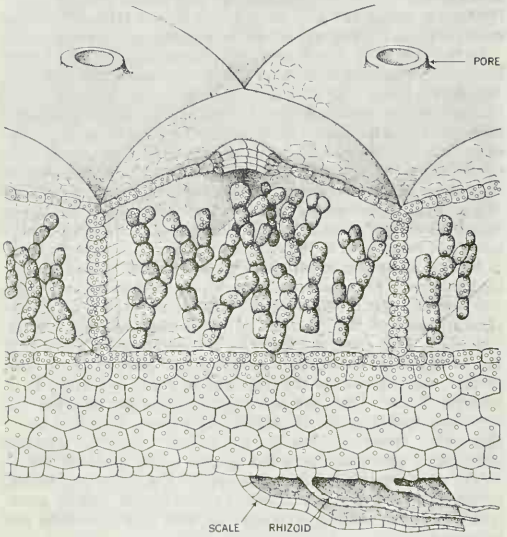
No liverwort has any important economic significance, although some (*Marchantia* and *Conocephaleum*) long ago were thought to have medicinal value for liver ailments in accordance with the doctrine of signatures. In nature they play a role as pioneers on newly exposed substrata in the reducing of rocks and woody materials to soil, in retarding soil erosion and in providing food and

homes for small animals.

The liverworts may be divided into the classes Hepaticae and Anthocerotae.

Hepaticae.—Sometimes called the true liverworts or hepatics, these plants may be divided into the leafy and the thalloid forms, the latter being flattened ribbons or rosettes without leaflike structures on the stems. The thalli vary in size from one-sixteenth to one inch in width.

The best-known thalloid species is *Marchantia polymorpha*, which appears like a green forking ribbon approximately one-half

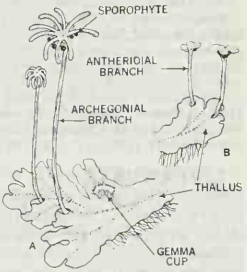


FROM N. J. FULLER AND O. TIPPO, "COLLEGE BOTANY," REV. ED. (1954); REPRODUCED BY PERMISSION OF HENRY HOLT & CO., INC.

FIG. 1.—SECTION THROUGH (MARCHANTIA) THALLUS, SHOWING UPPER EPIDERMIS WITH PORES, AIR CHAMBERS WITH COLUMNS OF CELLS CONTAINING CHLOROPLASTS, LAYER WITH FEW CHLOROPLASTS, AND LOWER EPIDERMIS BEARING SCALES AND RHIZOIDS

inch in width. It has an upper and lower epidermis with scales along the middle of the latter. The portion between the upper and lower epidermis is filled with walled cavities, each with an opening through a fixed pore in the upper epidermis. The cavities have short, green, cactoid filaments scattered in them.

These thalloid plants are haploid; *i.e.*, are gametophytes with a single set of chromosomes. They are unisexual, and eventually stalklike branches are formed. If female, the sexual branch somewhat resembles a palm tree or an umbrella without its fabric. The female sex organs (archegonia) are hung beneath the rays. The male branches terminate in a flattened, scalloped, screwhead-like structure with male sex organs (antheridia) buried in small-mouthed cavities in the upper surface. At maturity the male cells (sperms) may swim from the ruptured antheridia to the female plants and thence to the female cell (egg) contained in the enlarged, basal portion (venter) of the archegonium.



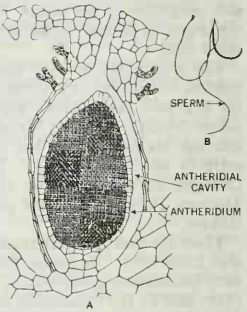
FROM P. WEATHERWAX, "PLANT BIOLOGY"; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 2.—MARCHANTIA GAMETOPHYTES: (A) ARCHEGONIA BORNE ON LOWER SIDES OF FINGERLIKE RAYS OF STAR-SHAPED STRUCTURE OF FEMALE PLANT; (B) ANTHERIDIA PRODUCED IN CAVITIES IN UPPER SURFACE OF DISC ON MALE PLANT

W. C. STEERE

FIG. 3.—GAMETOPHYTES OF RICCIOCARPUS NATANS FLOATING ON WATER (ABOUT ACTUAL SIZE)

The fertilized egg (zygote, formed by union of sperm and egg) by apical growth matures into a spore-bearing plant which is diploid; *i.e.*, a sporophyte with a double set of chromosomes. It consists of a foot embedded basally in the venter, a stalk (seta) that attaches the foot to the spheroidal spore-bearing capsule (sporangium), all of which develops within the archegonium. At maturity the cells of the seta rapidly elongate, bursting the archegonium and exposing the capsule. The spores, covered by a compact wall of one or two layers of cells, are often mixed with slender, hygroscopic cells (elaters) that may effect spore dispersal when the capsule splits open or ruptures as a result of wall deterioration. The spore germinates on moist substrata and, after a short (three or four cells) threadlike phase, grows into the ribbonlike gametophyte.



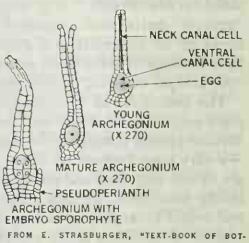
FROM G. M. SMITH ET AL., "A TEXTBOOK OF GENERAL BOTANY"; REPRODUCED BY PERMISSION OF THE MACMILLAN CO.

FIG. 4.—MARCHANTIA: (A) IMMATURE ANTHERIDIUM, WITH ADJOINING PARTS OF MALE DISC IN WHICH IT IS BORNE; (B) SPERM VERY MUCH ENLARGED

The leafy members of the Hepaticae often resemble mosses but usually can be recognized by the presence of only two rows of leaves (also characteristic, however, of the moss genus, *Fissidens*) or two rows of large leaves and a third row of small leaves on the side of the stem toward the substrate. They vary from species microscopic in size to those in which single leaves may be easily seen without a lens.

In *Trichocolea*, *Ptilidium* and others, the leaves are subdivided into hairlike segments. In *Frullania* and *Jubula* they have a small, pouchlike lobe bent up behind the main portion of the leaf. Some leaves have entire margins; others have long, marginal teeth. Some are smooth; others are rough with pimplelike projections (papillae).

The sexual life cycle of the leafy species is not essentially different from that of the thalloid forms. The antheridia are borne in the axils of leaves; the arche-

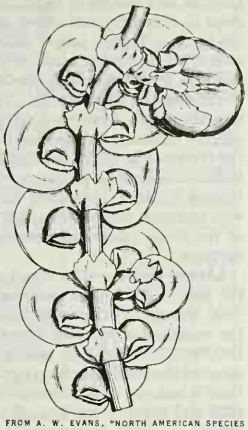


FROM E. STRASBURGER, "TEXT-BOOK OF BOTANY"

FIG. 5.—MARCHANTIA POLYMORPHA, SHOWING ARCHEGONIUM, WHICH ENCLOSES EGG AND EMBRYO

gonia are usually terminal. The sporophyte usually has a longer seta than many of those in the thalloid species.

In addition to reproduction by sexual means, liverworts also produce vegetative reproductive bodies (gemmae) of various shapes and sizes. Some are formed on the surface or edges of leaves or thalli; others are borne in specialized structures in the form of cups or flasks. New plants are also formed by growth from fragments and by branching and subsequent death of the older portion.



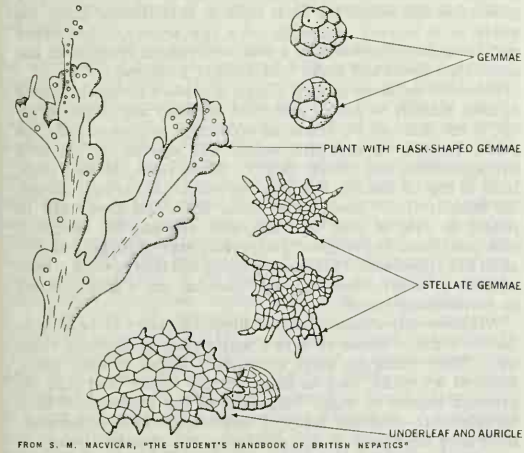
FROM A. W. EVANS, "NORTH AMERICAN SPECIES OF FRULLANIA," TRANSACTIONS OF CONNECTICUT ACADEMY OF ARTS AND SCIENCES (1899)

FIG. 6.—FRULLANIA BRITTONIAE, WITH PORTION OF EACH LATERAL LEAF FOLDED INTO A SAC

Anthocerotae.—These, often called horned liverworts or hornworts, do not constitute a very large group. American genera include *Anthoceros, Phaeoceros* and *Notothylas*. They differ from the hepatics in a number of characteristics, the most important of which is the indeterminate basal growth of the needle-shaped sporophyte. Thus arises the unique situation in which mature spores may be falling from the top of the apically split sporophyte while new ones are being initiated at the base. Also, there is no seta and the foot is large and irregular.

The cells of the hornwort sporophyte have two large chloroplasts containing starch-producing bodies called pyrenoids; cells of the hepatics have several to many small chloroplasts without pyrenoids. The sporophyte has a sterile central column (columella) and pores (stomata) in the epidermis; these structures are not present in the hepatics. The latter have unicellular elaters, if present; the hornworts usually have irregular multicellular elaters.

The gametophyte is not leafy but a thallus that has cavities, often opening by slits through the lower surface, containing symbiotic colonies of the blue-green alga *Nostoc*. The cells of the gametophyte each have a single, large chloroplast. The sex organs (antheridia and archegonia) are somewhat similar to those of the hepatics but are sunk in the upper surface of the gametophyte, the antheridia occurring in cavities and the archegonia appearing as an integral part of the thallus. The sexual life cycle is similar to that of the hepatics except for the different shape of certain structures as described above. Vegetative reproduction may occur through natural division of the thallus.

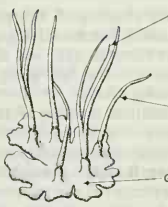


FROM S. M. MACVICAR, "THE STUDENT'S HANDBOOK OF BRITISH HEPATICS"

FIG. 7.—BLASIA PUSILLA, WHICH PRODUCES TWO TYPES OF GEMMAE, ONE OF THEM GROWING INTO A NEW PLANT

The Anthocerotae are interesting for several reasons. The large pyrenoid-containing chloroplasts appear primitive; in contrast, the basal indeterminate growth of the sporophyte makes it appear related to more advanced plants. They are the lowest plants in the plant kingdom to exhibit stomata. These structures, plus the indeterminate growth of the sporophytes, have led some botanists to suggest that they represent a type ancestral to the ferns. However, in spite of certain primitive characters they are probably the most highly evolved of the liverworts and represent the current end of a line rather than an ancestral form. The symbiotic relationship between the alga *Nostoc* and the thalli of the Anthocerotae suggests that the host may receive nitrogen-containing compounds or other beneficial materials from the alga.

The Anthocerotae are usually found in the moist, dim woodlands of tropical and warm temperate regions. In North America they are occasionally collected in southern Canada.



FROM E. STRASBURGER, "TEXT-BOOK OF BOTANY"

FIG. 8.—ANTHOCEROS LAEVIS, A HORNWORT

BIBLIOGRAPHY.—H. C. Bold, *Morphology of Plants* (1957); D. H. Campbell, *Structure and Development of Mosses and Ferns* (1905); Evans, "Classification of the Hepaticae," *Bot. Rev.*, 5:49–96 (1939); Fulford, "Recent Interpretations of the Relationships of the Hepaticae," *Bot. Rev.*, 14:127–173 (1948); F. Verdoorn *et al., Manual of Bryology* (1932). For identification of American species of Liverworts, *see* Conard, *How to Know the Mosses and Liverworts* (1956); T. Frye and L. Clark, *Hepaticae of North America* (1937); Macvicar, *The Student's Handbook of British Hepatics* (1926); Schuster, "Annotated Key to the Orders, Families and Genera of Hepaticae of America North of Mexico," *Bryologist*, 61:1–66 (1958); Schuster, "Boreal Hepaticae," *Amer. Midl. Nat.*, 49:253–684 (1953). (A. J. SH.)

LIVERY COMPANIES, institutions peculiar to the City of London, are survivals from the medieval trade and craft guilds once universal in Europe. Their name, popularly accepted but not found in their charters of incorporation, is derived from the grant by the court of aldermen of a "livery," or grade of membership in the guild privileged to wear a distinctive clothing in the form of a fur-trimmed gown. Thus the Parish Clerks and the Watermen & Lightermen, though both guilds of ancient foundation, have never been granted a livery and so are not properly included among the livery companies.

There were, in the mid-1960s, 84 livery companies containing 14,000 liverymen, and the numbers were increasing. Most of the companies were incorporated by royal charter between the 14th and the 17th centuries, but the Weavers gained a charter as early as the 12th century, and the Master Mariners, the Solicitors, the Farmers and the Air Pilots & Air Navigators have come into existence since 1925. The incorporation in 1960 of the Tobacco Pipe Makers & Tobacco Blenders is a revival of a former company which fell into desuetude in the 19th century. The companies vary a great deal in detail and the range of their wealth and influence is wide. Nearly every one of the 84 companies once controlled the craft or trade indicated by its name; 60 were concerned with skilled crafts such as the Goldsmiths, the Carpenters and the Glovers, while 12 dealt with victualing trades, as for example, the Bakers and the Vintners. Most of the companies have now lost control over their trades but the Fishmongers still possess wide and effective powers of search and inspection in Billingsgate fish market, the Goldsmiths continue to "hallmark" gold and silver, and the Gunmakers still "proof" small arms.

Most of the companies are governed by a small self-appointing body known as a court of assistants presided over by a master (or prime warden) and wardens. Few of the companies restrict their membership to persons following the particular calling represented by the company's name, but the Apothecaries' society confines its

senior membership to medical men, the Brewers' company is limited to the brewing trade and the Solicitors, Master Mariners and Air Pilots admit only persons qualified in those specialties. By the custom of London, admission to the basic grade of membership of a company—known as the freedom of the company—is by patrimony, servitude (apprenticeship to a freeman of the company) or redemption (purchase). An order of precedence was settled by the court of aldermen in Henry VIII's reign and the first "twelve great" companies are the Mercers, Grocers, Drapers, Fishmongers, Goldsmiths, Skinners, Merchant Taylors, Haberdashers, Salters, Ironmongers, Vintners and Clothworkers.

Origin and Growth.—Though most originated in the early religious fraternities, trade and craft guilds were formally established in the 12th century and in the 13th steadily grew in strength and influence (*see* GUILD). By the 14th century they had become the predominant power in the governing councils of the City of London and the liverymen still elect the lord mayor and the sheriffs.

The early charters of incorporation granted by Edward III to the Goldsmiths, Skinners, Drapers and a few others were the exception rather than the rule, but Henry VI extended the privilege of incorporation to the four great victualing trades and five leading manufacturing crafts.

It is a mistake to think of these guilds as associations of poor working men, or as the forerunners of the modern trade unions. In the early days apprenticeship was the normal method of entry into a trade or craft and on completion of his indentures and production of his "masterpiece" the apprentice became a freeman of his company and a master craftsman. He might then continue to work as a journeyman for others but would look forward to setting up on his own and taking apprentices in his turn. It was only when he became established that he would aspire to promotion to the livery. Thus the general pattern of the more influential companies was that of a master and court consisting of the leading members, who were often rich merchants; the main body of well-to-do shopkeepers forming the livery; and a substratum of working craftsmen, the freemen of the company.

At the zenith of their power the guilds controlled their members by the exercise of powers conferred by charter or ordinances: to regulate apprenticeship and conditions of employment, to examine workmanship and destroy defective goods, and to enforce rules by fines and penalties. The ultimate sanction was that only those free of the City of London could ply their trade, and the freedom of the city was obtainable only through membership of a guild.

Changing economic and political conditions from the 16th century onward resulted in a gradual but steady loss of power and influence. Repeated attempts to adapt the constitution and powers of the medieval guild to the new pattern of society failed; friction began to develop between the governing bodies of the livery companies and the growing ranks of artisans who resented the restrictions inherent in the apprenticeship system. By about 1787 most of the companies finally abandoned any pretense of controlling their respective trades. However, at the close of the 19th century there was a widespread movement on the part of the livery companies to revive interest in their respective crafts and trades and to devote corporate funds, where these existed, to technical education and charity. Benevolence and the relief of distress were always a principal concern of the old guilds and the livery companies of today continue this tradition.

Modern Activities.—After the middle of the 15th century the practice grew for testators to appoint companies as trustees; for instance, John Colet appointed the Mercers to administer a trust for St. Paul's school (founded 1509). Later in the same century the Skinners company were appointed trustees for Tonbridge school. Other schools maintained by livery companies are Oundle by the Grocers, Aldenham by the Brewers, Gresham's Holt by the Fishmongers, the Aske's schools by the Haberdashers and the Merchant Taylors' school. In the sphere of technical education and the promotion of industrial research the City and Guilds of London institute was founded by the corporation of London and the livery companies in 1880. The Clothworkers built and equipped the department of textiles and colour dyeing at Yorkshire college (now Leeds university) and expended vast sums on numerous technical schools dealing with textiles. The Drapers spent more than £500,000 on their foundation, Queen Mary college (now a principal school of the University of London). The Goldsmiths founded and maintained Goldsmiths' college which they presented to the University of London as a technical institute in 1904. The Salters founded an Institute of Industrial Chemistry which awards fellowships in chemistry and allied sciences. The Skinners have aided the Leather Trades' school at Bethnal Green and have given generously to such institutions as the People's palace, Mile End, the Borough Polytechnic and the Northampton College of Advanced Technology at Clerkenwell. The Carpenters founded and maintain their own Building Crafts Training school. The Leathersellers' Technical college, built by that company in 1909, is now the National Leathersellers' college. The Cordwainers have their technical college at Hackney; the Tylers & Bricklayers, Joiners, Painter-Stainers, Plaisterers and Wheelwrights are all concerned with technical education in their own particular spheres; and many of the livery companies provide scholarships at schools and universities.

Livery Halls.—The Merchant Taylors and the Goldsmiths are the only crafts known positively to have possessed halls before 1400, though 26 others were built in the next 100 years. Many of the wealthier companies, like the Grocers, the Drapers and the Leathersellers, began by taking over the mansions of feudal magnates or the buildings of a religious community. The Great Fire of 1666 is believed to have swept away as many as 44 livery company halls and some of the less affluent companies were never able to rebuild. In 1939 there were 34 livery halls standing but in the air raids of World War II 16 were destroyed and 14 damaged. By the mid-1960s rebuilding had raised the number to 28.

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LIVESTOCK FEEDS: *see* FEEDS, ANIMAL.

LIVESTOCK JUDGING is an art requiring the ability to select animals, on the basis of outward appearance, or phenotype (*see* HEREDITY: *Heredity of Quantitative Characters*), and for those characteristics associated with excellent productive performance. It attempts to correlate the appearance factors which will result in the reproduction of meat animals (beef cattle, sheep and swine) which will produce carcasses of high quality with a large proportion of edible cuts. It attempts to select dairy cows for milk production and horses for draft work or performance under the saddle or in harness. Although not a true science, it has served well throughout the world as a tool for livestock breeders to improve their herds and flocks (*see* ANIMAL BREEDING).

Increased emphasis is being placed in modern livestock judging of meat animals on rate of gain, feed efficiency and carcass quality, items that can be measured accurately, and eventually the grand champion or first prize animal will have to excel in both live appearance and carcass quality. Many times the best steer, lamb or hog on foot has not been the best in the carcass. Breeding animals (bulls, cows, rams, ewes, boars and sows) will be judged by rate of gain, feed efficiency, reproductive efficiency, milk production (dairy cows) and performance of progeny as well as on live appearance. Livestock judging will then become a combination of an art, based upon eye selection, and a science, based on performance records.

Whenever any characteristic of livestock ceases to be of productive value, it ceases to have a major place in livestock selection. Many times too much emphasis is placed on some minor fancy of a breeder, such as shade of hair colour; and thus the livestock breeder or judge loses sight of the fundamental basis for selection. Although many of these nonproductive characteristics have their place in contributing to the style and beauty of an animal, they should never be emphasized to the degree of masking the real purpose of livestock production; *i.e.*, the pro-

Beef Judging Card

Points to Consider	Placing			
	1st	2d	3d	4th
I. General appearance: straight top-line, deep, broad, uniform in width, low-set, compact, symmetrical stylish, standing squarely, trim middle				
II. Form:				
1. Head—muzzle broad, nostrils large, eyes large and clear; face short, clean and slightly dished; forehead broad; ears medium size and fine texture; horns medium size and well shaped				
2. Neck—thick, short, blending smoothly into shoulders; throat clean				
3. Shoulder—smooth, well-covered with flesh, compact on top; shoulder vein smooth and full				
4. Breast—wide, full; brisket neat and trim with little dewlap				
5. Forelegs—short, strong; arm full, shank medium fine				
6. Chest—deep, wide, girth large, crops full				
7. Back—wide, straight and thickly covered				
8. Loin—wide, straight and deep-fleshed				
9. Ribs—well sprung and smoothly covered with firm flesh				
10. Flanks—full and low				
11. Hooks—neatly laid in and smoothly covered				
12. Rump—long, wide, even; level and free from patchiness				
13. Thighs—deep, broad, wide and full				
14. Twist—full and deep				
15. Legs—straight, strong; shanks medium fine				
III. Finish: deep, mellow, firm covering especially over back, ribs and loin; freedom from patchiness and rolls desired. (Finish is of great importance in fat classes, but is not so important in breeding classes as long as the ability to take on finish is indicated)				
IV. Quality: smooth in frame and finish; hair fine, soft; hide mellow; bone medium-size and clean				
V. Dressing percentage: well finished, not paunchy, medium weight hide. (Not considered in judging breeding cattle)				
VI. Breed and sex character: (Applies only to breeding classes)				

vision of meat, milk and wool. The accompanying sample judging card for beef cattle indicates the main points considered in livestock judging.

Certain characteristics should be developed for proficiency in judging livestock:

1. The desire to know livestock. An intrinsic interest in livestock and the desire to know their characteristics, habits and productive points are necessary in a good judge. Livestock judging requires the sacrifice of time and energy for the sake of studying and working with good livestock. A good judge or animal breeder must be livestock minded and be keenly aware of the perplexing problems that confront the breeder who is continuously selecting and culling to improve his livestock quality and performance. The imperfections as well as the perfections of the different breeds, classes and types of livestock must be recognized. Livestock judging and selection must become a real and living task rather than a means of attempting to correctly place a class or group of animals in the show ring or on a farm or ranch.

2. A mental image of ideal types. If only one animal is judged or appraised, it must be compared with some standard, namely the ideal of its kind. If two or more animals are judged, each animal must be compared with the ideal, and then with the others in the class. These ideal types can be learned by observing good individuals in both the live and picture form. Ideal types of livestock have been set up by a majority of the breed associations. Pictures are at best a poor substitute for the same type of live animals, but in cases where only common classes are available, pictures of other classes may be used to advantage. A judge must be constantly in contact with good animals and observe them keenly. Great value can be obtained from intelligently observing good representatives of the various breeds at leading livestock shows, sales, farms, and ranches in all parts of the world.

3. Keen power of observation. The ability to detect important differences in livestock quickly and accurately must be developed. This keen power of observation is the result of intense concentration on the outstandingly good and bad points of an animal. Persistent practice in evaluating livestock in terms of an ideal is a sure way to develop a keen sense of differences. A herdsman knows his livestock well. As with human beings, each animal possesses a physical individuality which sets it apart. These individual differences become apparent to the herdsman through keen observation and habitual contact. The judge, too, must be among livestock and think about livestock to develop his power of observation.

4. Ability to make a logical analysis. Since judging is an art based on observation, it is impossible to appraise animals in the terms of exact percentages. While all parts of an animal do not have the same economic value, each part is interrelated and dependent on the other parts, and in the last analysis, the animal must be considered as a whole. A score card is excellent for learning the parts of the animal if the supposed numerical value of the parts is disregarded. To be sure, the relative importance of various parts on the basis of anatomy and wholesale cuts should be mastered, but to assign definite percentage values to each part of an animal often leads to confusion. Judging is not a mathematical formula or an aggregation of percentages, but is an art requiring practice and sound judgment. A judge must be honest and open minded in his search for facts. In market animals one must be able to appraise commercial values and still recognize the desirable balance in development that the breeders and producers prefer, even though some points such as constitution, feeding qualities, soundness and breed type may not much concern the packer. When one allows bias or prejudice to place a class of livestock, he is catering to his emotions and is disqualifying himself as a competent judge. If one observes the animals accurately, weighs the facts in a balanced manner, never follows hunches and concludes with a logical placing, his mistakes will be reduced to a minimum. Judging is applied, sound reasoning.

5. Independence of thought. Only in proportion to the extent that a judge exercises independence of thought is he able to improve his judging ability. A judge must be open minded to just criticism from others and make his mistakes steppingstones instead of stumbling blocks, strengthening his ability to select animals correctly.

6. The ability to give effective reasons. This ability depends partly on natural talent but primarily on acquired knowledge and practice. Accuracy is of prime importance. Presenting a pleasant-sounding and persuasive set of reasons without a high percentage of accuracy is worthless. A judge should give the reasons for his placing in a simple, straightforward manner and in suitable livestock terminology that serves to make his reasons clear, logical and to the point. (W. M. B.)

LIVIA DRUSILLA (58 B.C.–A.D. 29), wife of the Roman emperor Augustus and after his death called Julia Augusta, was daughter of M. Livius Drusus Claudianus, a Claudius adopted by M. Livius Drusus (*q.v.*), the tribune of 91 B.C. She married her cousin Tiberius Claudius Nero, who fought against Octavian (later Augustus) in the War of Perusia (41). To him she bore in 42 a son Tiberius (later emperor), but she was still pregnant with her second son Nero Claudius Drusus (*q.v.*) when early in 38 Octavian compelled her to divorce Nero and marry him, he having recently divorced his wife Scribonia. The new marriage was childless, but Livia was reputedly a devoted and an influential wife, accompanying Augustus on various journeys and counseling him successfully on state affairs. In her efforts to secure the succession for Tiberius she was credited with bringing about the deaths of many rivals, for instance Augustus' nephew Marcellus in 23 B.C. and his grandsons Lucius and Gaius in A.D. 2 and 4; it was even believed that she hastened Augustus' own end because she feared the reinstatement of his banished grandson Agrippa Postumus. Nothing in these stories is really credible, but the power and ambition of Livia are beyond doubt. To Tiberius after his accession they proved embarrassing: he forbade her to accept certain honours and eventually refused to carry out the terms of her will. In 42 she received divine honours from her grandson Claudius I.

Surviving portraiture confirms the literary tradition of Livia's dignified beauty; she was also noted for her chastity and affability. Her villa at Prima Porta has revealed some excellent examples of Roman painting, now in the Museo Nazionale at Rome.

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(G. E. F. C.)

LIVINGSTON, EDWARD (1764–1836), U.S. lawyer, legislator and statesman, is perhaps best remembered for his work in codifying the law, especially criminal law and procedure. He was born in Columbia county, N.Y., on May 28, 1764. He graduated from the College of New Jersey (now Princeton) in 1781, was admitted to the bar in 1785, and began to practise law in New York city. He was a Republican representative in congress, 1795–1801, where he was one of the leaders of the opposition to Jay's treaty, taking the ground that congress was not bound to appropriate money to carry out a treaty obligation. In 1801 Livingston was appointed U.S. district attorney for the state of New York and while retaining that office was in August of the same year elected mayor of New York city. When, in 1803, the city was overtaken by an epidemic of yellow fever, Livingston helped to prevent the spread of the disease and relieve distress, and was himself attacked by the fever.

On his recovery he found himself indebted to the government for public funds which had been lost through the dishonesty of a confidential clerk, and for which he was responsible as district attorney. He at once surrendered all his property, resigned his two offices in 1803, and moved early in 1804 to Louisiana. He soon acquired a large law practice in New Orleans and by 1826 had managed to repay the government in full, including the interest.

In Louisiana, he was appointed by the legislature to prepare a provisional code of judicial procedure, which (in the form of an act passed in April 1805) was continued in force from 1805–25. During the war with England from 1812–15 Livingston was active in rousing the mixed population of New Orleans to resistance, and acted as adviser and volunteer aide-de-camp to Gen. Andrew Jackson. In 1821, by appointment of the legislature, of which he had become a member the preceding year, Livingston began the preparation of a new code of criminal law and procedure, afterward known in Europe and America as the "Livingston Code." Completed in 1824, it was accidentally burned and had to be written again. It was presented to the legislature in 1825 but was not adopted. It was at once reprinted in England, France and Germany, and studied all over the world, attaining wide influence.

Livingston was again a representative in congress during 1823–29 and a senator in 1829–31. In 1828 he presented to the senate a system of penal laws for the United States but no action was taken on it. He served for two years (1831–33) as secretary of state under President Jackson. In this last position he was one of the most trusted advisers of the president, for whom he prepared a number of state papers, the most important being the famous anti-nullification proclamation of Dec. 1832. From 1833 to 1835 Livingston was minister plenipotentiary to France at a time when relations between the two countries were strained over claims of U.S. citizens for damages resulting from the Napoleonic Wars. He died May 23, 1836, at his home, "Montgomery Place," Dutchess county, N.Y.

His works include: *Reports of the Plan of the Penal Code* (1822); *System of Penal Law for the State of Louisiana* (1826); *System of Penal Laws for the United States of America* (1828); *Complete Works of Edward Livingston on Criminal Jurisprudence* (1873).

See W. B. Hatcher, *Edward Livingston* (1940).

LIVINGSTON, ROBERT R. (1746–1813), first chancellor of the state of New York, member of the continental congresses and U.S. minister to France, was born in New York city on Nov. 27, 1746. His father, Robert R. Livingston (1718–75), was a justice of the New York supreme court after 1763; his brother Edward achieved distinction in both law and politics. After graduating from King's college (now Columbia university) in 1765, Livingston studied law and was admitted to the bar in 1770. During the American Revolution he served in the second continental congress from 1775 to 1776, again from 1779 to 1781, and in the congress under the Articles of Confederation from 1784 to 1785. He was a member of the committee that drafted the Declaration of Independence, although before signing it he left the congress to take his seat in the newly elected New York convention. He was a member of the committee that drafted the first constitution for the state of New York in 1776. In 1777 he became the first chancellor of the state, a post he held until 1801, and he is best known in history as Chancellor Livingston. With inauguration of the government under the Articles of Confederation in 1781 Livingston became the first secretary of foreign affairs. In this position he approved the peace treaty negotiations by the American commissioners in Paris but reprimanded them for negotiating without the full concurrence of France. On April 30, 1789, in his capacity as chancellor of New York, he administered the oath of office to George Washington at his inauguration as president in New York city.

As a member of the New York convention of 1788, Livingston had advocated ratification of the new federal constitution, but he later became an anti-Federalist and unsuccessfully opposed John Jay in the New York gubernatorial campaign of 1798. In 1801 Pres. Thomas Jefferson appointed him minister to France where in 1803, in association with James Monroe, he purchased from France the territory then known as Louisiana. (*See* LOUISIANA PURCHASE.) Long interested in steam navigation, he obtained from the state of New York in 1798 a monopoly of steam navigation on the waters of the state and assisted in the experiments of his brother-in-law, John Stevens. While in Paris he met Robert Fulton and with him in 1802 made successful trials of a paddle-wheel steamboat on the Seine river. In 1803 Livingston and Fulton received a renewal of the steamboat monopoly in New York. Their first successful steam vessel, which operated on the Hudson in 1807, was named after Livingston's home, "Clermont." Livingston died at Clermont, N.Y., on Feb. 26, 1813.

See M. L. Bonham, Jr., "Robert Livingston" in S. F. Bemis (ed.), *The American Secretaries of State and Their Diplomacy*, vol. i (1927). (R. B. Ms.)

LIVINGSTON, WILLIAM (1723–1790), U.S. political leader and first governor of the state of New Jersey, was born at Albany, N.Y., on Nov. 30, 1723. He was the son of Philip Livingston (1686–1749), and grandson of Robert Livingston (1654–1728), an important figure in the early history of New York state.

William Livingston graduated from Yale college in 1741, studied law in New York city, was admitted to the bar in 1748, and served in the New York legislature (1759–60). His chief political influence was exerted, however, through pamphlets and newspaper articles appearing in his short-lived *Independent Reflector* (1752–53) and in the "Watch Tower" section (1754–55) of the *New York Mercury*. Together with William Smith (1728–93), the New York historian, Livingston prepared a digest of the laws of New York for the period 1691–1756, published in two volumes (1752 and 1762).

Moving to Elizabeth, N.J., in 1772, he represented New Jersey in the first (1774) and second (1775–76) continental congresses, but left Philadelphia in June 1776 to take command of the New Jersey troops. He was chosen in 1778 to be the first governor of the state of New Jersey and was regularly re-elected until his death on July 25, 1790. Livingston was a delegate to the federal Constitutional Convention of 1787, where he supported the New Jersey or small state plan. The following year he led his state to an early ratification of the constitution. (AT. S.)

LIVINGSTONE, DAVID (1813–1873), was the greatest explorer-missionary in Africa of the 19th century. He was responsible not only for opening up the southern half of that continent but also for disclosing to the civilized world what he called "the running sore of Africa," the slave trade, as practised in the interior.

Born at Blantyre in Lanarkshire, Scot., on March 19, 1813, the second son of humble parents, Neil and Agnes Livingstone, he went to work in a cotton mill at the age of ten. Even at that early age his energy and powers of concentration showed themselves so that, largely self-taught, he was able, by the time he was 22, to study Greek, theology and medicine at college courses in Glasgow. As a result he took a medical degree in 1840, having been accepted earlier by the London Missionary society as a candidate for the mission field.

Posted by the society to their mission at Kuruman in southern

Africa, he landed in 1841 at Algoa bay. He at once showed the two qualities which made him the great traveler-missionary he soon became, the ability to cope with all the practical difficulties of journeys by ox-wagon, horse or on foot, and a quick understanding of and sympathy with the native African. He was in fact so competent in these things after his ten weeks' journey to his base that after a few weeks there he pushed on with his wagon for another 200 mi., farther than any missionaries had yet penetrated, to seek a place for a mission where none had been before. His next step was to go alone to establish it, so as to learn the native language and explore the possibility of training native teachers.

At this stage Livingstone was plainly the devoted missionary, dedicated to his task of spreading the gospel. He differed from his colleagues in desiring to push far afield instead of wishing to remain in some degree of comfort at Kuruman, and he was already very forceful in his attitude to the Boers whom he regarded as thwarting the work of the missionaries. In following out this independent policy he spent the next seven years building missions, learning the languages and becoming a master at all the skills required for life in such remote places. It was at one of his early mission stations that he was wounded by a lion; he recovered, but at the cost of losing most of the power in his left arm. While convalescing at Kuruman he courted and married Mary Moffat, daughter of the veteran missionary, a step which he admits he took partly in pursuance of his duty as a missionary, though in fact it was also a love match. In the course of his travels he made friends with several sportsmen-hunters, including William Oswell, whose character sorted well with his own and whose wealth was to be the means of a new phase in his missionary career.

Livingstone was intensely interested in what lay ahead of him in what he always called the "dark interior," and by questioning he learned of a mysterious Lake Ngami to the northwest and, more to his purpose, of the powerful and enlightened chief of the Makololo tribe, named Sebituane, still farther north, under whom he hoped to establish a mission station beyond the range of both the Boers and the militant tribe of the Matabele.

With both these objectives in their minds, Livingstone and Oswell made a journey in 1849 across the difficult tract of the Kalahari and reached Lake Ngami and the swamps of the great Okavango river. The presence of tsetse fly and the obstruction of a local chief prevented their going on to Makololo territory. The next year he tried again, taking his wife and small children with him, as he was afraid they might be molested by the Boers, but the party got malaria at Lake Ngami. The next year he was successful when, with his family and Oswell, he followed a new route and found Sebituane on the Chobe river. The friendship between these two remarkable men, the great missionary traveler and the strong and wise black dictator, is the best example of how thoroughly Livingstone understood the African, for though it lasted only three weeks before Sebituane died of pneumonia, yet it was to colour the next four years of his wanderings. It was there that Livingstone first came into direct contact with the slave trade and where he first formed the opinion that the only way to fight it was to undercut it as an industry by bringing trade from the coast by cheaper means. It was at this stage that his missionary fervour became diluted by the more practical need to combat the iniquities of slavery. He felt that he was the man to explore Africa for trade routes and that became his principal aim thereafter.

The decision meant that his duty as a husband and father must take second place to his duty as a reformer and explorer, and reluctantly he decided to send his wife and family home to England and continue alone with his efforts to undercut slavery. Much criticism has been leveled at him for this action but never then or later did he allow his marriage to come before his avowed dedication to his mission and exploration. He returned alone in 1853 to Sesheke, the headquarters on the Zambezi of Sebituane's successor, his nephew Sekeletu, a weaker chief but one who befriended him and helped him to carry out his journeys.

In Nov. 1853 he started on his famous journey through unknown country to the west coast of Africa with 27 men lent by Sekeletu. He still hoped to find a site farther up the Zambezi healthy enough for a mission station but without success, and he himself began to have severe bouts of fever—no fewer than 27 before he reached the coast, after six months of hardship and danger from hostile tribes. He kept a very full diary and his surveying produced a map which for parts of the route was the only trustworthy one until well into the 20th century.

There is nothing that shows the character of this remarkable man so well as his decision on arriving at Loanda. Reaching his goal as a very sick man, broken in health though triumphant in success, he was at once invited by the captains of ships, including three British men-of-war, to take passage back to England, to health, to his family, to honours. It hardly occurred to him to accept, even when closely pressed. He had brought his men to a place whence they could not return by themselves, therefore he must take them back again. What seemed to him common humanity showed to the world as a degree of Christianity and a deep sense of brotherhood with the African which has rarely been equaled. He took his party on the even longer and more perilous journey back to Sesheke and was surprised to find his return welcomed almost as a miracle. For himself there was the disappointment that the route he had followed would not serve his great purpose of trade to undercut slavery: he now had to find a route to the east coast of the continent.

Sekeletu gladly furnished him with the means of following down the Zambezi to the sea, supplying over 100 of his tribesmen, and he started eastward in Nov. 1855. Only 50 mi. on his journey he discovered the great falls (Victoria falls), of which he had heard, and took this wonder feature of Africa as a disappointment rather than as a reward of exploration, since it was a barrier to the navigation he hoped to find practicable down the river. Half of the journey was through quiet unknown country, but by comparison with the Loanda route it was straightforward, and on arrival at the coast he was given hospitality by the Portuguese, before finding a ship to take him to England, leaving his Makololo in apparently good hands until he could return to lead them back again. In England he was received with honours and acclaim, forced into a limelight which he disliked and obliged to give lectures, which was a burden to him for he had always been a poor speaker. During the year of his stay in England he wrote his book, *Missionary Travels,* one of the classics of explorer narratives, not without literary merit.

Before leaving Africa he had received a letter from the directors of the London Missionary society which in polite language made it clear that they did not approve of the apparent diversion of his efforts from settled missions to exploration. It was a great shock to him, since he felt himself just as sincere a missionary as ever, but he accepted a severance from the society after 16 years of service.

His fame was to be the undoing of his plans. He had purposed to go back, alone, to take his Makololo back to their tribe, hoping to do it by water up the Zambezi and complete a survey for a trade route. Instead he found himself appointed as a peripatetic consul to the Zambezi region and in command of an official expedition under the aegis of the foreign office. He was given carte blanche for the arrangements and to a less extent for the selection of the personnel, and this exposed a weakness which neither he nor anyone else had ever expected. He had proved himself a master at commanding and organizing Africans, never suspecting that he could prove a failure at managing white colleagues and a large expedition. His greatest mistake was in taking his younger brother Charles, whose temperament was entirely unsuited to an expedition, as, in lieu of any other office, "moral agent."

Sailing from England in March 1858 there began an expedition which lasted for six years of disharmony and frustration, though, strangely enough, it had far more important consequences than his former explorations. He found that there were myriad obstacles to the navigation of the Zambezi, but, to balance that, he discovered Lake Nyasa and a feasible route to the interior. He took many of his Makololo back to their tribe as he had promised and came back, largely by canoe, down parts of the great river. He explored more of Portuguese East Africa than any one had thought possible, yet in doing so he opened a way for the slave trade. He

saw the commencement of the Universities mission to Nyasaland only to witness disaster and retreat come upon it. Only one of his team, John Kirk, came out of the venture with full credit, second only to his leader in fortitude and singleness of purpose.

Livingstone's own exertions were as incredible as ever but marred by his inability to command, and his persistence in clinging to the cause of most of the bickering, his own brother. A crowning sorrow to him was the loss of his wife who had, at his instance, come to join him and died of fever on the banks of the lower Zambezi. When he was recalled by the foreign office in 1864 he was a disappointed man and his narrative, written in collaboration with his brother, is a poor record of the failures intermingled with successes.

After a comparatively quiet year in England writing his book, Livingstone was persuaded without difficulty by his influential friend, Sir Roderick Murchison, to go back to Africa with the dual purpose of finding out more about the slave traffic in the interior and discovering the sources of the great rivers Zambezi, Congo and Nile. This time he was once more to be the only white man, commanding a curious mixture of Indians, mission boys and local carriers, 60 in number, together with animal transport. They landed at the mouth of the Rovuma river in April 1866 intending to pass round Lake Nyasa far from the influence of the Portuguese, with whom he was no longer *persona grata*. But the skill of the master traveler had gone and in five months he had lost by desertion or treachery all but 11 of his men.

Once past Lake Nyasa he was in unknown territory and back to his old practice of observing everything, mapping and even taking daily records of rainfall, temperature and barometric pressure, a model of scientific exploration. He was often a prey to his old enemy, dysentery, and for the second time in his life, lost his chest of medicine, again by robbery. His situation was now desperate. Reduced to a party of nine men he could not turn back and he was forced to seek help from the Arab traders, who were kind to him mainly because they dared not let him return to the coast to tell the tale of their misdeeds. So for the next four years there was the strange paradox of the great opponent of the slave trade associating with those who lived by it, and being dependent on them. During that period he discovered the southern end of Lake Tanganyika, and Lakes Mweru and Bangweulu.

The ardent missionary in him was still there but was being turned by circumstance into a great geographer and explorer. He knew he was in the region where the Congo and the Nile must have their sources and was determined to settle that problem. In 1869 he reached Ujiji, the headquarters of the trade in ivory and slaves, but as a desperately ill man, and only to find the stores which had been sent from the coast plundered and dispersed. It is doubtful whether the Arabs would have allowed him to go down to Zanzibar even if it had occurred to him. Instead, he spent the next two years striving to explore the upper Congo which he hoped might turn out to be the Nile, and there he witnessed a wholesale massacre by the slave traders which finally turned him from further association with them. He struggled back to Ujiji at the risk of his life, a broken and disappointed man.

Help then arrived in the form of the journalist-traveler, Henry Morton Stanley (*q.v.*), sent out by his American newspaper with the bare instruction of "Find Livingstone." Together they discovered that Lake Tanganyika could not be part of the Nile system, but Stanley could not persuade Livingstone to return with him to the coast. He had become strangely dedicated to the task of finding the source of the Nile, the geographer in him was now pre-eminent. In Aug. 1872 he received reinforcements of stores and men sent back to him by the loyal Stanley and he started on his last journey with the best party he had ever had, proposing to go to the south of Lake Bangweulu to find the source of the Nile or the Congo, he was never sure which it would be.

He took the difficult route down the east side of Lake Tanganyika so as to complete his survey and found himself entangled in the swampy region of Lake Bangweulu in the middle of the rainy season. For once his magnificent navigation was at fault, because of an accident to his sextant, and for a while he was lost. His attacks of dysentery were now almost continuous, but impatient to finish he started across the great swamps and reached the southern side a dying man, though continuing his mapping to within a day of his death, at a tiny village called Chitambo's in the district of Ilala.

The epic story of how his men embalmed his body and took it with his papers back to Zanzibar is perhaps the finest epitome of his life; he had become the "beloved master" of thousands of Africans and the remnant of these dared all risks to take him back to his own countrymen.

In the history of exploration there are other instances of lone travelers sojourning for years in far countries, but none is so well documented by the writings of the man himself. A poor speaker but a forceful writer with a delightful, if sardonic, humour, he lives now largely through his letters. Like many other great men he had the faults of his virtues. His failure as a leader of white men is an instance; for as his grandson, Hubert Wilson, has said, "He could only see black and white, he had no notion of grey." As a traveler and an observer he was supreme, but his fame really rests on his dedication to the welfare of the African, diverted by the slave trade from straightforward teaching of the gospel to other means of saving the people he had looked upon as brothers from his very first acquaintance with them.

See also references under "Livingstone, David" in the Index.

BIBLIOGRAPHY.—Besides Livingstone's own narratives, *see* W. G. Blaikie, *Personal Life of Livingstone* (1917); H. M. Stanley, *How I Found Livingstone* (1872); F. Debenham, *The Way to Ilala* (1955); G. Seaver, *David Livingstone: His Life and Letters* (1957). (F. De.)

LIVINGSTONE, a town of Northern Rhodesia, Africa, and the southern port of entry into the country, lies 2,977 ft. above sea level near the Southern Rhodesia border. Pop. (1956) 29,362. Named after the missionary explorer, David Livingstone, the town is a tourist and conference centre. The Victoria falls, the Zambezi river, the Wankie and Kafue National parks and the Kariba dam headwaters are within reach. There is a 673-ac. game park along the Zambezi. The Rhodes-Livingstone museum dominates Mainway and has a unique collection of ethnological, archaeological and historical exhibits, particularly those relating to Livingstone. Old Government house, now a national monument, contains the Southern provincial commissioner's offices. Barotse centre is the town park and there are sporting facilities on the Zambezi river. There are all grades of schools, European and African hospitals and places of worship for all denominations. The town is on the main railway system of southern Africa, has good road connections and an international airport 4 mi. N.W. Livingstone is a distributing centre for agricultural products and timber and its secondary industries include the Zambezi sawmills, blanket weaving and the making of furniture and steel river barges. The first settlement was at the Old Drift ferry station, upriver on the Zambezi in the 1890s and the town was established on its present site in 1905 with the completion of the Falls bridge and the new railway line. It became the capital of Northern Rhodesia in 1907 and remained so until 1935 when the capital was moved to Lusaka. It became the country's first municipality in 1927. (M. J. M.)

LIVIUS ANDRONICUS, LUCIUS (*c.* 284–*c.* 204 B.C.), the founder of Roman epic poetry and drama. His name shows that he was Greek and manumitted by a member of the Livian family; he may have been captured as a boy when Tarentum surrendered. He earned his living in Rome as a teacher of Greek and Latin, and it is probable that his main work, the *Odusia*, a translation of Homer's *Odyssey*, was intended as a schoolbook: Horace still read it at school. It was written in the rude Saturnian verse (a few hexametrical fragments belong to a later reworking in that metre) and, to judge from less than 50 surviving lines and the comments of Cicero and Horace, had little poetic merit. But it was both the first major poem in Latin and the first example of artistic translation, and the subject matter was happily chosen for the purpose of introducing Roman youth to the Greek world.

In 240 B.C. Andronicus produced at the *ludi Romani* a translation of a Greek play, probably a tragedy, and perhaps also a comedy. After this, the first dramatic performance ever given in Rome, he continued to write and stage both tragedies and comedies, from 235 onward in rivalry with Naevius. Only three titles

of his comedies are known, each represented by one fragment. The titles of his tragedies (*Achilles, Aegisthus, Aiax, Andromeda, Danae, Equos Troianus, Hermiona, Ino, Tereus*) show that he translated mainly the three great tragedians, Aeschylus, Sophocles and Euripides. Fewer than 40 lines have survived. The skilful adaptation of the Greek iambic and trochee metres, long considered his personal achievement, is rather the result of popular borrowing before his time.

Livius is reported to have taken part in his plays and, when his voice failed, to have had the arias sung by a boy behind the stage, while he himself acted a dumb show. In 207, to ward off menacing omens, he was commissioned to compose an intercessory hymn to Aventine Juno, to be sung by a procession of 27 maidens. It is related that, as a reward to him for the success of this intervention, the guild of poets and actors was granted a place of meeting in the temple of Minerva on the Aventine.

BIBLIOGRAPHY.—Fragments in the Teubner series, *Fragmenta poetarum Latinorum*, ed. by W. Morel (1927) and *Scaenicae Romanorum poesis fragmenta*, ed. by O. Ribbeck, vol. 1, 2 (1897); and with English translation in the Loeb series, *Remains of Old Latin*, ed. by E. H. Warmington, vol. 2 (1936). *See* also Schanz-Hosius, *Geschichte der römischen Literatur*, vol. 1 (1927). (OT. S.)

LIVONIA, the Latinized form of LIVLAND, the name given by the Germans in the 12th century to the lands on the eastern coast of the Baltic north of Lithuania, as the first people encountered by them there were the Livs, a Finno-Ugrian race (*cf.* the ancient form Liflandi, found in a runic inscription of *c.* A.D. 1030). In its most extended sense, the name was understood to cover practically all of Latvia and Estonia (*qq.v.*), the conquest and Christianization of which was begun by the Order of the Brothers of the Sword, founded in 1202. This order in 1237 became the Livonian branch of the Teutonic Order (*q.v.*), which continued its wars of crusading and colonization not only against the local pagans but also in rivalry with their Lithuanian and Russian neighbours. The conquered territory was divided between ecclesiastical states (bishoprics, under the archbishopric of Riga), lands ruled directly by the Order, and free towns.

This greater Livonia was dismembered in the course of the Livonian Wars (1558–83), which the Russian tsar Ivan IV the Terrible undertook to prevent Sigismund II Augustus of Poland-Lithuania from bringing the whole area into his sphere of influence. To save themselves from the Russians the Germans under the treaty of Wilno (Vilnius) of 1561, ratified in 1562, agreed that the region north of the Daugava river, including eventually Riga, should be incorporated with Poland, while Courland (*q.v.*) became a secular and hereditary duchy to be held as a Polish fief. The Swedes meanwhile took advantage of the situation to seize northern Estonia (also in 1561). These dispositions were maintained when Ivan came provisionally to terms with the Poles (1582) and with the Swedes (1583).

In 1621 the Swedes took Riga and Jelgava (Mitau), the capital of Courland. A Polish-Swedish war over Livonia followed. By the truce of Altmark (1629), not only all Estonia but also the greater part of the Latvian country to the south, namely the Lutheran area called Vidzeme in Latvian, were assigned to Sweden; but the Catholic southeast of Livonia, namely Latgale, remained with Poland, with the name Inflanty Polskie (Polish Livland).

In 1654 Livonia became the theatre of a triangular Russo-Polish, Polish-Swedish and Russo-Swedish war. The Polish-Swedish war ended with the treaty of Oliva (May 3, 1660), whereby Poland finally recognized Sweden's sovereignty over the territory ceded at the truce of Altmark, with Riga. By the Russo-Swedish treaty of Kardis (1661), Russia renounced all claim to Livonia. The Russo-Polish war ended in 1667 by the peace of Andruszow (Andrusovo).

In the great Northern War (*q.v.*) Peter the Great won the whole of Swedish Livonia for Russia, his possession of it being confirmed by the treaty of Nystad (1721). Latgale was annexed to Russia at the first partition of Poland (1772), Courland at the third (1795). Under the Russian regime the historic Livonia was divided into three "governments": the Estonian (*i.e.*, the northern part of ethnic Estonia), the Livonian (*i.e.*, the southern part of ethnic Estonia and northern Latvia) and the Courland. When after the Russian revolution of Nov. 1917 Estonia and Latvia proclaimed their independence, their common frontier was drawn across the Livonian "government," according to the ethnic boundary.

The name Livonia is sometimes used in a limited sense as the equivalent of Vidzeme, one of three historic constituents of Latvia.

LIVONIAN SWITZERLAND, a hilly district of great scenic attraction in the eastern part of the Latvian Soviet Socialist Republic, U.S.S.R., frequented both in summer and winter by tourists. The name "Switzerland" is applied in particular to the district of the upper Gauja valley, where the river cuts into the surrounding Vidzeme upland, the highest area in Latvia. Nowhere is the upland more than 1,040 ft. above sea level, but the morainic hills are sharply dissected and steep wooded slopes are characteristic. Popular summer resorts include the towns of Sigulda (Segewold), Ligatne (Ligat) and Cesis (Wenden).

(J. P. Co.)

LIVY (TITUS LIVIUS) (*c.* 59 B.C.–A.D. 17), most famous of Roman historians, was born at Patavium (Padua), Italy. Considering how celebrated he was in his day, remarkably little is known about his life. Even the date of his birth is not certain, since Jerome, in his history dealing with the year 59 B.C., links it with that of Messalla Corvinus, who was in fact born in 64 B.C. According to Quintilian, Livy had a son, who may have been the geographer cited by Pliny, and Seneca states that he had a daughter, who married a rhetorician L. Magius. If the T. Livius of a Paduan inscription of this period is the historian, he had two sons. He soon made his mark in literary circles at Rome, and it is known that Augustus was interested in his work, certainly in the early part of it. It may be assumed that he remained in favour despite his praise of Pompey and his doubts concerning Caesar, quoted respectively by Tacitus and Seneca, for he was able to encourage the later emperor Claudius in his youthful historical studies. Livy's fame throughout the empire is illustrated by the story of the man from Gades in Spain, who journeyed to Rome solely to see him. He presumably traveled; yet most of his time must have been spent at his desk in Rome or Padua. His work brought glory to Padua as can be judged from Martial's words *Censetur Apona Livio suo tellus* ("The Aponian land is celebrated for its son Livy"). His portrait may survive in a 3rd-century mosaic at Trier, Ger.

There is evidence for Livy's studies in rhetoric, and it is relevant to his historical methods. As a rhetorician he stood in the tradition of Cicero. "Read Demosthenes and Cicero," he wrote in a letter to his son, "then others as each is most like to Demosthenes and Cicero." He opposed Sallust and those who attempted a severe style by writing obscurely—*orationis obscuritatem severitatem putant*—and he condemned *verba antiqua et sordida* ("archaic and vulgar words"). Quintilian makes it clear that in the literary controversies of his day he carried on the campaign which Cicero had waged for a pure Latinity, without archaism or vulgarity. His position is not affected by Asinius Pollio's charge of *Patavinitas* which suggests a certain "provincialism" (*rusticitas*) by the standards of the Roman capital (*urbanitas*). In a literary sense the charge—for what it is worth—reflects upon his actual writing, not upon his theoretical views; but Pollio may have directed it originally against what he regarded as Livy's naïve treatment of Roman history. According to Seneca, Livy extended his interests to the composition of philosophical dialogues, including dialogues that were historical in character. Here again the influence of Cicero may be seen, particularly of his *De republica*. But Livy's great achievement lay in the application of his historical feeling and literary art to the writing of a full-dress history of Rome.

THE HISTORY OF ROME

Subject.—Livy's *History of Rome* (*Ab urbe condita libri*) was in 142 books and covered Roman history from the arrival of Aeneas in Italy to the death of Drusus, brother of the emperor Tiberius, in 9 B.C. After a formal preface, book i treated the origins of Rome and the regal period; books ii–v, the history of the republic to the sack of Rome by the Gauls (390 B.C.); books

vi–xv, the conquest of Italy; books xvi–xx, the First Punic War; books xxi–xxx, the Second Punic War; books xxxi–xl, the conquest of the east to the death of Philip V of Macedonia; books xli–xlv, the Third Macedonian War. So far Livy had composed his work in groups of five or ten books, and in a preface to book xxxi he refers to the two previous groups of 15 books; later the subject matter makes this arrangement impossible. Livy treated the Third Punic War and destruction of Corinth (146 B.C.) in books xlix–lii; the Gracchan period in books lviii–lxi; Marcus Livius Drusus and the Social War, with events to the death of Marius, in books lxxi–lxxx; and reached the death of Sulla in book xc. After the rise of Pompey and Crassus, Caesar's consulship and the first triumvirate are dealt with in book ciii. Books cix–cxvi on the civil war constituted a group that was called *Belli civilis libri* i–viii, closing with the assassination of Caesar (44 B.C.). Books cxviii–cxxxiii continued the work to Actium, and books cxxxiv–cxlii carried the history of Augustus' reign to the death of Nero Claudius Drusus (9 B.C.). The division of the whole work into decades is not attested before the 5th century A.D., although it may have been done by the book publishers of the 4th century.

There are some indications of the dating of publication. When Livy in the preface charges Rome with enduring neither vices nor their remedies, this may reflect the situation following Augustus' attempt at moral reform in 28 B.C. In i, 19, 3 he refers to the closing of the temple of Janus in 29 B.C. but not to its next closing in 25 B.C., and uses the name Augustus, which was conferred on Octavian in Jan. 27 B.C. The beginning of publication may therefore be dated in 27–26 B.C. Livy's silence at ix, 18, 9 about any return of Roman standards by the Parthians indicates that book ix appeared before 20 B.C. On the other hand, if xxviii. 12, 12 presupposes Agrippa's Spanish campaign, it cannot be dated earlier than 19 B.C. Book lix mentions Augustus' recital in 18 B.C. of Metellus' famous speech on marriage. If book cxxi appeared after Augustus' death, this leaves Livy publishing the large number of 21 books between A.D. 14 and 17; but he may have been ahead with his writing. In any event it may be supposed that he died with pen in hand.

Of Livy's immense work only 35 books survive: books i–x, xxi–xlv (some lacunae in xli–xlv); with a long fragment from book xci (in a Vatican palimpsest). Some quotations were given by later authors, notably two passages about Cicero quoted in Seneca's *Suasoriae*. For the rest information can be derived only from material already reduced to epitome scale. An epitome of Livy had already appeared in the 1st century A.D. of which Martial wrote *pellibus exiguis artatur Livius ingens* ("in tight skins huge Livy is constricted"). It has perished, and the lost books (excepting cxxxvi–cxxxvii) are now represented only by the *Periochae*, or summaries of contents (probably of the 4th century); the Oxyrhynchus papyrus epitome of books xxxvii–xl, xliii–lv (written *c.* A.D. 300) may be noted. The *Prodigiorum Liber* of Julius Obsequens preserves a list of prodigies from the years 190–12 B.C., and the *Chronica* of Cassiodorus a list of republican consuls. Some information can also be verified from such writers as Orosius, Florus, Eutropius and Rufius Festus.

Sources and Composition.—In studying the history of Livy it is necessary to refer again to Cicero, whose work gave guidance to Livy in the theory and practice of historical composition. Both men believed that history as *magistra vitae* ("guide to life") had a moral purpose, which could only be achieved by rhetorical presentation: *opus unum hoc oratorium maxime*. The first law of history was to tell the truth, and the whole truth; but this established merely the *fundamenta*. One must build up the historical narrative (*exaedificatio*), wrote Cicero, and embellish it in literary style (*exornatio*), so that history should take on a form befitting its dignity; previous writers had been no more than chroniclers. In Cicero's view Rome lacked a history worthy of its greatness: *abest enim historia litteris nostris* he said in the *De legibus*. Such was the challenge and Livy took it up.

Yet Livy was also the heir of the Roman annalistic tradition, which, if it is judged by broader principles than those of Cicero's rhetoric, had already developed a powerful and impressive character. At the outset Roman folklore and Greek mythography combined to enlarge upon the foundation legends of Rome. Naevius and Ennius gave the traditions a strong epic flavour, and Ennius, working through the annalists, influenced the first books of Livy. The senatorial historians from Fabius Pictor to Acilius also provided material about early Rome and, again, about their own period; and Fabius and Acilius were used by later annalists, thus in their turn reaching Livy. After Cato the antiquarian history of Calpurnius Piso gained special authority. In the Gracchan period two important developments occurred: first, the *Annales Maximi* made more archival material available under a yearly or annalistic arrangement that preserved its official appearance; secondly, the adoption of rhetorical methods of composition allowed the annalists to elaborate this material within its ceremonial framework. By the time of Sulla the annalists had established their genre of Roman historiography as it is found in Livy—traditional in content, form and expression, yet contemporary in its appeal. Claudius Quadrigarius may be noted in archaic style and Valerius Antias with conscious rhetoric, followed by Licinius Macer and Aelius Tubero, who submitted the traditions to fresh treatment.

Among these annalists Livy found his historical material already arranged in a form which provided both a chronological order and a traditional setting. In books i–iv he used Valerius Antias, Licinius Macer and Aelius Tubero, and in book v also included Claudius Quadrigarius, who had begun his history with the Gallic sack of Rome. He continued with these sources in books vi–x and (presumably) in the lost second decade. The Second Punic War allowed wider scope. In books xxi–xxx Livy kept Valerius Antias and Claudius Quadrigarius, dropping Macer and Tubero, and added fully descriptive material from Coelius Antipater's historical monograph on the war and from Polybius' "universal history" of the period 220–146 B.C. In books xxxi–xlv he used Valerius Antias and Claudius Quadrigarius, supplemented elaborately for events in the east from Polybius. He continued to the Sullan period with Antias and Claudius Quadrigarius, adding other sources, *e.g.*, possibly Poseidonius, who cannot be identified from the *Periochae;* and later he may have used, among others, Sulpicius Galba, Sisenna and Caesar. Livy does not seem to have used the older annalists directly, and his references to Fabius Pictor, Cato and Calpurnius Piso, as well as to Silenus on Hannibal, were most probably at second hand. At special points, *e.g.*, on the trial and death of Scipio Africanus, he might consult other authorities; but this is a rare occurrence in the extant books.

Method.—Livy did not claim to have studied his sources thoroughly. He recognizes the legendary character of the earliest stories and expresses doubts about the traditions before 390 B.C.: "I should be satisfied to take as true what appears to be true" he writes. In some passages he may prefer the oldest historian, *e.g.*, Fabius Pictor; in others the most authoritative, *e.g.*, Polybius; and he cites Valerius Antias' casualty figures skeptically throughout; sometimes he may even reject all the authorities. Yet for the most part he either judges on superficial grounds of probability in each instance or refrains from judgment entirely; for his comparison of variant details at the end of each section is conventional. In fact, despite his show of criticism, his method is basically uncritical. He did not inspect official documents; nor did he examine the inscription on the breastplate of A. Cornelius Cossus when Augustus raised the question of Cossus' *spolia opima* (spoils offered by a general who had killed an enemy leader in single combat), or the *libri lintei* (ancient records written on linen) when Macer and Tubero cited them differently. The set form of his annalistic sources enabled him to compose his work by the simple expedient of switching from one to another, as each offered the most immediately attractive material, and he incorporated episodes from other authors directly into his annalistic framework. He rendered all this subject matter, normally from one source at a time, without reconciling it with his previous narrative. As a result his history is disfigured everywhere by a multitude of inconsistencies, which fall in a pattern of change between sources from section to section.

The chief examples of this method must suffice. In dating events by years *ab urbe condita* Livy gives three systems; even in dating by consuls his use of different annalists, especially

Licinius Macer, has involved him in confusion. His description of the Roman disaster at the Caudine Forks (321 B.C.) represents the most tendentious tradition and is insufficiently corrected by his notes of variants. At the opening of the Second Punic War, as he admits, he is unable to clarify his chronology; and in following Coelius for Hannibal's crossing of the Alps—in agreement with Polybius, since both Coelius and Polybius drew upon Silenus—he inserts a passage in book xxi from another source which temporarily makes nonsense of the itinerary. In recording Spanish events in books xxxi-xlv he regularly refers to the governors—they were praetors with proconsular command—as both praetor (or propraetor) and proconsul, because the annalists differed in their titulature. When he incorporates Polybius on the Roman campaigns in the east, which Polybius reported under Olympiad years (autumn to autumn), he sets these sections under the Roman year (spring to spring) without any adjustment, and it is only the fact that very little happened during the winter that eases chronological difficulties. As regards his notorious "doublets," or repetition of reports of the same event, these arise from the mechanical combination of his sources, where he moves from one to another without noticing the order in which they have arranged the respective parts of their narrative.

In writing up his subject matter Livy followed the rhetorical principles which Cicero had laid down in the *De oratore* for the composition of full-dress history. The historian must define the time and place of the action, show how it was conceived and executed, and explain its results, with attention to the character of the men in command. This kind of narration will be clear, since it is systematic, and—being circumstantial—it will produce a realistic impression in the mind of the reader. The effect may be increased by set descriptions of topography or battle scenes and the composition of speeches. In addition to this technique, as Cicero mentions in writing to Lucceius, there was a "tragical" style of writing, in which the historian developed episodes as dramatic scenes, with vivid affecting detail, in order to inspire the reader, as if he were a spectator, with feelings of horror and pity. These methods had been practised in Hellenistic historiography, as is known from Polybius, who criticizes both the rhetorical procedure and Phylarchus' use of "tragical" effects. It is worth noting that one treatment does not necessarily exclude the other in a writer who is the master of his presentation. Livy began with the ceremonial appeal of the annalistic material to the Roman reader and elaborated his episodes in the rhetorical manner, heightened by dramatic touches, without ceasing to interpret the course of events in the light of his own conception of history.

The results of this treatment can be seen throughout Livy's narrative, but it may best be illustrated where he has rendered extant parts of Polybius. In describing the siege of Ambracia (xxxviii, 3–7; Polybius xxi, 25–28) Livy enlarges on the topographical setting; at Cynoscephalae (xxxiii, 5–11; Polybius xviii, 18–33) he stresses the influence of terrain and weather on the battle; at the conference of Nicaea between Philip V of Macedonia and Flamininus and his allies (xxxii, 32–37; Polybius xviii, 1–12) he describes the scene, with its lively incidents, before proceeding to a sober account of the negotiations. His feeling for a dramatic occasion is apparent where he shows Flamininus proclaiming "the freedom of Greece" (xxxiii, 32–33; Polybius xviii, 46), and his sense of dramatic irony, where he recounts how the Aetolians failed to realize that surrender *in fidem populi Romani* was unconditional surrender (xxxvi, 27–29; Polybius xx, 9–11). The literary conventions of the rhetorical method appear when he presents the appeal of Antiochus III the Great to Prusias of Bithynia (xxxvii, 25; Polybius xxxi, 11) in the fictitious form of a letter, which balances a letter from the Romans. Rhetorical argument, too, has its place. The Pergamene prince Attalus was in danger of being won over to Roman interests, and Stratius appeals to his loyalty (xlv, 19; Polybius xxx, 1–3) on grounds of honour and expediency: these are the rhetorical themes of *honestas* and *utilitas*, indicated by Polybius but more definitely formulated by Livy.

Such literary methods may be necessary, if only for the sake of the reader, but they should be based upon full knowledge of the evidence. The armchair writer, as Polybius points out, may sacrifice historical accuracy in elaborating material without knowledge of the local conditions. Livy is conscientious, systematic and vivid; but he may misrepresent the original account by trying to clarify it, especially where he is dealing with Hellenistic institutions or topography. It is bad to take an Aetolian meeting at Thermum for an Amphictyonic meeting at Thermopylae (Polybius xviii, 48, 5; Livy xxxiii, 35, 8); it is worse to turn a disorderly engagement at Cynoscephalae (Polybius xviii, 18–33) into a set battle piece (Livy xxxiii, 5–11); but what would Polybius have said of a historian who—misunderstanding his technical term for "laying" spears to the charge position—made the Macedonian phalanx "lay down" its spears because of their unwieldy length (*"longitudo impedimento erat"*) and fight with swords? However, this is an extreme example, and for the most part, and especially where he was dealing with more familiar Roman conditions, Livy faithfully passes on his subject matter little affected by the rendering into more readable Latin.

Style.—According to Cicero, again, in the *De oratore*, the style of historical writing should be comprehensive and smoothly flowing, that is, a periodic style; which would allow the historian to present a complex account with logic and force, relating its elements to one another syntactically so as to keep the main action moving forward. Livy followed this principle, so important for a long history. Quintilian praises him for elevated but natural writing, mentioning his "flowing style" (*lactea ubertas*) and "brilliant lucidity" (*clarissimus candor*), words which define the chief virtues of the periodic style. It should be noted that Livy wrote with force as well as fullness. He uses elaborate sentences to set out the circumstances and preparation of the main action, which he then describes in rapid, short sentences, adapting his composition to the rhythm of the events. Almost any page will provide illustrations; but his vigorous story about Hercules and Cacus (i, 7) in contrast to the leisurely account of Dionysius of Halicarnassus (*Roman Antiquities* 1, 39), who was in the same rhetorical tradition, may be particularly noted. Livy handles with equal facility the plain reporting of official matters, the vivid description of dramatic episodes, and the oratory of his speeches. Where he falls into difficulty through overconcentration in his sentences, this is usually due to the pressure of the forward movement of his narrative. Further, the freedom with which literary convention allowed a historian to draw upon all the resources of the Latin language for colour and warmth enabled him to present the "epic" story of early Rome in "poetical" style; this is seen in the story of Hercules and Cacus and in his rendering in book vii of Claudius Quadrigarius' account of the combat of Manlius Torquatus and a Gaul. He also developed ceremonial and ritualistic expression, in the annalistic tradition, for emotional appeal; *e.g.*, in describing in book vii the combat of Valerius Corvinus and a Gaul. That he would always raise his style in this way is proved by his impressive account of the siege of Abydos (xxxi, 17–18), based on the prosaic Polybius (xvi, 30–34).

Conclusion.—When Livy's work has been considered in terms of subject matter, historical setting and literary influences, there still remains the quality of his achievement, which transcends the technical and the contemporary. That he was uncritical by modern standards is undoubtedly true; yet he has passed on the traditions of Rome as they came to him, and uncritical transmission may be preferred to unsystematic rationalization. His material, then, is worth having, and where his work is lost the historian labours under a serious disadvantage. Even allowing for his idealization of the past, he preserves the standards of public conduct which had raised Rome to greatness and which Augustus, relying on Italian sentiment, hoped to recall. As the republic fell into civil strife, he could lift his history above the bitterness of party feuds—"Pompeian" though he was—to a level of national interest and present it in the light of Rome's destiny. Lacking cynicism, he wrote to inspire patriotism.

Yet Livy's history has more than a Roman appeal—or rather, where he is thinking of the men and events of Rome, he portrays Rome in the light of men and events, which he describes and in-

terprets in universal terms. It is no coincidence that he treats the Greeks struggling under the shadow of Rome as carefully as he treats the Romans. There is a quality of sympathy in his work that arises from his understanding of human nature, and—though he may fail in the finer distinctions—he succeeds in his main purpose, especially where he depicts not only individuals but groups acting under the stress of emotion. Herein lies the true greatness of Livy's history. His imagination fuses and fires his rhetorical technique and stylistic skill, giving spontaneity to his composition, so that he stirs the mind and moves the heart. The Romans of his day felt his power; Romans of the later empire looked to him to revivify their pagan traditions; and men of the Renaissance—such men as Petrarch and Machiavelli—took his instruction into their own experience. Since modern criticism has done its work on his subject matter, it is permissible to return to his historical conception and the artistry with which he has presented it.

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LI YUAN-HUNG (1864–1928), president of the Chinese republic, was born in the province of Hupeh, and educated at the Pei-yang naval college at Tientsin. He served in the navy during the war with Japan (1894–95) and later was in charge of fortifications at Nanking. He twice visited Japan to study its educational system and army organization. In 1911 he had risen to the rank of divisional commander in the army and was among the first military officials to realize the force of the revolutionary movement. In consequence he was empowered to negotiate peace at Shanghai, and upon the foundation of the republic became its first vice-president in 1912.

Upon the death of Yuan Shih-k'ai in June 1916 Li Yuan-hung succeeded as president and held office until the temporary restoration of the boy emperor in July 1917, when he resigned, remaining for the next five years in Tientsin. In 1922 he was prevailed upon to resume the presidency, but in September of the following year he was compelled to resign in favour of Tsao Kun. Li Yuan-hung at an early date opposed "Tuchunism"; *i.e.,* the system of military governorships, and advocated divesting the tuchuns of administrative duties; he worked for the reunification of the country by negotiation instead of by force but was unsuccessful. He died in retirement at Tientsin on June 5, 1928.

LIZARD, common name for scaly-skinned reptiles of the suborder Lacertilia or Sauria, who, with their close relatives the snakes (suborder Ophidia or Serpentes), constitute the dominant reptiles of the present day, the order Squamata. A relatively modern and still expanding group, the Squamata probably originated in Triassic times (extending from 200,000,000 to 160,000,000 years ago) from a group of extinct forms, the Eosuchia, that had earlier given rise to another stock, of which there is a single surviving species, the tuatara (*q.v.*). Both the lizard and the snake differ from the tuatara and from crocodilians in many anatomical features, of which the most significant, as an indicator of relationship, is the presence of not more than one bony arch across the temple, instead of two. Lizards are usually distinguishable from snakes by the presence of limbs but some lack limbs, and no single character distinguishes the two groups absolutely.

Distribution.—Like all the other cold-blooded (more accurately, poikilothermic) animals whose body temperature fluctuates and is determined by that of their environment, the lizards flourish most abundantly in tropical and subtropical regions, the numbers of individuals and species diminishing toward the northern and southern borders of the temperate zones; only a few species penetrate to the Arctic circle or slightly beyond it, the limit being set by the presence of permanently frozen subsoil, which prevents hibernation out of reach of frost. Like all reptiles, lizards have no physiological means of controlling their body temperature, which consequently varies with that of their surroundings. They habitually bask in the sun, for, until their temperature is raised to a certain level, they cannot achieve their full activity.

None of the present-day lizards is thoroughly aquatic (some extinct forms were), and none is an efficient flier; but lizards are adapted to almost every other environment and mode of life, showing a correspondingly great diversity of size, shape and structure.

Structure.—As in almost all reptiles the skin has a protective layer of keratinous scales that is periodically renewed from beneath, the old layer being sloughed away. The shape and size of the scales vary in the different families and with the mode of life. In many active forms maximum flexibility of the skin is achieved by reduction of the scales to small, nonoverlapping granules; among desert dwellers there is a tendency for some scales, particularly those on the head and tail, to be enlarged to form spines; burrowing and secretive forms have a slippery body surface due to the presence of smooth, highly polished overlapping scales. The skin is often reinforced by bony plates, which lie beneath the superficial scales (though corresponding with them in size and shape); these plates may form a continuous protective armour. Other defensive, or sometimes offensive, devices associated with the skin and scales are the occasional development of horns or fringing folds that break up the animal's outline and colouring. The colour pattern may be fixed and concealing by camouflage or there may be a highly developed mechanism for rapid colour change. The mechanism for colour changes consists of numerous star-shaped cells (chromatophores) each containing granules of pigment or a highly refractive substance, guanine. The granules are capable of movement within the cell and the cells themselves are capable of limited movement toward or away from the surface of the skin. Movement of a cell toward the surface and dispersal of its granules displays its particular colour to the maximum. Changes may result from the direct stimulation of the chromatophores by light or heat but the cells are under the control of the central nervous system. In consequence stimuli received through any of the sense organs may induce reactions and these will not be automatic and stereotyped but modified by such factors as associated memories and the individual's physiological condition.

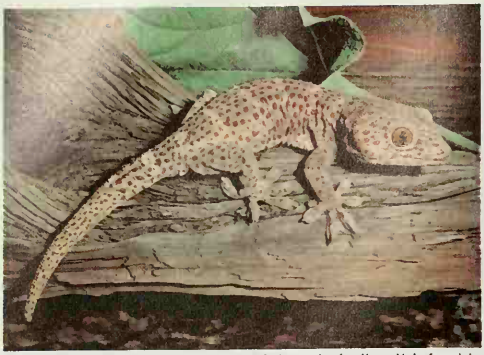
The sense organs exhibit some modifications found also in other vertebrate groups, but a few are peculiar to the lizards or shared only with the snakes. Replacement of movable eyelids by a fixed, transparent, protective covering of the cornea—a characteristic of snakes—is found also in many lizards, but in the latter group a peculiar condition is sometimes found in which eyelids are normally movable but a transparent window is developed in the lower one. The median (parietal or pineal) eye of primitive vertebrates persists in some lizards in a more complete form than in any other living reptiles except the tuatara. Lying beneath a transparent scale on the top of the head, it is an eyelike structure that may or may not have a nerve connection to the brain; it appears to control the animal's activities in relation to the intensity of solar radiation. Another sense organ modification shared with snakes concerns Jacobson's organ, which in other vertebrates is part of, and continuous with, the olfactory system and functions as part

HARDUN, OR STARRED LIZARD

Agama stellio, a north African agamid that prefers a climate of extremely high temperatures

PHOTOGRAPH, JOHN MARKHAM

LIZARD



Tokay (*Gekko gecko*), largest member of the gecko family. It is found in Indo-Malaya, usually in or near areas of human habitation

Australian bearded lizard or bearded dragon (*Amphibolurus barbatus*), an agamid, in an attitude of defense with its throat puffed out and its mouth open

Underside of a Moorish or wall gecko (*Tarentola mauritanica*) showing the pads on the feet, an adaptation that permits this lizard to climb any kind of surface. It is found chiefly in north Africa, Spain and Yugoslavia

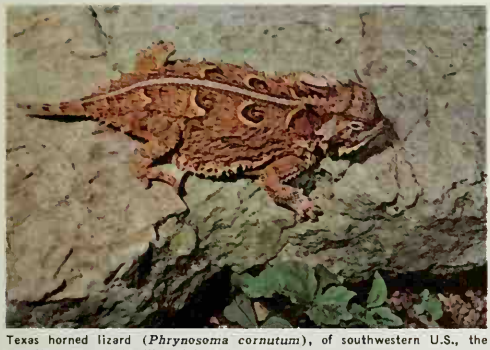
Meller's chameleon (*Chamaeleo melleri*), a large species found in Africa. True chameleons are found only in the eastern hemisphere

South African chameleon (*Chamaeleo pumila*), an arboreal species with a prehensile tail

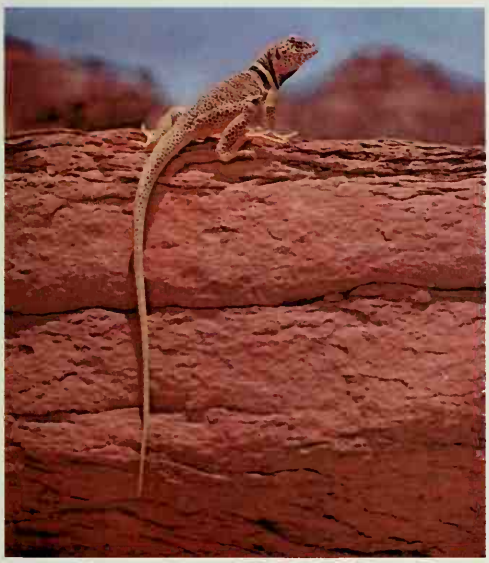
AGAMIDS, GECKOS AND TRUE CHAMELEONS

PHOTOGRAPHS, (TOP LEFT) JOHN H. GERARD, (TOP RIGHT) JOHN MARKHAM, (CENTRE LEFT) JOHN WARHAM, (BOTTOM LEFT) CY LA TOUR AND THE DETROIT ZOO, (BOTTOM RIGHT) EDWARD VAN BAERLE © ENCYCLOPÆDIA BRITANNICA

Southern prairie lizard (*Sceloporus undulatus consobrinus*), a spiny lizard of Texas and northern Mexico



Texas horned lizard (*Phrynosoma cornutum*), of southwestern U.S., the so-called "horned toad" sold in pet stores



Western collared lizard (*Crotaphytus collaris baileyi*), one of the lizards that runs on its two hind feet with its body upright. Found in western U.S.

Common or green iguana (*Iguana iguana*), which may grow to a length of more than six feet (including the tail). Found in tropical Central and South America

Close-up of the head of a male northern fence lizard (*Sceloporus undulatus hyacinthus*) showing the brilliant blue marking of the throat and side of belly. Ranges over east and south central U.S.

IGUANIDS

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT, BOTTOM RIGHT) JOHN H. GERARD, (TOP RIGHT, BOTTOM LEFT) WILLIS PETERSON

LIZARD

Brown colour phase of the green anole (*Anolis carolinensis*), also known as the American "chameleon." Ranges over southeastern U.S.

Cuban ground iguana (*Cyclura macleayi*), one of the most primitive types of iguanas. Found on a few islands of the West Indies and Caribbean area

Close-up of the head of an eastern collared lizard (*Crotaphytus collaris collaris*). Found in central southern U.S.

Marine iguana (*Amblyrhynchus cristatus venustissimus*) shown in its native habitat, the rocky shore of Hood Island, one of the Galapagos group

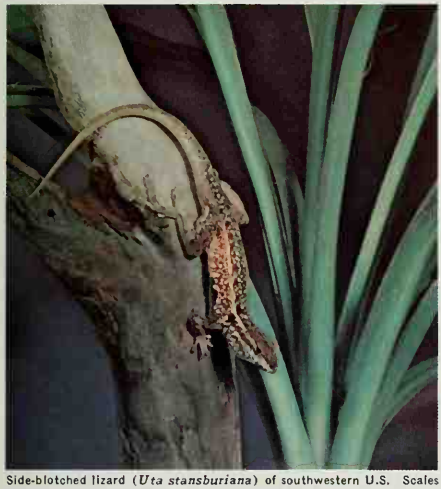
Desert iguana (*Dipsosaurus dorsalis*) of southwestern U.S., a herbivorous species. Like several other iguanids, this species employs bipedal locomotion

Rhinoceros iguana (*Cyclura cornuta*), one of the largest ground iguanas. The mottled appearance of this specimen is due to sloughing or shedding of the skin, a phenomenon usually associated with periods of growth in reptiles. Occurs on a few islands of the West Indies

IGUANIDS

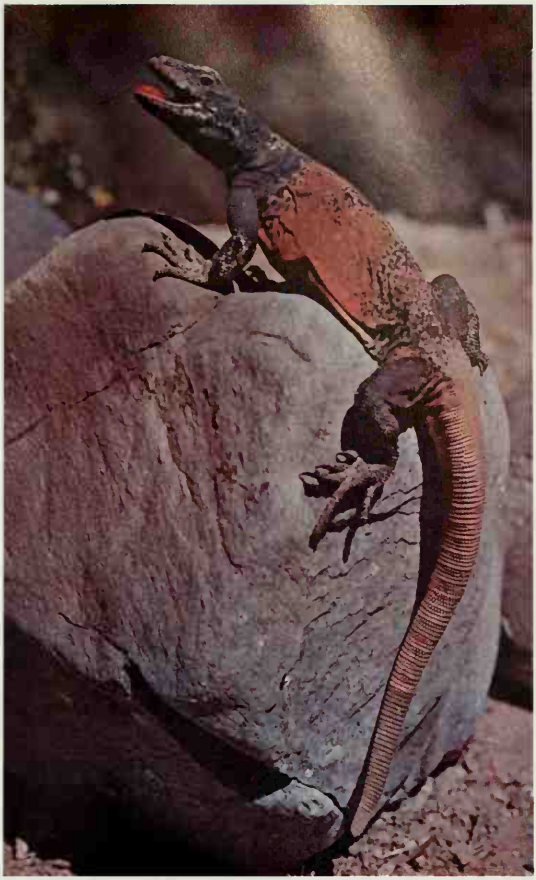
PHOTOGRAPHS, (TOP LEFT) AMERICAN MUSEUM OF NATURAL HISTORY, PHOTO BY R. G. ZWEIFEL, (TOP RIGHT) EDWARD VAN BAERLE © ENCYCLOPÆDIA BRITANNICA, (CENTRE LEFT) JOHN N. GERARD, (CENTRE RIGHT) I. EIBL EIBESFELDT, (BOTTOM LEFT) WILLIS PETERSON, (BOTTOM RIGHT) CY LA TOUR AND THE SAN DIEGO ZOO

Northern earless lizard (*Holbrookia maculata maculata*), a burrowing iguanid found from South Dakota to northern Texas

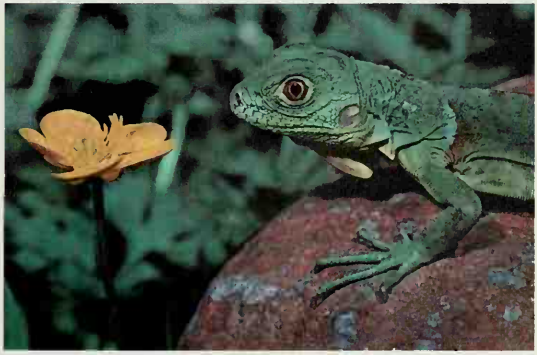


Side-blotched lizard (*Uta stansburiana*) of southwestern U.S. Scales in its tail, which catch into bark, adapt this iguanid for climbing trees, its usual habitat

Fringe-toed lizard (*Uma notata*), another burrowing iguanid found in the desert. When alarmed it buries itself completely in the sand



Chuckwalla (*Sauromalus obesus*), found in rocky, arid regions of southwestern U.S. and northern Mexico. When frightened the chuckwalla hides among the rocks where it inflates its lungs to wedge itself tightly within a crevice



Head of the common or green iguana (*Iguana iguana*) showing pattern of scales and detail of the sense organs and foreclaw

IGUANIDS

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT, BOTTOM RIGHT) JOHN H. GERARD, (TOP RIGHT, BOTTOM LEFT) WILLIS PETERSON

LIZARD

Blue-tongued skink (*Tiliqua scincoides*) of Australia, among the largest of the family, with a length up to about two feet

Western skink (*Eumeces skiltonianus*), which ranges from Canada to Baja California. The brilliant blue tail is common among young skinks of several genera

Trachysaurus rugosa, commonly known as the stump-tailed or shingle-back skink. The scales overlap like those of a pine cone. Australian

Broad-headed skink (*Eumeces laticeps*), an arboreal, woodland species found in most of the south central and southeastern U.S.

African skink (*Mabuya perrotetii*). Other *Mabuya* species are widely distributed in tropical regions of both hemispheres

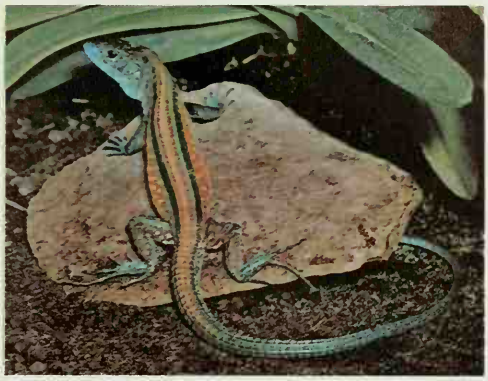
SKINKS

PHOTOGRAPHS, (TOP) EDWARD VAN BAERLE © ENCYCLOPÆDIA BRITANNICA, (LEFT) WILLIS PETERSON, (SECOND RIGHT) HANS ROSENBERG, (THIRD RIGHT) JOHN H. GERARD, (BOTTOM RIGHT) INSTITUT DES PARCS NATIONAUX DU CONGO ET DU RUANDA-URUNDI

Red worm lizard (*Amphisbaena alba*) of South America. Reaching a length of about 1½ ft., this lizard is only occasionally seen above ground

Scheltopusik or glass lizard (*Ophisaurus apodus*), largest of the snakelike anguid lizards, will grow to a length of almost four feet. Found in southeastern Europe and southwestern Asia

Six-lined race runner (*Cnemidophorus sexlineatus*), found in southeastern and south central U.S., is, like all race runners (or whiptails), noted for its speed



Cnemidophorus lemniscatus, the strand race runner, of South America, uses bipedal locomotion when running at top speed

Golden or northern tegu (*Tupinambis nigropunctatus*), one of the largest of the teiid family. Found in South America

WORMLIKE LIZARDS AND TEIIDS

PHOTOGRAPHS, (TOP LEFT) JOHN MARKHAM, (TOP RIGHT) © ROY PINNEY (CENTRE LEFT, BOTTOM) JOHN H. GERARD, (CENTRE RIGHT) HANS ROSENBERG

LIZARD

Gila monster (*Heloderma suspectum*), one of two venomous lizards known (the other is the beaded lizard). Found in the southwestern U.S. and Mexico

Head of a jeweled lacerta (*Lacerta lepida*), of the western Mediterranean area, largest member of a family found throughout Europe and Africa

Indian yellow monitor (*Varanus flavescens*). Monitors constitute a family of large, carnivorous lizards widely distributed in Africa, the middle east, southern Asia and Australia

African savanna monitor (*Varanus exanthematicus*). Strong limbs and large claws characterize this family of lizards

MONITORS, LACERTIDS AND THE GILA MONSTER

PHOTOGRAPHS, (TOP) EDWARD VAN BAERLE © ENCYCLOPÆDIA BRITANNICA, (CENTRE LEFT) CY LA TOUR AND THE BROOKFIELD ZOO, (CENTRE RIGHT) JOHN H. GERARD, (BOTTOM) JOHN MARKHAM

of the sense of taste. In the Squamata Jacobson's organ is completely separated from the other nasal structures and appears as two separate pouches opening on the roof of the mouth. Into these pouches the tips of the forked tongue are thrust after they have collected particles from external objects that are being investigated, or even from the air.

Natural History.—Although the majority of lizards are creepers, they exhibit many modifications for locomotion in different environments. In those that scamper over loose, shifting sand, the area of the feet is increased by the development of lateral fringes on the digits. In those that climb among rocks or in trees, the hands and feet may have scales beneath them, usually spiny, acting as additional "claws," or adhesive pads. Chameleons, which are mostly arboreal, have digits bound together into opposable bundles like tongs, and prehensile tails. The larger and more active terrestrial forms, such as the monitors, can run with the body held clear of the ground, and some iguanas and agamas, when alarmed, can rise and run on the hind limbs only. Reduction of digits and limbs in connection with burrowing habits or life among dense, tangled vegetation has occurred many times.

Other modifications associated with burrowing habits are elongation and slimming of the body, elimination of a distinct neck, reduction of eyes, reduction of the outer and middle ear and the development of a smaller but more compact and stronger skull. In the truly subterranean lizards the tail is short and blunt, but the trend of those living in dense herbage is in the opposite direction, the tail being sometimes more than four times as long as the head and body. Gliding flight has been achieved by a few oriental species constituting the genus *Draco*, the so-called flying dragons. As in the gliding mammals (flying squirrels and flying lemurs) the wings are extensions of the skin on the flanks, but in the lizards this patagium is supported by five or six enormously elongate ribs. Flipperlike limbs for swimming were possessed by the extinct marine mosasaurs but no modern lizards are aquatic to the same extent, though many live in close association with fresh water, and one (*Amblyrhynchus*) with the ocean. These semiaquatic lizards swim readily by means of their laterally compressed tails, whose area is increased by crests of enlarged bladelike scales. Many lizards can shed their tails as a defensive measure. If one of these animals is attacked, the tail may be broken off to the surprise and confusion of the assailant. The lizard suffers only a temporary loss, however, as a new tail regenerates from the stump (*see* REGENERATION).

The great majority of lizards are insectivorous, consequently there is relatively little diversification of the teeth, which are mostly simple and peglike. Even among the insectivorous forms, however, there may be some differentiation into incisors, canines and molars (though these are not homologous with the similarly named teeth of mammals) and the molars may be elaborated by the development of additional cusps even to the extent of being serrated. In some of the larger forms that tend to be omnivorous scavengers the teeth are enlarged and strengthened. In herbivorous forms, notably among the iguanas and agamas, the anterior teeth may be fused together to form a long, cutting edge for grazing. Two unusual specializations for the capture of prey are found, one being the remarkably extensible tongue of the chameleons and the other the venom apparatus of the Gila monster and the Mexican beaded lizard.

As in all reptiles, fertilization is internal and the developing embryo is provided with an amnion and allantois. Secondary sex characters associated with courtship are of widespread occurrence in the different families. Frequently the males are brilliantly coloured during the mating season and there is usually a simple display pattern by this sex. This may consist in no more than bobbing of the head, but there is often inflation of the body, and more particularly the throat, which may be equipped with a specially dilatable and brilliantly coloured dewlap. In many male lizards, hedonic glands, whose secretion may or may not serve as a sexual attractant, open by pores on the hind side of the thighs or in front of the anus or vent.

The majority of lizards are oviparous, laying eggs with a tough parchmentlike shell; these are usually buried in the ground and incubation is accomplished by the sun's heat. There are, however, many forms that retain their eggs in the oviducts, in some instances until the eggs are on the point of hatching. In these ovoviviparous forms the normal thick protective eggshell is reduced to a thin transparent membrane, which is ruptured by the young lizard at the moment the egg is laid. Rupture of the eggshell, whether there is external incubation or not, is facilitated by a special forwardly directed tooth on the middle of the upper jaw, the egg tooth, which is shed after it has served its purpose. In both the oviparous and ovoviviparous types the whole of the food material for the development of the embryo is provided by the egg yolk, but in some skinks, xantusiids and geckoes there is true viviparity of a simple type; the eggs contain much yolk but the embryo is supplied additionally through a primitive type of placenta.

Classification and Survey.—The number of species of lizards extant today is of the order of 2,500–3,000. They may be grouped into 18 families based on certain anatomical features.

Gekkonidae (*Geckoes*).—Most geckoes have a soft, granular skin often beset with tubercles, and the vast majority lack movable eyelids. The family has a world-wide tropical and subtropical distribution and shows considerable tolerance of climatic and environmental conditions. Unlike the majority of lizards, which are sun seekers, many geckoes are nocturnal, with contractile pupils, like a cat. Most species are climbers and have adhesive pads on the fingers and toes; one genus, the African *Lygodactylus*, also has a similar adhesive pad on the tip of the tail. The tail is extremely fragile in most geckoes and is also more variable in shape in this group than in any other family. Geckoes are often to be found in and about human dwellings; where sanitary arrangements are defective they may be carriers of pathogenic organisms such as *Salmonella*. (*See* GECKO.)

Pygopodidae.—This is a small assemblage of lizards, confined to Australia and New Guinea, that have some anatomical features in common with the geckoes, but that are all snakelike and without functional limbs. None has movable eyelids nor any external traces of forelimbs, though there are vestiges of a shoulder-girdle; hind limbs are present as small scaly flaps on each side of the vent. They are semiburrowers, to be found in grass, among tangled scrub herbage or in loose soil. In the grass-dwelling forms such as *Lialis* and *Pygopus* the tail is inordinately long, up to twice as long as the body, and fragile.

Iguanidae (*Iguanids*).—This ancient and generalized family is confined in modern times to the new world and Madagascar, with a single form (*Brachylophus*) in the Fiji and Tonga islands. Presumably the family at one time had a world-wide distribution; one fossil genus has been found in Europe. (*See* IGUANA.)

Agamidae (*Agamids*).—This family is the old-world analogue of the Iguanidae. The two groups are mutually exclusive in their territorial ranges, the agamids being confined to Europe, Africa, Asia and Australia. Each group has invaded the same kinds of environment within its own territory with many strikingly similar evolutions of form. The agamids are mostly insect eaters; they have the teeth differentiated into simple incisors, enlarged canines and laterally compressed more or less tricuspid molars. The scales are relatively small (though they may form spines), there are no enlarged plates on the head (except for the scale under which lies the pineal eye) and there are no bony plates under the scales. Movable eyelids and limbs are always well developed and the tail is not capable of being shed and regenerated. The shape of the body varies considerably, ground-dwelling forms tending to be horizontally flattened and arboreal species to be compressed from side to side.

The genus *Agama* is a generalized, ground-dwelling type common throughout Africa, the near east and southeast Europe; most of the species are cryptically coloured in shades of brown, but the males often develop brilliant red or blue heads and throats, the latter being distended and pulsated in courtship.

Dilatation of the throat, and special structures developed in association with it, is a common habit throughout the family, the gesture being either part of a courtship display or a threat. In the Australian frilled lizard (*Chlamydosaurus*) the neck has an erectile collar, consisting of a fold of skin that, when not in

use, hangs like a cape about the shoulders. When the lizard is angered or frightened this cape is erected so that it stands out like an enormous ruff and at the same time the mouth is opened wide, displaying a saffron-yellow interior. The gesture is impressive but is mostly bluff, and if further molested the animal usually flees, running swiftly on the hind limbs only. This habit of running on the hind legs is shared by other members of the family, including *Physignathus,* found from Australia to Tonkin, some of whose species are semiaquatic, living on the banks of streams and taking to the water readily when disturbed.

It is in the Indo-Malayan region that the greatest diversity and the most bizarre developments are to be found. The extreme among the inexplicable modifications is probably in the East Indian water lizard (*Hydrosaurus amboinensis*), found in the Philippines, Java, Celebes and the Moluccas. This animal reaches 3 to 4 ft. in length, more than half of which is the tail, which has a high sail-like crest supported by enormously developed spines from the vertebrae. Like the iguanid *Basiliscus,* it has fringed toes that enable it to run across water. Horns on the tip of the snout, similar to those of chameleons, are found in genera such as *Ceratophora* of Ceylon and *Harpesaurus* of Java. Parallelism with chameleons extends also to the development of a prehensile tail (*Cophotis* of Ceylon, Sumatra and Java), to bony ridges above the eyes in *Lyriocephalus* (which also has a globular excrescence on the tip of the snout) and to remarkable powers of colour change in genera such as *Calotes,* which, like the American anoles (family Iguanidae), are sometimes erroneously known as chameleons. This phenomenon is associated more with emotional changes and physical conditions than with colour of the background and is most marked at the breeding season, either during courtship or when males fight. *Calotes versicolor,* known in some parts of its range as the bloodsucker, is extremely pugnacious during this period; the males develop a brilliant scarlet or crimson colour that may be restricted to the head and shoulders or may involve almost the whole of the body. The acme of specialization in the family is in the arboreal flying lizards (*Draco*) of the Malayan region.

Most of the forms hitherto mentioned are either insectivorous or have a mixed diet. It is surprising that the most exclusively herbivorous members of the group live in the Saharo-Sindian desert belt. They are the mastigures (*Uromastyx*), heavily built lizards with short limbs and a short but heavy tail armed with whorls of strong spines. The presence of spines reaches its maximum in the Australian thorny devil (*Moloch*); this is a small, squat, short-tailed creature, liberally beset all over with spines, the largest being on the snout and above the eyes.

Chamaeleontidae (*Chameleons*).—These are arboreal lizards with many unique specializations, including the grouping of the fingers and toes to form opposable bundles for grasping twigs and branches and an enormously protractile tongue for catching insect prey. (*See* CHAMELEON.)

Xantusiidae.—This small Central and western American family comprises lizards with geckolike eyes lacking movable eyelids. The body is covered with small granular scales, with or without some scattered enlarged tubercles on its upper surface, but the lower surfaces and the top of the head have larger, platelike scales; there is no bony armour under the scales. *Xantusia* is found in the arid regions of the southwest of the United States, *Lepidophyma* and *Gaigeia* in Central America and *Cricosaura* in Cuba.

Scincidae (*Skinks*).—Skinks constitute the largest lizard family. A cosmopolitan group, its members have relatively large overlapping, platelike scales underlain by bony plates, which form a complete armour. Compared with such families as the Iguanidae and Agamidae, the skinks show relatively little diversity of form and scale modifications, nor have they powers of rapid colour change, though the colours are often brilliant. A widespread colour feature in the group is a sky-blue or turquoise tail, particularly in young individuals. In the vast majority, the scales are uniform in size and smoothly polished, but sometimes they have one or more raised longitudinal ridges (keels) that continue beyond their edges to form spines. In the Australian stump-tails (*Trachydosaurus*), for example, the keels are wide and blunt and each scale resembles that of a pine cone; in the Australian genus *Egernia* the keels are enlarged and prolonged to form effective, thornlike spines, particularly on the broad tail.

The family is noteworthy for the extent to which there is limb degeneration in association with burrowing habits. There is every gradation between well-developed limbs, each with five digits, and complete absence of any external traces of limbs. One evolutionary line in Africa culminates in a group of blind, limbless burrowers that is sometimes given family status under the name Feyliniidae. The American genus *Anelytropsis,* sometimes placed in a separate family, is probably a parallel development.

Another modification of which gradational stages can be traced is the development of a fixed transparent covering over the eye, similar to that found in some other families and in all snakes. This modification may be associated with burrowing habits but is also found in some nonburrowers. In the most primitive condition the lower eyelid is still movable, but a few scales in the centre of it are enlarged and transparent; in more advanced stages, as for instance in the genera *Leiolopisma* and *Emoia,* almost the whole of the lower lid has lost its scaly character and is transparent; the most advanced stages in genera such as *Panaspis, Ablepharus* and *Ophiseps,* have the lower lid immovable in the "closed" position and also more or less fused along its edge with the upper lid.

Most skinks lay eggs, but a few species of *Leiolopisma, Hinulia* and *Chalcides* are truly viviparous, the later stages of fetal development being nourished through a simple placenta (this phenomenon occurs also in two New Zealand geckoes and in the family Xantusiidae).

The skink, the species that has given its name to the whole family, is a small desert-dwelling lizard of the Sahara and Arabian deserts. When dried, powdered and swallowed this lizard was formerly regarded as a panacea for many ills, and as an aphrodisiac, and is still esteemed by primitive tribes both as a food and a drug. It shares with a few close relatives from the same region the ability to "swim" through loose sand by modifications similar to the moles among mammals: it has a pointed, wedge-shaped snout, tiny eyes and short, broad, paddlelike limbs with broadly fringed fingers and toes.

Dibamidae.—This family comprises a single genus (*Dibamus*) of degraded, blind, burrowing lizards, of unknown ancestry, found from New Guinea to Annam and the Nicobar Islands. In females both the forelimbs and the hind limbs are absent; in males the hind limbs are represented by a pair of small scaly flaps. The general appearance is wormlike, both head and tail being of the same diameter as the elongate body and there being no recognizable neck. The snout is covered with a thickened shield and the eyes are minute and concealed beneath the skin. The body is covered with smooth overlapping scales with no bony armour beneath them. Reproduction is by eggs that, like those of the geckoes, have a brittle calcareous shell.

Lacertidae.—These are the true lizards of the old world exclusive of Madagascar and Australasia; their northern limits coincide approximately with the southern edge of the permafrost zone (*i.e.,* where the subsoil remains frozen even through the summer). They are the dominant lizards of Europe. All are terrestrial, and the family shows relatively little diversity of form and no tendencies toward limb degeneration. The head is covered by enlarged symmetrically disposed plates, each with a corresponding bony plate beneath it; the body scales, on the other hand, lack any such bones and are generally small and granular on the back, but enlarged to form rectangular plates on the under surfaces. The tail, almost always long and slender, is fragile.

The common or viviparous lizard (*Lacerta vivipara*), which occurs over a large area of northern Europe, is plentiful throughout Great Britain and also occurs in Ireland, though scattered there. The scientific name is slightly misleading since the species is really ovoviviparous and not viviparous; *i.e.,* the eggs are retained within the mother's body until they hatch but the embryos obtain their nutriment solely from the yolk material in the egg; in the Pyrenees it has been reported that eggs may be laid before the young are ready to emerge.

The sand lizard (*L. agilis*) always lays eggs and, despite its scientific name, is a more heavily built and less nimble species.

Although common enough in north central Europe, this species is relatively rare in Britain and is restricted to a few areas of sand dunes or sandy subsoil. Females of the species are inconspicuously coloured, being gray-brown with longitudinal rows of large darker blotches enclosing white spots. Males, in the breeding season, are a beautiful dark emerald green, with a row of conspicuous black-bordered white circles on the sides of the neck and the flanks. Their colour sometimes leads to erroneous records of another species, the true green lizard (*L. viridis*), which is a much larger species common throughout western and southern Europe.

It is especially in the Mediterranean region that the genus *Lacerta* is dominant. Everywhere wall lizards are to be found, showing great variability, particularly in colour and pattern. Almost every small island has a recognizably different form; on the mainland, too, there are almost endless variations from place to place. Some of the colour forms are associated with special environmental conditions, and, in fact, may be caused by them; for instance, on small barren rocky islands where there is little or no vegetational cover, the lizards are almost always black or nearly so. But in most cases there is no obvious cause and effect relationship. Circular sky-blue spots on the flanks are of common occurrence in the family, and the handsomest of the European lizards, the eyed lizard (*L. lepida*), has rows of such spots, each one black bordered, on a green ground colour.

In Africa and the near east, lacertids show great tolerance of arid climatic conditions. *Acanthodactylus* has the area of the fingers and toes increased by fringes of elongate scales and is thereby enabled to run over soft sand. Probably in connection with life in desert and semidesert conditions the eyelids of lacertids have undergone the same modifications as those of other families, namely the development of a transparent window in the lower lid and, where the window is perfect, fusion of the lower lid with the upper so that the delicate cornea is completely covered. This condition is found in the Indian *Cabrita* and in *Ophiops*, a genus that ranges from Algeria to India.

Cordylidae.—The plated lizards and zonures from southern Africa and Madagascar resemble the skinks and lacertids. The head is covered with enlarged scales having bony plates beneath them; both the back and belly have relatively large, almost rectangular scales, which form linear series longitudinally and transversely over a bony armour. The result is a somewhat rigid shield on the back and a similar one covering the belly. Flexibility is provided in several of the genera by an inverted box pleat along each flank; this inturned fold of skin is covered with small granules and is devoid of bony plates. Most of the group have well-developed limbs, but *Chamaesaura* and *Tetradactylus* of South Africa show various stages in limb reduction, the most degenerate species being snakelike with limbs represented by mere stumps devoid of recognizable digits. *Chamaesaura* dwells in dense herbage and possesses to a marked degree the elongate tail often found in association with that environment; the tail is four times as long as the rest of the animal. *Cordylus* (*Zonurus*), on the other hand, is a rock dweller, and has a short tail with enlarged scales forming whorls of large spikes. These structures must surely deter would-be predators trying to extract the lizard from a cranny in which it has taken refuge.

Teiidae.—The typical members of this American family superficially resemble the Lacertidae of the old world, the head being covered with large symmetrical plates, the back usually with small granules and the belly with rectangular plates in regular transverse series. Genera such as *Kentropyx*, *Ameiva* and *Cnemidophorus* (race runners in the United States) found from the south and west of the United States and the West Indies to Patagonia, resemble the old-world genus *Lacerta* not only in general appearance but in the multiplicity of local races or subspecies.

The family as a whole, however, shows a much greater range of form and adaptability than the lacertids. The teyous (*Tupinambis*), found from the Guianas to tropical Argentina resemble the monitors (see *Varanidae* below) in size (up to 4 ft. or more), form and habits; they are general predators and scavengers. *Crocodilurus*, of the Amazon basin, is probably semiaquatic, and has a flattened tail with a double crest, like that of a crocodile. *Dracaena*, another large species of the same region, has large oval crushing teeth in connection with its diet of mollusks. In the smaller forms there is progressive reduction of the limbs and development of a window in the lower eyelid: *Alopoglossus* of Ecuador and Peru has a few enlarged semitransparent scales on the lower eyelid; *Pantodactylus* of southern Brazil and northern Argentina is a rather elongate form with an undivided transparent disc; and *Gymnophthalmus* and *Micrablepharus* have, like some skinks and lacertids, the transparent lower eyelid fused with the upper. *Anadia* of Central America and Ecuador is elongate and has five digits on its limbs. *Scolecosaurus* is serpentiform, with three or four clawed fingers and toes, and burrows in humus and rotten wood, feeding principally on termites.

Bachia and *Iphisa*, of northern South America, exhibit the greatest degree of degeneration in the family: the body is elongate and serpentiform, the eye minute but still equipped with functional eyelids, the scales no longer granular or overlapping but squarish and arranged in regular longitudinal and transverse rows like those of the amphisbaenids (*see* below), the fingers reduced to clawless tubercles or quite absent and the hind limbs having perhaps a single toe. One of the most remarkable modifications is in the Trinidad species (*Proctoporus shrevei*) that lives in the half-light of caves on Mt. Aripo. The males have a series of white spots along their flanks, each being a transparent area of thickened skin. These appear to be crude lenses, for it is reported that if a beam of light strikes the animal, each spot reflects it weakly.

Amphisbaenidae.—These wormlike creatures are highly specialized for subterranean life and they are probably not closely related to any other lizards. Only one genus, *Bipes* of western Mexico and Lower California, has any external trace of limbs; in it the forelimb alone persists and, though short, it has five, four or three digits. The head is always small, no wider than the body, and the bones of the skull are much stouter than in other lizards. Eyes are minute and completely covered by the skin though they may be visible through the scales. The conducting apparatus of the ear, instead of being connected to an ear drum to pick up sound waves, is connected with the lower jaw and chin to transmit soil vibrations. The head is covered by a few enlarged plates, but the outer covering of both head and body, though of the same horny material as normal reptilian scales, is a thin sheet. The skin on the body and tail is divided into small rectangular segments, which form transverse rings, and usually contains no pigment; in consequence the animals are always somewhat pink because of the blood colour showing through. The right lung is vestigial or absent.

The name, derived from Greek words meaning "both go," arises from the ability of these lizards to progress either backward or forward and from the fact that the tail is so short and blunt that, at a glance, it is scarcely distinguishable from the head. All the species are completely subterranean in habits and are predators on burrowing invertebrates, particularly ants and termites. They are found in the Iberian peninsula southward and across north Africa to southwestern Asia, and from the southern U.S. southward to Argentina. (*See* AMPHISBAENA.)

Helodermatidae.—This family contains the only known poisonous lizards, the Gila monster (*Heloderma suspectum*) of Arizona, New Mexico and Utah, and the beaded lizard or Escorpión (*Heloderma horridum*) of Mexico. These are sluggish, heavy-bodied creatures with weak limbs and short stumpy tails. The skin is beset with tubercles and presents a warning coloration of alternating rings of blackish-brown and yellow or pinkish-orange. The poison apparatus consists of a row of glands along the inside of the lower lip whose openings lie near the bases of the recurved, grooved teeth. When the animal bites, it deliberately chews the object; in this way a considerable amount of venom is worked into the wounds through the channels of the teeth. The food consists chiefly of small lizards on which the poison acts fairly rapidly. The bite is not, as a rule, fatal to man. (*See* GILA MONSTER.)

Lanthanotidae.—The rare Bornean lizard *Lanthanotus* was for a long time regarded as a close relative of the Gila monster, but has been shown to be allied to the monitors and even more closely to some of their extinct relatives, the mosasaurs and dolichosaurs.

Although it is by no means snakelike in general appearance, it possesses many of the structural features to be expected in an ancestor of the snakes, a fact that supports the hypothesis that the snakes are derived from some monitorlike lizard.

Anguidae.—This small family is chiefly American, but with a few species in Europe and the Indian region. All the species have large, overlapping scales with bony plates beneath them. *Gerrhonotus*, of North and Central America, and *Celestus*, of the West Indies, Central and South America, are genera with well-developed, pentadactyle limbs. *Ophisaurus*, which has the limbs reduced to a pair of small stylets on each side of the vent, has a peculiar distribution, species occurring in the United States, Mexico, India and Burma and in southern Europe and Morocco. The European species (*O. apodus*) is the "Scheltopusik" or glass snake, the latter name bestowed because of the extreme fragility of its tail, which, if the creature is roughly handled, breaks into several fragments. The American species have similar habits. *Anguis*, another genus, has no external rudiments of limbs. Its sole species, *A. fragilis*, known in England as the slowworm or blindworm, is a snakelike creature, frequenting grassy banks and ditches, and is one of the few animals that preys largely on slugs.

Xenosauridae.—This family comprises two montane lizard genera, one Mexican (*Xenosaurus*) and one Chinese (*Shinisaurus*). These forms resemble the Anguidae in many features, but differ, among other things, in a reduction of the subsurface armour. On the head the bony plates are consolidated with the underlying bones but elsewhere they are reduced to small isolated nodules. *Shinisaurus* looks like a miniature, foot-long crocodile and is semiaquatic. It frequents the banks of streams into which it plunges when disturbed, seeking refuge at the bottom under rocks and stones.

Anniellidae.—This family contains a single genus (*Anniella*) of elongate and limbless burrowing lizards related to the Anguidae. These wormlike lizards from California have no external vestiges of limbs and have the minute eyes covered by scales. The scales are soft and without bony plates. The colour is silvery, each scale edged with brown, and a narrow dark line courses down the middle of the back.

Varanidae (*Monitors*).—This old-world family of large lizards shows little diversity of form despite the fact that its members are successful in many different habitats. All are typically lizardlike in general appearance, with heavy bodies, slender tails that are not fragile, and with well-developed pentadactyle limbs armed with powerful claws. The neck is longer and more flexible than in most other lizards, and the tongue is snakelike, forked and protrusible. The head and body are covered with small granular scales and there is either no bony armour or the plates are small and widely separated.

The family is an old one, fossils as old as the Cretaceous being known, and it is closely allied to the extinct semiaquatic dolichosaurs and marine mosasaurs. The living varanids are found in Africa, Arabia, southern Asia and Australia. Some, such as the Nile monitor (*Varanus niloticus*) and the Indo-Malayan water monitor (*V. salvator*) frequent the vicinity of rivers and streams and take readily to the water, swimming by lateral undulations of their vertically flattened tails, the limbs being held close to the sides. Others, such as the desert monitor (*V. griseus*), which ranges from north Africa to the Caspian sea and northwestern India, are restricted to arid country. Others again are semiarboreal. Most are adaptable and are not inseparably associated with any restricted environment. All monitors are carnivorous, most of them indiscriminately so, with no objection to carrion, and are active predators. Some will eat fruits, several regularly prey on the eggs of crocodiles and turtles, digging out the nests, and the semiaquatic forms often feed on fresh-water mussels.

Monitors are the largest lizards of the present time. The largest species is the Komodo dragon (*V. komodoensis*), found on the two small East Indian islands of Rincha and Komodo and on the adjacent part of Flores. Exaggerated and sensational stories accumulated around this creature, until it was studied in the field by E. R. Dunn in 1926. It has the heaviest build of any of the monitors, but it also has a relatively short tail so that a specimen 9 ft. long has a body three or four times as heavy and bulky as that of, say, a water monitor of the same over-all length. This led, by inapplicable arithmetic, to stories of 30-ft. specimens; the maximum size is probably about 10 ft. It is a diurnal animal that preys mainly on small wild pigs.

The largest number of forms is found in Australia, where the rare Queensland species (*V. giganteus*) closely rivals the Komodo dragon in size. Monitors can run at a considerable speed, though this, again, is often exaggerated and probably does not exceed 10 m.p.h., and that for only a short distance. When angered they inflate themselves, hissing violently, lashing the tail and threatening with widely opened mouth. The threat may be no idle one since both the bite and the tail slap can be effective. In some cases, however, this behaviour is mere bluff: the African savanna monitor (*V. exanthematicus*) will sometimes, after threatening, sham death, rolling over on its back and remaining inert until the danger is past. All monitors lay large oval, soft-shelled eggs, which are deposited in holes in the ground or in termite nests.

See also references under "Lizard" in the Index. (H. W. P.)

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LIZARD PENINSULA (THE LIZARD), terminates in Lizard point or Lizard head, Cornwall, Eng., the southernmost point of Great Britain, in 49° 56′ 30″ N., 5° 12′ W. The beam from the Lizard lighthouse is visible for 21 mi. The cliff scenery is magnificent; the coast is fretted into small bays, caves pierce the cliffs and bold isolated rocks fringe the shore; Kynance and Mullion coves are particularly beautiful. The dark green and purple colouring of the serpentine rock, of which most of the peninsula is formed, is remarkable; it is used for building and worked into ornaments. Most of the peninsula is 200–300 ft. above sea level and on the thin soil Cornish heath is a characteristic plant. Lizard Town, at the southernmost extremity, is a straggling village. The nearest town of importance is Helston (*q.v.*), 11 mi. N. by road from Lizard point. At Poldhu, 2 mi. N. of Mullion, a monument marks the spot where Marchese Guglielmo Marconi sent and received the first transatlantic radio messages in 1901. There are remains of ancient settlements. The name (Lis-ard) means "high court."

LJUBLJANA (Ger. LAIBACH; Ital. LYBIANA), the capital city of the People's Republic of Slovenia, Yugos., in the Ljubljana *srez* (district), lies on the Ljubljanica river 153 km. (95 mi.) W.N.W. of Zagreb by road. Pop. (1961) 133,386. It is dominated by the medieval fortress of Grad, from which a magnificent view is obtained of the Slovene mountains. Below Grad is the oldest part of Ljubljana. In 1895 the town suffered severely from an earthquake but some parts built in baroque style were preserved. Buildings of interest include the Franciscan church and those of St. Florian and St. James (all 17th century), St. Nicholas cathedral and the Knights of the Cross and Ursuline churches (all 18th century). There are a national museum, a national gallery, an opera house and a university. Ljubljana is an important communications centre with rail and road connections with other parts of Yugoslavia and central Europe. The main industries include the manufacture of machines, cotton, wool, porcelain, paper, furniture, boots, tobacco, soap, pottery, fire hose, matches and chemicals; there is also brewing, distilling, tanning and brickmaking. The town is a tourist centre.

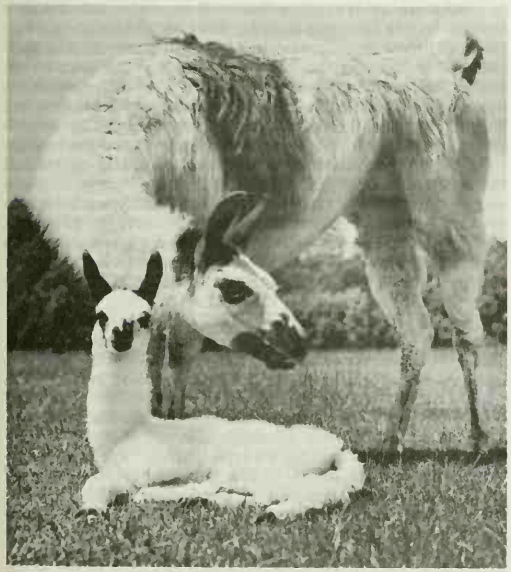
The Roman city of Aemona was founded on the site in 34 B.C. An important crossroad on the route to Pannonia (the Ljubljana gap), it was probably destroyed by Attila. In 900 it suffered much from the Magyars, who were defeated there in 914. In the 12th

century the city passed into the hands of the dukes of Carinthia. It was taken by Otakar II of Bohemia in 1270 and in 1277 it came under the Habsburgs. In 1320 it obtained town rights. Ljubljana was a Roman Catholic see from 1461. In 1809 the city was twice taken by the French and from that year to 1813 it became the general seat of the government of the Illyrian provinces. In 1821 the congress of members of the Holy alliance, known as the congress of Laibach, was held there. When the southern railway from Vienna was built in 1849, Ljubljana began to prosper. While under Austrian rule, it became a centre of the Slovene national movement, the first Slovene newspaper having been published there in 1797. It became part of Yugoslavia in 1918. (V. De.)

LJUSNAN, a river of Sweden, flows from Härjedalen province on the Norwegian frontier east to Hälsingland province and then turns southeast to enter the sea at Ljusne. Its total length is 430 km. (267 mi.). There are no lakes in the headstreams but near Ljusdal are lakes Norra and Södra Dellen. The river lacks important tributaries; Voxnan enters near Bollnäs (created a town in 1942).

In its middle and lower courses Ljusnan is one of the major timber-floating routes of Sweden and Ljusne has important sawmills; there are pulp mills at Mama, Bergvik and Ljusne. Ljusnan is not important for hydroelectricity. (A. C. O'D.)

LLAMA (*Lama glama*) and the smaller alpaca (*q.v.*), the two domesticated species of the camel family indigenous to South America, are thought by some authorities to be derived from the guanaco (*q.v.*). Fossils from Pleistocene deposits in Argentina indicate that the llama forms a distinct species. Apparently it was a vanishing relict during postglacial time and was saved from extinction only through domestication by aborigines. The achievement of the Incas in llama husbandry was a marvel to Spanish conquerors. Incas used llamas to carry burdens, as food for sacrifice in religious ceremonies, for their wool and hide and as a source of fuel (dried dung). No wild populations exist today. Llamas are still in common use by highland natives from Peru to northern Chile and Argentina. Only males over three years old are used as pack animals. A 200-lb. llama can carry 100 to 130 lb. for a three-week trip, averaging 15 to 20 mi. a day. High thirst tolerance, endurance and ability to subsist on a wide variety of forage are important advantages in crossing bleak Andean plateaus.



W. SUSCHITZKY

LLAMA (LAMA GLAMA) AND YOUNG

Loyalty and affection reach their limits, however, when llamas are overloaded or exhausted, at which time they lie down, hiss, spit and kick, refusing to move until relieved of some of the weight or until rested sufficiently to continue the journey. Although usually white, the animals vary in colour to solid black, with any combination of brown or black spotting between these extremes. The coarse fleece is inferior to the wool of the alpaca. Sheep have largely replaced the llama as a source of wool.

See also references under "Llama" in the Index. (H. K. B.)

LLANBERIS, a small town of Caernarvonshire, Wales, 7½ mi. E.S.E. of Caernarvon by road. Pop. of civil parish (1961) 2,110. It is a favourite tourist centre, being situated between two lakes, Llyn Padarn and Llyn Peris, the latter of which lies at the foot of the fine Llanberis pass (1,169 ft.), and being also the starting point for the easiest ascent of Snowdon (*q.v.*), which rises to the southeast. At Llanberis is the station of the Snowdon railway. Nant Peris, the old village, is about 2 mi. S. at the foot of the pass. Near Llyn Peris are the ruins of the 13th-century Dolbadarn castle. Although picturesquely situated, slate quarrying has spoiled the appearance of Llanberis, but the great Dinorwic quarries export fine slate to all parts of the world. A road over Llanberis pass leads through Nant Gwynant to Beddgelert.

LLANDAFF (Llandaf), a ward (since 1922) in the county borough of Cardiff, Wales, lies on the west bank of the Taff 2 mi. N.W. of Cardiff. Pop. (1961) 22,164. It contains the cathedral church of one of the six dioceses of the Church in Wales, embracing the populous region of Monmouthshire and a great part of Glamorgan. Traditionally Llandaff was claimed to have been founded as an episcopal see by St. Teilo in the latter half of the 6th century, but it came into existence as a see in the diocesan sense only after the Norman conquest when the delimitation of the boundaries of the diocese was the subject of acute controversy during the time of Bishop Urban (1107–34), who visited Rome in 1128–29 to press his case in the Roman Curia. It was in support of these claims that *Llyfr Teilo* (the *Book of Llan Dâf*) was compiled as a record of grants and privileges made to the see in earlier times in recognition of its ecclesiastical status. Urban began building the present cathedral structure on the site of an earlier one and the Norman chancel arch is of this period. The Early English west front is of later date, and was not completed until about the time of Bishop Henry of Abergavenny (1193–1215).

After the Reformation and during the English Civil War the cathedral, deprived of much of its revenues, became a prey to the weather. The southwest tower and a large part of the roof of the nave collapsed in 1703 and again in 1722–23. Later in the same century a small church in debased Italian style was built within the ruins, but it was not until the mid-19th century that the original church was restored to reveal much of its former dignity and grandeur.

The restored cathedral was almost totally destroyed in World War II during an air raid in which St. Michael's Theological college also suffered. Since then the cathedral has again been restored and now contains the figure of "Christ in Majesty" by Sir Jacob Epstein.

Geoffrey of Monmouth, the chronicler, died at Llandaff in 1155. The castle, which during the middle ages served as the residence of the bishops, was destroyed by Owen Glendower about 1403–04, leaving only the ruined gatehouse, which still stands. In the mid-19th century Llandaff court was acquired by Bishop Ollivant (1849–82) as the bishop's residence.

Among the educational institutions at Llandaff are the Cathedral school and the grammar school for girls, the latter maintained by money bequeathed by Thomas Howell, a merchant who died in Spain in 1540, and now managed by the Drapers' company as trustees of the charity. (W. Re.)

LLANDOVERY (Llanymddyfri), a municipal borough in Carmarthenshire, Wales, lies 27 mi. E.N.E. of Carmarthen by road. Pop. (1961) 1,911. Situated on the river Towy, it is a market town serving the surrounding agricultural area. In the cobbled Market square stands the town hall (1857) and adjoining is the Market hall, with its clock tower listed as an ancient

monument. The church of Llandingat has a 15th-century tower, and one of its vicars was Rhys Prichard (*c.* 1579–1644), author of *Canwyll y Cymry* (*The Welshman's Candle*), a collection of religious poems marking the rise of popular poetry in Wales. The church of Llanfair-ar-y-bryn, mainly Early English, is built on the site of a Roman fort (probably called Alabum). The town has developed round the 12th-century Norman castle, bounded by the river Bran, and its remains overlook the cattle market and the Castle sports ground. Llandovery college, a public school for boys founded in 1848, is in Queensway. The town is served by the Western region of British railways line and is on the main London-Fishguard road. While mainly dependent on agricultural industry and a railway depot, it is the centre of a developing forestry area and has its own sawmills. Situated on the edge of the Brecon Beacons National park and in an area of great natural beauty, it is also increasingly a tourist centre. In 1485 Llandovery was incorporated by a charter from Richard III, a privilege confirmed by Henry VIII and by Elizabeth I, whose charter is still held by the corporation. (V. M. W.)

LLANDRINDOD WELLS (Llandrindod), an urban district of Radnorshire, Wales, lies in a delightful setting on a plateau surrounded by hills, about 700 ft. above sea level, east of the river Wye and west of Radnor forest. Pop. (1961) 3,248.

The town is well laid out with broad streets, open spaces, including the Rock park with its international bowling greens, the recreation ground and the common with its beautiful 14-ac. lake providing boating and fishing. There is a free library (1911) and a small museum. The medicinal waters for which Llandrindod Wells is famous first became known about 1696. Its fame spread rapidly in the next 50 years, and many people came to take the waters, staying at farm houses nearby. The town developed slowly, most of it being built in the first half of the 20th century. It is now a popular health and tourist resort and is affiliated with the British Spas federation. It is the seat of county administration, and the inhabitants are mostly occupied in administrative and professional offices, shops, garages and personal service. There are good road and rail communications with the principal towns in south Wales and the Midlands. (W. E. Pe.)

LLANDUDNO, a seaside town and urban district in the Conway parliamentary division of Caernarvonshire, Wales, is situated 47 mi. W.N.W. of Chester by road. Pop. (1961) 17,852. It lies between the limestone headlands of Great Orme (northwest) and Little Orme (east), on a peninsula formed by the Irish sea and the Conway river, and has two sandy shores. On Great Orme are prehistoric sites, including a camp and a burial chamber; copper mines, now disused, that were worked by the Romans; and the old parish church of St. Tudno, believed to occupy the site of an oratory erected by its patron saint in the 7th century. Llandudno has grown from a fishing village into a health and resort town with two golf courses, Alpine displays in the Happy Valley park, magnificent views from a marine drive encircling the Orme, and steamers operating from Llandudno pier to Liverpool, the Isle of Man and Anglesey in the summer.

Charles Lutwidge Dodgson (Lewis Carroll) frequently visited Dean Liddell and his daughter Alice at their residence in the town and a memorial to him stands on the west shore.

LLANELLY (Llanelli), a seaport and municipal borough of Carmarthenshire, Wales, is situated on the Burry inlet (Carmarthen bay) at the mouth of the Loughor river, 19 mi. S.S.E. of Carmarthen by road. Pop. (1961) 29,994. The town derives its name from the dedication of the parish church to the Celtic saint Elliw or Elli. With the beginning of the Industrial Revolution, Llanelly became important for its lead-smelting works, shipbuilding and flannel industries. In 1804 copperworks were established, but gradually the old industries were superseded by the manufacture of tin plate. The first tinworks opened in 1847, and others followed in 1852–53, until, in 1888, 92 mills were in operation. This industry declined when the Ebbw Vale strip mill was set up, and the town became a colliery centre and collecting ground for the anthracite from the Gwendraeth valley. Secondary industries, including potteries, iron foundries and chemical works, also grew up. The tin-plate industry was revived in the mid-20th century by the opening of a cold reduction plant at Trostre, on the outskirts of Llanelly, to work with the huge Margam strip mills in Glamorgan. Other steelworks have also been built. In 1955 the Towy water scheme was opened. The port, which exported many tons of coal in the 19th century, ceased operating for trading purposes in 1951, but the north dock was let to the admiralty for the laying up of reserve fleet vessels.

Llanelly was a borough by prescription in the old lordship of Kidwelly; by royal charter granted by George V, it was incorporated in 1913. In the same year its first mayor presented Parc Howard to the town, the grounds of which are used for recreation and the house for a museum, art gallery and tearooms. The town also has a mining and technical institute, a junior technical school and a school of art. There are two miles of sand along the shore.

LLANGOLLEN, a market town and urban district of Denbighshire, Wales, lies 23 mi. S.W. of Chester by road. Pop. (1961) 3,050. The Welsh Dee winds through the town and is crossed by a 14th-century bridge. Plâs Newydd, now a museum, was the residence from 1780 of the "Ladies of Llangollen," Lady Eleanor Butler (d. 1829) and Sarah Ponsonby (d. 1831), two eccentric spinsters of well-known Irish families. The remains of Castell Dinas Brân, built early in the 13th century, stand on a hill 1,000 ft. above sea level. The Cistercian Valle Crucis abbey, 1¾ mi. N.N.W., was founded by Madog ap Gruffydd Maelor, in the year 1200. Eliseg's pillar, north of the abbey, is a remarkable 9th-century stone cross.

Llangollen is the home of the international musical Eisteddfod (*q.v.*), founded in 1946 and supported entirely by voluntary workers for the promotion of international peace and good will.

The town's industries include the manufacture of leather, woolen goods (especially flannel) and sheet metal; farming, forestry, seed packing, lithography and colour printing are also carried on. There is also a considerable tourist trade. (E. E. Ro.)

LLANIDLOES, a market town and municipal borough in the Montgomery parliamentary division of Montgomeryshire, Wales, lies in the Severn valley, 30 mi. E. of Aberystwyth by road. Pop. (1961) 2,375. The parish church of St. Idloes (a 7th-century saint) has a 14th-century tower capped with a wooden belfry of Welsh border type, and a fine early 15th-century arcade, transferred from Cwmhir abbey (Radnorshire) in 1542. The town grew up under the protection of its motte and bailey castle, and in 1280 Owen of Arwystli, prince of Powys, obtained a charter establishing the fairs and Saturday markets of Llanidloes. Full civic privileges, granted about 1300, are still retained. The half-timbered market hall, standing on oaken legs at the town centre, is the only surviving example in Wales. It still possesses its ancient curfew bell and now houses a museum of local history and industry. Flannel weaving and lead mining flourished in the 19th century but after 1918 both industries declined and are now extinct. The present interests of the town are mainly agricultural but there is a foundry (established 1850), and a tannery for sheep and goatskin leathers (1908). There is a weekly market and a monthly fair and a cattle market was opened in 1955. Llanidloes was an active centre of Chartism, and for five days was in the hands of the rebels when the weavers rose in arms in 1839. The eastern slopes of Plynlimon, 10 mi. E., are now part of the Hafren state forest, covering several thousand acres.

LLANO ESTACADO (Staked Plains), a portion of the high plains of the United States, covers an area of approximately 30,000 sq.mi. in western Texas and eastern New Mexico; the northern half is known as the Panhandle. The "break of the plains" bounds the area on the east; the Mescalero ridge overlooking the Pecos valley is the western margin; the Canadian river valley is at the northern edge; while in the south the region grades imperceptibly into the Edwards plateau. The present surface is composed of a mantle of silts, sands and gravels. Porosity of surface materials, levelness of terrain and semiaridity have combined to eliminate nearly all water erosion. The flatness of the surface is striking. Locally, small saucerlike depressions, varying in diameter from a few feet to almost a mile, and in depth from a few inches to several tens of feet, partially break the surface monotony. These hollows retain water for a short

time after rains and a few contain permanent though varying amounts of water.

Soils of high inherent fertility have evolved in the region, but their usefulness is restricted by meagre rainfall, high evaporation rates and periodic droughts. Blistering summers are succeeded by cool winters, strong winds are omnipresent, and weather extremes are commonplace. "Short grass," largely grama and buffalo grass, cloaks the uncultivated portions of the region.

Extensive grazing, dry-land farming of wheat and grain sorghums, localized irrigated cotton production, and the pumping of natural gas and petroleum are the principal economic pursuits of the area. Lubbock and Amarillo, Tex. (*qq.v.*), are the most important cities of the region, but a less than salubrious climate, monotonous landscape and isolation combine to restrict population densities.

See also TEXAS: *Physical Features;* UNITED STATES (OF AMERICA): *Physiography: Interior Plains.* (A. H. DR.)

LLANOS, Spanish American name for the vast plains or prairies of northern South America, extending from the Atlantic ocean to the Andes, and bounded by the coastal ranges in the north and by the Orinoco river (*q.v.*) and its Guaviare tributary on the south. The region, which covers about 125,000 sq.mi. in Venezuela and 100,000 sq.mi. in eastern Colombia, has a hot climate, supports little wild life and is sparsely populated.

The plains slope gently from a few hundred feet elevation at the base of the mountains toward the Orinoco and are broken here and there by low mesas. Many tributaries of the Orinoco drain the plains and flow in relatively straight courses. The largest of these are the Apure river (*q.v.*), the Arauca and the Meta, which rise in the far western part of the llanos.

The llanos are alternately flooded and dry in response to conditions of weather and terrain. The rainy season begins in May and reaches a peak between June and October when much of the area becomes flooded. The swollen rivers slowly recede during the dry season (December–March) and the land becomes parched and baked, the grass becoming brown and brittle for lack of moisture. Dense forests are confined to the stream courses and near the base of the mountains. The typical vegetation is tall, coarse grass with some dry, scrubby forests and scattered palms. Soils are chiefly infertile laterites, though fertile alluvial soils are fairly extensive.

Cattle were introduced into the llanos in 1548 and have been the mainstay since colonial days. The plains are Venezuela's most important stockbreeding region, accounting for two-thirds of the nation's cattle. Although plagues of insects make life difficult and herds must be driven to higher land during flood, several million head range widely in a region where fences are rare. Because of distance, much of the beef is shipped by air from such centres as San Fernando de Apure, the largest town in the central llanos, to Caracas. Irrigated agriculture has been developed in several places in the upper llanos since the eradication of malaria and the construction of large dams.

The *llanero,* the tough, hard-riding herdsman and skilled horseman of the plains, played an important role during the Venezuelan war of independence and has been an ardent supporter of successive revolutionary *caudillos. See* also VENEZUELA and COLOMBIA. (D. R. D.)

LLANQUIHUE, province of southern Chile bordering the northern shores of Ancud gulf, bounded on the north by Osorno province, and extending from the Pacific to Argentina. Area 7,029 sq.mi. Pop. (1960) 165,959. The western half of Llanquihue is a rolling country of forests and pastoral and farm land; the east is a rough, volcano-studded, cordilleran landscape of deep glaciated valleys, lakes and virgin forest. It is noted for sports fishing. Chile's largest lake, Llanquihue (marginal to the mountains), and Lake Todos los Santos mark a scenic trans-Andean route to Argentina which draws sizable summer tourist traffic to Puerto Varas, Ensenada, Petrohué and Peulla. The provincial capital, Puerto Montt (*q.v.*), pop. (1960) 41,681, affords road access to the scenic southern coast line of the province and air and water service to island and mainland points extending from the Gulf of Ancud to Punta Arenas (*q.v.*). Rail, air, road and sea communications are available to Santiago and Valparaíso. Summers are comfortable; winters are cool and very wet.

The province was formed in 1937 by dismembering Chiloé province. Less than 15% of its area is considered arable but about 50% of its gainfully employed people are in agriculture. Beef, dairy products, potatoes, wheat, fruit and wool are important. The increasing significance of sugar beets results from the construction of a beet sugar factory at Llanquihue in 1958. Lumbering, farm product processing, tourism, shipbuilding, fishing and the canning of seafood support large segments of the population. Since 1853 German pioneers and their descendants have played an important economic role. (J. T.)

LLANTWIT MAJOR (LLANILLTUD FAWR), a small town in the Cowbridge rural district of Glamorgan, Wales, lies 1 mi. from the coast and 16 mi. W.S.W. of Cardiff by road. Pop. (1961) 4,243. Weapons and implements of the Bronze Age were discovered in a tumulus in the town. Castle Ditches, a triple line of earthworks, commands the entrance to the creek of Colhugh, once the port of Llantwit. At Caermead (1 mi. N.N.W.) lie the remains of a large Roman villa. Llantwit Major castle is now ruined.

The town derives its name from St. Illtyd or Iltutus (*c.* 500), a native of Brittany who established there a monastic college which became a famous seat of learning, associated with the Celtic saint movement in Wales. The monastery later became a cell of Tewkesbury abbey and was finally destroyed at the Dissolution, only the gatehouse and dovehouse remaining. The present church of St. Illtyd, dating from the 12th and 15th centuries, is divided into the old (western) part, probably the parish church, which houses Celtic crosses, effigies, etc., and the new, probably the monks' chapel, which has a Jesse niche and is now used as the parish church. The ruined chantry was finally destroyed by an air raid in 1940. The town hall is 15th century. Llantwit lies in a fertile district; its people depend to some extent upon agriculture, but most of them are employed at a nearby Royal Air Force station. (W. A. L. S.; P. CR.)

LLEWELYN, the name of two Welsh princes.

LLEWELYN AP IORWERTH (d. 1240), known as the Great, was the most outstanding ruler to appear in Wales before the Edwardian conquest. A patrimony in Gwynedd having been denied him as a child, he was brought up by his mother's family in the neighbouring principality of Powys. Returning to Gwynedd about 1190, he had eliminated rival kinsmen, restored the unity of Gwynedd, and brought the greater part of north Wales under his sole rule by 1202. King John's acquiescence was secured and Llewelyn married John's illegitimate daughter, Joan. Llewelyn's subsequent attempts to dominate other Welsh states alarmed the king, who invaded Wales in 1211 and brought temporary disaster to the prince's ambitions. John's political embarrassments, culminating in the Magna Carta crisis in 1215, gave Llewelyn an ideal opportunity to reassert his supremacy and in 1218 he wrested very favourable terms at Worcester from the regency that followed John's death. The treaty recognized the prince's mastery over territories lying roughly west of a line from Carmarthen to Montgomery, including control of those two strongholds. Checked only once after Worcester, by William Marshal, earl of Pembroke, in 1223, Llewelyn was obliged, to his ultimate advantage, to move back to the more restricted Cardigan-Builth boundary. Henceforth Llewelyn concentrated on preserving this position, striving to secure the interests of his dynasty through marriages arranged for David, his younger son, by his marriage with Joan, and four of his daughters with the Anglo-Norman aristocracy in south Wales. He also explored every avenue whereby David should be recognized as sole heir to a feudal principality of Wales. This was a new concept which was realized through Llewelyn's insistence on homage from the other Welsh princes, although this did not mean their withdrawal from direct allegiance to the crown. When he died in April 1240 at the Cistercian abbey of Aberconwy, where he was buried, the chronicler described him as prince of Wales, which he was in fact, if not in law.

LLEWELYN AP GRUFFYDD (d. 1282), grandson of Llewelyn the Great, and the only Welsh ruler to be officially recognized as

prince of Wales, was given a share of Snowdonia by the treaty of Woodstock in 1247 when the kingdom of Gwynedd collapsed after the death in 1246 of David II (*see* DAVID). Llewelyn, establishing an ascendancy over his brothers by 1254, and taking full advantage of renewed civil disturbance in England, proclaimed himself prince of Wales and received the homage of the Welsh princes (1258). The defeat of the prince's ally, Simon de Montfort, and the cessation of civil war in England still left Llewelyn strong enough to be offered most advantageous terms in the Montgomery settlement (1267). In addition to confirmation of territorial conquests, which included several marcher lordships in mid-Wales, Henry III conceded to Llewelyn the homage of native lords, permitting Llewelyn alone to do homage and fealty for the entire principality of Wales. With the accession of Edward I in 1272, Llewelyn, apparently unaware of how things had now changed in England, defied the new king and brought upon himself a signal humiliation in the war of 1277. When hostilities were renewed in 1282 the prince was mortally wounded in a skirmish near Builth on Dec. 11, and his death marked the end of Welsh political independence. Shortly before Llewelyn's death his wife, Eleanor de Montfort, gave birth to a daughter, Gwenllian, who spent the remainder of her life in an English nunnery. *See* also WALES: *History*. (T. J. P.)

LLIVIA, a town and enclave of Spanish territory in the French *département* of Pyrénées Orientales, a part of the ancient district of Cerdagne or Cerdaña. Llivia is included in the Spanish province of Gerona. Pop. (1960) 755. The Cerdagne comprises the upper basin of the Segre on the southern flank of the Spanish Pyrenees. A faulted basin at about 3,300 ft., formerly a lake floor, it is surrounded by such high mountains as Carlitte (9,583 ft.), Campeardas (9,560 ft.) and Puigmal (4,540 ft.). The irrigated meadows of the Cerdagne are important for winter pasturage—the Canal de Puigmal was constructed in 1310. The Roman Julia Livia, the town was capital of the Cerdagne until the 11th century. In 1659, by the treaty of the Pyrenees, 33 Cerdagne villages were ceded to France and the political enclave was created.
(J. M. Ho.)

LLOYD, GEORGE AMBROSE LLOYD, 1ST BARON (1879–1941), British statesman and colonial administrator, was born at Olton hall, Warwickshire, on Sept. 19, 1879. He was educated at Eton and Trinity college, Cambridge. After traveling widely in Asia and north Africa Lloyd was appointed attaché to the British embassy at Constantinople in 1905. During World War I he saw service in Russia and the middle east and was with the sherif of Mecca's forces in the Hejaz and was decorated in 1917. He was Conservative member of parliament for West Staffordshire (1910–18) and for Eastbourne (1924–25). He was governor of Bombay from 1918 to 1923 and in May 1925 was appointed high commissioner of Egypt and the Sudan, where he was notable for refusing concessions to nationalist agitation. On this account he was recalled by the Labour government in 1929. In the 1930s he was one of Winston Churchill's stanchest supporters. In 1940 he entered Churchill's cabinet as colonial secretary and was appointed leader of the house of lords shortly before his death in London on Feb. 4, 1941. (H. G. N.)

LLOYD, HENRY DEMAREST (1847–1903), U.S. author and social reformer, was born in New York city, May 1, 1847. After graduating from Columbia college and Columbia law school, he spent three years practising law and engaging in reform activities. In 1872 he left New York to accept a position on the staff of the *Chicago Tribune*. He served on that paper for the next 13 years at its literary, financial and editorial desks and then retired to devote full time to public affairs.

During the remainder of his life, Lloyd was an outstanding advocate of the rights of labour and a severe critic of the abuses by private monopoly. His most publicized work was *Wealth Against Commonwealth* (1894), a carefully documented study of the methods used by the Standard Oil company in ridding itself of its competitors. In the late 1890s Lloyd made several trips to Europe and New Zealand to study experiments in the fields of voluntary co-operation, public ownership and social legislation. On returning home he wrote a series of books on these experiments and urged the adoption of a number of them in the United States. In his last years he regarded himself as a socialist and was on the verge of joining the Socialist party when, in the midst of a traction fight in Chicago, he died (Sept. 28, 1903). His life and writings profoundly affected the social reform movement of the late 19th and early 20th centuries.

See Caro Lloyd, *Henry Demarest Lloyd, 1847–1903,* 2 vol. (1912).
(H. W. L.)

LLOYD, MARIE (MATILDA ALICE VICTORIA WOOD) (1870–1922), English music-hall artist, who made her name in the particular kind of London or cockney low comedy which attained great popularity in the 19th century, was born on Feb. 12, 1870, the daughter of John and Matilda Wood. She first appeared at the Eagle music hall in 1885 under the stage name of Bella Delmore. Six weeks later she adopted the stage name of Marie Lloyd, which she retained. She was responsible for a series of music-hall entertainments, songs, sketches, etc., which placed her in the front rank among artistes of her day. She introduced to the British public a series of studies in cockney humour, *e.g.,* "Everything in the garden's lovely," "Oh, Mr. Porter" and "One of the Ruins that Cromwell knocked about a bit." She was married to Percy Courtney; to Alec Hurley, a singer of coster songs (d. 1913); and to Bernard Dillon, a jockey. She died in London on Oct. 7, 1922.
(E. I. J.)

LLOYD, WILLIAM (1627–1717), English bishop, politician and writer, was one of the seven bishops arrested in 1688 for refusing to have the Declaration of Indulgence read in their dioceses. He was born at Tilehurst, Berkshire, on Aug. 18, 1627, and educated at Oriel and Jesus colleges, Oxford. He was successively bishop of St. Asaph (1680), Lichfield and Coventry (1692) and Worcester (1699). His anti-Romanist outlook made Lloyd a bitter opponent of James II, and he strongly supported the Revolution. His chief publication was *An Historical Account of Church Government as It Was in Great Britain and Ireland When They First Received the Christian Religion* (1684). He died at Hartlebury castle, Worcestershire, on Aug. 30, 1717.

See A. Tindal Hart, *William Lloyd, 1627–1717* (1952). (G. HU.)

LLOYD GEORGE OF DWYFOR, DAVID LLOYD GEORGE, 1ST EARL (1863–1945), radical reformer, leader of Britain in World War I, and one of the most brilliant statesmen in British history, was born in Manchester on Jan. 17, 1863. His father was of Welsh yeoman extraction from Pembrokeshire and had become headmaster of an elementary school in Manchester. His mother was the daughter of David Lloyd, a Baptist minister. His father died in June 1864, leaving Mrs. George in poverty. She moved to Llanystumdwy in Caernarvonshire where her brother Richard was a shoemaker and pastor of the Campbellite Baptists in that area. He supported her and her children, and it was from him that David Lloyd George imbibed many of his formative beliefs. It was thanks to his uncle that he was able to embark at the age of 14 on the career of a solicitor, and became articled (1879) to a firm at Portmadoc, passing his final examination in 1884. The atmosphere in which he was brought up was one of intense Liberalism combined with Welsh nationalist enthusiasm. In Wales, as in Ireland, an anglicized and Anglican Tory "ascendancy" class of landed gentry dominated a Celtic people of different race and religion. The cause of the Liberal party, the Welsh nation and Nonconformity were inseparable and Lloyd George made his name by a successful battle in the courts to establish the right of Nonconformists to burial in the churchyard of their parish. By a curious irony, he who came to be the standard-bearer of the oppressed religious sects had lost his faith even as a boy. But the habits and way of thought, the emotions, the eloquence and the biblical fervour of Welsh Nonconformity remained with him to the end of his days. As a young man he had the romantic good looks which ensured success with women. After numerous love affairs he married in 1888 Margaret Owen, the daughter of a Methodist farmer near Criccieth. She bore him five children, two sons and three daughters. It cannot be described as a happy marriage. Lloyd George was incapable of fidelity and his affairs with other women were notorious throughout his life. His wife stood by him on many critical occasions but in the end his behaviour was

too much for even her long-suffering tolerance.

Member of Parliament.—In 1890 a by-election took place at Caernarvon Boroughs. Lloyd George was the Liberal candidate and after a recount he was declared victor by 18 votes. He retained the seat for 55 years. He soon made a name for himself in the house of commons by his audacity, his almost poetical command of language, his extraordinary charm, his mordant wit and his mastery of the art of debate. During the ten years of Liberal opposition which followed the election of 1895 he established himself as a leading figure in the radical wing of the party. He bitterly opposed the South African War and one of his most famous exploits was his attempt in 1901 to penetrate that stronghold of Conservative imperialism, Joseph Chamberlain's Birmingham. He had frequently accused Chamberlain of personal profiteering from the war—a wholly unwarranted charge. It was not surprising that he was nearly lynched. He had to leave the town hall disguised as a policeman. With the arrival of peace Lloyd George fiercely attacked Balfour's Education act (1902), and worked up a great agitation in Wales against rate-aided grants to church schools. This period saw him at the height of his reputation as the leader of Welsh nationalism. Cabinet office somewhat reduced his fervour in this field and, although he succeeded in achieving one of the objects of the movement, the disestablishment of the Anglican church in Wales, which finally, after many vicissitudes, became law in 1920, he ceased to press the case for federal home rule. With the passage of time his nationalism became cultural rather than political.

A. J. Balfour resigned in Dec. 1905 and Sir Henry Campbell-Bannerman formed a Liberal administration which was confirmed in office a few weeks later by a crushing electoral victory. Lloyd George walked straight into the cabinet as president of the board of trade. He was responsible for important legislation—the Merchant Shipping act (1906), which laid down minimum conditions of decent living for seamen; the Patents and Designs act (1907), which stopped foreign exploitation of loopholes in the British law; and the Port of London act (1908), which set up the Port of London authority. He also earned a high reputation by his patient work in settling strikes. He suffered a cruel bereavement in Nov. 1907: his second child and eldest daughter, Mair, to whom he was devoted, died of appendicitis at the age of 17. For a time he plumbed the depths of despair and for years afterward the sight of her portrait could plunge him into tears.

CHANCELLOR OF THE EXCHEQUER

Campbell-Bannerman's health broke down in 1908. He was succeeded as prime minister by the chancellor of the exchequer, Herbert Henry Asquith, who promptly appointed Lloyd George to take his own place. This was a notable promotion and made him, if not second man in the cabinet, at least a very strong competitor for the premiership after Asquith. By this time the Liberal party's fortunes were beginning to languish. The house of lords had blocked much of their social reform legislation, and the radical wing was beginning to show impatience at the danger of their thunder being stolen by the nascent Labour party unless the deadlock could be broken. At the same time the demand for more battleships to match the German naval program threatened the finances available for social reform. It was to meet these difficulties that Lloyd George framed the famous "people's budget" of 1909. New methods of raising money, by taxes upon unearned increment on the sale of land and on land values, by higher death duties and by a super tax on incomes above £3,000, solved the problem of means. Moreover it seemed for a time that the house of lords' veto on progressive legislation would be bypassed, since the custom, though not the law, of the constitution forbade the upper house from interfering with the budget. In fact, however, the Conservative majority in the house of lords decided to reject it. It is sometimes said that Lloyd George deliberately trapped them, but there is no evidence to support this view. His conciliatory method of presenting the budget suggests on the contrary that he never expected such a foolish reaction. The consequences of this rejection were two general elections, a major constitutional crisis and the ultimate passage of the Parliament act of 1911, which severely curtailed the powers of the upper house. The principal burden of all this fell upon Asquith, but Lloyd George, ably seconded by Winston Churchill, gave him vigorous support in a series of notable philippics against the aristocracy and the rich. The most famous of all was his speech at Limehouse where he denounced the rapacity of the landlord class, particularly the dukes, in unforgettable language. Intense passion was aroused, King Edward VII expressed strong disapprobation, and the duke of Beaufort declared that there was nothing that he would like to see so much as "Winston Churchill and Lloyd George in the middle of 20 couple of dog-hounds." Lloyd George was one of the greatest platform orators of his time—perhaps of any time—and he rose to his highest during the budget campaign. At Caernarvon he uttered his most splendid peroration. He described how as a child he never attempted to gather sticks for firewood except after some great storm:

> We are in for rough weather; we may even be in for a winter of storms which will rock the forest, break many a withered branch, and leave many a rotten tree torn up by the roots. But when the weather clears, you may depend upon it there will be something brought within the reach of the people that will give warmth and glow to their gray lives, something that will help to dispel the hunger, the despair, the oppression and the wrong which now chill so many of their hearts.

Yet in spite of his, at times, extremist language, Lloyd George was not averse to compromise. During the summer of 1910 he was a leader of those—Balfour, Churchill and F. E. Smith (later Lord Birkenhead) among others—who favoured a coalition with the Conservatives, based upon agreed solutions of the problems of Irish home rule, tariffs and conscription. Nothing came of these negotiations, although they were prophetic of subsequent events.

In 1913 he faced one of the gravest personal crises in his career. In April 1912, along with Rufus Isaacs (later marquess of Reading), the attorney general, he had purchased shares in the American Marconi company through Isaacs' brother, Godfrey, who was managing director, at a preferential rate well below that available to the general public. The American Marconi company was legally independent of the British concern, but the fortunes of the two companies were closely connected, and the latter's shares had recently boomed as a result of the government's decision to accept its proposal to construct a chain of radio stations throughout the empire. Rumours of corruption were widespread and were only stilled by a libel action brought by Lloyd George and Isaacs against a French newspaper. But unluckily they had already denied, in somewhat ambiguous language, any transactions in the shares of "the Marconi company," a denial which technically referred only to the British company but was generally assumed to cover the American as well. The select committee of the house of commons appointed to investigate the matter revealed the facts and, although by a party majority it acquitted the ministers of blame, Lloyd George's reputation for integrity was damaged.

Social Reform and the Outbreak of War.—Lloyd George's major achievement during the years immediately before the war was in the field of social insurance. Old-age pensions had already been introduced, though on a noncontributory basis, by Asquith in 1908. Inspired by a visit to Germany (1908), where he studied the Bismarckian scheme of compulsory contributory insurance benefits, Lloyd George decided to introduce health and unemployment insurance on a similar basis in Britain. This he did in the National Insurance act of 1911. The measure inspired bitter opposition. It was unpopular with the working class who were not convinced by Lloyd George's own slogan "ninepence for fourpence," the difference in these two figures being the employer's and the state's contribution. Naturally the employers were against it, and the doctors were up in arms at a threat to their private practices. Lloyd George was undeterred, and piloted his measure through parliament with great skill and determination. He thus laid the foundations of the modern welfare state and, if he had done nothing else, would deserve fame for that achievement.

Much of the government's time during these years was occupied by the Irish question. Lloyd George was not in the forefront here. Nor was he normally much concerned with the grave issues of foreign policy which increasingly dominated the minds of his

leading colleagues. On the whole he inclined to the "little Englander" side of the party. It was, therefore, something of a sensation when, in July 1911, after careful consultation with Asquith and Sir Edward Grey, he chose the occasion of the chancellor of the exchequer's traditional Mansion house speech to utter a formidable warning to Germany as to the limits of British endurance over the Agadir crisis. When the question of intervention on the side of France convulsed the cabinet in late July and early August 1914 he seemed at first to incline to the isolationist section. For a brief moment he contemplated retirement. But the tide of events swept him to the other side. As chancellor he plunged into the financial problems posed by the war. Less than two months after its outbreak he made one of his most eloquent speeches; referring to the comfortable existence in "a sheltered valley" led by most of his compatriots, he urged them to remember "the everlasting things that matter for a nation—the great peaks we had forgotten, of Honour, Duty, Patriotism, and, clad in glittering white, the great pinnacle of Sacrifice pointing like a rugged finger to Heaven."

Minister of Munitions and Secretary of State for War.—Throughout the remainder of 1914 and the early months of 1915, Lloyd George was a vigorous advocate of increased munitions production. Here he came into sharp conflict with Earl Kitchener, for he pressed again and again the case for removing the whole field of supply from the war office. The resignation of Admiral Fisher in 1915 forced Asquith to reconstruct the government on a coalition basis and admit the Conservatives. In the new administration Lloyd George became minister of munitions. In this capacity he made one of the most notable contributions to the victory of the Allies. His methods were unorthodox and shocked the civil service, but his energy was immense, and it is to be doubted whether any other person could have produced the tremendous expansion needed. He imported able assistants from the world of big business, and he used his persuasive eloquence to induce the co-operation of organized labour. When in the summer of 1916 the great battle of the Somme began, supplies were adequate, though not lavish. On war strategy Lloyd George acquired definite views at an early stage. He was an "easterner," one of those who doubted the possibility of breaking through on the western front and advocated instead a flank attack from the near east. He was thus at loggerheads, almost from the beginning, with the view of the official military hierarchy, cogently pressed by Sir Douglas Haig and Sir William Robertson, that the war could only be won in the west. On June 5, 1916, Kitchener was drowned on his way to Russia. A last-minute accident—acute developments in the Irish situation—alone prevented Lloyd George from traveling with him and suffering the same fate. After some hesitation Asquith appointed him to the vacant position at the war office.

Lloyd George held the post for five months. Robertson as chief of the imperial general staff possessed, under a concordat arranged at the end of 1915, nearly all the really important powers of the war minister. Lloyd George chafed under these restrictions, the more so since he profoundly disagreed with Robertson on the vital issues of strategy. Thus frustrated he began to survey the whole direction of the war with increasing skepticism, and he did not conceal his doubts from his friends, Sir Edward Carson, Andrew Bonar Law, and above all Sir William Maxwell Aitken (afterward Lord Beaverbrook), who played an important role as an intermediary in the crisis that ensued. By the end of November Lloyd George and his friends had become convinced that Asquith should delegate the day-to-day running of the war to a small committee whose chairman should be Lloyd George. There was undoubtedly widespread uneasiness at Asquith's conduct of affairs, particularly in the Conservative party. A series of maneuvers, too complicated to describe here, resulted in Asquith's resignation on Dec. 5 and his replacement on Dec. 7 by Lloyd George. He was supported by the leading Conservatives, Bonar Law becoming chancellor of the exchequer, leader of the house and second in command of the government, and Balfour becoming foreign secretary. But the most prominent Liberal ministers, Reginald McKenna, Grey, Lord Crewe and Sir Herbert (later Viscount) Samuel, resigned with Asquith, and, although about half the rank and file of the party supported the new government, Lloyd George was never forgiven by the old guard of his party for having, as it seemed to them, jockeyed Asquith out of office.

PRIME MINISTER

Lloyd George was now 54 and at the height of his powers. His energy, eloquence and ability had already made him the leading statesman of the day, and his accession to the premiership was highly popular in the country generally. A sense of renewed vigour, of "push and go," was given to the whole war effort. Lloyd George immediately substituted a small war cabinet of 5, which was to be in constant session, for the unwieldy body of 23 which had hitherto conducted affairs. He instituted a cabinet secretariat headed by Sir Maurice (later Lord) Hankey, and for the first time decisions were properly recorded and minutes kept. The result of these changes at the top was a general speeding up of decisions and the disappearance of the procrastination which from time to time seemed to have marred the activities of the previous government. Among Lloyd George's earliest actions was his resolve to associate organized labour with the government. Another early and important decision was to secure the closer co-operation of the dominion prime ministers and other leaders in the empire by the creation of an imperial war cabinet and the holding of regular imperial war conferences.

One of Lloyd George's most notable achievements was in combating the submarine menace which in the early months of 1917 threatened to starve Britain into submission. Not only did he force the adoption of the convoy system upon a very reluctant admiralty, but he also succeeded in greatly increasing the construction of merchant shipping to replace losses—his instrument being a great shipowner, Sir Joseph (afterward Lord) Maclay whom he appointed as director of shipping. Another acute problem which arose from the submarine threat was the food shortage. Drastic action had to be taken to step up agricultural production, and eventually a system of food rationing had to be introduced (1918). In all these matters Lloyd George was at his best, contemptuous of red tape and official obstruction, determined to take action and to make his will prevail.

It was in the field of grand strategy that he was least successful. By the time of his accession it was too late, even if it ever had been possible, to launch an effective "eastern" strategy. But Lloyd George remained profoundly skeptical of the ability of the British high command to conduct even a "western" strategy successfully. Without warning Haig or Robertson in advance he confronted them at the Calais conference of Feb. 1917 with a plan concerted with Aristide Briand, the French prime minister, to place the British army under French command for Gen. Robert Nivelle's forthcoming offensive. Although the plan was somewhat modified as a result of protests from Haig and Robertson, the two generals deeply distrusted Lloyd George from that moment onward. The Nivelle offensive was a total failure and Lloyd George was, as a result, on slightly shaky ground when he endeavoured to resist Haig's proposals for a major British campaign in Flanders in the summer. After much hesitation he gave way, and on July 31, 1917, the ill-fated Passchendaele offensive began. Although there can be argument as to whether on balance the German or the British army was the more devastated at the end of the campaign and, although the offensive may have forestalled a possible German attack on the French, Passchendaele achieved none of its main objectives. In November mud and rain brought it to a final halt. Lloyd George was now convinced of the incompetence of Haig and Robertson.

He still dared not take action against them openly. Instead he began what Sir Winston Churchill calls "a series of extremely laborious and mystifying maneuvers" with the object of creating a unified command whose generalissimo would be someone other than Haig. In Feb. 1918 Robertson offered his resignation, which Lloyd George accepted. It was tantamount to dismissal. Haig, however, remained as commander in chief while Sir Henry Wilson was promoted to fill Robertson's place. Such was Lloyd George's distrust of Haig that during the winter of 1917–18 he had deliberately kept him short of troops for fear that he might renew the

attack. The result was that Ludendorff's March offensive broke the British line, came near to splitting the French and British armies, and threatened to drive the latter into the sea. The emergency caused a unified command under Marshal Foch to be established (April) and by May the situation became stabilized. Out of these events arose the famous Maurice debate. Maj. Gen. Sir Frederick Maurice, who was in the war office, published a letter claiming that Lloyd George had given incorrect figures in reply to a question about manpower on the western front. Lloyd George made a brilliant speech at the subsequent debate, though later evidence shows that Maurice was undoubtedly right. But the Asquithian Liberals pressed the matter to a division and were heavily beaten.

The tide now turned in the west. Haig launched a series of successful attacks upon an exhausted German army that had shot its last bolt. The Armistice of Nov. 1918 faced Lloyd George with a dilemma. Should he allow a return to peacetime party politics or continue the coalition? There was little doubt of the answer. Bonar Law was willing to co-operate. A somewhat perfunctory offer to include Asquith was declined. The ensuing election in December gave the coalitionists an overwhelming victory. Those who followed Asquith at the Maurice debate were not granted the "coupon," the joint letter from Lloyd George and Bonar Law which certified the candidate as a coalitionist. Nearly all, Asquith included, lost their seats. The rift in the Liberal party became wider than ever and Lloyd George was now largely dependent on Conservative support. It is sometimes said that he handicapped himself at the peace conference by having pandered to ill-informed public demand for a Carthaginian peace during the "coupon" election. Examination of his speeches does not bear out the charge. He never ceased to utter cautionary warnings about Germany's capacity to pay, although he did not fail to emphasize the Germans' moral obligation to pay all they could.

Postwar Policy.—As one of the three great statesmen at Versailles, Lloyd George must bear a major responsibility for the peace settlement. He pursued a middle course between that of Georges Clemenceau, who was determined to keep Germany as weak as possible in the interest of France, and President Wilson, who aimed at a peace based upon international justice, self-determination and the League of Nations. But, throughout, Lloyd George was under strong pressure at home to pursue the more draconian policy. Lord Northcliffe, one of the few press proprietors whom he had failed to placate, was foremost in advocating harsh terms. It is to Lloyd George's credit that the final settlement was not far worse, and many of the bad features of Versailles arose from later developments which he could not have foreseen. The treaty was well-received in Britain, and in Aug. 1919 the king conferred on him the Order of Merit.

Meanwhile at home Lloyd George had reconstructed his cabinet, restoring it to its peacetime size. Bonar Law remained leader of the house, but gave up the exchequer to Austen Chamberlain. Lord Curzon had the foreign office, Churchill the war office, and F. E. Smith, the lord chancellorship. There was much industrial discontent, and the difficulties of adjusting Britain's economy from war to peace were formidable. Lloyd George played an important part once again as arbitrator and conciliator in numerous strikes.

A major domestic problem was Ireland where the Sinn Fein refused to recognize the British parliament and from 1919 to 1920 a civil war of massacre and reprisal raged. The temporary retirement of Bonar Law in March 1921 indirectly weakened Lloyd George's position, for the former's successor as leader of the Conservative party, Austen Chamberlain, was less in touch with the rank and file of the party and less capable of stating disagreeable home truths to the prime minister. In the summer of 1921 Lloyd George, with full agreement of his Conservative colleagues, reversed the policy of repression in Ireland and initiated the negotiations with Arthur Griffith and Michael Collins that culminated in the Irish treaty of Dec. 1921. The more rigid Tories never forgave this "surrender," as they deemed it. In 1922 Lloyd George ran into further trouble over the so-called honours scandal when accusations were made in both houses of parliament that peerages and other honours were being regularly sold for large sums of money. There seems to have been some truth in the allegation. Lloyd George lacked the funds to finance a party machine of his own, the Liberal organization being in Asquith's hands. It is certain that he raised a very large sum, and probable that he was not overscrupulous about the character of the contributors. Tory discontent was rife when from a wholly unexpected quarter a crisis occurred that drove Lloyd George from power forever. This was the Chanak incident (*see* TURKEY: *History*), when it seemed to critics that the reckless foreign policy of the government had led Britain to the verge of an unnecessary war with the Turkish dictator, Mustafa Kemal Atatürk. These criticisms were not warranted. Lloyd George's firm line in fact preserved peace and was not the act of a warmonger. But when the Conservative leaders decided to appeal to the country on a coalition basis once again, a party revolt ensued. Bonar Law returned to the political scene and on Oct. 19 a 2 to 1 majority of Conservative M.P.s endorsed his and Stanley Baldwin's plea to fight as an independent party. Lloyd George at once resigned, and was succeeded by Bonar Law who won an easy victory at the general election that followed.

POLITICAL ECLIPSE

The long twilight of Lloyd George's career was a melancholy anticlimax, and can be but briefly told here. The feud with the Asquithians was never healed. There was a temporary *rapprochement* for the 1923 election, and the united party won 158 seats, but in 1924 the number slumped to 40. In 1926 Lloyd George expressed opinions on the general strike which conflicted with those of Asquith (now Lord Oxford and Asquith) and the latter resigned his leadership. Lloyd George was elected in his place but his personal control over the immense political fund that he had acquired as prime minister caused endless discontent, for he firmly declined to hand it over to the party whips and doled it out as he saw fit. In the election of 1929 the party's fortunes slightly revived, numbers rising to 59, but the economic crisis of 1931 saw the end of Lloyd George's leadership. He was ill at the time and subsequently denounced the decision of Samuel and Sir John Simon to join the national government. Thereafter he was a lonely political figure, and, although there was from time to time talk of his joining the government, nothing came of it. He devoted himself to writing his *War Memoirs* (1933–36) and *The Truth About the Peace Treaties* (1938). Of vast length, yet supremely readable and interspersed with many brilliant pen portraits, these volumes are an exercise in the forensic rather than the historian's art. He seldom admits error and the endless diatribes against his opponents carry little conviction. His memoirs lack the Gibbonian majesty and the genuine detachment of Churchill's. In 1936 he visited Germany and met Hitler. Like many others he was temporarily taken in by him, but he soon saw his error, and in 1938 and 1939 he was a leading opponent of appeasement. In 1940 Churchill invited him to join his war cabinet, but Lloyd George, who had become something of a defeatist, declined, ostensibly on grounds of age and health. On Jan. 1, 1945, he was elevated to the peerage as Earl Lloyd George of Dwyfor. He died on March 26, 1945.

Lloyd George's first wife died in 1941 and in 1943 he married Frances Louise Stevenson, who had been his private secretary since 1913. Of the four surviving children of his first marriage, two entered politics. Gwilym (1894–) entered parliament as a Liberal in 1922 and as Liberal and Conservative member for Newcastle upon Tyne was home secretary and minister for Welsh affairs from 1954 to 1957, when he was created Viscount Tenby of Bulford. Megan (1902–) was a Liberal member of parliament from 1929 to 1951 and deputy leader of the party (1949–51), but subsequently joined the Labour party and became Labour M.P. for Carmarthen in 1957.

CHARACTER AND ACHIEVEMENTS

"What is this glittering whirl at the centre of our public life?" asked one of Lloyd George's many critics. It is not an easy question to answer. His personality is something of an enigma to the historian. It is easy to list his qualities: his eloquence; his

extraordinary charm and persuasiveness; his sense of wit and fun; his capacity to see to the heart of problems whose complexity baffled lesser men; his profound sympathy with oppressed classes and races; his genuine hatred of those who abused power, whether that power was based on wealth or caste or military might. But there was an obverse side to these virtues: his love of devious methods; his remarkable, albeit temporary, gullibility in the face of Hitler and the Nazis; his carelessness and want of discretion—some would use severer words—over appointments and honours; his defeatism in World War II, which contrasted so sadly with his earlier courage.

The truth is that Lloyd George, for all his greatness, aroused in many people a profound sense of mistrust. "England, a country subject to fogs and possessing a powerful middle class, needs grave statesmen," wrote Disraeli. Lloyd George, like Disraeli himself, was never a grave statesman. Like Disraeli, too, he was not even English, and it was in the English middle class, represented in politics by Stanley Baldwin and Neville Chamberlain, that he inspired the acutest misgivings. They were both determined to exclude him from office, and it would be wrong to ascribe his long years in the political wilderness solely to the declining fortunes of the Liberal party. It is perhaps significant of his defects that Lloyd George, though possessing a host of acquaintances and a number of sycophants, never had a really intimate friend. Winston Churchill was the only political personage who habitually addressed him in letters as "My dear David." There was in him a streak of ruthlessness which left little room for the cultivation of personal friendship. Lord Beaverbrook, who knew him well, wrote: "Once he is estranged there is none of that lingering afterglow which makes us still cherish memory and hesitate to strike the sometime companion."

For these and other reasons he was never able to recover the position he had lost in 1922. It was one of the tragedies of the interwar years that in an era not notable for political talent the one man of genius in politics, who might have found some solution for Britain's economic malaise, should have been condemned to remain an impotent spectator on the sidelines. But his earlier achievements make his place in history secure. He laid the foundations of the welfare state. He led Britain to victory in what seemed then the greatest of all wars. For 16 years from 1906 to 1922 he dominated the political scene. In the words of Churchill addressing the house of commons after Lloyd George's death: "When the English history of the first quarter of the twentieth century is written it will be found that the greater part of our fortunes in peace and in war were shaped by this one man." *See* LIBERAL PARTY (BRITISH); *see* also references under "Lloyd George of Dwyfor, David Lloyd George" in the Index.

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(R. N. W. B.)

LLOYD'S, an international insurance market in London and the world centre of shipping intelligence, is known throughout the world as "Lloyd's of London." Its origins date from the 17th century. The corporation of Lloyd's is the governing body of the market but does not itself transact insurance business: this is done by individuals, known as underwriting members of Lloyd's, who accept insurance for their own account and risk and in competition with each other.

Only underwriting members are eligible to accept insurance at Lloyd's. The corporation of Lloyd's lays down very strict financial rules and other regulations for membership designed to insure the maximum security behind Lloyd's policies. Candidates for membership must be supported by six existing members and are elected by ballot only after they have proved to the satisfaction of the committee of Lloyd's that their resources are sufficient to meet any liabilities likely to be incurred. Underwriting members must make deposits in cash or approved securities with the corporation of a minimum of £15,000 where marine and nonmarine business is to be transacted. They must also pay their annual premium income into trust funds from which only amounts for the payment of claims, expenses and ascertained profits may be released; submit to a searching annual audit; and carry on their underwriting with unlimited liability.

There were in the mid-1960s approximately 5,500 underwriting members of Lloyd's, not all of whom were actively engaged in insurance. They were formed into about 300 syndicates comprising from a few to several hundred members. These syndicates are represented at Lloyd's by underwriting agents and it is they who accept insurance business on behalf of the members of their syndicates. This syndicate system was developed to handle the greatly increased insured values of the 20th century and to enable underwriters to give much larger insurance cover than they would be able to do if they accepted risks on behalf of themselves alone. Members of syndicates not underwriting personally are known as "names" but are still responsible with unlimited liability for the business transacted for them by their underwriting agents.

Insurance may be placed with Lloyd's underwriters only through Lloyd's brokers, of which there were more than 200 firms in the early 1960s. Brokers are the representatives of the insured and it is their function to try to obtain from underwriters the most favourable terms possible. When placing insurance, the broker prepares what is known as a "slip," a folded sheet of paper, on which are written the principal facts of the risk to be covered. He takes this slip from underwriter to underwriter in the underwriting room at Lloyd's to obtain competitive quotes of premium. When the broker has reached agreement with an underwriter on a suitable rate of premium, the underwriter writes his initials on the slip and the amount of the risk he is prepared to accept; if the insured value is very large an underwriter may be prepared to accept only a portion of the risk on behalf of his syndicate. In this case the broker must approach other underwriters and persuade them also to accept percentages at the same rate of premium until he has obtained the required cover.

By this system an insurance risk is spread over a number of individuals and should a claim be made each underwriter is responsible only for his portion of it. This practice enables extremely heavy losses to be borne without the dire repercussions that might otherwise be felt.

Lloyd's Coffeehouse.—Lloyd's has an interesting history. In 1688 Edward Lloyd kept a coffeehouse in Tower street. There, as in other similar houses, merchants, bankers and seafarers assembled to drink coffee and transact business informally. The coffeehouse was also the popular meeting place for underwriters—those who would accept insurance on ships for the payment of a premium—and over the years it became recognized by seekers of insurance cover as the most likely place where a number of underwriters could be found.

From this informal beginning Lloyd's gradually grew in repute and influence. It had been the practice of Edward Lloyd to supply his customers with shipping information obtained from the docks by runners and from other sources, and in 1696 he published for a short period *Lloyd's News*, giving details of shipping movements and other matters of interest; this was the forerunner of *Lloyd's List*, first published in 1734.

Lloyd died in 1713 but his coffeehouse, then situated in Lombard street, retained his name and survived two and a half centuries of subsequent development. In 1774 under the guidance of John Julius Angerstein, perhaps the most outstanding personality who has appeared in its history, Lloyd's moved to the royal exchange. It remained there for more than a century and a half during a tenancy broken only by the period of rebuilding after a fire in 1838. In 1928 a new building was opened on the site of the East India house in Leadenhall street, and in 1952 the foundation stone was laid of another new building in Lime street, which was opened in 1957.

The outbreak of war with France in 1793 led to a period of remarkable expansion during which Lloyd's advanced in wealth and importance, although the underwriters were at times subjected to losses that strained their resources. In the year 1794–95, for example, one underwriter, Robert Sheddon, paid out £190,000

to satisfy claims. During 1793–1815 Lloyd's exerted a salutary influence on the admiralty and the direction of naval operations in relation to seaborne trade, especially in regard to the use of convoys. At a time when the state made no provision for war victims, Lloyd's inaugurated many subscriptions for that purpose, culminating in the establishment in 1803 of the patriotic fund, which is still in operation. Gifts of silver plate were made to Lord Nelson and to the captains at Trafalgar. A portion of the Nelson plate and a Trafalgar cup, designed by John Flaxman, later came into the possession of Lloyd's and form part of the society's Nelson collection.

In 1811 under the influence of its chairman, Joseph Marryat, M.P., father of the novelist Frederick Marryat, and himself a man of unusual ability, Lloyd's prepared the way for incorporation by the curious expedient of inducing the subscribers to sign a trust deed vesting the corporate funds in the committee of treasury and imposing bylaws on the subscribers. It was, moreover, in this period that the system of Lloyd's agencies was initiated and the duties defined.

Incorporation, 1871.—In 1871 the control over the affairs of the society by its committee was consolidated by the act of incorporation (Lloyd's act, 1871), which formed the constitution of Lloyd's as it has continued to exist. The society was given power to make its own bylaws, to acquire real and personal property and to do all acts in its corporate name. By the act of 1871 the society was restricted to marine insurance but by an act of 1911 it was empowered to carry on insurance of every description.

Although individual initiative is still a most striking characteristic of Lloyd's, the powers and activities of the corporate body have increased. The measures designed to make the security of a Lloyd's policy unquestionable were taken almost entirely after the act of 1871. Under the Assurance Companies acts, 1909 and 1946, consolidated by the Insurance Companies act, 1958, special provisions are set forth to regulate Lloyd's underwriters. *See* also LLOYD'S REGISTER OF SHIPPING.

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LLOYD'S REGISTER OF SHIPPING, a society whose main purpose is the survey and classification of merchant shipping and whose standards for the construction and maintenance of ships have been accepted throughout the world. The society is governed solely by the industry it serves and its revenue is devoted to the maintenance and improvement of its services. International in scope, its head office is in London. Like the insurance institution known as the Corporation of Lloyd's (*see* LLOYD'S), it originated in the 17th-century coffeehouse kept in London by Edward Lloyd. Among the men who conducted their business there the need was felt for some guide as to the ships available. To meet this need a group of underwriters combined in 1760 to issue a register, the first known edition of which appeared in 1764. In the first register, ships were graded according to their condition and assigned classes, indicated by letters. The symbol of "A1" for the highest class of ship was introduced in 1775 and has since passed into many languages, either as "A1" or "A1 at Lloyd's," as a connotation of excellence. Nowadays there is only one class, which for ocean-going iron and steel ships is symbolized by "100A1."

In 1834, after some rivalry with the shipowners, issue of the register was placed under the control of a society to be known as Lloyd's Register of British and Foreign Shipping ("British and Foreign" later deleted), and for the first time standard rules for shipbuilding were issued. Management of the society in its new form was vested in a committee composed of merchants, underwriters and shipowners of London; the committee came to include shipbuilders, engineers, steelmakers and representatives from other parts of the U.K. and from 13 other maritime countries. In addition to an international technical committee, which deals with the formulation of rules, there are local committees at Liverpool and in Scotland, and national committees in Australia, Canada, Denmark, Finland, France, Greece, India, Italy, the Netherlands, New Zealand, Spain, Sweden and the United States. The first volume of the register's book contains particulars of all known seagoing merchant ships of 100 or more tons gross, while the second, third and fourth volumes contain additional technical information and lists of shipowners, shipbuilders, dry and wet docks throughout the world, harbours, etc. Registers of British and American yachts, and quarterly and annual statistics regarding ships under construction and ship casualties, are also published. The society's main activity is the supervision of the construction of ships and their machinery, from the examination of plans and testing of materials, through the various stages of building to the trial trip, and the holding of regular periodical surveys throughout the ship's life to ensure that it is fit to retain the society's class. The society publishes comprehensive rules providing standards of construction for ships and for their propelling, electrical and refrigerating machinery. A staff of over 1,100 surveyors, stationed at all principal ports and at engineering centres throughout the world, is employed to carry out the highly specialized duties, which include the calculation and fixing of load lines on behalf of 49 different nations in accordance with the International Load Line convention, 1930, and the issue of safety certificates under the International Convention on the Safety of Life at Sea, 1948. A comparatively new aspect of the society's work is the inspection of material for land installations such as oil refineries, hydroelectric and atomic power stations, railways and chemical plants. This work, increasing steadily, is performed by a special nonmarine department.

(E. E. PA.)

LLULL, RAMON (Castilian, RAIMUNDO LULIO; English, RAYMOND LULL or LULLY) (*c.* 1234–1316), Catalan author, lay missionary, philosopher in the Augustinian tradition, the first great mystic of the Iberian peninsula. He wrote some 292 works in Catalan, Arabic and Latin, most of which survive, although no Arabic manuscripts are known. The creator of literary Catalan, which he used not only in poetry, novels and mystical works, but also to discuss theological, philosophical, moral and scientific subjects before any other romance vernacular had been used professionally in this way, he is best known in the history of ideas as the inventor of an "art of finding truth" (*ars inveniendi veritatis*) primarily intended to support the Catholic faith in missionary work but also designed to unify all branches of knowledge.

Born in Majorca (Mallorca), shortly after its reconquest from the Moors, Lull grew up in a kingdom with large non-Christian minorities, and the national preoccupation with their conversion had a decisive effect on his life and writings. On his entering upon a religious way of life (*c.* 1263), after seeing five visions of Christ on the cross, he made a threefold resolution: to seek martyrdom; to found schools of oriental languages for missionaries; and to write "the best book in the world against the errors of the infidel." He then spent some nine years in preparation for his mission, during which he composed his longest book (*Llibre de contemplació*, a meditative work with an elaborate symbolic structure containing numerous separate opuscula, written first in Arabic and then in Catalan), and the *Llibre del gentil e los tres savis*—an account of a fictitious theological discussion between a Jew, a Christian and a Muslim which influenced the *Libro de los estados* of Don Juan Manuel (*q.v.*). Neither of these, however, was the "best book in the world" contemplated in his third resolution, which first took shape as the first version of his "Art," written *c.* 1272, after a mystical "Illumination" on Mt. Randa in which he saw how everything in the universe could be related to the Godhead through the divine attributes (goodness, greatness, etc.), which he called "Dignities." The rest of his life was spent in constant traveling, writing, preaching and lecturing on the "Art"; in missions (Tunis 1292, Bougie 1307, Tunis 1315) and disputations; and in pleading with kings and successive popes for support, especially in connection with the colleges envisaged in his second resolution. Only King James II of Majorca could be persuaded to establish one (at Miramar, 1276, apparently abandoned soon after 1292), but the Council of Vienne (1311–12) endorsed Lull's proposals, and a number of schools of oriental languages were founded in the years after his death. According to pious tradition, this came in the form of the martyrdom he had so long desired, by stoning in Bougie (? Jan. 1316). His last three works were un-

doubtedly written in Tunis in Dec. 1315. He had never taken holy orders (though long attracted by both the Dominicans and Franciscans), but there is a late tradition that he joined the Third Order of St. Francis in 1295. He is revered by Franciscans as *"Doctor Illuminatus,"* and his feast day is kept throughout the Order on July 3. Traditionally regarded as a saint in Majorca and elsewhere, he has never been officially canonized, though in 1858 his *cultus* was confirmed by Pius IX.

In his mystical writings he belongs to the Franciscan tradition, though his best-known mystical work, *Llibre d'amic e amat* (*Book of the Lover and the Beloved;* included in book v of *Blanquerna*), is strongly influenced by Muslim Sufi mysticism (*see* SUFISM), and his longer mystical treatises—*Art amativa,* 1290; *Arbre de filosofia d'amor (Tree of Love),* 1298—are so dependent on the methods of his "Art" as to stand outside the main stream of that tradition. His didactic allegorical novels, the *Llibre d'Evast e Blanquerna* (?1284) and the *Llibre de meravelles,* or *Felix* (*c.* 1288), occupy a prominent place in the rise of prose fiction, the former being a well-developed utopian romance, the latter including the famous *Llibre de les besties* (*Book of the Beasts*), a collection of animal apologues in imitation of the Arabic *Kalila wa Dimna* (*see* ARABIC LITERATURE: *Belles-lettres*). His *Llibre qui és de l'orde de cavalleria* (between 1275 and 1281), a manual of chivalry, was widely translated, an English version (made from the French) being among the books published by William Caxton (*q.v.*); and his *Arbre de sciència* (1295) was one of the last great medieval compendia of universal knowledge. His lyrical poetry combines great simplicity with sublimity of thought.

Most of Lull's nonliterary writings are connected with his "Art," which was (like the *Summa contra gentiles* of St. Thomas Aquinas completed in 1264, only a few years before Lull's "Illumination") an attempt to place Christian apologetics on the level of rational discussion, mainly to meet the needs of disputation with the Muslims—against whom "arguments from authority" based on Scripture (the basic approach in Dominican disputations with Jewish theologians during the previous generation) were inapplicable. Its use of complex semimechanical techniques involving symbolic notation and combinatory diagrams justifies its classification among the antecedents of both "logic machines" and modern symbolic logic, but these techniques are purely ancillary, and should not be allowed to obscure its fundamental nature. Basically the "Art" works by relating all forms of knowledge (including religious belief) to the manifestation of God's "Dignities" in the universe, taking for its point of departure the monotheistic vision common to Judaism, Islam and Christianity, and their acceptance of a broadly Neoplatonic exemplarist world-picture, and arguing its way analogically up and down the "ladder of being." Lull uses it in apologetics to draw specifically Christian conclusions concerning the Trinity and the Incarnation from generally accepted views regarding the active nature of the divine attributes. It seems probable that his combinatory techniques were modeled on those developed in the medical field to deal with combinations of the "four elements" in connection with humoral pathology, and that Lull hoped that the analogy of the elements would provide, as it were, a "scientific" basis for argumentation at higher levels of the "ladder"—since all levels were analogically related to each other, being reflections of the same divine exemplar, their Creator. The more "elemental" features of the "Art" were, however, dropped when the "Dignities" were reduced (*c.* 1289) from 16 to 9, and it is in its ternary—or more obviously Trinitarian—form that the "Art" was known to later thinkers, most of whom used its final version: the *Ars Magna* [*Generalis Ultima*] of 1305–08. Its apologetic application also receded into the background after Lull's death, and it was as a universal system of knowledge that the "Art" remained influential until long after the Renaissance, ultimately inspiring Leibniz' dream of a "universal algebra." *See* LOGIC, HISTORY OF: *Modern Logic: Leibniz.*

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LLWCHWR, an urban district in the Gower parliamentary division of Glamorgan, Wales, is situated 5 mi. N.W. of Swansea and bounded on the west by the Loughor river. Pop. (1961) 24,903. The district comprises four small towns: Gorseinon, the administrative and business centre, with steel and tinplate works; Loughor, the old borough which gives its name to the district and contains the ruins of a 13th- to 14th-century castle, a Perpendicular church and a fine modern bridge; Gowerton, a modern steel town where a "Flannel and Pleasure" fair has been held annually from early times; and Pontardulais, a modern tinplate manufacturing and coal-mining town, possessing the 12th-century church of St. Teilo, isolated on the river plain a little way out of the town. Pontardulais has gained a reputation for its music.

LOACH, any of the small but elongate carplike fishes of the fresh-water family Cobitidae. More than 200 species are known, mostly from mountain streams in central and southern Asia; 3 species occur in Europe and 1 in Ethiopia. Few species attain a length of 12 in. The typical loach has very small scales; three to six pairs of barbels; the air bladder reduced and wholly or partly enclosed in a bony capsule; and the pharyngeal teeth in a single series. In low and stagnant ponds, loaches come to the surface and swallow air, the intestine serving as an organ of respiration. The stone loach (*Nemachilus barbatula*) and the spined loach (*Cobitis taenia*) range through Europe and northern Asia to Japan. One species of European loach, *Misgurnus fossilis,* is called weatherfish because of its heightened activity during periods of rapid change in barometric pressure, as occurs prior to a storm. *See* FISH. (L. A. WD.)

LOAN: *see* CREDIT RATING; MONEYLENDING; PAWNBROKING; USURY.

LOANGO, a region of the west coast of Africa, extending north from the mouth of the Congo. In the 17th and 18th centuries it formed a kingdom of that name (also known as Brama), but after 1885 the country was divided between French Equatorial Africa, the Portuguese district of Cabinda and the Belgian Congo. The inhabitants belong to the Bantu group of Vili (subgroup of the Kongo [*q.v.*]), formerly known as the Fiote. Loango town is now an insignificant coastal place having been superseded by the port of Pointe-Noire.

The early history of Loango is unknown. During the 15th and 16th centuries Portuguese merchants visited the kingdom which appears to have belonged to the kingdom of Congo, located south of the Congo river. It achieved independence toward the end of the 16th century. The kingdom was bounded to the north by Mayombe, east by the Mayombe plateau, and south by the Kakongo kingdom. It was divided into four provinces. During the 17th and 18th centuries the country was an important source of slaves for the new world. Loango was visited by Portuguese and Dutch ships and later principally by French and English. Roman Catholic attempts at missionary work were unsuccessful. By the middle of the 19th century the kingdom had been reduced in influence. In 1883 the king of Loango signed a treaty placing his country under the protection of France; it became part of the Middle Congo (Moyen-Congo) territory and, since 1958, of the Republic of Congo.

See D. Lopez, *A Report of the Kingdom of Congo,* by F. Pigafetta, Eng. trans. by M. Hutchinson (1881); L'abbé Proyart, *Histoire de Loango, Kakongo et autres royaumes d'Afrique* (1776).
(H. A. WF.; HU. DE.)

LOBACHEVSKI, NIKOLAI IVANOVICH (1792–1856), Russian mathematician, the founder of a system of non-Euclidean geometry, was born in Nizhni-Novgorod (now Gorki), on Dec. 2 (new style; Nov. 21, old style), 1792. He studied in Kazan university, began teaching there in 1812, and was professor from 1822 to 1846. Lobachevski was one of the first mathema-

ticians to become convinced of the possibility of a geometry different from that of Euclid and the first to publish, in 1829, such a system (*see* GEOMETRY, NON-EUCLIDEAN). Presented in a form hard to understand, it was met in the beginning with derision. Some recognition came during his lifetime (election to the Göttingen Scientific society in 1842) but full appreciation of his work came only at the end of the century, when the non-Euclidean geometries, by suggesting a new way of looking at space, had important implications for theoretical physics and the development of the theory of relativity. In addition to his work in geometry, Lobachevski proved an excellent administrator. At Kazan university, where he was rector from 1827 to 1846, he helped organize the teaching staff and arranged and enriched its library. He also furnished instruments for its observatory, collected specimens for its museums and provided it with proper buildings. In order to be able to supervise the erection of the buildings, he studied architecture. Efficient measures taken by Lobachevski during an outbreak of cholera in 1830 and a disastrous conflagration in 1842 prevented great losses in personnel and equipment of the university. He died at Kazan on Feb. 24 (N.S.; 12, O.S.), 1856.

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See F. Engel, *N. I. Lobatchewsky* (1899); A. Vucinich, "Nicolai Ivanovich Lobachevskii: the Man Behind the First Non-Euclidean Geometry," *Isis*, vol. 53 (1962). (G. Y. R.)

LOBANOV-ROSTOVSKI, ALEKSEI BORISOVICH, PRINCE (1824–1896), Russian diplomat and statesman, minister of foreign affairs from March 1895 to his death, was born on Dec. 30 (new style; 18, old style), 1824. He began his career in the diplomatic service in 1844 and later held posts in Berlin, Paris and Istanbul, where he became minister in 1859. He retired in 1863 but resumed his career in 1878, when he became ambassador at Istanbul before being transferred to London in 1879. He was sent to Vienna in 1882 and to Berlin in 1895. During this time he was one of the most influential of Russian foreign representatives. On March 10 (N.S.; Feb. 26, O.S.), 1895, he succeeded N. K. Giers as foreign minister.

In European affairs Lobanov was a firm supporter of the Franco-Russian alliance, but he sought amicable relations with Austria-Hungary and Germany. He was also able to settle the long-standing quarrel with Bulgaria in 1896. In regard to the crucial question of the Turkish straits, Lobanov believed that under the existing circumstances the Ottoman empire was best suited to play the role of guardian; and, not wishing to compromise Russo-Turkish relations, he refused to co-operate with Great Britain over the issue of the Armenian massacres. Lobanov's chief efforts, however, were directed toward the far east, where Japan had imposed the treaty of Shimonoseki on China. In co-operation with France and Germany, Russia induced Japan to surrender its acquisitions on the Chinese mainland (1895); and on June 3, 1896, Russia signed a defensive alliance with China directed against Japan. In return, China agreed to allow Russia to extend the Trans-Siberian railway across Manchuria to Vladivostok. On Aug. 30 (N.S.; 18, O.S.), 1896, traveling from Kiev to meet the German emperor William II in Silesia, Lobanov died suddenly at Shepetovka, on the Russo-Austrian frontier. (B. J.)

LOBBYING. In its original meaning, "lobbying" referred to the efforts of individuals to influence the votes of legislators, generally in the lobby outside the legislative chamber. In its broadest modern sense it means any attempt by individuals or groups to influence the decisions of government. It is most commonly associated with the activities of private interest groups, often called pressure groups, although even public officials may be said to lobby when they attempt to influence the making of public policy by other officials.

Lobbying in some form is inevitable in any political system, for politics is a struggle for power. Any group that makes claims upon other groups or upon society finds it well-nigh impossible to stay out of politics, for even in a simple society the power of government to say who gets what is too important to ignore. Even in a strictly laissez-faire system—assuming such a system to be possible—the government still would have to provide the legal framework within which social action would take place. In a modern industrial society, where regulation extends in some degree to almost all human activities and relationships, the decisions of public officials may be of crucial importance; they are and must be subject to the close and continuous attention of the groups they affect. Conversely, the government must heed the pressures of group demands. Even the most authoritarian rulers must take into account the army, the priesthood or some other politically influential elements. In a free society, the government's obligation to consult the governed is recognized and institutionalized through guarantees of freedom of speech, press and assembly, and the right of people to petition the government for a redress of grievances. Lobbying occupies a preferred position in the constitutional system because it is necessary to the preservation of self-government.

United States.—If lobbying is necessary for self-government, why does it have such a bad reputation in the United States? In the 19th century its poor reputation was deserved and much of it has hung on. Lobbying was then largely a matter of personal influence in which many lobbyists plied legislators with wine, women and money. Moreover, the moral climate of public life was low. U.S. senators were not chosen by the people but by state legislators and many of them virtually belonged to the interests that engineered their selection. This situation has changed. Lobbying never will be wholly above suspicion, but several congressional investigations in the 20th century have made it clear that modern pressure activities are rarely corrupt; they have become increasingly indirect and are largely group efforts rather than individual efforts.

Several reasons for these trends may be suggested. Exposure of corruption by muckraking writers at the turn of the century undoubtedly had some effect. Direct election of senators and the opening of legislative hearings to the public diminished the influence of interest groups enjoying favoured access to officials. But most important, perhaps, has been the growth of giant associations. The typical national association is a federation of state and local units, capable of operating at every level of government. Representative examples of this kind of association are the National Association of Manufacturers, the Chamber of Commerce of the United States, the American Medical association, the American Federation of Labor-Congress of Industrial Organizations, the American Farm Bureau federation and the National Farmers union. With their large memberships and resources the associations have found it more effective to lobby through their members and to create a sympathetic public opinion than to court individual officials. Besides, the associations have too large a stake in their reputations to risk scandal.

One of the reasons for the frequent criticism of lobbying in the United States is to be found in the fact that lobbies can easily be seen. The group struggle is brought out into the open by the structure of government and the character of political representation. Because they were more concerned with protecting minority rights than with effectuating majority will the makers of the federal constitution deliberately set obstructions in the way of control by a temporary majority. They provided a separation of powers that institutionalized conflict between president and congress and not even the unifying influence of party has been able to overcome it. They gave to each branch of the government some power to check the action of the other branches, thus making obstruction easy and co-operation difficult. There are, moreover, not 1 but 51 governments in the United States, each exercising powers guaranteed to it by a hard-to-amend constitution. In this framework the national parties are merely federations of state and local parties, incapable of carrying out a promised program of action. Power is further dispersed in congress among standing committees, and localism is strengthened by the individual member's dependence on his constituency. With political power so fragmented the group struggle is bound to be public. This makes it easy for participants to denounce the lobbying of the other side; as Sen. Jim Reed once said, "a lobbyist is anyone who opposes legislation I want."

Lobbying in the United States takes many forms. Group in-

terests may be represented openly before legislative committees and administrative tribunals. Public officials may be "buttonholed" in legislative lobbies, offices, hotels, bars, restaurants or private homes. Letters may be written or telephone calls made to public officials, and "grass-roots" campaigns may be organized for this purpose. Organizations seeking to influence public policy may provide favoured candidates with money and services—including radio-television coverage for public speeches and friendly mention or outright endorsement in the publications of the organization. Research and writing services may be made available to public officials. Massive public relations campaigns employing all the techniques of modern communication may be launched to influence public opinion. The persons who lobby in these ways may be full-time officials of a powerful association, individual lobbyists with many clients who pay for their services, or ordinary citizens who take the time to state their hopes or grievances. Some of the most effective lobbyists are former congressmen or administrative officials whose principal asset is that they "know their way around."

The regulation of lobbying poses difficult problems. It is necessary somehow to curb the excesses of pressure groups without restricting their right to represent their members. The national government and more than half the states regulate lobbying. Most laws relating to lobbying, such as the Federal Regulation of Lobbying act (1946), which requires that lobbyists register and report contributions and expenditures and that groups they represent must make similar reports, are based on the assumption that lobbyists cannot do much harm if their activities are publicized. The efficacy of these laws is doubtful; the 1946 federal law, for instance, is poorly written, has no provision for proper administration or enforcement or even for effective publicity, and requires only summary and superficial information. Moreover, indirect lobbying—group activity designed to influence government by shaping public opinion—has proved almost impossible to regulate. Campaigns addressed to the public through newspapers, magazines, television, radio, books, pamphlets and public speeches are protected by constitutional safeguards. The supreme court of the United States has made clear its intention not to permit laws for the regulation of lobbies to infringe upon freedom of speech or of the press. Although the Federal Regulation of Lobbying act covers efforts made "directly or indirectly" to influence the passage or defeat of any legislation by congress, the supreme court in 1953 (*United States* v. *Rumely,* 345 U.S. 41) said that "lobbying" should be construed in its commonly accepted sense as "representations made directly to the Congress, its members or its committees." The next year, in upholding the constitutionality of the lobbying law (*United States* v. *Harriss,* 347 U.S. 612), the court re-enforced its interpretation of the narrow scope of the law.

Great Britain.—Lobbying flourishes in Great Britain as it does in the United States, but not in the same political environment. Different procedures are required in Great Britain to deal with disciplined political parties and a governmental structure that concentrates power in a cabinet that is able to control both legislature and administration. British interest groups show a coherence and concentration of power similar to that of the parties and government. For example, about 90% of British farmers are members of the National Farmers union, while only about 30% of U.S. farmers are thus organized; about half of all British workers belong to labour (trade) unions, compared with 25% of U.S. workers; and the Federation of British Industries represents directly or indirectly about 85% of all manufacturing concerns employing ten or more workers, far more than any U.S. business association. The leaders of these giant organizations exercise such authority that they may bargain directly with party leaders who control the government; indeed, their co-operation is indispensable to the success of the detailed and technical regulations imposed by government on most aspects of British economic life. In addition to such organizations representing economic interests, many groups promote causes reflecting the diversity of British society. They rarely sponsor American-style public relations campaigns, however; their appeals are made directly to party and administration leaders rather than to the electorate and to individual legislators. The vigour and effectiveness of lobbying in Great Britain, where it was formerly assumed there was little, suggest that comparative analyses will document similar activity in all relatively well-developed systems.

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LOBE, any round projecting part, specifically the lower part of the external ear, one of the parts into which the liver or lung is divided, also one of several parts of the brain, divided by marked fissures. (*See* RESPIRATORY SYSTEM, ANATOMY OF; BRAIN: *Anatomy of the Brain.*) The diminutive "lobule" is applied to a similarly shaped portion of a gland, *e.g.,* breast, liver, when of microscopic size.

LOBELIA, the common and scientific name of the typical genus of the family Lobeliaceae, refers to about 250 species of plants, natives of nearly all the temperate and warmer regions of the world, excepting central and eastern Europe and western Asia. They are annual or perennial herbs or undershrubs, rarely shrubby, although the "tree" lobelias found at high elevations on the mountains of tropical Africa are remarkable arborescent forms. *L. dortmanna* (water lobelia) occurs throughout the north temperate zone. *L. urens* (acrid lobelia) is found locally in damp pastures in England and western Europe. The genus is distinguished from *Campanula* by the irregular corolla and completely united anthers, and by the excessive acridity of the milky juice.

The species earliest described and figured appears to be the North American *L. cardinalis,* under the name *Trachelium americanum sive cardinalis planta,* "the rich crimson cardinal's flower"; Parkinson (1629) says, "it groweth neere the riuer of Canada, where the French plantation in America is seated." It is a native of the eastern United States (*see* CARDINAL FLOWER). This and several other species are cultivated as ornamental garden plants, *e.g.,* dwarf blue *L. erinus* from south Africa, which, with its numerous varieties, forms a familiar bedding plant, much used for edging. *L. splendens* and *L. fulgens,* growing from one to two feet high, from Texas and Mexico, have scarlet flowers; *L. tupa,* a Chilean perennial six to eight feet high, has reddish or scarlet flowers; *L. tenuior,* with blue flowers, is Australian and grown in the greenhouse, while *L. georgiana,* from North America, as well as *L. siphilitica* and its hybrids, also have blue flowers. The hybrids raised by crossing *cardinalis, fulgens, splendens* and *siphilitica* constitute a fine group of fairly hardy and showy garden plants.

JOHN N. GERARD

FLOWER SPIKE OF BLUE LOBELIA (LOBELIA SIPHILITICA)

The species *Lobelia inflata,* the Indian or wild tobacco of North America, has been used in medicine, the entire herb, dried and in flower, being employed as an expectorant. The species derives its specific name from its characteristic inflated capsules. It is somewhat irritating to the nostrils, and is possessed of a burning, acrid taste. The chief constituent is a volatile liquid alkaloid named lobeline, which occurs to the extent of about 0.3%; it is similar in physiological action to nicotine. Lobeline is pungent, with a tobaccolike odour, and is very poisonous. From it is made

a medicinal tincture of lobelia, used in treating spasmodic asthma and chronic bronchitis. Fatal cases of poisoning are not uncommon, even if only a few leaves or capsules and their seeds are ingested. Milder manifestations include vomiting, nausea, coma or convulsions. The drug has also been incorporated in compounds used to discourage the smoking of tobacco products.

(N. Tr.; X.)

LOBITO, a town on the west coast of Africa, is situated in the Benguela district of the Portuguese overseas province of Angola, 240 mi. S. of Luanda. The mean annual temperature is 18°–24° C. (65°–75° F.) and the average rainfall, 1⅓–1¾ in. The hottest and wettest months are February and March. In 1955 the population was estimated to be 31,630, made up of 6,390 whites, 420 mestizos and 24,820 Africans. By 1960 it was probably about 9,000 Europeans, 700 mestizos and 31,000 Africans. There are seven primary schools and four secondary schools. Roman Catholicism is the predominant religion.

Lobito is served by a municipal bus service and has an all-season airport. It is the starting point by road for the Huíla and Huambo uplands and for the whole of Angola up to the frontier with the Republic of the Congo; and it is linked by rail with the other principal cities of Angola and with the Republic of the Congo (Katanga), Rhodesia and the east coast of Africa. There are regular sailings of passenger-carrying cargo ships to all parts of the world. The bay of Lobito is one of the finest natural harbours on the whole west African coast, being protected by a natural mole of sand about 3 mi. long and 220 yd. wide. The quays, accommodating vessels with a draft of 34 ft., extend for 1,230 yd. There are about 5½ ac. of covered storage space.

The main industries are metalworking, shipbuilding, the manufacture of cement, building materials, food and clothing. The principal agricultural products are sisal, peanuts, castor oil, coconuts, maize, beans and potatoes. Citrus fruit, pineapples and mangoes are grown. The main exports are minerals and various agricultural products, such as maize, beans and sisal.

Lobito was founded in 1843 as the result of a royal order of Maria II, made in response to the repeated requests of the inhabitants of Benguela for a healthier and geographically and strategically more favoured place to live. Very little in the way of development occurred, however, before the building of railways in the early 20th century.

LOBO, FRANCISCO RODRIGUES (1579–1622), Portuguese poet, best known for his pastoral eclogues, was born in 1579 at Leiria, where he lived until he went to the University of Coimbra to study law. After taking his degree he entered the service of the duke of Braganza. Lobo was drowned in the Tagus, probably before the end of 1622. Some biographers have traced his Jewish descent and possible noble birth, but this is uncertain.

His first book of poems—*Romances* (1596)—reveals a refined sensibility and skill in describing the moods of nature. At this time he was deeply influenced by Luis de Góngora y Argote, and 57 of the 61 poems were in Spanish, which remained a second language for Portuguese writers until the end of the 17th century. Lobo's last work, *Jornada* (published posthumously, 1623), a series of short poems welcoming Philip III to Lisbon, was written in pure Castilian. Although Lobo preferred writing pastoral poems—*e.g., Églogas* (1605)—he also wrote an epic in 20 cantos on Dom Nuno Álvares Pereira, *O Condestabre de Portugal* (1609), but the narrative is monotonous and lacks Camões' vigour and inspiration. Lobo's pastoral trilogy—*A Primavera* (1601), *O Pastor Peregrino* (1608) and *O Desencantado* (1614)—contains his best eclogues. In the countryside where he was brought up, on the banks of the rivers Lis and Lena, his shepherds and shepherdesses discourse wittily on the wiles and whims of love and the weariness of life. A similar pessimism, tempered with philosophical resignation, informs the prose dialogue *Corte na Aldeia* (1619), in which the author discusses, through his characters, such subjects as the harm resulting from the extinction of the Portuguese court under Spanish rule, the best system of education and the new theories of literary expression. Lobo has won a high place in Portuguese literature for his vivid descriptions of the countryside and for the sincerity of his lyrics.

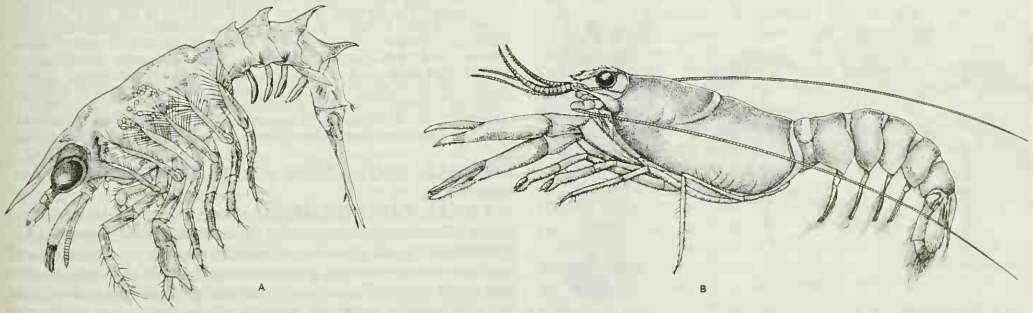
See R. Jorge, *Francisco Rodrigues Lobo* (1920); C. A. Ferreira, "Francisco Rodrigues Lobo—Fontes inéditas para o estudo da sua vida e obra," in *Biblos,* vol. xix (1943). (L. de S. R.)

LOBSTER, an edible crustacean found on the coasts of the north Atlantic and the Mediterranean. The name is sometimes applied to any of the larger Crustacea (*q.v.*) of the shrimplike Decapoda used for food.

True Lobsters.—The true lobsters (family Nephropsidae) are distinguished by having the first three pairs of legs terminating in chelae or pincers, the anteriormost pair being the largest. The dark greenish common lobster (*Homarus gammarus*) is found on the European coasts from Norway to the Mediterranean. The closely related American or northern lobster (*H. americanus*), generally treated as a separate species, ranges from Labrador to North Carolina. Although uncommon, giant American lobsters measuring about 2 ft. long and weighing more than 30 lb. have been taken; a weight of 44½ lb. has been recorded. The average-sized lobster in a catch is about 9 in. in total length (from tip of rostrum to end of tail) or 3½ in. in carapace length (from eye socket to end of dorsal shield along the centre line). Although conservation laws vary considerably, most regulations require that a lobster of carapace length less than $3\frac{3}{16}$ in. (determined quickly by the use of a simple measuring device) be returned to the sea. The European lobster rarely reaches 10 lb. in weight, though individuals of 15 lb. have been found. A third species (*H. capensis*), 4–5 in. long, from the Cape of Good Hope, is of no economic importance.

The principal foods of the omnivorous and scavenging adult are fish, alive or dead, and bottom-dwelling invertebrates, especially small mollusks and such larger ones as can be crushed. Vegetable matter is eaten occasionally. Cannibalism is not unknown.

The true lobsters are the basis of important fisheries. They are generally fished in relatively shallow water, 5 to 50 fathoms, from more or less rocky bottoms by means of lobster pots or creels,



FROM F. N. HERRICK, "THE NATURAL HISTORY OF THE AMERICAN LOBSTER," BUREAU OF FISHERIES BULLETIN, VOL. 29

FIG. 1.—LARVAL STAGES OF THE AMERICAN OR NORTHERN LOBSTER (HOMARUS AMERICANUS): (A) SECOND, SWIMMING OR "MYSIS," STAGE, 9 MM.; (B) SIXTH STAGE, 16 MM.

rectangular traps of wooden slats, or frames covered with netting and provided with a funnel or two permitting entrance but preventing escape. Oily fish, fresh, salted or partially decomposed, are the greatest attraction as bait. Lobsters constitute a multimillion-dollar industry in the United States, where more than 30,000,000 lb. are caught annually; they are marketed fresh, frozen or canned.

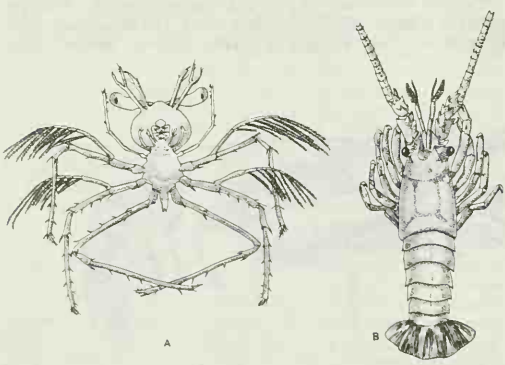
The Norway, or Dublin, lobster, the Italian scampo (*Nephrops norvegicus*), also called maiden lobster because of its slender shape as compared with that of the common lobster, averages about 6 in. in length; 8½- to 10-in. specimens are rare. Found in the Faeroes and off Iceland, it ranges from the coasts of Norway, Scotland and Ireland to the Mediterranean.

Spiny Lobsters.—The names spiny lobster, rock lobster, seacrawfish, langouste, langosta and kreef refer to members of the family Palinuridae, readily distinguished from the Nephropsidae by the lack of prominent pincers and the presence of a more or less spiny carapace or shield. Their distribution is world-wide in tropic and subtropic latitudes and in certain temperate regions. Several species are of major economic importance. Preferring coral reefs or rocky areas, palinurids may also be found over smoother sandy bottoms, if sheltered niches or even brush piles are available; muddy grounds are avoided. Like the true lobsters, all are omnivorous and scavenging and consume considerable invertebrate food; fish heads are the favoured bait.

The European *Palinurus elephas* (formerly, *P. vulgaris*) ranges from Great Britain and France to the Mediterranean. Along the Atlantic and Gulf coasts of the Americas, from Bermuda, the Bahamas and Florida southward through the Caribbean to Rio de Janeiro, *Panulirus argus* is the important species. On the west coast from Monterey to the Gulf of Tehuantepec *P. interruptus* is fished.

Most widely distributed is *Jasus lalandei*, believed to be a complex of several closely related species that range along the coasts of western and southern Africa, Australia, New Zealand, Tasmania and about the islands of Juan Fernandez (off Chile), Tristan da Cunha (south Atlantic) and St. Paul (south Indian Ocean); some specimens attain a length of 20 in. and a reputed weight of 10½ lb. Various other spiny lobsters are fished throughout the Indo-Pacific area, including Japanese waters. The Florida and western American spiny lobsters, taken principally by trapping, average only a few pounds in weight because of heavy fishing; however, 6½ pounders, 18 in. long, are caught occasionally, and a few weighing more than 15 lb. have been reported from Mexican and Central American waters.

Traps similar to the New England lobster pots, and occasionally spears and a modification of the dip net ("bully-net"), are used in American fishery, but South African fishery, because of the abundance of *Jasus lalandei*, employs almost exclusively the simple hoop net between the low-water mark and the 25-fathom line.



FROM C. VON BONDE AND J. M. MARCHAND, "UNION OF SOUTH AFRICA FISHERY BULLETIN" NO. 1

FIG. 2.—STAGES OF THE SOUTH AFRICAN SPINY LOBSTER (JASUS LALANDEI): (A) PHYLLOSOMA, 1.7 MM.; (B) PUERULUS, 22.0 MM.

The bulk of the catch, frozen or canned, is exported as lobster tails, chiefly to the United States.

Other "Lobsters."—The Murray lobster, of Victoria, New South Wales and South Australia, is a large species of fresh-water crayfish (*Euastacus armatus*) of the family Parastacidae, about 7–10 in. long, much used for food in Australia.

Some of the larger-clawed true shrimp (family Palaemonidae) are also loosely called lobsters. They are fished in baskets, nets or traps in tropic and subtropic fresh and occasionally brackish waters in many parts of the world.

Natural History.—A true lobster is hatched from the egg in a shrimplike, free-swimming form (naupliosoma). With the eighth molt, it becomes quite definitely a bottom-dwelling, juvenile lobster. In the spiny lobsters the naupliosoma hatched from the egg soon molts into a phyllosoma. This unique larva is quite transparent except for the pigmented eyes. Several phyllosome stages later, the puerulus, almost a young spiny lobster, develops.

Larval molts appear to succeed one another with considerable rapidity and without much difficulty; growth in the adult is a much more serious proceeding. The stout exoskeleton prevents increase in body size until there is a literal bursting at the seams. In *Homarus* the "seam" that gives is the chitinous articulating membrane between the hinder margin of the carapace and the fore edge of the tergum of the first abdominal somite. Through that narrow opening passes the entire soft body of the animal, including the relatively huge chelae. The chitinous lining of the foregut (masticatory stomach and esophagus), the hindgut (the intestine) and the endophragmal skeleton are also shed. The latter consists of a series of infoldings of the external skeleton of the thoracic somites for the attachment of muscles.

The body, and the soft cuticle that in the premolt period (endysis) was forming beneath the old shell, in the next few hours expands rapidly in size by the absorption of water. When this periodic increase (about 11%–12%) has reached its maximum, the cuticle begins to harden with a deposition of lime salts. Within an hour the new shell perceptibly hardens; in six to eight weeks it has the rigidity and strength of the old one. In the soft condition the lobster remains in hiding, for it is at this time easy prey for its enemies. For each successive increase in size, the operation must be repeated. F. H. Herrick (1911) described a large *H. americanus* that weighed 34 lb. and measured about 2 ft. in length. The crushing claw of its pincer was 15 in. long and had a 20½ in. girth; the more slender, half-inch longer toothed, or cutting, claw had a girth of 15½ in. Herrick has estimated that such giants are possibly 50 or more years old.

Food Value.—Lobster flesh is relatively rich in protein; it has almost 62% of the nutritive value of beef. Canadian researchers found that the flesh of the lobster stimulates the stomach glands to a greater secretion of digestive enzymes and acid; it is therefore especially valuable in overcoming functional depression of gastric juice.

See also references under "Lobster" in the Index.

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(W. L. ST.)

LOCAL EDUCATION AUTHORITY: *see* EDUCATION, HISTORY OF.

LOCAL GOVERNMENT. Some degree of local government characterizes every state in the world; the degree is all-significant. Local government means authority to determine and execute measures within a restricted area inside and smaller than the whole state. The variant, local self-government, is important for its emphasis upon the freedom of the locality to decide and act.

There is more than a technical importance in the difference be-

tween the two terms, because they are related to the distinction sometimes drawn between deconcentration and decentralization. Local government is often, but not necessarily, related to the former; local self-government to the latter. That distinctions have been made is important, even if they are blurred. By deconcentration some have meant that for the mere convenience of a congested central government some functions have been devolved to administration on the spot, rather than from the centre, but still administered through officials appointed by and responsible to the centre. Authority and discretion are vested in the centre. On the other hand, decentralization represents local government in areas where the authority to decide has been devolved to a council of locally elected persons acting in their own discretion with officials they themselves freely appoint and discipline.

The term local self-government has been traditionally used of local government in Great Britain and Germany. Thus the constitution of the Federal Republic of Germany says, "The *Gemeinden* (that is, local authorities) must be safeguarded in their right to regulate, under their own responsibility, all the affairs of local community within the limits of the laws." On the other hand, the constitution of the French fourth republic said, "The French Republic, one and indivisible, recognizes the existence of local administrative units. . . . The local administrative units shall be governed freely by councils elected by universal suffrage." This expresses the spirit of deconcentration. The Union of Soviet Socialist Republics constitution (chap. VII) makes provision for "the local organs of state power," but offers no breath of decentralization.

However tightly bound to the central office's authority and regulations, a degree of discretion in its local officials is unavoidable. Often, again, the fairly pure organs of local self-government, *e.g.*, a British county borough council, are obliged to execute the purposes of the central government. Primarily units of local self-government, they are simultaneously units of local obligation acting as ordered by the central government, for services, *e.g.*, education and police, willed and imposed by it.

Thus modern local government has a twofold aspect—it is a mixture of both deconcentration and decentralization, of central convenience and an acknowledgment that not all authority ought to be exerted by the centre. The mixture is revealed by the extent to which some of the powers exercised by local government units are exercised compulsorily and under fairly strict control by central authority with financial assistance, while others are not. This mixture produces the high complexity of modern local government. Further, local government is a departmentalization of the state's work, based on the territorial distribution of services, as contrasted with (1) division into departments at the centre, or, (2) as in the decentralization of functions to public corporations, such as the British Coal board or the metallurgical trust (*Glavki*) in the U.S.S.R. In local government, territorial distribution of power is the essence.

The history of local government in western Europe, Great Britain, the United States and Russia exhibits the growing awareness of its significance. This awareness is a product of a development of parochial and town life which began long before the modern state emerged between the 15th and 17th centuries. Any central control over these and other areas was, until the 18th century, rather scanty, though sometimes, as under Jean Baptiste Colbert in France or in 17th century Prussia already overlaid by the heavy hand of the central *Intendants* in the former and the war commissariat in the latter. Many Germanic states were nothing but cities; *e.g.*, the Hanse towns. In England and especially New England, the local units, parishes, towns, cities emerged from their origins as spontaneous self-governing units; so also in Russia, although there the tsars took strict control of the cities through their provincial governors and over the *Mir*—the village-cum-agricultural unit —through taxes, the police and the *boyars;* the state colonized some cities from the beginning. The various local units were gradually integrated by the state which exacted obligations from them regarding peace, crime and police duties, taxes, military supplies, assistance to the poor and highways. By ordinances or statutes or judicial decisions local units were subordinated, so that the idea of an inherent right to self-government was extinguished. By the 19th century all local units were legal creatures of the state, subsidiary in authority on principle and acting independently by sufferance alone.

Indeed, the battle for the continuance of local self-government is desperate though not hopeless. The local freedoms of the 19th century were challenged by (1) speed of communications which has reduced administrative space time; (2) demands of a planned economy; (3) growth of nationwide parties with social welfare programs uniform for all parts of the nation; (4) growth of a consciousness favouring a national minimum of services; (5) realization that the best technical administration of modern utilities requires areas knitted together by a central plan and different from the traditional ones; (6) needs of civil defense against air attack. These are powerful forces working against claims to purely self-regarding government.

More than ever, on the other hand, local freedom is supported by need for (1) intimate local knowledge and variation; (2) intensity of local interest and enlistment of loyalty and co-operation; (3) small areas for easy impact of the citizen-consumers upon officials-producers; (4) an accessible area of political education; (5) counterweight to the abuse of central power; (6) the democratic value of a plurality of political experience and confidence. In all plans, decentralization, whether to a regional corporation such as the Tennessee Valley authority in the U.S., or to reformed traditional units, is pressing, necessary and fruitful.

COMPARATIVE STUDY OF CHARACTERISTICS

The chief characteristics of local government, which may be studied by comparison of Great Britain, France, Germany, the U.S. and the U.S.S.R., are (1) constitutional status; (2) areas and authorities; (3) powers; (4) finance and local freedom; (5) organization; (6) central controls.

Constitutional Status.—In Great Britain, the local authorities are subordinate corporations formed by acts of parliament or charters. Their powers and immunities derive from statute and judicial interpretation. They have many obligatory duties and a vast field of permissive powers. Each authority is independent within the sphere of power authorized by the central government: there is no hierarchy of authorities. Slight tutelary control over the health and roads services of the urban and rural districts has been given to the counties. Local councilors are freely elected and constitute the local executive as well as the legislature. There is no appointment or ratification of local executives by the central government, though certain important local officials require qualifications stipulated thereby. The local authorities combine many functions, and are not, like the school or sanitary districts so frequent in the U.S., single function or authorities created for a specific purpose. The local finances—rates—are locally raised in amount and appropriated in detail with practically no interference by the centre. Though local authorities have considerable freedom to use their permissive powers, and even their obligatory ones, they operate within judicial controls lest they act beyond their powers or are negligent, and are under continuous central administrative controls. A condition of local central partnership characterizes the system. Though the central controls have increased markedly in the last 30 years, local powers have also greatly increased. The local units are powerful. They exercise an important influence over the central administration through their members of parliament, and through their increasingly large representation on advisory councils and committees officially attached to the several departments. The nationwide associations of the different classes of local authorities exercise an advisory and representative influence on the centre and sustain the standard of local administration, as, similarly, the German association, the Deutscher Städtetag, does.

French local government differs from the English in being both hierarchical and centralized. Though the municipal code of 1884 gives the municipalities a wide general scope of activity, these communes and *départements* are limited by strong central controls over their budgets, modified for the bigger cities by political influence. The inspectorial system, strong in Great Britain because

the relationship of government to the localities is direct, is of less consequence in the French, where hierarchical control seeps down through the *préfet* of the *département*. Obligatory functions which must be carried out by the municipalities can be inscribed by both the *maire* and the *préfet*. The *préfet* may be removed by the central authority at its discretion—he is appointed by it; the *maire*, until 1884 appointed by the central government, since elected by the local council, is removable by the central government for default in acting as the law requires, and is suspendible by order of the *préfet* for similar cause for from one to three months. Judicial control over the activities of local government is very heavy, culminating in the supreme administrative court, the *conseil d'état*. The rather severe centralization of French local government, a legacy of the *ancien régime*, jolted by the Revolution but radically re-established by Napoleon, is considerably criticized, but decentralization is very unlikely. The rural nature of France, despite many cities, and the fear of the divisive political passions of the people, most recently of the Communist party, militate against local freedom.

German local government (omitting the Nazi interlude) attempted to unite the agelong pride in free and enterprising civic life with the full popular enfranchisement that came first only in 1919. Its hierarchical system, with strong central surveillance reaching back to the 18th century, was a little eased during the Weimar period. The position of the local executives, *Bürgermeister* or *Magistrat*, ratifiable by the central government, was much troubled by the universal suffrage of 1919 which replaced the oligarchic three-class system. A very wide scope of authority was accorded to the *Gemeinde*, whether rural or urban, by the basic laws, such as the Prussian *Stadteordnung* of 1808, the *Kreisordnung* of 1872 and the *Provinzialordnung* of 1873. Though this authority came to be limited by financial stringency, German cities showed great enterprise and developed many utilities. The Nazi system in general kept the framework of areas and authorities but abolished all elections and substituted appointed councilors and executives dominated by Nazi *Gauleiters*. After World War II, the several states were glad to revive local self-government and the constitution guaranteed it.

In the U.S. the main features of the constitutional status of local authorities are the variety of arrangements in the various states and the large degree of freedom of the local units deriving from early English township forms reinforced by migration into new lands. Nevertheless, that freedom is subordinate and defined by state statutes and charters giving corporate status. The special charter, referring to individual cities; the general charter, which is a state-wide municipal code; the charter which confers status by classifying the local units for privileges—these are various means of trying to give the local units a status which relieves them of the need for repeated application to the legislature, while subjecting them to a firm pattern of permissions and limits. Amendments, however, still require suppliancy to the legislature; and growth requires powers in addition to the general grant.

In 26 states home rule charters, granted by the legislature, allow the city to draft its own charter by a local convention, sometimes requiring legislative ratification, sometimes not. Another system allows the local units to choose from among several forms of charter provided in a state general law. There is much independence and vigour, no hierarchy, little central administrative control and much judicial control to hold the units within their charter and statutory position. There are increasing direct relations between federal government and local units.

The local government system of tsarist Russia was one of absolute centralized hierarchy, executed through the governors of the 78 *guberniya*, with police, military and taxation powers, and the scantiest recognition of rights of local government. Provincial and village governments were dominated by the landlords who had an ex officio right to chairmanship of local administration, especially of the *zemstvo*, set up in 1864 to govern the provinces under strict control of the imperial governors. The *zemstvo* (with an indirect and unequal class franchise), nevertheless, made progress in educational, health, welfare and agricultural development in spite of the tsarist techniques of tyranny. The Soviet constitution of 1936 and the decree on the city soviets (1933) and specific economic and social planning decrees give extraordinarily wide specified powers to the local units, but very rigorously subject them to hierarchical control of the next higher authorities upward to the central government of the various republics, and in some cases to the union itself. Authority and direction are heavily centralized and animated in the last resort by the All-Union Ministry of State Administration and the public prosecutors. All units from lowest to highest are manipulated in unity by the ubiquitous activities of the Communist party, the members of which are required by the rules to form cells for administrative "fulfillment."

Generally speaking, then, local government as local self-government is discernible more fully in the British and American environment than elsewhere, rather more in the German than in the French and hardly at all in the U.S.S.R. Yet centralization and control of units originally holding authority themselves are not inconsistent with vigorous first-line activity by the local units in the matters entrusted to them.

Areas and Authorities.—Local authorities in England and Wales are (from smaller units upward): 13,000 parishes (of minimal importance even in rural areas); 1,047 rural and urban districts (mainly health and minor roads authorities and some water supply); 317 noncounty boroughs like the districts, some of which, however, have police forces and elementary education and housing authorities—both about to disappear; 83 county boroughs, being great towns of 50,000 population and above, with the widest scope of local services including the public utilities; and 62 county councils, being mixed urban and rural areas. The county boroughs are independent of the counties; all other units have some of the services in their area rendered by the county council in whose area they fall.

In addition to these authorities, there are 2,000 joint authorities, councils, committees or boards, established to administer burials, water and electricity, sewerage and hospitals. There is a tendency in all countries to rely more upon such unions where the services are of a large-scale nature compared with the traditional units having responsibility. Local authorities are mutually independent: unanimity is required for joint schemes, which are amply permitted in the statutes. Even some counties are far too small for large-scale administration, while extremes of size in area and population may be encountered in each of the above-named classes of authorities.

Areas can be reformed after a procedure of local inquiry conducted by the central ministry of local government followed in the case of the creation and extension of county boroughs by legislation, and in the other cases by central administrative sanction. For the districts a maximum decennial review of areas is called for. In 1926 the creation of county boroughs was set back by the stipulation that the minimum population must be 75,000 in place of 50,000, as the counties suffered from the subtraction of area and taxable capacity. The movement for technically more justifiable regions is strong, but cannot prevail against local inertia and the claim that small areas are needed to activate democratic vitality. Nationalization of the electric and gas utilities facilitated the reform of the local units of production and distribution.

The French local government units are, in a downward order: 90 *départements;* 311 *arrondissements;* 3,031 *cantons;* and 38,000 communes. The first and the last are genuine units of local government; the middle two are only convenient administrative subdivisions and electoral, tax and *gendarmerie* districts. The *départements* vary in size from 185 sq.mi. to more than 4,000 sq.mi., with an average population of 500,000. This framework, which serves the centralizing authority of the state, was established in 1790 to unify France by abolishing the traditional 35 *généralités* which partly coincided with and partly cut across the ancient provinces. The communes are the basic roots of local government. The name applies to units from the smallest village up to the capital. The span is from several acres to 400 sq.mi.; and from fewer than 100 people to the 3,000,000 people of Paris. Two-thirds have fewer than 500 inhabitants. Powers and practical hierarchical control vary accordingly, within the uniform pattern of the law. Area alterations can be made only by parliamentary statute, preceded

by local vote, inquiry and acceptance by the *département* and *conseil d'état*. There is a regionalist movement which has been unsuccessful.

Indeed civil disruption fomented by the Communists in 1947 led to further centralization; France was divided into eight regions centring in the army commands in which all governmental power may instantaneously at need be transferred to the regional superprefects in emergencies; they are called inspectors general of administration on mission extraordinary, or I.G.A.M.E.

The German areas of local government are (in Germany as a whole): more than 50,000 *Gemeinden* (like the communes) divisible into *Stadt* and *Land*, urban and rural (one-third of the population live in the latter). Then, upward, the *Kreis* (equivalent roughly to county in England and the U.S.); above this again, the *Regierungsbezirk* (government district), a unit of central government control and police authority; and above, the *Provinz* (only in Prussia, which was disintegrated after World War II).

There are also numerous joint authorities for roads, schools, health, fire, agriculture, water, gas and electricity. The *Gemeinden* exhibit an enormous diversity of area and population. There are *Stadtkreis* and *Landkreis;* the former, where the population is above 25,000, is a city-county (like the English county borough). There is a rather special kind of holding company local authority, the *Amt*, to administer the common affairs of some contiguous villages while they still remain separate *Gemeinden*. More important area changes require parliamentary statute. Free agreement among the local authorities is practically unobtainable. The impetus toward city-countyship is enormous, for the same reasons as toward county boroughship in England. The Nazi municipal order of 1935 gave wide powers of areal change to the national cabinet.

Whereas all other nations combine most local government functions in single compendious areas, the U.S. has distributed many of these, especially education, health and parks, to special authorities. The area structure of local government in the U.S. has a different foundation according to the historic settlements. In the south and south central region the chief unit is the county (or parish in Louisiana); in the north central, the combined county and township; in New England, the town. Alaska is divided into 24 election districts that are the equivalents of counties. In some states, the people of each county may vote to divide the county into townships. In the early 1960s there were 3,042 organized counties and parishes. The smallest had 208 inhabitants, the largest (Los Angeles county, Calif.) more than 6,000,000. The average was 45,000.

Some of the functions such as taxation, judicial registrations and records, first instance judicial action through the county court and justices of the peace and elections are those of modern central rather than local authorities. Others such as education, highways and bridges, social welfare, poor law, hospitals, pensions, health, defectives and delinquents are serious burdens on nonpopulous areas. Services remain inefficient or the state takes them over, for consolidation of counties is resisted. Some unions of counties have been formed for hospital and poorhouse administration.

Inset in the county is the city, with its own powers, and in direct relationship with the state government. Sometimes both city and county conduct for two concentric areas many similar services with substantial duplication of staff and organization. The cities are the areas of the heaviest integration of local government services. As elsewhere, there is antagonism between city and county, and the federal authority after the 1930s became an important direct supporter of city unemployment, public works, municipal utility and housing schemes. Towns, which are mostly but not exclusively semirural communities and are fairly populous in New England, New York, Pennsylvania and the north central states, play the part of the counties elsewhere and have city functions and sometimes city status also. As a part of a township or a county, there are inhabited centres, called villages or boroughs. The state legislature usually requires that such a subdivision reach a certain level of population before it may become self-governing. Area problems in the U.S. revolve around the adjustment of county and city, and the problem of metropolitan areas. Here also, political vested interests and simple inertia obstruct modernization by the legislatures.

In the Soviet Union the tsarist areas were replaced by territories, regions and *oblasts*, and include districts (*raion*), cities and boroughs (within cities), settlements and villages. At the top of the pyramid is the supreme soviet of the union republic. The upward relationship may be expressed in Lenin's phrase, "centralized supervision with decentralized activity." Within the cities of 100,000 there are subordinate soviets, of which Moscow has 240. Cities of more than 50,000 and especially important places of lesser population receive a status independent of the *raion* hierarchy and are directly subordinate to the republics. Attached to these cities are surrounding rural settlements which fully participate in the city government but possess village soviets also. The republics enact these connections. A marked reduction of the local middle units of government has occurred since 1917.

Powers.—Broadly speaking, the large geographic units in the hierarchy are concerned with financial and administrative supervision of the primary units, the provision of environmental and institutional and police services, and technical and financial supplements and assistance to the smaller authorities. Authority to act is always a combination of specific grant and general grant by the central authority, sometimes with modifications by the administrative supervisory authorities and the courts.

In Great Britain, the specific grant of power is supreme. Powers are granted to the various classes of local authorities by general statutes, and by special addition to individual local authorities in private or local acts. The powers granted by general statute are either permissive; *e.g.*, libraries, or compulsory; *e.g.*, education or hospitals for infectious disease. The powers appear in the great statutes such as the Municipal Corporations act (1835) and the Local Government act (1933), which may be termed constitutive, or in acts on education or police, which may be called functional. The permissive powers offer remarkably wide opportunities for initiative. Where local authorities petition parliament for private acts, they may obtain the opportunity to pioneer, if they prove desirability and financial capacity, and successful administration is sometimes followed by granting extension of powers to all authorities. The merit of the system of specific grants is the addition of the good sense of the central authority to that of the local electorate in determining new services, which necessarily involve controls over local citizens and power to raise taxes. All the bigger authorities have a rather restricted power to make by-laws.

In France and the Federal Republic of Germany the municipalities are given by the constituent statutes a general authority to do whatever is proper for the good of the municipality. But what is proper is legally challengeable by citizens, and administratively by the central departments. Initiative is limited by the claims of other communities, private enterprise and the state organs. Also there are functions obligatory on the local units—from 50% to 80% measured in expenditures—prior to the discretionary ones. The approval of the higher administrative authorities and the administrative courts is needed for utilities so that not very much is accomplished. In Germany from 1890 on, the cities proceeded remarkably with municipal enterprise. Despite specific grant in Great Britain, that country was probably unmatched in the extent of municipal management of utilities until the nationalization referred to.

In the United States counties have specific grants. The cities receive their powers in the charters. These are stated specifically, but in broad outline, while additional powers are granted from time to time.

The Russian republic constitution grants to all local authorities the power to "direct the cultural, political and economic construction of their respective territories," and the power to make decrees within the laws of the union and the republic, and then specifies further by requiring the local soviets to set up executive departments. The local soviets are generically unbounded in these powers, but in all are minutely subject to central plans.

The powers actually exercised by modern local authorities in the middle of the 20th century were immensely in advance of anything known in the early 19th century. Then the main services were

highways, police, public assistance, the removal of health nuisances, perhaps fire fighting, perhaps infectious diseases, here and there public education. In Great Britain about 80% of the work of the local authorities came to include the modern social services and municipal enterprise: in other countries the situation was similar or was becoming so. The powers usually exercised by local authorities included education up to high school and technical schools (in the U.S. sometimes colleges and universities); public health in a variety of environmental and personal services; mental diseases; housing provision and management; town planning, zoning, building regulation; poor relief and, in the U.S., local administration of social security services; small holdings, allotments; parks and open spaces and playgrounds; agricultural improvement and land drainage, agricultural education; roads and bridges; streets; public lighting; fire fighting; police (larger authorities only, except in the U.S.); lower instance justice; foods and drugs, and weights and measures inspection; enterprises of gas, electric power, public transportation, water supply (in the German cities, laundries, milk supply, bakeries, theatres, concerts); and land purchase. In the soviet system, the local soviets are subordinate units in the vast industrial and agricultural plans, the local soviets in their turn bringing the collective farms under especially stringent tutelage.

The tendency was toward more local powers, because all government was getting more power, but the development of planned economy, social security, public medical care and civil defense transferred the decision making and higher direction to the bigger authorities, though not excluding the smaller from direct local execution with much latitude therein.

Finance and Local Freedom.—The finances of local authorities have a bearing upon their administrative freedom. Two of the crucial points are: (1) their authority to raise revenue and (2) freedom of budget making.

1. Revenue may be raised by authority of general codes or special statutes. In France, tax freedom is limited by the need of superior authorization of the budget. In the Soviet Union the fully planned economy limits tax freedom, and the constitution itself requires that all local soviet budgets fit into, and be previously sanctioned by, the budgets of the republics.

In Great Britain and the United States, the principal financial limitations are on loans. In the former, previous administrative authority is required; in some states of the United States, limitations of total indebtedness are prescribed. German cities have wide financial freedom, though loans require higher sanction.

2. Local budgets need no superior approval, either in Great Britain or the U.S. In France, the *maire's* and the *préfet's* approval is required and they may require balancing and inscribe mandatory expenditures or invalidate optional expenditures. The Federal Republic of Germany also requires compulsory appropriations when higher authorities consider that provision is inadequate. In the soviet government, the higher authorities exercise penetrating control over revenue raising, appropriations and budgets.

In Great Britain grants-in-aid from the central authority play a very important financial and administrative role; in the U.S., rather less so, but with growing importance. In France and Germany the sharing of taxes with the central government was more important relatively than grants-in-aid. Grants and the form they take are instruments of superior control, regulation and stimulation. In the Soviet Union, the local soviets draw revenue from the communized property allotted to them as public corporations. They may add to the state turnover tax a percentage sanctioned by the superior local authorities to meet expenditure on functions authorized by them, these higher levels controlling their budgets in minute detail.

Organization.—The local government statutes of all the countries concerned prescribe certain kinds of internal organization—mayor, chairman, aldermen, committees and commissions for executive and legislative operations and management of the permanent staffs. Some significant differences deserve notice. The English form of internal organization is that of all-party committees each in touch with the technical or expert directors of departments. The only co-ordinator is the town or county clerk, in collaboration with the mayor or chairman who is annually elected from the council. The committees have a very large degree of delegated authority, subject to ratification by the council, but not to tax, raise a loan or make a contract. The French system has the centrally appointed *préfet* dominating the *département* council; in the municipalities, the council elects the mayor. The former works with a secretary-general appointed by the central government. A small standing committee of the council, called the *commission départementale,* controls and co-operates with the *préfet* as regards the budget, the audit of expenditures and civic property. It has further delegated powers from the council, but not to tax or spend. The *maire* is served by a number of *adjoints,* chosen from the council by seniority and value of services to the commune, who supervise the various departments of municipal activity, and jointly act as an advisory body to the *maire* and draw up the budget.

In the German system, in the county, the chief executive is the *Landrat,* appointed by the central government, who co-operates with a small executive committee of the county council. In the rural communes, a chairman or *Bürgermeister* is elected by the council, and works with assistants or aldermen chosen by the councilors. The various states of Germany have diverse practices. In some there is a kind of bicameral system, called *Magistrat.* The elected council co-operates with the *Magistrat,* which is an administrative board of officials and some laymen chosen by the council led by the *Bürgermeister,* the principal official—but since World War II, the *Magistrat's* power has been reduced to a suspensive veto only. In the *stadtrat* system, the elected council is singly the supreme authority, and works with an elected first *Bürgermeister,* but has an appointed second *Bürgermeister* as its administrative officer. The system prevails in Bavaria. There is also the *bürgermeister* system, as in North Rhine-Westphalia, where the elected council has supreme authority, chooses its *Bürgermeister* who has a suspensive veto over the council's resolutions, and then a professional *Stadtdirektor* like a U.S. city manager, appointed for 12 years, as chief of administration.

In the U.S. system there are four conspicuous forms of organization: the town meeting, the commission system, the council and mayor system, the city manager system. In the first, the meeting of taxpayers settles main lines of policy, chooses selectmen and officials, accepts the budget, controls administration and checks expenditures. It is unwieldy for large cities. These then may be administered by a small number of commissioners elected simultaneously as heads of the executive departments and are collectively the general government of the city. The system encourages disintegration of leadership, and is on the decline. Elsewhere a council and some officials and the mayor are elected at the same time. There is a separation of legislative and executive authority at an enormous cost of energy which produces some but not all of the desirable progress.

From the mid-1910s to the early 1960s the city manager system developed strongly until it applied to about 1,275 cities, towns and counties, a great part of the increase coming after World War II. The elected council appoints an executive, a career official to energize, manage and appoint the officials, and to co-ordinate and make the budget—this official operating side by side with the elected mayor. The city manager is no tsar; he serves the council, and the local statutes give him a strong status, but it cannot be stronger than the authority of the council. His indefinite tenure may be cut short. (*See* CITY MANAGER.) In general, the United States system is distinguished by its use of the initiative and referendum, especially necessary in the commission form.

In the soviet system the local soviet elects a presidium or executive committee from its members. This body is the formulator of policy as well as the executive—the council discusses and ratifies. The presidium is assisted by experts or interested citizens co-opted onto its committees. This practice of co-option was originated in Britain; many countries now practice it. The Soviet Union and some German states require of councilors an annual or semiannual "open house" to the public. Soviet councilors may be recalled by dissatisfied constituents, but this happens very rarely.

During the 19th century, local administration had little power

and was a field of much unpaid service, patronage and spoils, but the merit and career system advanced. Appointments are made by the chief executive officials in the French and German systems, but according to general statutory qualifications and tests. In England, the central government by law prescribes the basic qualifications of some officials—the medical officer of health, the sanitary inspector, the police, teachers, etc., but appointment and management are fully by the local authorities, though since 1946 a nationwide examination and appointment and salary code has been fashioned and introduced by the local authorities' associations. Some officers have the right of appeal to the central authority against dismissal; *e.g.,* medical officers of health. In practically all large authorities and most small, a career service prevails. In the U.S. it has been estimated that civil service appointments total about 55% in the cities, and about 30% in the counties.

Central Control.—The intensity and techniques of administrative control by the central authorities are indexes of the limitation of local self-government. General tutelage, characteristic of France, Germany and the U.S.S.R., operates through continuous organized hierarchical vigilance and intervention downward from the designated central department to the lower levels of local authorities. In Great Britain statutory rules and orders made by the designated central department administering the statutes relating to local functions, advice, admonition, exhortation, preparation of scientific memoranda and reports of experience are parts of tutelage.

The sanction of administrative schemes is a more severe and specific form of central control: it is strong though not fully comprehensive in England. In France and Germany it is more comprehensive and in the Soviet Union it is total through the agencies already mentioned. In the U.S., higher sanction is rare and applies to welfare and public works schemes assisted by the federal authority, and occasionally to highways, education and hospitals financially assisted by the states.

Submission of periodic reports is universal, but applies in the U.S. mainly to the services already mentioned, and in some states to the local accounts. The growth of standards, scientific definition, forms and statistical analysis after the middle of the 19th century was a powerful instrument of centralization, since both local and central officials can be of one mind in reporting and deciding answers to governmental problems.

Audit of local accounts by central officials is severe and important in England; in France and Germany it is hierarchical, going finally in each case to the special courts of accounts. In the U.S., though accounting and fiscal practices are in some cases state regulated and the election of local auditors required, external and compulsory audit hardly exists. Inspection by central officers is the most distinctive feature of the English system, having been carried to a highly comprehensive and efficient stage in which the inspectors are not only investigating and enforcement-assisting agents, but counselors on good practices, and flexible intermediaries between the capital and the localities. There is also inspection in the French and German systems, but it is overshadowed by the centralist form of the system. In the U.S. the small amount of inspection is related only to the services already mentioned. Action in default is very limited and rare in England; practically nonexistent in the U.S.; has been practised in Germany; is unnecessary in France because previous sanction (*tutelle*) and obligatory expenditure prevent local default. The central power to remove the French *maire* or the *préfet* may be borne in mind. Stern hierarchical and party and newspaper criticism is designed to obviate local default in the U.S.S.R., but self-seeking and inefficiency often produce defects punished by recall.

Finally, personnel rules are laid down by the English central authority for some key officials; the office of *préfet* in France in 1945 was made a career service, intermingled with service in the central administration, following successful graduation from the government-sponsored École Nationale d'Administration. A few states in the U.S. exert some small influence on the civil service conditions of the localities; in Russia, the local soviets use the graduates of technical schools as screened by the Communist party. The payment or withholding of grants constitutes a sanction of these various instruments of central control. This is especially strong though flexible in England; much less so in France and Germany; firm over its small field in the U.S.; while the soviet system relies on other incentives, mainly fear or revolutionary zeal. In France and Germany, local authorities are subject to control by appeal to the administrative courts; in Britain, to the ordinary courts; in the U.S.S.R. no such appeals to a judiciary are entertainable, and the only recourse is to the hierarchy or the prosecutor's office.

Variety and development are marks of contemporary local government. Larger areas for local government with more central direction are on the way. Many new functions are impending. The feeling of attachment to the old areas is a retarding factor; the recognition that the small area has continuous human values and certain long-run technical advantages in assisting consumer control over administrators will force centralization to assume accommodating forms. The great associations of municipalities and the professional officials already contribute considerably to the efficiency of the localities, and their services are destined to be even more valuable as moderators of centralization. Yet the forces of modern large-scale economic organization and civil defense weaken the scope and independence of local self-government.

See also HOME RULE (MUNICIPAL); and references under "Local Government" in the Index.

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LOCAL OPTION. The term local option has been used to refer to a variety of permissive laws effective locally only after affirmative vote by the local electorate; for example, laws allowing political subdivisions a choice between forms of government or methods of representation.

It has particular significance, however, in alcoholic beverage control. In this context local option refers to a liquor control system under which each locality is permitted to vote upon the existence of legal dispensaries within its boundaries.

Early History.—Local option was a natural outgrowth of earlier licensing plans. As early as the 16th century English alehouses were licensed by the sessions of the peace and in the American colonies, though the licensing authority was first exercised by the governor, the advent of the American Revolution found the tradition of local licensing firmly established. The history of Massachusetts is typical; in 1633 it was provided that none should sell wine or strong water without leave of the governor or deputy governor. In 1645 the licensing authority was shifted to the quarter courts and two years later to the county courts. In 1680 a provision was adopted prohibiting the court from issuing licences without the prior approval of the selectmen of the town in which the licensee sought permission to operate.

These provisions, and similar ones in the other colonies, were directed at policing the propriety and good morals of public houses and were not designed to implement total prohibition. The birth of the vigorous temperance movement of the 19th century coincided, however, with a trend toward the popular election of the county courts and their successors, and it was natural that the pressures of the early prohibition movement should be focused upon these officers. The reasoning of the prohibitionists ran thus: if the local governing body can deny one licence, it can deny all licences and local prohibition will be a reality. The problem became one of electing officials committed to a policy of "no licence."

The "no licence" movement met with several legal and practical obstacles. In 1844 the supreme court of North Carolina held that the discretion vested in the county court was not broad enough to sustain a policy of denying all applicants for retail liquor licences as "injurious to good morals" (*Attorney General* v. *Justices of Guilford,* 27 N.C. 315). In those states in which no legal objection was raised, although results in the rural areas were gratifying to the prohibitionists, temperance leaders were generally disappointed at their inability to carry the larger cities and towns and turned their attention to pressure for state-wide prohibition.

Local option in the sense of direct vote by locality on the question of prohibition came into vogue as a grudging concession to these pressures. The democratic flavour of local choice was never accepted by temperance workers. Theirs was a moral fight with a single ultimate goal. The *Cyclopedia of Temperance and Prohibition,* p. 394 (New York, 1881) frames the issue with candour: "By far the greatest of local option's defects is its rotten basis as to morals, where its presumptious elective system appears most audacious. With its majority rule set up as an origin of right, the results are most destructive to all proper conceptions of divine law." Within this ultimate objective, however, prohibitionists were willing to carry on their fight at all levels, adhering to the slogan provided by Judge Robert Pitman of Massachusetts, "Wherever license prevails, wrest every inch of territory you can for prohibition; wherever prohibition prevails, never surrender an inch to license, except from dire necessity" (*Alcohol and the State,* New York, 1877). By 1906, 30 states were operating under local option and more than half of all the counties, 60% of all the incorporated towns and villages and 70% of all the townships in the United States were dry.

Later History.—Local option in the United States disappeared, of course, with national prohibition. With repeal, though the older system of local licensing generally gave way to some form of central regulation, typically U.S. states returned to local option.

The plans varied greatly both as to voting unit and as to the alternatives placed before the electorate. In the typical state, cities and counties (incorporated towns often voting separately) may choose between total prohibition, sale of wine and malt beverages, package sale of distilled spirits and sale by the drink. Initiative in such elections is customarily left to petition by a fixed percentage of the qualified electors and elections may be held every year or two years.

In some communities elections may be held in a single precinct constituting at times not more than a few square blocks. Where precinct elections are permitted, however, they are usually considered as a device for protecting residential neighbourhoods from the influx of taverns, rather than an opportunity for an expression of wet or dry sentiment.

By the second half of the century, only two states in the United States still had state-wide prohibition, Mississippi and Oklahoma; in both of these dry states, however, alcoholic beverages could be sold providing they did not contain more than 4% (Mississippi) or 3.2% (Oklahoma) of alcohol by weight. In 1959 the constitution and statutes of Oklahoma were amended to provide for licensed sale, leaving Mississippi the only "dry" state.

There were provisions for local option in approximately three-fourths of the states in the early 1960s. An estimated 22,000,000 persons, including those in Mississippi, lived in areas which prohibited the sale of distilled spirits.

Local Option in the United Kingdom.—The principle of local option is embodied in s. 6 of the Licensing act, 1961. This provides for the holding of a poll at requisition in any county or county borough in Wales or Monmouthshire by not less than 500 local government electors to determine whether or not s. 111 of the Licensing act, 1953, shall apply to the area in question. This section of the 1953 Licensing act directs in effect that there shall be no opening of licensed premises in Wales and Monmouthshire on any Sunday. As a result of polls held in accordance with the 1961 act, all four county boroughs, Swansea, Newport, Cardiff and Merthyr, declared in favour of Sunday opening. Of the counties, five declared in favour of opening and eight against.

See also Prohibition. (J. D. Ls.; X.)

LOCARNO (Ger. Luggarus), a town in Ticino canton, Switz., is picturesquely situated at the northern end of Lake Maggiore near the mouth of the Maggia river, 18 km. (11 mi.) W. of Bellinzona by rail. Pop. (1960) 10,155. Favoured by a warm Mediterranean climate, Locarno is an Italianate city, chiefly noted as a health and tourist resort. It contains numerous hotels and other tourist facilities, and the nearby shores of the lake are studded with villas. The city's gardens are famous. The principal shopping centre is in the arcaded Piazza Grande. In the Pretorio or law court the pact of Locarno was signed in 1925 (*see* Locarno, Pact

OF). On a rock above the town, in the suburb of Orselina, is the convent church of Madonna del Sasso, containing a "Flight Into Egypt" by Bramantino and an "Entombment" by Antonio Ciseri. A magnificent view of the city and of Lake Maggiore can be obtained from its terrace. Locarno was taken by the Swiss from Milan in 1512. From 1815 to 1878 it was one of the three capitals of Ticino canton.

LOCARNO, PACT OF, a series of agreements made in 1925 whereby Germany, Belgium, France, Great Britain and Italy mutually guaranteed the peace in western Europe, and Germany undertook to arbitrate disputes with Belgium, France, Czechoslovakia and Poland. The treaties were initialed at Locarno, Switz., on Oct. 16 and signed in London on Dec. 1.

The pact was significant because it marked a break from the atmosphere of World War I, and former enemies committed themselves to a peaceful policy among themselves. The pact was, in a sense, a substitute for the Geneva protocol negotiated by the League of Nations in 1924 but never ratified.

The agreements consisted of (1) a treaty of mutual guarantee between Germany, Belgium, France, Great Britain and Italy; (2) arbitration agreements between Germany and Belgium and Germany and France; (3) a note from the former Allies to Germany explaining the use of sanctions against a covenant-breaking state as outlined in art. 16 of the League of Nations covenant; (4) treaties of guarantee between France and Poland and France and Czechoslovakia.

The treaty of guarantee provided that the German-Belgian and Franco-German frontiers as fixed by the treaty of Versailles (*q.v.*) were inviolable; that Germany, Belgium and France would never attack, invade or wage war against each other except in "legitimate defense" or in consequence of a League of Nations obligation; that they would settle their disputes by pacific means; and that in case of an alleged breach of these undertakings, the signatories would come to the defense of the party adjudged by the League to be the party attacked and also in case of a "flagrant violation." The treaties between France and Poland or Czechoslovakia provided for mutual support against unprovoked attack.

To allay Soviet suspicions, Germany in April 1926 concluded a neutrality pact with the Soviet Union and reaffirmed the treaty of Rapallo (*q.v.*), but this did not prevent Germany from joining the League in Sept. 1926. A further consequence of the pact was the evacuation of the Rhineland in 1930 five years ahead of schedule.

The clear meaning of Locarno was that Germany renounced the use of force to change its western frontiers, but agreed only to arbitration as regards its eastern frontiers, and that Great Britain promised to defend Belgium or France but not Poland and Czechoslovakia.

In March 1936 Germany sent troops into the Rhineland, which had been demilitarized by the treaty of Versailles, declaring that the situation envisaged at Locarno had been changed by the Franco-Soviet alliance of 1935. France regarded the German move as a "flagrant violation" of Locarno, but Great Britain declined to do so, and no action was taken. Germany made no effort to arbitrate its dispute with Czechoslovakia in 1938 or with Poland in 1939.

See also references under "Locarno, Pact of" in the Index.

See William M. Jordan, *Great Britain, France, and the German Problem. 1918–1939* (1943). (B. E. S.)

LOCATELLI, PIETRO (1695–1764), Italian violinist and composer, was born at Bergamo on Sept. 3, 1695. A pupil of Corelli, Locatelli was the first of the great violinists who practised virtuosity for virtuosity's sake, thereby extending the vocabulary of the instrument. Some of the *bravura* effects in his studies and caprices, which anticipate those of Paganini in their concentration on technical feats, overstep the legitimate bounds of music. But these are ostensibly exercises, and in his sonatas and concertos, of which he composed several sets, Locatelli proves himself to be a serious musician capable of elegant and expressive melody. He died on March 30, 1764, at Amsterdam, where he had settled about 1721 and where he gave regular public concerts.

(Dv. H.)

LOCH, HENRY BROUGHAM LOCH, 1ST BARON (1827–1900), British soldier and colonial governor, chiefly remembered as governor of the Cape colony and high commissioner in South Africa in the period before the Jameson raid (1895). Loch was born on May 23, 1827, the son of James Loch, a Midlothian economist and estate manager. After a brief period as midshipman in the Royal Navy he served in the army in India between 1845 and 1853. When the Crimean War broke out Loch was sent to Bulgaria to help raise an irregular Turkish cavalry force. He accompanied the earl of Elgin's special embassy to China (1857–58) and was attached to the headquarters of the commander in chief during operations in the second Chinese War. While in China again in 1860, as secretary to Elgin's second embassy, he was captured by the Chinese when negotiating under a flag of truce and during two or three weeks in prison was most cruelly treated. Loch's appointments after 1860 were in the civil rather than the military sphere. After a brief period as private secretary to Sir George Grey, home secretary, he became lieutenant governor of the Isle of Man in 1863, for the next 19 years earning the devotion of Manxmen for his sympathetic administration of the island. Knighted in 1880, he was appointed governor of Victoria, Austr., in 1884.

In 1889 Loch was sent to the Cape to succeed Sir Hercules Robinson. He believed in vigorous imperial rule in all its plenitude, and, as high commissioner, his attention was inevitably directed mainly toward the Transvaal where President Kruger's policy was threatening British paramountcy in South Africa. Attempts on the part of the colonial office to act indirectly through the Cape parliament having failed, Loch wanted the imperial government to assert itself much more directly to maintain British supremacy in South Africa. He was also dubious about the wisdom of entrusting British expansion in southern Africa to a group of financiers such as the British South Africa company; and he only reluctantly agreed to the use of British forces by the company in the Matabele War of 1893. Sir Henry was inevitably involved with the grievances of the "Uitlanders," British subjects resident in the Transvaal who were suffering a number of serious disabilities under the Kruger regime. He paid official visits to the Transvaal in 1893 and 1894, his enthusiastic reception on each occasion leading him to underestimate the support which existed for President Kruger, and to exaggerate the ease with which the republic might be obtained for Britain as a prelude to South African federation under the Union Jack. After his first visit he decided to intervene should disturbances occur in the Transvaal, and he evolved the "Loch Plan" for the rapid use of imperial police from the Bechuanaland border, should the opportunity occur, a scheme which, with the imperial factor eliminated from it, Rhodes seems eagerly to have adopted after the return of Loch to England in April 1895, at the end of his term.

Created Baron Loch of Drylaw in the peerage of the United Kingdom (1895), Loch felt obliged to defend himself in the house of lords on May 1, 1896, after the Jameson raid, against press allegations that he had promised the reform committee in Johannesburg armed intervention if insurrection occurred there. Modern South African historians find his explanations not wholly convincing. After the outbreak of the South African War in 1899, Lord Loch raised in England the mounted volunteer force known as "Loch's Horse." He died in London on June 20, 1900.

(L. M. Y.)

LOCHABER, a district at the "mouth of the lochs" of southern Inverness-shire, Scot., stretching approximately from Loch Linnhe to Glen Spean and Loch Lochy. The scenery, wild and beautiful, includes Ben Nevis (*q.v.*), through which a 15-mi. tunnel is part of the Lochaber hydroelectric scheme, designed to make use of a catchment area of 303 sq.mi. The powerhouse is close to Fort William.

LOCHES, a town in France, capital of an *arrondissement* of Tours, in the *département* of Indre-et-Loire, 25 mi. S.E. of Tours by road, on the left bank of the Indre river. Pop. (1962) 4,526. Loches (the Roman *Leucae*) grew up around a monastery founded about 500 A.D. by St. Ours. It belonged to the counts of Anjou from 886 until it was seized from King John of England by Philip

Augustus. From the middle of the 13th century until after the time of Charles IX the castle was a residence of the kings of France.

The picturesque town lies at the foot of the rock on which stands the castle of the Anjou family; the castle is surrounded by an outer wall and consists of the old collegiate church of St. Ours, the royal lodge and the donjon. The church of St. Ours (10th, 12th centuries) has huge stone pyramids surmounting the nave and a beautifully carved west door. The royal lodge, built by Charles VII, contains the tomb of Agnès Sorel, mistress of Charles VII, and the oratory of Anne of Brittany. Besides the ruined keep, the donjon includes the Martelet, celebrated as the prison of Ludovico Sforza, duke of Milan, who died there, and the Tour Ronde, built by Louis XI and which once contained the famous iron cages for the confinement of state prisoners. After 1955 restoration work on both the donjon and the royal lodge was carried on.

LOCHGILPHEAD, a small burgh of Argyll, Scot., lies at the head of Loch Gilp and at the eastern entrance to the Crinan canal, 37 mi. S. of Oban by road. Pop. (1961) 1,208. It is the seat of a county court and the administrative centre for the district of Mid-Argyll. Until the disappearance of the herring from the loch, which is a western inlet of Loch Fyne, the town had a flourishing fishing industry. It is now a tourist resort.

LOCHMABEN, a royal and small burgh of Dumfriesshire, Scot., 8½ mi. N.E. of Dumfries by road. Pop. (1961) 1,279. It is a delightfully situated holiday resort in Annandale, with several lakes and the Waters of Ae, Kinnel and Dryfe in the neighbourhood. The town's charter, originally granted by Robert Bruce, was ratified in 1612 by James VI (James I of England). In the parish church is a bell said to have been presented to the original kirk by Bruce, whose statue stands in front of the town hall. At the southern end of Castle Loch are the ruins of Lochmaben castle, dating from the 13th century, where local tradition declares that Bruce was born. He exempted his followers in the district from feudal service and their descendants—the "kindly tenants of Lochmaben"—were confirmed in their tenure by the court of session in 1824. The Bruces had been closely associated with Lochmaben since David I granted Annandale to the second Robert Bruce.

The Lochmaben vendace, a small kind of whitefish, is found only in a few small lakes round Lochmaben. It is captured in fine nets and is considered a delicacy. Lochmaben is famous for curling, and a team entirely composed of shoemakers (souters) who held their own against all comers once added the phrase "to souter" to the vocabulary of the sport, the word indicating a match in which the winners scored "game" to their opponents' "love."

LOCHNER, STEPHAN (*c.* 1400–1451), one of the most attractive of German painters, who is often compared to Fra Angelico and is considered to have brought the Cologne school to its peak of achievement, was born about 1400 in Meersburg. His name has come down to us through Albrecht Dürer's diary of his journey through the Netherlands, in which he remarks that at Cologne he has had Master Stephan's tablets unlocked. By this he means the great, well-preserved triptych which presents the "Adoration of the Magi" and, on the wings, SS. Ursula and Gereon and their followers—that is, the patrons of Cologne. Formerly in the chapel of the town hall, it is now in the cathedral. In this work Lochner fills out the idealism of the older painters of the Cologne school with a seemingly inexhaustible wealth of naturalistic observation in the figures and composition, while the splendid plasticity of the draperies lends them a monumental dignity.

Lochner came to Cologne about 1430; he must previously have been in the Netherlands. The earliest work he did in Cologne was an altarpiece for the church of St. Lawrence. Only the centrepiece with the "Last Judgment" is now in Cologne (Wallraf-Richartz museum); the inner sides of the wings with the martyrdom of the apostles are in the Städel in Frankfurt, while the outer sides with "standing saints" are in the Pinakothek in Munich. The disconcertingly impressive posing of the saints and of the damned, with their back views and half-inducted profiles, the precise representation of the overturned tombstones and of the plants—this realistic vision came to Lochner through suggestions from the circle of the Limburg brothers. But his eye would never have moved beyond individual things if he had not attempted in the central picture to bind the various themes into a unity. In the light and delicate treatment of the objects and the people the work is already masterly.

A little later Lochner painted a small panel with "St. Jerome Meditating in his Study," a "Crucifixion with Saints" (Nürnberg), and for St. Katharine's, the church of the Teutonic order, a two-winged altarpiece painted on both sides, each with three saints. These are in the National gallery in London and the museum in Cologne. In the later 1430s Lochner must have been in the Netherlands again, where he encountered the art of Van Eyck. The first work to reflect this influence is the "Madonna with the Violets," which was done for Elisabeth von Reichenstein, the abbess of the St. Cecilia chapter, about 1443. Van Eyck's influence is noticeable above all, however, in Lochner's chief work, the great town hall altarpiece described above, and in a charming little "Nativity." In 1447 he became a member of the town council, and from the same year dates the splendid "Presentation in the Temple" (Darmstadt museum), which was originally in St. Katharine's. The exquisite "Madonna in the Rose Bower" (Cologne museum) was painted soon afterward.

In 1451 Lochner died, probably being carried off by the plague. He had come to Cologne from afar, but he was in the deepest sense closely related to the city's genius. He became one of the greatest of Cologne's painters, subduing the naturalism of his early works and building up colour and form into a festal solemnity of representation. Lochner must have had a highly productive workshop during all his years in Cologne. From it originated such works as the Gulbenkian collection's "Presentation in the Temple" (1445), Cologne museum's "Madonna in the Garden of Paradise With Saints," two altarpiece wings with St. John and Mary Magdalene now in the Pannwitz collection, and an "Adoration of the Christ Child" painted on canvas in the Diocesan museum in Cologne. Book illumination was also done in the workshop.

See O. H. Förster, *Stefan Lochner* (1938); A. Stange, *Deutsche Malerei der Gotik*, vol. iii, pp. 94–112 (1938). (A. Se.)

LOCK, a device for securing a door, drawers or a box with an inside bolt which cannot be moved except by a key, or by setting a handle or wheel in a way known only to one or a few persons.

Ancient History.—The earliest form of lock appears to be that found in the ruins of the palace of Khorsabad near Nineveh, about 4,000 years old. It is of wood, and the bolt is held in the closed position by several loose wooden pins which fit into holes in it. A long wooden key can be inserted into a slot in the bolt. This key also has pins in it and these pins raise the loose wooden pins to the height that will allow the bolt to be withdrawn (fig. 1). This type of lock was known to the ancient Egyptians and has

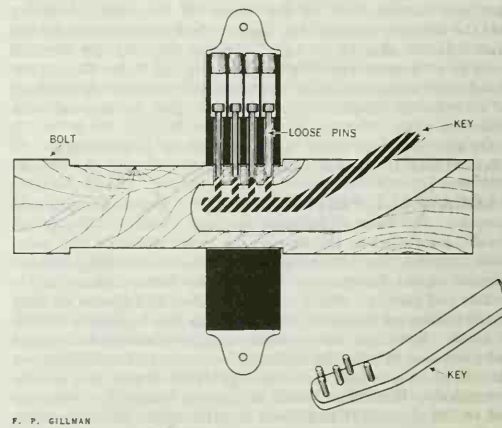

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FIG. 1.—ANCIENT EGYPTIAN LOCK

been found in Japan, in the Faeroe Islands and in Norway. The long keys were carried on the shoulder and account for the verse in Isaiah, xxii, 22, "And I will place on his shoulder the key of the house of David." The principle of the loose locking pins is later to be found in the Yale lock.

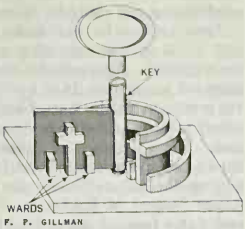

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FIG. 2.—WARDED LOCK AND KEY

The Romans invented metal locks and keys, and the system of security provided by wards. This system was, for hundreds of years, the only method of ensuring that only the right key would rotate in the keyhole (fig. 2). The wards are projections around the keyhole (inside the lock) which make it impossible for a plain key to be turned in it. If, however, the key has slots cut in it which correspond with the projections, the slots clear the projections, the key can be turned and the bolt is thrown back. Throughout the centuries immense ingenuity was exercised by locksmiths in the design of the wards, and consequently some keys are very complicated. All the same it was not difficult to make an instrument which could be turned in spite of the wards, to achieve what is known as "picking" a lock. The Romans also developed very small keys which were often designed to be worn as finger rings (fig. 3), and they also introduced the padlock (though the Chinese may have invented this independently), which is found throughout the near and the far east.

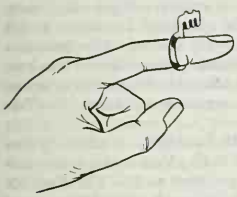
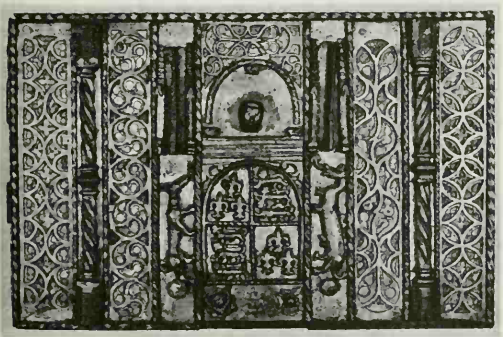


FIG. 3.—ROMAN FINGER RING KEY

From the Middle Ages to the 18th Century.—The locksmiths of the middle ages, especially in Germany, excelled in the workmanship of their products. The keys and moving parts were beautifully finished, the wards were of extreme complexity and ingenuity, and every art of the designer was lavished on the exteriors (fig. 4). This practice was continued by the French into the 18th century, as shown in the illustrations and descriptions of H. L. Duhamel du Monceau's *Description des Arts et Métiers. Art du Serrurier* (Paris, 1767). Nevertheless, in spite of all this attention and the great need in those lawless days for a secure fastening, little progress was made in the mechanism of the lock; elaborate warding of the key and concealment of the keyhole remained the chief safeguards.

Mechanical Improvements.—In 1778 Robert Barron, in England, patented and manufactured a double-action tumbler lock, which was the first of a series of great advances in lockmaking.


C. H. CANNINGS
FIG. 4.—THE WROUGHT-IRON BEDDINGTON LOCK, PROBABLY MADE BY HENRY ROMAINS, LOCKMAKER TO HENRY VIII. IN THE VICTORIA AND ALBERT MUSEUM, LONDON

A tumbler (later known in England as a lever and in the U.S. as a lever tumbler) is a pawl which engages the bolt of the lock and makes it impossible for it to be withdrawn until the tumbler is raised. However, as almost any key which the wards allow to be turned will raise the tumbler, it is of little value in its simple form. In Barron's lock there were two tumblers engaging in a slot in the bolt. As shown in the illustration (fig. 5), the key had to lift each tumbler to exactly the right height before the lock would open. This was an enormous improvement in security and in the 1960s it remained the basic principle of all lever locks.

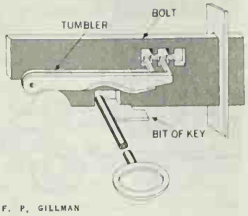


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FIG. 5.—BARRON'S TUMBLER LOCK, 1778

In 1818 Jeremiah Chubb improved on the Barron lock by adding a device called a detector which not only made the lock more difficult to pick but also indicated that an attempt had been made to do so. This detector is a lever placed among the other levers so that if any one of them is raised too high (by an incorrect key or an attempt to pick the lock), a spring will maintain it in the raised position. This prevents the bolt from being thrown and also indicates that the lock has been tampered with.

Very important in the progress of lock design is Joseph Bramah's lock, patented in England in 1784 (fig. 6). For more than 50 years it was the most difficult of all locks to pick and in the 1960s many were still in use. It is operated by a cylindrical key in the end of which fine slots are cut. The key, whose smallness is one of the assets of the lock, is pressed into the keyhole and forces thin metal plates down varying distances, thereby clearing a slot and allowing the key to turn.

The machines made by Bramah (*q.v.*) for the fast and accurate manufacture of his locks were probably the first mass-production machinery in the world. Lockmaking reached its heyday in 1851. At that time, manufacturers demonstrated the safety of their locks by challenging others in the trade to pick them, and it was in that year that the Bramah lock was first picked, by an American, A. C. Hobbs.

In 1848 Linus Yale of Middletown, Conn., patented his first pin tumbler lock, employing the same principle as the ancient Egyptian lock. His son, Linus Yale, Jr., improved on this in the 1860s and evolved the familiar Yale cylinder lock (fig. 7) with its thin, convenient key capable of many thousands of variations. The key is made in a number of different cross sections so that only a particular variety of key will fit into a particular keyhole; this, in effect, is a form of ward. The serrations on the edge of the key raise pin tumblers to exactly the correct height, allowing the cylinder of the lock to revolve and withdraw the bolt. Although not impossible to pick, these locks are convenient and compact and offer a reasonable degree of security. In the 1960s they were the most usual form of fastening for an outside door and were made by locksmiths in all parts of the world, being universally known as Yale locks.

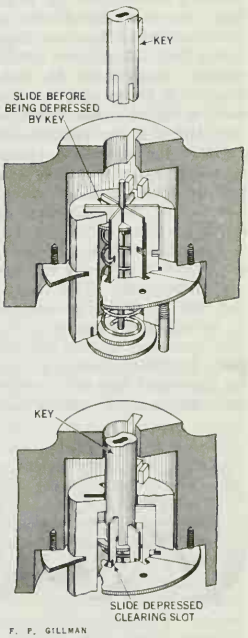

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FIG. 6.—BRAMAH'S LOCK, 1784: (TOP) KEY ABOUT TO ENTER; (BOTTOM) KEY ABOUT TO TURN LOCK

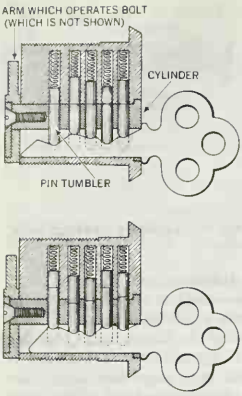

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FIG. 7.—PRESENT-DAY YALE LOCK PATENTED IN THE 1860S: (TOP) CORRECT KEY LIFTS ALL PINS TO PROPER HEIGHT SO KEY CAN BE TURNED; (BOTTOM) WRONG KEY LIFTS PINS TO INCORRECT HEIGHT SO LOCK WILL NOT OPEN

Combination Locks.—The origin of the combination lock is obscure, but it was well known in Europe by the beginning of the 17th century. A combination lock has no key and in its most familiar form consists of a number of rings (tumblers, U.S.) threaded on a spindle, with numbers or letters engraved on the circumference of each ring (fig. 8). These rings are turned until the correct combination of figures or letters is in line along the length of the lock. This brings the corresponding slots in line along the inside circumferences of the rings and the bolt of the lock may be withdrawn. To fasten the lock, the rings are turned to random positions. Although first used for padlocks and for trick boxes, in the mid-20th century combination locks were widely used for safes and strong rooms. The absence of a keyhole is a great advantage for there is thus no inlet to the lock into which an explosive charge can be inserted. The security of this lock depends on the unlikelihood of anyone choosing the right combination by accident and the impossibility of trying all the combinations; for example, in a simple safe lock with four rings and 100 numbers on the dial (*i.e.*, 100 positions for each ring) there are 100,000,000 combinations, of which only one will open the lock. Figure 9 shows how the single knob can set all the wheels; in this case the lock has three rings, giving 1,000,000 possible combinations. Suppose that the combination is 48, 15 and 90. The knob is turned counterclockwise until the 48 comes opposite the arrow for the fourth time, a process which ensures that there is no play between the other wheels. The slot on the first wheel (on the left in the diagram) is then in the correct position for opening and it will not move in subsequent operations. The knob is then turned clockwise until the 15 is opposite the arrow for the third time; this sets the slot of the middle wheel in line with the first. Finally the knob is turned counterclockwise to bring the 90 for the second time to the arrow. All three slots are then in line and another handle can be turned to withdraw the bolts. The combination can easily be changed from time to time.

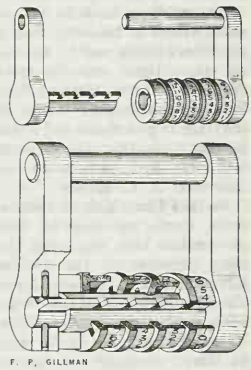

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FIG. 8.—COMBINATION LOCK: (TOP) OPEN; (BOTTOM) CLOSED

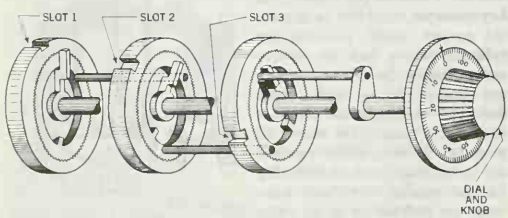

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FIG. 9.—COMBINATION SAFE LOCK OPENS WHEN SLOTS 1, 2 AND 3 ARE IN LINE

Time Locks.—In these locks, a clock inside the safe allows the lock to be opened only after a predetermined number of hours have elapsed. Although the first time lock appears to have been patented as early as 1831 by W. Rutherford in Jedburgh, Scot., the invention was little used until the 1870s, when an alarming increase in bank robberies in America brought about its reintroduction. These robberies all followed the same pattern: the bandits would kidnap the cashier and force him by torture or threats to give up the key or divulge the combination. However, in 1873 James Sargent of Rochester, N.Y., patented a time lock which ended this form of robbery. The mechanism is placed inside the safe and usually comprises two clocks, for safety, with a five-day running time so that they can be used over weekends and bank holidays. The clocks are set so that the locks may be opened at a specified time, and an indicator shows if the lock is in the locked or unlocked position. Access to vaults and strong rooms is usually controlled by locks requiring two different keys to open the doors, and each key is held by a different official.

Master Keys.—A system incorporating a master key is used when a number of locks, such as those securing bedrooms in a hotel or offices in a building, each has a different key and yet all must be opened by a landlord or caretaker using a single key. Where the only security is by wards, a skeleton key which avoids the wards may be the type of master key chosen. In other cases many methods are employed; for instance, there may be two keyholes (one for the servant key, the other for the master), or two sets of tumblers or levers, or two concentric cylinders in a Yale lock.

Locks and Safes in the Mid-20th Century.—The basic types of lock are the Barron, Bramah, Chubb, Yale and combination locks, but innumerable variations have been made. These include locks which are designed particularly to resist being blown open; locks which shoot or stab intruders or seize their hands; locks whose keys can be altered at will; locks which can be opened or closed by several different keys but can be unlocked only by the particular key which closed them; and so-called "unpickable locks," which are usually devised to prevent the thief from exploring the positions of the lock parts from the keyhole or from sensing with his picking tool slight changes of resistance in the mechanism when pressure is applied to the bolt. Also, electronic devices are used to manipulate combinations or to make it possible to control locks from a distance. However, the importance of security (the degree of difficulty involved in picking a lock) declined greatly after the 1940s, for, except in those thefts which were "inside jobs" and for which keys were available, robbers tended to ignore the lock and to use high explosives to blow open the door of a safe. An attempt to blow up the mechanism of a lock by putting gelignite in the keyhole can be foiled by having a second series of bolts which are not connected to the lock mechanism but which are automatically inserted by springs when an explosion occurs; the safe then cannot be opened except by cutting through the armour. Until recently the plating or hinge of a safe could be burned away by an electric arc or an oxyacetylene flame, though only after many hours' work. In the 1960s the materials used in safe building were so resistant that only prolonged burning by an electric arc whose electrode is supplied with oxygen could make an impression.

See also SAFES, STRONG ROOMS AND VAULTS.

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LOCKE, DAVID ROSS: *see* NASBY, PETROLEUM V.

LOCKE, JOHN (1632–1704), English philosopher, the initiator of the Age of Enlightenment and Reason in England and France, an inspirer of the American constitution, and, more than a quarter of a millennium after his death, still a powerful influence on the life and thought of the west, was born at Wrington near Bristol on Aug. 29, 1632. He belonged to a decent and devout

middle-class family, probably Anglicans with Puritan leanings, settled in the Somerset villages near Bristol; his father, John Locke, an attorney, who owned or rented land at Pensford, served for a short time on the Parliamentary side in the Civil War. The father's conduct toward his son was exemplary; as the boy matured he relaxed control and consulted him about his affairs, a course that probably influenced Locke's views on education. In 1647 Locke entered Westminster school. He proceeded to Christ Church, Oxford, in 1652; presumably following the usual arts course, he graduated B.A. in 1656 and M.A. in 1658, and in 1658 was elected a student (equivalent to a fellow in other colleges) of Christ Church.

During the next few years he performed college duties and took pupils. Dissatisfied with the scholastic philosophy still taught in the universities, he was attracted by the scientific studies that flourished in Oxford during the Protectorate, attaching himself to Robert Boyle and applying himself to medicine. From reading Descartes he learned to appreciate philosophy, and he read widely in contemporary English writers. One outcome was his *Essays on the Law of Nature*, written about 1662–63 (in Latin; first published, with English translation, notes, etc., by W. von Leyden, 1954).

In 1661 Locke inherited part of his father's estate, worth, with some additional property, about £60 per annum. He had still to fix on a career. Normally his studentship was not tenable indefinitely unless he took holy orders, which he refused to do. His medical studies brought him the friendship of a doctor, Thomas Sydenham, whose method of treatment, rejection of *a priori* views, and reliance on observation, may have helped Locke to form his philosophical system; but, though he continued his studies, graduating B.M. in 1675 and frequently advising his friends, he was averse to practising medicine. He spent some months in the winter of 1665–66 in Germany at Cleves, as secretary to a diplomatic mission to the elector Frederick William of Brandenburg.

In the summer of 1666 Lord Ashley, the chancellor of the exchequer (Sir Anthony Ashley Cooper, created earl of Shaftesbury in 1672), required some medical attention while visiting Oxford; Locke was introduced by a common friend and immediately won Ashley's friendship. In November he was granted a royal mandate to retain his studentship without further qualification. In 1667 he joined Ashley's household at Exeter house in the Strand in London. He served the family as physician, operating on Ashley in 1668 and attending the birth of the third earl of Shaftesbury in 1671, but was more important as a confidential adviser and secretary. He was concerned in Ashley's colonial ventures and helped him to draft a constitution for the newly established colony of Carolina. While Ashley—now Shaftesbury—was lord chancellor (1672–73) Locke was his secretary for patronage. In 1673–74 Shaftesbury was president and Locke was secretary of the council of trade and plantations.

Partly in response to a controversial pamphlet, Locke wrote in 1660–61 two treatises concerning the powers of the civil magistrate, which stated that, whatever its origin, whether by divine right or by the contract of the members of the community, the magistrate's authority must be supreme; the ruler of the nation must have an absolute and arbitrary power over all indifferent actions; subjects have no right to religious liberty. If these were his views at that time, they had changed radically by 1667, when he wrote an essay on religious toleration: he questions divine right; the magistrate's power is restricted to the preservation of peace among the subjects; everyone is entitled to religious liberty, except when it may endanger the community—an exception especially disqualifying Roman Catholics as they appeared to contemporary Englishmen. Locke was perhaps influenced by Ashley, a champion of civil and religious liberty, who in the constitution of Carolina extended freedom of worship to all comers, atheists alone being inadmissible as colonists.

In London, Locke moved in good intellectual society. He was elected fellow of the Royal society in 1668. At a gathering of some friends in his rooms, probably early in 1671, he writes, when they were discussing a subject not stated:

> After we had a while puzzled ourselves, without coming any nearer a resolution of those doubts which perplexed us, it came into my thoughts, that we took a wrong course; and that, before we set ourselves upon enquiries of that nature, it was necessary to examine our own abilities, and see what objects our understandings were or were not fitted to deal with.

This was the starting point of the *Essay Concerning Human Understanding*. Two drafts of it written in 1671 are extant. Locke worked on it, as opportunity offered, during the next 18 years.

By 1675 Shaftesbury had lost all his offices. Locke suffered from asthma. Believing at this time that his ailment was phthisis and hoping to improve his health, he went to France late in the year. He spent his time partly in Montpellier, where there was a good medical school; partly in Paris, where he made friends with several scholars and scientists; partly traveling about France, noting especially the great works of civil engineering, methods of cultivation, and Louis XIV's treatment of his Protestant subjects, whose rights, granted them by the Edict of Nantes, were being diminished legally or by chicanery. So far as is known Locke met neither Malebranche nor the great Antoine Arnauld. While in France he worked on the *Essay* and wrote short essays on various philosophical subjects.

Locke returned to England in 1679, to find Shaftesbury leading the opposition to Charles II in a major political crisis. This had started with the revelation of a fictitious Roman Catholic conspiracy to assassinate Charles II, who would be succeeded by his brother (the future James II), a Roman Catholic; contributory circumstances favoured the acceptance of the revelation. Shaftesbury now proposed the exclusion, by act of parliament, of Roman Catholics from the throne. This raised the issue, whether succession goes by indefeasible hereditary right, and, following on that, whether the king is absolute, with no responsibility to his subjects, or bound by law and obliged to govern in accordance with their wishes. To support the king's side Sir Robert Filmer's *Patriarcha*, a vindication of the divine right of kings written about 40 years earlier, was published in 1680. Locke set out to controvert it, refuting in detail each of Filmer's arguments in turn in a first treatise and describing the foundations of government in a second (for the publication of this work, in Oct. 1689, *see* below). He also joined with a friend in replying to an Anglican attack on the right of Nonconformists to separate from the Church of England.

The agitation over the Exclusion bill was succeeded in 1681 by a royalist reaction. Charles II wanted to guard against future crises of the kind and to avenge himself for the humiliations that he had undergone. He struck at Shaftesbury and his adherents, who were now called Whigs. Shaftesbury eluded him, but indulged in some wild talk and perhaps projected a rising; he eventually fled to Holland, where he died in 1683. Some of the leading Whigs engaged in a conspiracy, the Rye House plot, which was discovered in June 1683. The treatment of the conspirators, and of other followers of Shaftesbury's who could be associated with them, showed that Charles meant to take full toll. Locke is exceedingly unlikely to have participated in any subversive movement, but his position in royalist Oxford was uncomfortable; as a valetudinarian of timorous character he decided to seek refuge in Holland, going there about Sept. 1683.

In Amsterdam, Locke met a doctor whom he had known in Paris and, through him, Philippus van Limborch, the head of the Remonstrant Church in Amsterdam, a distinguished theologian and an ardent believer in toleration; he became one of Locke's closest friends. He also met Jean Le Clerc, a former Calvinist divine, now turned liberal, and a notable publicist. In 1684 Charles II ordered Locke to be deprived of his studentship at Christ Church, probably as the reputed author of some seditious pamphlets. Locke had, however, an adequate income, not less than £150 per annum, from his paternal inheritance and from an annuity purchased with Shaftesbury's help; he kept a servant and could buy what books he wanted. His English affairs were managed principally by a friend, Edward Clarke of Chipley, Somerset. Money was remitted to him for some time through followers of Shaftesbury who had sought refuge in Holland; but Locke generally avoided them and was not concerned in the preparations for the

duke of Monmouth's rebellion against James II in 1685. In that year, fearing lest the English government should seize him, he lived for a time in concealment. By 1687 he had outgrown his fears and went to live in Rotterdam with an English Quaker, Benjamin Furly.

Until 1686 Locke had published nothing except a few Latin poems contributed to various books. In that year Le Clerc started a periodical for scholars and men of letters, the *Bibliothèque universelle et historique;* he paid great attention in it to English books and ideas. To it Locke contributed (all in French) an account of his method of indexing commonplace books; then abstracts of several new books; then, in Dec. 1687, an abridgment (*"abrégé"*) of his *Essay Concerning Human Understanding.* He sent copies to English friends and sought their criticism. He had already written for Limborch his *Epistola de Tolerantia,* which was published without his name at Gouda in 1689 (for the translation by W. Popple, *see* below). In it he holds that, in regard to the state, churches are voluntary societies; the state has no right to interfere with them or their members except when they break laws purely secular (*e.g.,* human sacrifice is punishable as murder); where the head of a church is under the control of a foreign government the state may restrict toleration in order to defend itself. Though Locke could not forget England, the *Epistola* was written not so much to influence English policy as to defend Protestantism, which was now threatened not only in England, where James II was using toleration to establish the ascendancy of the Roman Catholic Church, but also in France, where Louis XIV had subjected the Protestants to the dragonnades and then deprived them of all their confessional rights by revoking the Edict of Nantes, and in Holland, where the Calvinist clergy, so far as the government would permit, ruthlessly attacked dissidents, especially Unitarians. In 1692 Limborch published his *Historia Inquisitionis,* in which, even more strongly than Locke, he condemned all religious persecution as unchristian.

By the time that the *Epistola* was published the Revolution of 1688–89 had taken place in England, displacing James II in favour of William III. Locke returned in Feb. 1689 in the ship that carried the princess Mary, William's consort. Though the new settlement did not provide everything that he desired, it brought the crown under parliamentary control and provided in practice a large measure of religious liberty; the constitution could be altered by legal means, without recourse, as so frequently hitherto, to violence. Locke became attached to a new generation of strictly constitutional Whigs, whose leader was Sir John Somers (later Baron Somers). On his arrival William III offered Locke the post of ambassador to Brandenburg; this he refused on account of his health and unsuitability. He was appointed a commissioner of appeals in excise cases, with an annual salary of £200 and easy duties. But he could not tolerate the London winters, and in 1691 took up residence with an old friend, Lady Masham (Damaris, daughter of Ralph Cudworth, the Cambridge Platonist), at Oates in Essex, about 20 mi. from London. He visited London every summer until 1701. He exercised some political influence through Somers and through "the College" a small group of his friends, including Clarke, who was a member of parliament from 1690 to 1710.

In Oct. 1689 there appeared, without Locke's name, *Two Treatises on Government* (all copies dated 1690), the book composed in reply to Filmer, with some passages retouched or added and a dedication to William III. Part of the first treatise had been lost, but James II's conduct had shattered the concept of the divine right of kings. The second treatise was so appropriate to the new situation that until the middle of the 20th century it was always regarded as having been written to vindicate the Revolution. About October also appeared *A Letter Concerning Toleration,* the translation by William Popple of the *Epistola de Tolerantia.* It aroused some controversy, and Locke wrote two further *Letters,* both anonymous, to vindicate his position. The *Essay Concerning Human Understanding* was published in Dec. 1689 (all copies dated 1690). It made its mark at once. Many of Locke's contemporaries felt the need of a new attempt to reach ultimate truth; the book, thanks to its plain language and the care taken in demonstration, was easy to understand. During the rest of his life Locke had to prepare fresh editions, to superintend a French translation (by P. Coste, 1700) and to answer criticism. An abridgment by John Wynne (1695) came into use at Oxford.

While Locke was in Holland, Clarke had consulted him about the education of his son. Using his replies, Locke put together a book published in 1693, *Some Thoughts Concerning Education.* Intended specifically for the sons of the English country gentry, it was widely diffused in England and on the continent of Europe and ranks as a classic of educational theory. Locke's last major book, *The Reasonableness of Christianity,* appeared without his name in 1695. In it he urged the rational element in the Gospels. Although he remained an Anglican, the book appealed to Unitarians and Deists and brought him into fresh controversy.

Meanwhile "the College" was discussing Locke's political views and Clarke was bringing them before the house of commons. Locke was especially concerned with the freeing of the press from the Licensing acts (1695) and with the recoinage of 1696. In 1692 he wrote for Somers *Some Considerations of the Consequences of the Lowering of Interest, and Raising the Value of Money.* Early in 1695, when the bad state of the silver coinage was a principal factor in a great financial crisis, he wrote *Short Observations* on the coinage question. In the summer he and Isaac Newton were consulted by Somers (now lord keeper of the great seal) and the chancellor of the exchequer. William Lowndes, the secretary of the treasury, proposed a scheme for devaluation; Locke in reply published *Further Considerations Concerning Raising the Value of Money,* in which he argued for maintaining the standard. Those of his proposals that were practical were adopted. The question, which was the better scheme, Lowndes's or Locke's, is controversial; on one permanent issue, the coinage as a pledge of public faith, Locke exerted an important and lasting influence.

In 1696 Locke was appointed a member of a new council of trade and plantations, at an annual salary of £1,000; despite his deteriorating health he was an active member until 1700, when he resigned. Besides his controversial pieces he wrote in his last years paraphrases of and notes on some of St. Paul's Epistles, and *The Conduct of the Understanding,* which he planned as a fresh chapter of the *Essay;* these and other pieces were published posthumously. He died at Oates on Oct. 28, 1704, and was buried nearby at High Laver.

In person Locke as a young man was handsome. He was strictly continent and had little wish to marry. He is notable for his many long-lived friendships with men and women, and for his happy relations with children. He had a quick temper that sometimes escaped control; was reticent about his private affairs, and in early life perhaps closefisted. His harshness in proposals for the treatment of the poor is apparent rather than real. He was devout, though incapable of strict orthodoxy in any church. He could not be a scholarly recluse; politics, the life of the great world, concerned him almost as much as intellectual life; he felt himself obliged to make the best use of his talents. Distrusting imagination, or, rather, fancy, and emotion, averse to speculation, he exalted reason as, next to revelation, mankind's guide in life and thought.

Manuscripts and Editions.—The Bodleian and other libraries have many of Locke's private papers, including drafts or final versions of some which he did not publish, early drafts of the *Essay* or of other books published by him, notebooks of various kinds, the greater part of his journals from 1675 to his death, and a huge amount of his correspondence and business papers. The bulk of the material is catalogued by P. Long, *A Summary Catalogue of the Lovelace Collection of the Papers of John Locke in the Bodleian Library* (1959).

The diffusion of Locke's printed writings is remarkable. At least 12 editions of his collected works appeared between 1714 and 1823, followed by one called the 12th, in nine volumes, in 1824; a French translation in 1821–25. Of the *Essay,* there were 28 or more editions in English by 1838; 9 editions of Coste's French translation by 1774; 4 editions of a Latin translation; and abridgments. *Some Thoughts Concerning Education* was translated into French, Italian, German, Swedish and Czech. This

diffusion continued, probably at a slower rate, later in the 19th century and was still continuing in the 20th (notably in Italy after 1945).

Besides A. C. Fraser's edition of the *Essay*, two volumes (1894; facsimile 1959), and a reprint of the 5th edition by J. W. Yolton (in Everyman's Library, two volumes, 1961), there are abridgments by A. S. Pringle-Pattison (1924) and by R. Wilburn (in Everyman's Library, 1947); of the early drafts, the first is edited by R. I. Aaron and J. Gibb (1936) and the second by B. Rand (1931). The *Two Treatises of Government* are edited by P. Laslett (1960); there is another edition in Everyman's Library; and the second treatise is also printed in *Social Contract* (World's Classics, 1947), with an introduction by Sir Ernest Barker. J. W. Adamson's edition of *Locke's Educational Writings* (2nd ed., 1922) contains *Some Thoughts Concerning Education.*

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LOCKE'S PHILOSOPHY

Theory of Knowledge.—Locke was thoroughly suspicious of the view that a thinker could work out in his study by pure reason alone the truth about the universe. Much as he admired Descartes, he feared this speculative spirit in him, and he despised it in the scholastic philosophers. In this sense he rejected metaphysics. Knowledge of the world around us could only be gained by experience and reflection on experience, and this knowledge was being gained by Boyle, Sydenham, Christiaan Huygens and Newton. They were the true philosophers who were advancing knowledge. Locke set himself the humbler task, as he conceived it, of understanding how this knowledge was gained. What was "the original, certainty and extent of human knowledge, together with the grounds and degrees of belief, opinion and assent"?

Empiricism.—As for "the original", the answer was plain. Knowledge of the world around us began in sense-perception, and knowledge of ourselves in introspection, or "reflection" in Locke's language. It did not begin in innate knowledge of maxims or general principles, and it did not proceed by syllogistic reasoning from such principles. In the 17th century there had been much vague talk about innate knowledge, and in book i of the *Essay Concerning Human Understanding* Locke examines this talk and shows its worthlessness. The case that he makes against innate ideas, being now of historic interest only, need not detain us. The only question that remains is whether there is innate knowledge in another sense (or in other senses) ignored by Locke, but this too is something that we need not here consider. In book ii of the *Essay* he begins by claiming that the sources of all knowledge are sense-experience and reflection; they are not themselves, however, instances of knowledge in the strict sense, but they provide the mind with the materials of knowledge—and already Locke is opening the door for the phenomenalism and the idealism of the future. Sense-experience is not direct knowledge of the world as it is. The senses provide the mind with "material"; he is not sure what to call the material so provided, perhaps "species" (as the scholastics did) or "notions", but he finally decides on "ideas." These are the objects "before the mind," but we must not assume that the ideas are the physical objects. Rather they represent them; and though we may concur with common sense that, for instance, physical things have size, shape, weight, as they appear to have, yet in respect to colour, taste, smell and so on we may seriously doubt whether things are as they appear to be in sense-experience. In a word, Locke accepts the representative theory of sense-perception and holds that while some of the representations are exact copies of the physical, most of them are not. On this basis he distinguishes between what he calls primary qualities, such as size, weight, etc., and secondary, such as colours, tastes, smells and sounds.

Locke now proceeds to group and classify the ideas, with a view to showing that the origin of all of them lies in sensation and reflection. For though they are immediately "before the mind" not all of them are simple. Many of them are compounded and their simple parts can be revealed on analysis. It is these simples alone which are given in sensation and reflection. Out of them the mind forms complex ideas, though Locke is ambiguous on this point. For while he uses the language of "forming" or "compounding" and speaks of the "workmanship" of the mind, yet the compounding is frequently in accordance with what is perceived "to go together" and is not arbitrary. A conflict is apparent between Locke's desire to sustain the common-sense view that we do know physical objects and the demands of his compositionalist theory that all ideas can be reduced to the simple ideas of sensation and reflection of which they were originally compounded. Further troubles met him in his attempt to classify ideas. While the idea of a particular apple may be a complex of round, sweet, red, etc., what of the general idea of apple? And what of ideas of relation, such as taller than, identical with, etc.? Locke's compositionalism in this part of the *Essay* is patently insecure; yet its purpose is clear, namely, to provide him with a method of showing that all ideas, however remote they may appear to be from sense-experience and reflection, are in fact derived from these sources and from no other. This applies even to the idea of infinity itself. Ideas of space, time and number and mathematical ideas are derived, too, from simple ideas. Locke saves himself from the difficulties inherent in this position by the superficiality of his treatment.

So, too, his reflections upon cause and effect, had they been elaborated, would undoubtedly have led him into acute difficulties. He does admit one failure. As an empiricist he can give no account of the idea of substance; it is, he thinks, essential and not to be denied, and yet it is not a simple idea given in sensation or reflection nor is it derived from simple ideas so given. In fact he can say little of it; it is "a-something-I-know-not-what." Thus the case for empiricism cannot be said to be entirely established by book ii, but Locke thinks it strong enough for him to persist in the view that our knowledge of the physical world is wholly derived from sense-perception.

Self-Knowledge.—Some of our ideas are not of things outside us, but are reflexive and of ourselves. Locke finds it necessary to classify these in book ii and in doing so sets down the foundations of empirical psychology. His source of information is introspection and rarely the observation of behaviour. His account of sense-perception is celebrated for its appreciation of the part which the interpretative mind plays in perceiving, and some of his farsighted observations on the relations between the senses, particularly vision and touch, have profoundly affected subsequent thought. He makes valuable remarks on memory, on discerning, on comparing, on madness, on pleasure and pain, on the emotions and on the association of ideas.

Locke holds that we have an intuitive knowledge of our own existence and supposes that we exist as material and immaterial substances, but he is none too clear about this and at one point plays with the idea that we are simply material substances to which God has "superadded" a power of thinking. His most valuable contribution, however, is his account of personal identity. Having distinguished between different types of identity, he argues that personal identity depends on self-consciousness. I am the person who did so-and-so 20 years ago because I can remember myself doing it. This is the key to the identity of persons.

Language.—Locke tells us that book iii, on language, "cost him more pains" than any other book of the *Essay;* yet it is the book which has been most neglected. To understand our thinking and knowing we must understand the language with which we think and communicate our thoughts. Words are conventional signs; but signs, according to Locke, not immediately of things but of ideas of things, so that he carries his theory of ideas into his account of language. Frequently, the idea signified by the word is not clear and sometimes we use words when we have no ideas corresponding to them. This is particularly so in the case of general words, without which language would be so impoverished as to lose most of its worth. What is involved in the use of general words? The answer, in Locke's mind, is bound up with the theory of universals. Does the general word stand for a particular idea which is used in a representative capacity? Or is the universal

nothing more than a creation of the mind, through abstraction, to which is attached a name? Or, again, is it simply the manner in which we desire that this general word be used? Locke considers these matters without giving a definite answer, but in dealing with natural substances he is inclined strongly toward a conceptualism according to which the use of general words is possible only because in using them we have in mind "nominal essences," that is to say, not the real essences of things but what we mean by these general words. On this view what we mean is the concept, something we have ourselves brought about, the "workmanship of the understanding." Locke also discusses the names of simple ideas and of relations, and it is interesting to find the crude beginnings of a discussion of what were later to be called logical or operative words. Book iii contains also a valuable account of definition, which denies the theory that all definition must be *per genus et differentiam*. The final chapters deal with the inevitable imperfections of language and with avoidable abuses.

Conclusions.—After the consideration of the "materials" of knowledge in book ii and of language in book iii, Locke is ready to discuss the nature and extent of human knowledge. It is noticeable that the tone of book iv is more rationalistic than is that of the previous books, and this is because the skepticism which emanated from his empiricism drove him to find the ideal of knowledge in the indubitable certainties of mathematics. Here he was on common ground with the rationalists of his day, and indeed the direct influence of Descartes seems to be observable in the opening chapters of book iv. Knowledge is perception; not sense-perception but intellectual perception or intuition. We do not, however, gain all the knowledge that we require by direct intuition; we have frequently to proceed discursively, that is, by demonstration. But even when this is so, each step in the demonstration is observed intuitionally, so that knowledge in the strict sense is essentially intuitive. "This part of knowledge is irresistible and, like bright sunshine, forces itself immediately to be perceived, as soon as ever the mind turns its view that way; and leaves no room for hesitation, doubt or examination."

Unfortunately, what can be so intuited is limited, as is too what can be demonstrated. We need not confine strict knowledge entirely to mathematics, but the intuition of relations within the physical world is beyond us. Books ii and iii have shown that we deal directly with ideas and nominal essences and that the inner nature of real things cannot be known by us, so that "science," in the exact sense of perfectly certain knowledge, is not possible in this sphere. The only possibility of intuiting, consistent with books ii and iii, is that within the world of ideas, an ideal world, be it noted, which is for Locke empirically derived and not intellectual in character. Knowledge in general terms he accordingly defines as the intuition or "perception of the connection of and agreement, or disagreement and repugnancy, of any of our ideas." If we keep ourselves within ideas—and this is the case in mathematics, for instance—we gain indubitable knowledge, but when we deal with ideas "whose archetypes are without them" we are less sure.

The connections between ideas may be of four kinds: (1) identity or diversity; (2) relation, such as larger than, wider than, etc.; (3) co-existence, such as the co-existence of malleableness and yellowness in my idea of gold; and (4) real existence. Of these four, knowledge of identities and differences is as wide as the ideas themselves: if we have the idea of a spade we know that that idea is itself, and that it is not the idea, for example, of a hammer. This division points somewhat vaguely to a fourfold grouping which is certainly not dominated by the subject-predicate relation.

Secondly, in dealing with the relations between ideas which are their own archetypes, for instance in mathematics, we need seek no further than the intuition or perception itself. But when, thirdly, we affirm co-existences there is an implied reference beyond the idea to the thing itself; and clearly this is also the case when, fourthly, we say that something exists. In these cases, therefore, our certain knowledge is not likely to extend very far. In other words, Locke distinguishes here between logical and factual truth. Certain knowledge, he thinks, is possible of the former, but not of the latter.

In spite of this, and somewhat inconsistently, Locke thinks that we do have knowledge approaching certainty in our "sensitive knowledge" of the existence of physical things. Further, we intuit our own existence. In these cases knowledge which is not an apprehension of a relation between ideas is none the less certain. But he makes it clear that, for the most part, when we talk of knowledge of the physical world and of ourselves, such knowledge is probable and not certain. It rests not on intuition but on judgment; it is assenting to a proposition on the strength of the evidence, and there may be degrees of assent and wrong assent or error. Locke recognizes the need for a logic of probability; though he does little himself in the chapters devoted to probable knowledge at the end of book iv to meet that need. Yet it should be added that the important regular-sequence theory of induction, afterward developed by Berkeley and Hume, is put forward in the pages of Locke's *Essay*. He speaks, too, in book iv, though only briefly, of "habitual knowledge" and is aware of the dispositional element in knowledge.

Political Theory.—Locke's most important work on political philosophy is that entitled *Two Treatises of Government* (1690). The first treatise, as has been explained above, is a refutation of Sir Robert Filmer's defense of the divine right of kings; the second and more important treatise refutes the absolutist theory of government as such, particularly that found in Hobbes' *Leviathan*, though the latter work is not mentioned.

Locke defines political power as "a right of making laws, with penalties of death, and consequently all less penalties for the regulating and preserving of property and of employing the force of the community in the execution of such laws, and in the defence of the commonwealth from foreign injury, and all this only for the public good." He seeks to show the inevitability of this institution in terms of theories of natural law and of social contract which, as held by Locke, are both now discredited. The outcome of his explanation is that only such political power can be justified as is genuinely "for the public good." This means that government is a trust, forfeited by a ruler who fails to secure the public good. The ruler's authority, that is to say, is conditional rather than absolute. Nor does the individual abrogate all his rights when he enters a civil society. He has established his right to property, by "mixing his labour" with things originally given to mankind in common, but now made his own by his labour. (Here in germ is the labour theory of value.) He has the right to expect political power to be used to preserve his property, in his own person and in his possessions. He has the right to think as he chooses, to worship as he wishes, to freedom in speech. In fact the one right which he gives up in entering a civil society is the right to judge and punish his fellow man which is his right in the state of nature. He quits his "executive power of the law of Nature" and "resigns it to the public"; he himself makes himself subject to the civil law and finds his freedom in voluntary obedience. "Freedom of men under government is to have a standing rule to live by . . . a liberty to follow my own will in all things where that rule prescribes not, not to be subject to the inconstant, uncertain, unknown arbitrary will of another man." To secure this freedom, Locke favoured a mixed constitution: the legislative should be an elected body, whereas the executive is usually a single person, the monarch; and he argues for a separation of legislative and executive powers. The people are ultimately sovereign, though it is not always clear in Locke's theory where the immediate sovereignty lies. But the people always have the right to withdraw their support and overthrow the government if it fails to fulfill its trust. In economic theory Locke adopted the principles of the mercantilists.

Moral Philosophy.—One searches in vain for a consistent moral theory in Locke. His view that morality can be a science, as certain as mathematics, is well known. This might imply a rationalism, and there are indeed rationalist trends in his moral philosophy—although sometimes when advocating a science of morals he seems to have in mind simply the possibility of an exact analysis of the terms used in moral discourse and the clarification of moral statements. At other times, he puts forward a hedonist theory. "That we call *good* which is apt to cause or increase pleasure or

diminish pain in us." But not every good is moral good: "*Moral* good and evil is only the conformity or disagreement of our voluntary actions to some law, whereby good or evil is drawn on us, from the will and power of the law-maker." On this view law rests on God's will, "the true ground of morality," though in saying this Locke does not appear to be consistent with what he says elsewhere of the law of nature.

On the question of free will, discussed in the *Essay*, Locke's position at first is determinist, but in the second edition he tries—not very successfully, it must be admitted—to defend the indeterminist theory by holding that man can always "*suspend* the execution and satisfaction" of any of his desires.

Theory of Education.—The genesis of the work entitled *Some Thoughts Concerning Education* is described above, and in reading this book it is well to bear in mind that the education proposed is meant for a squire's son in late 17th-century England.

A good education, in Locke's view, attends to both the physical and the mental. The body is not to be coddled, on the contrary it is necessary that it should be hardened in various ways. The good educator insists on exercise, play and plentiful sleep, "the great cordial of nature." Young children should be allowed to give vent to their feelings and should be restrained rarely; "the chief art is to make all that they have to do sport and play too." As for mental training, character comes first before learning; the educator's aim is to instill virtue, wisdom and good breeding into the mind of the young. Parents, too, must interest themselves in their children's upbringing and, as far as possible, have them near; for no educative force is more powerful than the good example of parents. A stock of useful knowledge must be imparted: languages, the pupil's own and another modern language together with Latin (Locke thought the practice in his day of teaching Hebrew, Greek and Arabic generally was misguided); geography, history, some anatomy; mathematics, as the "powers of abstraction develop"; and later a little civil law and an introduction to morals, natural science and philosophy. For recreation, training in the arts, crafts and useful hobbies should be available, but these should not take up too much of a young man's time.

Religion.—Locke's reaction against the "enthusiasm" of the sects in his youth had been sharp, and he disliked religious fanaticism throughout his life. He was a broad, tolerant Anglican anxious to heal the breach in English Protestant ranks. His own views on church government and on the priesthood were close enough to those of the dissenters to have made union possible, for he favoured the liberal views of the Latitudinarians, of the Cambridge Platonists and of the Remonstrants of Holland. This becomes manifest in *The Reasonableness of Christianity*, while his commentaries on the Epistles of St. Paul make him one of the pioneers of modern biblical criticism. Two essentials, and two alone, he thinks, are involved in being a Christian: first, that a man should accept Christ as God's Messiah, secondly, that he should live in accordance with Christ's teaching. His point of view is not far removed from that of the Deists on the one hand and the Unitarians on the other, yet he cannot be grouped with them. Christianity, though reasonable, needs revelation as well as reason, for human reason alone is inadequate: there is an experience of God "through His Spirit" without which all religion is empty. However, any act of persecution in the name of religious truth is wholly unjustified, since our knowledge and understanding are so confined.

See also references under "Locke, John" in the Index.

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LOCKE, MATTHEW (*c.* 1630–1677), English composer who, of all English composers before Henry Purcell, showed most talent for the theatre, was born in Exeter about 1630. He was a chorister at the cathedral there under Edward Gibbons and later, at the age of 18, he visited the Low Countries. Together with Christopher Gibbons, nephew of his former teacher, he wrote the music for James Shirley's *Masque of Cupid and Death* (1653). He also wrote part of the music for Sir William Davenant's *The Siege of Rhodes* (1656), usually considered to be the first operatic entertainment produced in England, and sang in it himself. In the same year appeared his *Little Consort of Three Parts*, for viols. By 1660 he had been appointed Composer in Ordinary to the King. Locke wrote the music for the "king's sagbutts and cornetts," used when Charles II "progressed" from the Tower of London to Whitehall the day before his coronation; he also wrote several anthems for the Chapel Royal. After his own conversion to Catholicism he was appointed organist to the queen. Much of his later music of importance is concerned with the stage: for Thomas Shadwell's *Psyche* (1673), Davenant's version of *Macbeth* (1663) and Shadwell's of *The Tempest* (1674). He died in London in Aug. 1677.

None of Locke's instrumental music contains the harmonic daring so typical of his vocal style, but the consort music mentioned above and other works for viols remain some of the most masterly instrumental music of the century. In the *Tempest* music Locke uses for the first time in English music such markings in the vernacular as "soft," "louder by degrees," and uses tremolos for string instruments. His treatise, *Melothesia* (1673), contains his "Certain General Rules for playing upon a Continued Bass."

(B. P.)

LOCKERBIE, a small burgh of Dumfries, Scot., in the district of Annandale, 12 mi. N.E. of Dumfries by road. Pop. (1961) 2,826. It is near the Roman road and of the Roman camps in the vicinity the best preserved is Burnswark (Birrenswark). Lockerbie is famous for its sheep sales, particularly for the great August lamb fair. The Tower of Lockerbie was once the stronghold of the Johnstones, long the ruling family under whose protection the town grew up. At Dryfe Sands, about 2 mi. W., the Maxwells were almost exterminated by the Johnstones in 1593, hence "Lockerbie Lick" became a proverbial expression, signifying an overwhelming defeat.

LOCKHART, JOHN GIBSON (1794–1854), Scottish biographer, critic and editor, whose biography of Sir Walter Scott has been ranked next to Boswell's *Johnson*, was born in Lanarkshire on July 14, 1794, the son of a Presbyterian minister descended from the landed gentry. Educated at the universities of Glasgow and Oxford, he left the latter in 1813 with a first class in classics, studied for the Scottish bar, and was admitted advocate in Edinburgh in 1816, but his reserve unsuited him for that profession. When *Blackwood's Magazine* was founded in 1817 as a Tory rejoinder to the Whig *Edinburgh Review*, Lockhart became a leading contributor and helped to write the notorious *Chaldee MS.* which, lampooning Scottish celebrities in a parody of Old Testament style, made the first number of the new magazine a *succès de scandale*. Whether Lockhart was wholly, or partly, or at all responsible for the early Blackwood attacks on Keats and the Cockney poets must remain a controversial question in considering a magazine where different writers shared the same pseudonyms, but his sobriquet of "the Scorpion" indicates that his fellow contributors recognized the cutting edge of his wit, which flicks playfully but keenly around the contemporary Scottish scene in *Peter's Letters to His Kinsfolk* (1819). But if Lockhart's aristocratic satire has something of the devilment of Byron's, he again resembles Byron in possessing imagination as well as impudence, and the romantic aspect of his nature was expressed in his verse translations, *Ancient Spanish Ballads* (1823). He attempted fiction too, but although one of his four novels, *Adam Blair* (1822), attracted attention by its "daring" theme of a clergyman's failure to resist sexual temptation, it suffers from gentility of treatment.

As a gentleman, a Tory, an advocate and an author, Lockhart became a friend of Sir Walter Scott, whose elder daughter Sophia he married in 1820, and it was through his father-in-law's good

offices that he was appointed editor of the Tory *Quarterly Review* in 1825. To this he contributed much sound literary criticism, and his judicious praise of Wordsworth, Coleridge, Shelley, and of Byron's *Don Juan* should be recalled alongside his damaging attack on Tennyson's *Poems* of 1833. In 1828 Lockhart produced his biography of Burns, a compilation in which his own comments are remarkable for sympathetic insight and freedom from any tendency to patronize. His *magnum opus*, the *Life of Scott* (1837–38), was attacked on publication for its frankness about Scott's faults, but modern criticism has viewed it as an idealization rather than as a denigration of its subject. That Scott was a hero to Lockhart is indisputable, but if the picture of Sir Walter's years of greatest success is painted in the brightest of colours, the biographer's subtle, incisive wit indicates the foibles of Scott himself alongside the follies of his henchmen, the Ballantynes. Lockhart's wife died in 1837, and his son Walter—Scott's heir—in 1853. Poor health compelled him to resign the editorship of the *Quarterly* in 1853, and he died at Abbotsford on Nov. 25, 1854.

See A. Lang, *Life and Letters*, 2 vol. (1897); M. Lochhead, *John Gibson Lockhart* (1954). (A. M. S.)

LOCKJAW: *see* TETANUS.

LOCKOUT: *see* STRIKES AND LOCKOUTS.

LOCKPORT, seat of Niagara county, in western New York, U.S., 25 mi. N.N.E. of Buffalo, and part of the Buffalo standard metropolitan area. The city owes its name to five double locks of the Erie canal (now part of the New York State Barge Canal system), which overcome a difference of 66 ft. between the levels of Lake Erie and the Genesee river. Abundant electric power from Niagara falls serves diversified manufacturing interests, including pulp and paper, flour, wallboard, plastics, textiles, brooms, glass, foundry, brass and bronze products, automobile radiators and parts and sundry machine shop products. Located in the heart of the Niagara frontier fruit belt, the district is noted for its apple, peach and cherry orchards. Quarrying of limestone is also significant. In 1792–93, the Holland Land company bought the present Lockport site, and in 1816 sold most of it to Esek Brown, a local tavern proprietor, and 14 others. In 1822 the settlement was made the county seat and in 1823 it became a temporary headquarters for construction on the Erie canal. Lockport was incorporated as a village in 1829 and as a city in 1865. For comparative population figures *see* table in NEW YORK: *Population*. (A. G. SE.)

LOCKYER, SIR JOSEPH NORMAN (1836–1920), English astronomer, a pioneer in the application of the spectroscope to the sun and stars, was born at Rugby on May 17, 1836. Educated partly on the continent, he obtained a clerkship in the war office in 1857 and was appointed secretary to the royal commission on science in 1870. He became professor of astronomical physics in the Royal College of Science in 1881 and director of the Solar Physics observatory in South Kensington in 1885; he conducted eight governmental expeditions for observing total solar eclipses between 1870 and 1905.

Lockyer initiated, in 1866, the spectroscopic observations of sunspots; announced, in 1868, that the prominences were upheavals in a layer around the sun, which he named the chromosphere, and applied C. J. Doppler's principle to the sun in 1869. In 1868, Lockyer and P. J. C. Janssen, working independently, discovered a spectroscopic method of observing solar prominences without the aid of an eclipse, and to commemorate this discovery a medal bearing the names of both astronomers was struck by the French government in 1872. With the co-operation of Lady Lockyer, he built an observatory at Sidmouth where he carried out many important photographic and spectroscopic researches. He inaugurated the periodical *Nature* in 1869 and edited it until a few months before his death at Salcombe Regis, Devon, on Aug. 16, 1920. He received a Rumford medal from the Royal society in 1874 and was vice-president of the society in 1892–93. He was created knight commander of the Bath in 1897.

In addition to his many scientific papers, Lockyer wrote *Stonehenge and Other British Stone Monuments Astronomically Considered* (1906) and *Inorganic Evolution* (1900).

See T. M. and W. L. Lockyer, *Life and Work of Sir Norman Lockyer* (1928). (O. J. E.)

LOCMARIAQUER, a village of Brittany, western France, in the *département* of Morbihan, lies on the west shore of the Gulf of Morbihan, 14 km. (9 mi.) S. of Auray by road. Pop. (1962) 513. Locmariaquer has a small harbour; it is a seaside resort and oyster culture is carried on. It is famous for its megalithic monuments: standing stones (a huge, broken standing stone, the Fairies' stone, was 66 ft. high) and stone tables (the Merchants' Table, carved slabs). There are some Gallo-Roman remains and a church which dates in part from the 12th century. (Y. Ro.)

LOCOMOTION, ANIMAL. Disregarding some of the lower forms of life, one of the most obvious distinctions between animals and plants is that the former exhibit in striking degree a capacity for locomotion. They move about in pursuit of food, foothold and mates, or in flight from enemies and harmful influences. Locomotion may be defined as the ability of animals to move from place to place by their own actions. It does not include transport by forces such as wind or water currents that carry the animal along, although this is an important supplement to locomotion in some species. The galloping horse clearly is using powers of locomotion; the egg of a fish carried by ocean currents is not. The young spider that climbs to a high branch, spins a long silken thread, then is carried on this thread by the wind, or the Portuguese man-of-war, in which a gas-filled float acts as a sail before the ocean breezes, are passive travelers. Different kinds of animals live successfully through adaptations that vary from highly specialized and efficient methods of locomotion, through a bewildering array of intermediate adaptations, to a completely sedentary, even sessile, mode of life. Thus, while active locomotion is emphasized in this survey article, it is important to remember that in the animal kingdom many alternatives exist. Information regarding the speeds attributed to different animals may be found in many separate articles.

Each animal's powers of locomotion fit, along with its many other faculties, into a complex design that enables it to exist as an individual and as part of a population. The rabbit must run to escape enemies, and is well adapted to do so, while the porcupine is protected by a coat of sharp quills but is not specialized for rapid locomotion. Many birds adapted to particular climatic conditions migrate with the changing seasons. Grazing animals and nomadic human tribes move to new areas when old food supplies become depleted. Fishes move to different depths during different seasons because of changes in the oxygen content and temperature of the water. Many reptiles crawl back and forth from sun to shade during the day, following the environmental temperature that best suits them. Flying insects, because of their great mobility, can exploit widely scattered food supplies. Salmon, which are bound to fresh-water streams by rigid spawning requirements, take advantage of the great abundance of food in the oceans by migrating great distances to the sea. When animals become very abundant locally, they tend to interfere with one another in such vital functions as feeding, respiration or breeding. Dispersal, usually involving locomotion, may then act as a safety valve by reducing the local density of the population.

Adaptations for locomotion reflect both the environmental pressures under which an animal evolved and the basic ancestral body plan from which it was derived. The basic body plan may limit the amount of adaptive modification possible. For example, the vertebrates, having evolved from fishes, are committed to a basic pattern of two pairs of limbs. Some use both pairs for the same type of locomotion (four-footed land mammals); some use each pair for a different type of locomotion (birds); some rely principally upon only one pair (man); and some have vestigial limbs not used in locomotion (snakes). These modifications involved relatively simple evolutionary changes compared with the drastic revision of the vertebrate body plan that would have been required to produce a method of locomotion involving, for example, three pairs of limbs.

BASIC MECHANISMS

Animal locomotion is based upon the ability of protoplasm to convert chemical energy, obtained from food, into the mechanical

energy of contraction. In the amoeba, changes in shape of the entire protoplasmic mass are involved. In other simple animals only specific protoplasmic structures are moved. In most animals, however, locomotor contractions are produced by long, slender muscle cells that contain tiny elastic fibres (myofibrils) capable of shortening and then returning to their original length.

Musculature.—A primitive musculature used in locomotion is found in coelenterates, where the body walls contain opposed sets of epitheliomuscular cells capable of shortening the body or of decreasing its diameter. The flatworms have muscle fibres arranged in longitudinal, transverse and dorsoventral directions; when the muscles contract in one direction, the plastic, fluid-filled body extends in the other two. In roundworms the muscle cells all lie parallel to the main body axis; these animals can bend and straighten by alternately contracting fibres along opposite sides of the body, but they are not able to extend the body lengthwise. Earthworms have an outer layer of circular muscles and an inner layer of longitudinal muscles in the body wall; when the circular muscles contract, the fluid-filled body increases in length, and when the longitudinal muscles contract, the worm becomes shorter.

The arthropods are the only invertebrates that depart from a layered arrangement of muscles. They possess many muscles of different sizes and arrangements, fastened to the internal surfaces of the hard exoskeleton in opposed pairs. These muscles move the body segments and the jointed appendages. The muscles of vertebrates also vary greatly in size and arrangement and, as in the invertebrates, are usually grouped in opposing pairs. They are attached to the exterior of the bones and are used to move the various skeletal components, which function as levers.

The principal component of the muscular system in many invertebrates is smooth muscle, which is capable of only relatively slow contraction. In the arthropods and in the vertebrates striated muscle predominates in structures used for locomotion. This type of muscle is capable of rapid contraction, a decided advantage where speed of movement is important.

Activation.—In the lower animals the protoplasm or contractile fibres respond directly to environmental stimuli such as contact with obstructions or with chemical substances. In intermediate forms the stimulus may be received by specialized sensory nerve endings (photosensitive "eyespots," chemoreceptors, etc.) and the muscle stimulated by an electrical impulse conveyed by a motor nerve process. In vertebrates the complex muscular movements involved in locomotion are basically compound reflex actions, subject to central control through association nerve cells (neurons) connected with parts of the nerve cord and the brain. These reflex actions may be initiated by impulses entering on one sensory neuron and affecting several motor neurons; by impulses from several sensory neurons compounded to act on a single motor neuron; or by chain reactions in which the response of one reflex becomes the stimulus for the next. Many related reflexes are co-ordinated by the nervous system in producing the complex muscular movements of walking or flying.

INVERTEBRATES

Advances From Protozoa to Arthropoda.—A major group of protozoans, the Mastigophora or Flagellata, possess long, filamentous, protoplasmic extensions called flagella, which beat in whiplike fashion, drawing the animals through the water. Unicellular forms such as *Euglena* revolve on their long axis as they swim forward. *Euglena* can also crawl wormlike by altering body shape through local expansions and contractions. This method of locomotion, called euglenoid movement, is controlled by protoplasmic contractile fibres. Colonial flagellates such as *Volvox* consist of many individual cells imbedded on the surface of a gelatinous ball. The flagella beat in co-ordinated waves causing the ball to roll over and over as it moves through the water, but one end of the colony always remains oriented forward.

In a second group of protozoans, the Sarcodina, each animal literally flows along over the substrate in what is called amoeboid movement. The protoplasm at the trailing edge of the organism changes in consistency to a thin "plasmasol" state and flows forward, thickening to the "plasmagel" state at the leading end. The plasmagel then passes backward, increasing in elastic strength as it goes. During the continually reversing gel-sol process, the amoeba may be temporarily and reversibly attached to the substrate, possibly by a secretion. This method of locomotion is found in modified form in some more advanced animals. Individual cells isolated from sponges are capable of amoeboid movement. The coelenterate *Hydra* can glide along by the pseudopodia-like action of the cells on its basal disc. In the higher vertebrates, most of the white blood cells are capable of amoeboid movement within the animals' tissues.

In a third class of protozoans, the Ciliata, the organisms possess fine, hairlike projections called cilia on the surface of the protoplasm. *Paramecium* is a typical example. The cilia beat backward to carry *Paramecium* through the water. Because the animal is not quite symmetrical and the ciliary stroke is oblique, *Paramecium* rotates on its longitudinal axis as it moves, following a spiral course about a straight line. When the animal meets an obstacle in its path it backs up by reversing the beat of the cilia.

Locomotion by the action of cilia is also found in some higher invertebrate phyla. The sponges, which are incapable of movement through most of their lives, have a ciliated, free-swimming larval stage. Ciliated larvae also occur in the coelenterates (the planula of colonial hydroids) and in the bryozoans and the marine annelids (trochophore). In free-swimming rotifers, an anterior crown of whirling cilia is the chief means of locomotion. Free-living flatworms glide along a slime track, laid down by epidermal glands in the head end of the animal, by means of backward strokes of cilia on the ventral surface.

Flatworms can also crawl by contracting the circular and dorsoventral muscles to elongate the body, anchoring the head end by a sticky mucus, then drawing the body forward by contraction of longitudinal muscles. Many nematodes are covered with minute bristles, spines or scales that assist them in crawling through the soil. Mollusks glide smoothly along a slime track secreted by a gland below the mouth, propelled by waves of muscular contraction on the underside of the protruding, fleshy foot. Clams and oysters extend the foot between the valves of the shell, hook it to the substrate or wedge it into a crevice and fasten it by expansion, then contract the foot to drag the shell forward. The earthworm crawls through the soil by forcing its slender anterior end into crevices, then swelling the pharynx to force the soil particles outward; or by actually eating its way through the ground. The bristlelike setae are used to grip the sides of the burrow, and alternate lengthening and contracting of the body carries the animal forward. The starfishes and other echinoderms crawl along the bottom in marine habitats by extending their arms, gripping the substrate with suction cuplike tube feet, then contracting so as to pull the animal along; sea urchins, which do not have tube feet, use movable spines or bristles on the under-surface for locomotion. A different mode of crawling is found in *Hydra*, which can loop along like a measuring worm, attaching the tentacles to the substrate by nematocysts, releasing the basal disc from its original location on the substrate and attaching it at a new location, then releasing its grip with the tentacles. Leeches and some rotifers are capable of a similar type of locomotion.

Not all these invertebrates are limited to some form of crawling or the protozoan modes of swimming for locomotion. Marine clam worms swim in much the same manner as snakes, by lateral wiggling of the body. Jellyfish can swim feebly by contracting the bell rhythmically, forcing water out of the cavity. Squids and octopuses eject water from their mantle cavities to provide underwater jet propulsion; they can turn the siphon through which the water is expelled to control their direction of movement. Some animals in this group also swim by means of fins. A few rotifers use the taillike posterior end of the body as an organ for catapulting. And terrestrial planarians of the tropics lower themselves from leaf to leaf on self-produced threads of slime.

Arthropodan Innovations.—Possession of jointed appendages and a diversified musculature opens up many new opportunities in locomotion. The basic arthropod body plan of many segments, each with a pair of appendages, lends itself readily to

a wide variety of adaptations through fusion or modification of some segments and specialization of appendages. Thus, various arthropods have become accomplished swimmers, runners, jumpers, burrowers or fliers.

In crustaceans such as the fairy shrimps and water fleas the same feathery appendages function as both breathing and swimming organs. In copepods, antennae attached to the head are used in locomotion, along with thoracic legs. The amphipods have climbing legs on the thorax and swimming and jumping legs on the abdomen. The sowbug *Asellus,* which spreads its weight over a large area of the substrate by walking on seven pairs of feet, can travel easily over thin, unstable bottom muds. Crayfish, lobsters and crabs have eight thoracic segments that bear the true limbs; these are variously modified, with the last four usually functioning as walking or swimming legs. Arachnids have four pairs of legs; most are active runners and climbers in terrestrial habitats. Millipedes, commonly called "thousand-legged worms," have from 20 to 100 segments to the trunk, each of which bears two pairs of legs. The legs move in a series of waves, carrying the animal smoothly along.

Practically all insects are capable of walking or crawling. In the adults three pairs of legs, variously specialized, provide efficient locomotion in many different environments. Insects may crawl beneath the surface of the water, atop the surface film, on dry land, over vegetation and even on glass-smooth surfaces. Some seemingly defy the law of gravity by maintaining a footing while climbing sheer vertical walls or walking upside down across ceilings. Various types of claws provide a firm grip on irregular substrates. Pulvilli (hairy pads or suckerlike structures on the feet) enable some insects to adhere to very smooth surfaces. In the praying mantis the first pair of legs is specialized for grasping food and only the remaining two pairs are used for locomotion. Grasshoppers can jump with great agility, powered by the enlarged third pair of legs, the first two serving for slow walking and clinging. Insect larvae may be without legs, have the usual three pairs or have additional prolegs such as are found in caterpillars. In some of the legless forms, locomotion is by means of pseudopods. Insects that inhabit fast-flowing streams have greatly flattened bodies and legs, adaptations that allow them to cling closely and to crawl on the surfaces of submerged rocks without offering much resistance to the swift currents. The water strider *Gerris* has a velvety, nonwettable hair pile and long legs with which it scampers across the surface film of lakes and streams, the specialized structure of the feet preventing the insect from breaking through. The second and third pairs of legs in water scorpions are long and slender, enabling them to run among tangled mats of vegetation. The back swimmers (Notonectidae) have long, oarlike back legs, fringed with long hairs; these insects row themselves through the water on their backs. Many other aquatic insects have flattened, fanlike hairy legs that are used as oars. Dragonfly nymphs use jet propulsion as an auxiliary means of locomotion, by using sudden muscular contractions to force water through a terminal opening in the abdomen.

Among the invertebrates only the insects are capable of flight. The same aerodynamic principles that underlie the flight of birds and of airplanes appear to be adequate to explain insect flight. However, at present no mathematical theory of the way in which lift and thrust are generated by wing motion has been developed. During flight the wing action, angle of attack, wing tip path and velocity, acceleration and twisting of the wing, stroke amplitude, stroke-plane angle, frequency of beat, etc., all can be varied. Thus insect flight is clearly an enormously complicated subject.

In some insects muscles power the wings directly. In others the muscles control movements of the exoskeleton, which in turn moves the wings by exerting leverage. In general the smaller the insect the more rapid the wing beat must be to provide sufficient lift for flight. In insects with very rapid wing beat the muscular contractions that power each beat are not each triggered by a motor nerve impulse; motor nerve impulses bring the muscle fibres to a state of excitation in which they are stimulated by stretching to contract. Two antagonistic sets of muscles alternately relax and contract much more rapidly (sometimes in excess of 200 times per second) than motor nerve impulses can be generated continuously. *See* FLIGHT (NATURAL).

VERTEBRATES

In the vertebrates the principal means of locomotion is through variously adapted propulsive levers, consisting of parts of the skeleton such as limbs or vertebrae, powered by muscles which are arranged in opposing pairs. One muscle of a pair pulls the lever forward; the other muscle pulls the lever backward again.

Swimming.—The simplest arrangement is found in aquatic animals, where the vertebrae act as the lever. Thus, the head of a fish may be thought of as a fulcrum for the flexible tail-end lever. The entire propulsive force derives from the muscles of the trunk. Swimming is accomplished by sweeping the tail from side to side, in much the same manner that a boat may be sculled with a single oar. Aquatic mammals, such as whales and dolphins, swim in the same way as fishes except that the posterior part of the body is flattened horizontally instead of vertically, and locomotive force is generated by sweeping the tail up and down rather than from side to side.

The streamline body form of most fishes and the mucus covering that reduces friction help them to move swiftly through the water. The viscosity of water is about one hundred times as great as that of air, so the problems posed by frictional resistance to a moving body are much greater for a fish in the water than for a man who moves through the fluid medium of air. The speed of a fish is roughly proportional to the frequency of the tail beat and the length of the body. The maximum speed a small fish can attain is about ten times its length per second. Fish regulate their depth in water by action of their air bladders, which can be inflated or deflated, and adjust their direction and balance by using their fins.

The body shape of fishes is roughly related to their swimming habits. Departures from streamline form occur at the expense of swimming speed. The most streamlined fishes are usually those that swim the open waters or that are predaceous. Alternatives to locomotion by means of body sculling are found in the tropical parrot fish, which rows itself along with the pectoral fins; the trunk fish, which sculls its inflexible body with its free caudal fin; and the seahorse, which propels itself with its dorsal fin. Other fishes may creep along the bottom with the aid of the pectoral fins, burrow in the bottom or move short distances propelled by jets of water from the gill chambers. The flying fish leaps into the air and glides by means of greatly enlarged pectoral fins, after attaining considerable speed swimming just beneath the surface.

Crawling.—In the sense of locomotion in which the body is in direct contact with the substrate, crawling is perhaps most typical of the snakes. The principal locomotive movement of snakes is termed "horizontal undulation." It resembles the swimming motion of fish in that the body is curved, the curved section being forced against a relatively stable medium with which the animal is in contact. Rather than a single body curvature as in fish, however, snakes throw their body into a series of gentle horizontal curves, and the body is pressed against the ground or vegetation at each curve. The entire body moves forward at the same time, each part following smoothly along the path traced by the part immediately ahead. This mode of locomotion is made possible by the great number of vertebrae (sometimes more than 200) which constitute the backbone. Some heavy-bodied snakes, such as rattlesnakes, can crawl in a straight line by alternately pulling the skin forward on the body, anchoring the edges of the belly plates against the substrate, then inching the body forward within the skin. The sidewinders, especially adapted for moving across loose desert sand, throw the anterior part of the body through the air, followed by the rest of the body, which comes forward and sideways in a rolling motion. The body is not dragged but rather "looped" at right angles to its long axis. All snakes can swim by using the same horizontal undulation as in terrestrial movement. Snakes are also excellent climbers; because of their length they are able to distribute their weight evenly over tree branches or other upright objects. Some climb vertically by pressing the belly plates into irregularities in the surface up which they are moving. Others

are especially adapted to life in trees, their long slender bodies enabling them to reach from one branch to another. Snakelike locomotion is also found in other vertebrate groups, such as very elongated fishes and lizards, where certain lines of specialization have resulted in great reduction or loss of the limbs.

Flight.—Among the vertebrates the birds are the undisputed masters of flight. The same principles that underlie flight in airplanes are utilized in bird flight. When moved through the air, the streamline wing provides lift because of greater air pressure on the lower surface than on the upper. An auxiliary airfoil, the equivalent of a small wing in front of the main wing, can increase the speed of airflow over the main wing and thus maintain lift at slow air speeds. The alula, or bastard wing, a group of feathers at the forward edge of the wrist, performs the function of an auxiliary airfoil in birds. The inner wing, from the shoulder to the wrist, provides lift and is analogous to the wing of an airplane. The outer wing, from the wrist to the tip, acts as a propeller and generates forward thrust in flight. The outer half of the bird's wing is moved from the wrist joint, while the inner half is moved from the shoulder joint. The primary feathers near the wing tips twist as the wings beat, taking the proper shape and angle to function as propellers. The path of these feather propellers is down and forward on the downstroke of the wing and up and backward on the upstroke of the wing.

In addition to flapping flight some birds (albatross, vulture, gull) are specialized, by means of long narrow wings, for gliding. They exploit vertical warm air currents rising from the surface of land or water to bear them aloft with little expenditure of energy.

The only mammal capable of true flight is the bat; others such as flying squirrels do not fly but are able to glide for relatively short distances, using folds of skin that are stretched between the forelegs and hind legs as "wings."

Walking and Running.—In animals such as salamanders body undulations much like those of a fish are of primary importance in locomotion, but the limbs also play a prominent role. Dogs and cats, which arch the back during running, greatly increase the speed and power of the hind limbs by contracting the muscles in the back. Possibly the ultimate development in terrestrial locomotion is that of the horse, in which nearly all the power is provided by the muscles of the limbs. For combined speed and endurance in running, animals such as the horse are the champions of the animal world. Large cats such as the cheetah are capable of spurts of speed but tire quickly.

An animal's centre of gravity may be near the forefeet, as in the horse, near the hind feet, as in rabbits and bears, directly above the hind feet, as in birds and man, or behind the hind feet, as in the kangaroo (which, as a consequence of its weight distribution, must balance partly on its tail when at rest). These differences in location of the centre of gravity are related in important and usually obvious ways to locomotion.

Four-legged animals walk by lifting one foot at a time, swinging it forward, and placing it on the ground some distance ahead. When the extended foot touches the ground it begins to act as a fixed fulcrum from which the action of the muscles on the limb lifts the body forward. The normal order of movement of the feet in unhurried walking is: right fore, left hind, left fore, right hind. At a fast walk a point is reached where each foot is lifted off the ground before the one ahead has been returned, and the animal balances for brief periods on only two feet. As the speed of movement is increased, a stage is reached where there are never more than two feet in contact with the ground. In this two-point gait the legs never provide an adequate triangle of support for the animal's body, and balance is maintained only by bringing each new pair of supporting legs into use quickly enough to correct the imbalance. When the two-point gait becomes fast enough that a limb is in contact with the ground for a shorter time than it is off, there are intervals when the animal is not in contact with the ground at all. Finally, at a gallop, only one foot at a time is in contact with the ground; between the periods of contact none of the feet touch the ground. The order in which the limbs are moved in this gait is: left fore, right fore, left hind, right hind—or right may precede left.

Other Modifications.—The jumping vertebrates, such as frogs and rabbits, have relatively long, slender legs that can be folded tightly under the body, then extended full length to push the animal up and forward. This departure from the typical four-legged gaits reaches an extreme in animals such as the kangaroo, which moves about almost entirely on the hind legs. Another line of divergence from four-footed locomotion is found in the apes, some of which swing (brachiate) from limb to limb in tropical forests by means of their arms (modified forelegs), the terminal parts of which are modified for grasping.

The feet of many animals are specially adapted for travel over a certain type of substrate. On hard, rocky ground, feet with nonskidding adaptations, such as those of mountain goats and sheep, are advantages. Animals such as the moose, which inhabit marshy areas, usually have large feet. The webbed feet of ducks assist them in walking on muddy areas as well as in swimming. Many lizards have lateral rows of scales or fringes on the toes that enable them to walk on loose sand. Feathered feet in the grouse and widened feet in the snowshoe hare act as snowshoes. Suckers on the feet of tree frogs and claws on various mammals are aids in climbing.

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LOCOWEED, certain North American species of the genera *Astragalus* and *Oxytropis* of the Leguminosae (pea family), found mainly in arid and semiarid regions of the western and southwestern United States, which when ingested cause a cattle disease called *loco* ("mad"). Animals so poisoned stagger and become stuporous. The toxic properties may result from selenium absorption by the plant (some *Astragalus* species), or an unknown intrinsic alkaloid (in certain *Oxytropis* species). Some *Astragalus* species also produce a poison which does not induce true locoism. Wholesale eradication appears to be impossible, but individual plants may be killed chemically.

LOCRI, a people of ancient Greece, inhabiting two separate districts, one extending from the northeast of Mt. Parnassus to the northern half of the Euboean channel, between Boeotia and Malis, the other southwest of Parnassus, on the north shore of the Corinthian gulf, between Phocis and Aetolia. The former branch was divided into the Locri Epicnemidii, situated on the spurs of Mt. Cnemis (Knimis), and the Locri Opuntii, so named from their chief town Opus (*q.v.*). Homer mentions only these eastern Locrians; their national hero in the Trojan War is Ajax, son of Oileus, who often appears afterward on Locrian coins. The Opuntians were thought by some ancient writers to be of "Lelegian" origin (*see* LELEGES), but they were hellenized early (though matriarchal customs survived among them). The western Locri Ozolae on the Corinthian gulf were described in the 5th century B.C. as backward and warlike; their chief towns were Naupactus (Navpaktos) and Amphissa (Amfissa). Relations between the two branches were usually close, though they took opposite sides in the Peloponnesian War. For the Locri Epizephyrii of southwestern Italy *see* LOCRI below.

LOCRI, an ancient city on the eastern side of the "toe" of Italy, founded *c.* 680 B.C., its name derived from that of some of its settlers. The colonists occupied the Zephyrian promontory (Capo Bruzzano), and though after three or four years they moved 12 mi. to the north near the coast, 2 mi. S. of Gerace Marina (now renamed Locri), they still retained the name of Locri Epizephyrii to distinguish them from the Locri (*see* above) of Greece itself. This was the first Greek community to have a written code of laws, given by Zaleucus *c.* 660 B.C. From Locri were founded the colonies of Medma (Rosarno) and Hipponium (Vibo Valentia). In the 6th century it repelled the attacks of Crotona and later found support in Syracuse against Rhegium. During the Peloponnesian War it was an active adversary of Athenian intervention in the west. Pindar extols it in his 10th and 11th *Olympian Odes;* Stesichorus (*q.v.*) was of Locrian origin. Dionysius I of Syracuse married a Locrian; its territory was then increased and the circuit

of its walls was doubled, but it lost its freedom. From 352 to 346 B.C. it was ruled by Dionysius II. From the battle of Heraclea (280) until 205, when it was captured by Scipio Africanus and placed under the control of his legate, Q. Pleminius, Locri was continually changing allegiance between Rome and its enemies. In later Roman times it was of no great importance. It was destroyed by the Saracens in 915.

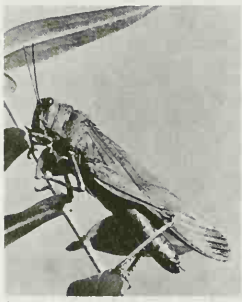
Excavations in 1889–90, extended in 1954 *et seq.*, disclosed a sanctuary at the northeast angle of the town—originally, in the archaic period, a Doric temple. This was destroyed about 450 B.C. and a new temple in the Ionic order (rare in the Greek west) built on the ruins. In front are altars for sacrifice. The marble figures from the pediment of the Dioscuri Castor and Pollux (*q.v.*), who according to the legend assisted Locri against Crotona, are in the National museum, Naples. A Doric temple was also cleared under the house called Casa Marafioti: the fine equestrian group in terra cotta from the western gable is, with other objects from Locri, in the museum at Reggio di Calabria. There was also a sanctuary of Persephone from which came numerous terra-cotta votive plaques (*pinakes*) of the 5th century B.C.

The city walls, the length of which was nearly 5 mi., consisted of three parts: the fortified castles with large towers on three different hills, the city proper, and the lower town, the latter enclosed by long walls running down to the sea. Prehistoric objects confirm the accounts of Thucydides and Polybius that the Greek settlers were preceded by Siculi.

See W. Oldfather in Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, xiii, 1289–1363 (1927); T. J. Dunbabin, *The Western Greeks;* esp. pp. 68ff., 293ff. (1948).

LOCUS (meaning "place" in Latin) specifies in mathematics a geometric system which satisfies a given set of conditions. In a plane, for example, the locus of a point at a given distance from a fixed point is a circle whose centre is the fixed point, and whose radius is the given distance. In three dimensions, the corresponding locus is the surface of a sphere. Thus, in analytic geometry the locus of the equation $x^2 + y^2 = 1$ is a circle; while the locus of $x^2 + y^2 + z^2 = 1$ is the surface of a sphere. For diagrams and equations of a number of loci which have attracted the interest of mathematicians *see* CURVES, SPECIAL; CONIC SECTION.

LOCUST, any of certain insects of the family Acrididae, which at times multiply greatly and migrate long distances in destructive swarms. In Europe the term "locust" connotes large size; smaller acridids are called grasshoppers (*q.v.*). In North America "locust" and "grasshopper" are used for any acridid. Unfortunately cicadas (order Hemiptera) are also called locusts or harvest locusts; the 17-year locust is the periodic cicada (*see* CICADA).

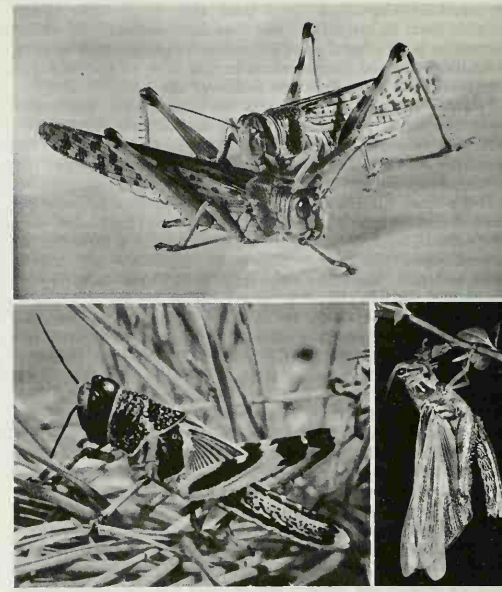


J. M. CONRADER FROM NATIONAL AUDUBON SOCIETY

CAROLINA GRASSHOPPER OR LOCUST (DISSOSTEIRA CAROLINA)

The Phases of Locusts.—In 1921 B. P. Uvarov satisfactorily explained for the first time the sporadic coming of locust swarms and the apparent disappearance of the insects between times by the phase theory, later substantiated and elaborated by many workers. Each plague species exists in two phases, solitary and gregarious, connected by transitional forms. The extreme phases differ in coloration, form, physiology and behaviour.

Solitary phase nymphs vary in colour and pattern, adjust their colour to match that of their surroundings, do not congregate, have low metabolic and oxygen-intake rates and are sluggish. Gregarious phase nymphs have a black and yellow (orange) coloration of fixed pattern, are gregarious, have high metabolic and oxygen-intake rates and are active and nervous; their dark pigments absorb more radiation. Adults differ less in colour, but often notably in form. The solitary phase has shorter wings, longer legs, narrower pronotum with higher crest and larger head; the gregarious phase has a more saddle-shaped pronotum with broader shoulders and long, ample wings.



(TOP) CROWN COPYRIGHT: CENTRAL OFFICE OF INFORMATION, LONDON; (BOTTOM LEFT) FOX PHOTOS, LTD.; (BOTTOM RIGHT) SHELL PHOTO

SCHISTOCERCA. (TOP) ADULT AND (BOTTOM LEFT) YOUNG "HOPPER" STAGE DESERT LOCUSTS (S. GREGARIA); (BOTTOM RIGHT) SOUTH AMERICAN MIGRATORY LOCUST (S. CANCELLATA) DRYING WINGS AFTER LAST MOLT

Progeny of the solitary phase, reared in crowds, change toward the gregarious type; and if the crowding is of sufficient degree and duration, the extreme of the gregarious migratory phase is produced. Progeny of the gregarious phase, reared in isolation, revert to the solitary phase. By rearing single nymphs in constantly agitated cages J. C. Faure (1932) showed that the effects of crowding result from the unceasing activity it induces. The solitary phase is the normal state of the species, while the gregarious phase is a physiological response to violent fluctuations in the environment. Within the territory of each species its solitary phase exists at all times and in a wide variety of ecological conditions. Swarms do not form in the regions most favourable to the species, but in marginal areas where suitable habitats are restricted and climatic balance is delicate. There a succession of favourable seasons enables the restricted populations to expand into adjoining areas, but return of unfavourable conditions forces the enlarged populations back into the small permanently habitable areas and crowding results. The exact circumstances vary with the species and region.

The outbreak areas of the migratory locust of the old world, *Locusta migratoria*, are of four ecological types: (1) deltas of rivers entering the Caspian and Aral seas and Lake Balkhash (and similar situations in China and Africa), surrounded by arid sandy tracts; there the extent of the grassland habitat of the locust changes greatly as a result of irregularities of floods; (2) grassland areas adjoining deserts, subject to extreme fluctuations in precipitation with corresponding changes in extent of habitable area; (3) islands of dry warm soil in the central U.S.S.R., a region generally too cold and wet for the species; there overcrowding occurs after several exceptionally warm dry years; (4) grasslands produced by periodic burning in the unfavourable, humid forestlands of the Philippines; their extent varies greatly, leading to overcrowding and production of the gregarious phase.

Locusts of the gregarious phase are restless and irritable; the bands of nymphs wander, and adult swarms take flight spontane-

ously on warm dry days when their body temperature is high. The muscular activity of flight further raises their temperature, and a swarm can therefore cease flying only when conditions change. Rain, a drop in temperature or nightfall will usually stop a flight. The distances traveled may be great; swarms have been seen 1,200 mi. at sea and the desert locust (*Schistocerca gregaria*) reached England in 1869, probably from west Africa. The flights often end in destruction of the swarm. Some swarms are very large; a particularly large flight of the desert locust across the Red sea in 1889 was estimated as 2,000 sq.mi. in extent. The gregarious instinct is strong, and swarms remain compact even when reduced to small size by high mortality; they are dispersed, with resultant transformation into the solitary phase, only by storms and other external factors as mentioned above.

Important Species.—The migratory locust (*Locusta migratoria*, with its races *rossica, migratoria, migratorioides, capito* and *manilensis*) has a wider range than any other acridid. It is found in grasslands throughout Africa, most of Eurasia south of the taiga forest, the East Indies, tropical Australia, and New Zealand. *Schistocerca gregaria* inhabits dry grasslands and deserts from Africa to the Punjab. Its swarms arrive during the summer monsoons in India; in autumn they migrate to Iran and Arabia with others from Africa, and thence spread to soviet Asia, Syria, Palestine and Egypt. In late fall some return to India and East Africa, where breeding occurs during the next monsoon rains. The smaller Italian and Moroccan locusts (*Calliptamus italicus* and *Dociostaurus maroccanus*) do much injury in the Mediterranean area; the second is found discontinuously east to Turkestan. In South Africa the brown and red locusts (*Locustana pardalina* and *Nomadacris septemfasciata*) are both very destructive. In Central and South America the chief migratory species is the South American locust (*Schistocerca paranensis*), of which the nonmigratory *S. americana* of the United States may possibly be the solitary phase. The Rocky mountain locust or lesser migratory grasshopper (*Melanoplus spretus*) wreaked havoc on the prairie farms of Canada and the United States in the 1870s, but later disappeared. The clear-winged grasshopper (*Camnula pellucida*) is a major crop pest in North America. Many other species of Acrididae in different regions occasionally increase to plague proportions but few of them compare in economic importance with those named above.

ANTI-LOCUST RESEARCH CENTRE, LONDON; PHOTO BY O. L. GUNN

DESERT LOCUSTS SWARMING ON THE TRUNKS OF THORN TREES, GLANVILLE, KENYA

Control Measures.—Once well started, a locust plague is almost impossible to check, and only palliative measures can be taken. These have included (1) the destruction of egg masses laid by invading swarms, (2) the digging of trenches to trap the nymphs, (3) the use of hopperdozers (wheeled screens, upon striking which locusts fall into troughs containing water and kerosene) and poison baits and (4) dusting and spraying of swarms and breeding grounds with insecticides from aircraft.

DDT proves virtually ineffective against locusts. One of the most economical insecticides is dinitro-ortho-cresol (DNC); the disadvantages of DNC are that it is also highly toxic to man, since it is absorbed through the skin, and that it kills certain kinds of plants. Dieldrin and more recent organic insecticides are also used. Application from aircraft has proved helpful in subduing incipient swarms, but concerted efforts by ground forces are still necessary to control the nymphs and nonmigrating adults.

The control problem is made difficult by the great extent of the territory affected, with many invasions beginning in sparsely populated, undeveloped regions. Permanent control requires both national and international action. Such control is possible because locust swarms do not arise simultaneously over wide regions but emerge in a few outbreak areas, many of which are known.

In 1932 the Anti-Locust Research centre was set up in London; it directed international surveys and field studies and, during World War II, large-scale campaigns in Africa and Asia against the desert locust. Since that time several other international bodies have arisen to control the locust in Africa. Warnings are given of incipient outbreaks and swarm movements, and control measures are planned and supervised. Ultimately many outbreak areas may be made ecologically unsuitable for production of the gregarious phase, when the ecology and behaviour of each plague species are better known.

See also references under "Locust" in the Index.

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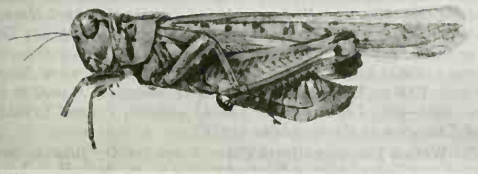
LOCUST, the common name given to any tree of the genus *Robinia*, which comprises about 20 species native to North America, belonging to the family Leguminosae, and, as "honey locust," to leguminous trees of the genus *Gleditsia* (*see* HONEY LOCUST). The best known is the black locust (*R. pseudoacacia*), introduced into Europe in 1636. This tree, often called false acacia and yellow locust (acacia in England), is widely cultivated as an ornamental tree. It grows to 80 ft. high, and bears long, graceful compound leaves with 6 to 20 bright green oblong leaflets, and white fragrant flowers in loose pendulous racemes. There are many varieties, varying in the manner of growth, the presence or absence of thorns on the branches and the colour of the flower.

In the eastern United States where it is native, the black locust



BY COURTESY OF SMITHSONIAN INSTITUTION

MUSEUM SPECIMEN OF THE ROCKY MOUNTAIN LOCUST (MELANOPLUS SPRETUS)

(LEFT) NEW YORK BOTANICAL GARDEN; (RIGHT) THE MCFARLAND COMPANY

(LEFT) SEED PODS AND (RIGHT) FLOWERING BRANCH OF THE BRISTLY LOCUST (ROBINIA HISPIDA)

may have a trunk three or four feet in diameter. It has been widely planted to control erosion in fields and gullies. It is a useful timber tree; the wood, being heavy, hard, strong, close-grained and durable, is used mainly for fence posts.

The clammy locust (*R. viscosa*), a tree sometimes 40 ft. high, with pinkish flowers, and the rose acacia or bristly locust (*R. hispida*), a small shrub, with showy rose-coloured flowers and twigs covered with bristly hairs, both native to the southeastern United States, are also cultivated for ornament.

The shipmast locust, a variety of black locust, is used extensively in reforestation projects, and as a good street tree resistant to dust, wind and smoke. (N. Tr.; X.)

LÓCZY, LAJOS (1849–1920), Hungarian geologist, who first scientifically described the mountains that connect the Kunlun chains with the northeast Indian chains behind the Red basin of Szechwan. Born at Pressburg (Bratislava) on Nov. 2, 1849, he studied at the Zürich polytechnic, obtaining his engineer's diploma in 1874, and from 1877 to 1880 traveled through India and China as geologist to the expedition of Count Bela Széchenyi which he described in his principal work (1890). In 1886 he became professor of geology at the University of Budapest, and in 1908 director of the Hungarian Geological institute. He completed geological researches in China, in Hungary and, during World War I, in Serbia. His researches concerning the steppe formations of the Gobi and the northern Hwang Ho territory were also of great importance. His other important work was a monograph on the Hungarian lake Balaton, in which the formations of the region are explained. His posthumous works include a new geological map of pre-World War I Hungary, and a book on the geology of west Serbia, which revolutionized the geological map of Serbia. He died at Balatonáracs on May 13, 1920.

LOD (Lydda), an ancient town of Israel in the Plain of Sharon, 12 mi. S.E. of Jaffa. Pop. (1961) 19,012. It is a railway junction where the line along the coastal plain and that from Tel Aviv to Jerusalem meet. The main civil airfield of Israel, home of the Israeli national airline, El Al, is 2 mi. N. of the town.

Lod is mentioned several times in the Old Testament (*e.g.*, I Chron. viii, 12), and in the New Testament (Acts ix) it was the scene of Peter's healing of the paralytic. It was the seat of rabbinical schools after the destruction of the Temple (A.D. 70) and an early Christian settlement, traditionally the home of the martyr St. George, to whom an Orthodox church in the town is dedicated. It was a Roman colony, Diospolis, from A.D. 200, and had a Byzantine cathedral. After the Arab conquest, Lod was the chief town of Palestine until the capital was moved to Ramle. It was captured by the crusaders in 1099 and destroyed by Saladin in 1191. Until the establishment of the state of Israel its inhabitants were mainly Arabs. In the fighting during 1948 most of the Arabs fled and have been replaced by Jewish immigrants. (No. B.)

LODGE, HENRY CABOT (1850–1924), U.S. statesman and author, was born in Boston, Mass., on May 12, 1850. He graduated from Harvard college in 1871 and the Harvard Law school in 1875; was admitted to the Suffolk (Mass.) bar in 1876; and from 1876 to 1879 was instructor in American history at Harvard. He was a member of the Massachusetts house of representatives in 1880–81, and of the national house of representatives from 1887 to 1893. In 1893 he was elected U.S. senator from Massachusetts, a place he continued to hold for nearly 32 years.

His continuous service in the senate brought recognition during the closing years of the Roosevelt administration and under Taft as one of the most prominent of the Republican leaders. He was a member of the Alaskan Boundary Commission of 1903, and of the U.S. Immigration Commission of 1907. He served as permanent chairman of the Republican national conventions of 1900, 1908 and 1920. During the Republican-Progressive split which led to the election of Woodrow Wilson in 1912, Lodge maintained his personal friendship with Roosevelt, while he held true to his long-established principles of party regularity by supporting Taft, the Republican nominee.

In 1914 Lodge supported Wilson's demand for the repeal of the Panama tolls exemption, but lost confidence in him as a result of the president's handling of the Mexican problem in 1914, and thereafter became one of his principal critics. He opposed Wilson's Caribbean policy and Colombia treaty, and desired the entrance of his country into World War I after the sinking of the "Lusitania." In Jan. 1916 he offered a resolution calling for armed intervention in Mexico.

With the entrance of the United States into World War I, Lodge called for united support of the president in all policies that might increase the war effort of the United States, although he opposed the Overman act, designed to organize war-making agencies. Wilson's peace policies were another matter. In 1915 and 1916 Lodge had advocated a league of nations and the principle of compulsory arbitration. But the conviction that the United States must always keep its word, which had led Lodge to support President Wilson's demand for the repeal of the Panama Canal tolls exemption in 1914, led him to oppose President Wilson's draft of the League. He felt that it embodied commitments which, when the moment came, the United States would not and could not keep. In 1918 Lodge became Republican floor leader of the senate and chairman of the foreign relations committee. He believed: that the League of Nations and the Versailles treaty should be separated; that the League covenant should be changed to provide that the United States should determine for itself what were and what were not domestic questions; that the United States should have more than mere equality of voting with the small countries; and that the League should not commit the United States to preserve the territorial integrity and political independence of League members except with the consent of congress. These beliefs were sustained in essence 25 years later when the senate dealt with the United Nations charter. Lodge succeeded in attaching to the treaty embodying the League of Nations reservations to carry out these beliefs. Wilson refused to accept the reservations. On March 19, 1920, the treaty, which had been reintroduced, having been previously defeated both with and without reservations, failed by seven votes to secure the necessary two-thirds vote of the senate, the Democratic senators voting against it at the wish of the president.

As the successful leader of the opposition to Wilson, Lodge's prestige was increased. He served as one of the four U.S. delegates at the Washington Conference on the Limitation of Armaments in 1921. His influence waned after he opposed Harding's proposal for joining the World Court, but he was re-elected to the senate in 1922 by a narrow margin. He died at Boston on Nov. 9, 1924, at the age of 74.

Senator Lodge was one of the chief congressional figures of the last decade of the 19th and the first two decades of the 20th centuries. Regarded by some as cold and distant in manner, he enjoyed the prestige indicated by his popular appellation, the "scholar in politics," and held the respect of his colleagues.

His literary production started early and continued until the close of his life. In 1873–76 he edited the *North American Review* with Henry Adams; and in 1879–81, with John T. Morse, Jr., he edited the *International Review*. In 1884–90 he was an overseer of Harvard college. His doctoral thesis at Harvard was published with essays by Henry Adams, J. L. Laughlin and Ernest Young, under the title *Essays on Anglo-Saxon Land Law* (1876). He wrote: *Life and Letters of George Cabot* (1877); *Alexander Hamilton* (1882), *Daniel Webster* (1883) and *George Washington* (2 vol., 1889), in the American Statesmen series; *A Short History of the English Colonies in America* (1881); *Studies in History* (1884); *Boston* (1891), in the Historic Towns series; *Historical and Political Essays* (1892); with Theodore Roosevelt, *Hero Tales From American History* (1895); *Certain Accepted Heroes* (1897); *The Story of the American Revolution* (2 vol., 1898); *The War With Spain* (1899); *A Fighting Frigate* (1902); *A Frontier Town* (1906); with J. W. Garner, *A History of the United States* (4 vol., 1906). He edited *The Works of Alexander Hamilton* (9 vol., 1885–86); *The Federalist* (1891); *André's Journal* (1903); and *Education of Henry Adams* (1918).

See William Lawrence, *Henry Cabot Lodge* (1925); John A. Garraty, *Henry Cabot Lodge: a Biography* (1953). (C. Sey.; H. C. L.)

LODGE, HENRY CABOT (1902–), U.S. senator, army officer and ambassador, was born in Nahant, Mass., July 5, 1902,

the grandson of Henry Cabot Lodge (*q.v.*). He studied in France, graduated from Middlesex school, Concord, Mass., in 1920 and Harvard university (*cum laude*) in 1924. Six of Lodge's ancestors served in the U.S. senate; his grandfather spearheaded the senate defeat of the Versailles treaty at the end of World War I. Lodge prepared for politics through an active career in journalism as a reporter for the *Boston Evening Transcript* and later as editorial writer for the *New York Herald Tribune*. He served two terms in the Massachusetts general court, 1933–36. In 1936 he was elected as a Republican to the U.S. senate from Massachusetts, and was re-elected in 1942. In 1941 and 1942 he went on extended active duty as a reserve officer with the U.S. army. In Feb. 1944 he resigned his senate seat to go on active duty with the U.S. army. He won re-election in 1946 but his senate seat was successfully challenged by Rep. John F. Kennedy in 1952. In that year Lodge had devoted much of his time to promoting the presidential campaign of Gen. Dwight D. Eisenhower. In 1953 President Eisenhower appointed him as permanent U.S. representative to the United Nations with ambassadorial rank and cabinet membership. He played a prominent role in many critical UN debates. In July 1960 the Republican convention nominated Lodge for the vice-presidency on a ticket headed by Vice-Pres. Richard M. Nixon, but in the November election the Nixon-Lodge ticket was defeated. In 1963–64 Lodge served as U.S. ambassador to the Republic of Vietnam (South Vietnam), returning home in 1964 when it appeared he might again win a place on the Republican ticket. In the summer of 1965 he returned to Vietnam as U.S. ambassador upon the retirement of Gen. Maxwell D. Taylor, who had replaced him in 1964. (C. P. C.)

LODGE, SIR OLIVER JOSEPH (1851–1940), English physicist who studied lightning and electricity and was a leader in psychic research, was born at Penkhull, Staffordshire, on June 12, 1851. He entered University college, London, in 1872, and obtained his doctorate in 1877. In 1875 he was appointed reader in natural philosophy at Bedford College for Women, and in 1879 he became assistant professor of applied mathematics at University college, London. Two years later he was called to the chair of physics in University college, Liverpool, where he remained until in 1900 he was chosen first principal of the new Birmingham university. He retired from this position in 1919. He was knighted in 1902. His original work includes investigations on lightning, the seat of the electromotive force in the voltaic cell, the phenomena of electrolysis and the speed of the ion, electromagnetic waves and wireless telegraphy, the motion of the ether near the earth and the application of electricity to the dispersal of fog and smoke. In addition to numerous scientific memoirs he wrote, among other works, *Lightning Conductors and Lightning Guards, Signalling Across Space Without Wires* (1897), *Modern Views of Electricity* (1889), *Electrons* (1907) and *The Ether of Space* (1909).

After 1910 Sir Oliver Lodge became increasingly prominent in psychic research. A strong believer in the possibility of communicating with the dead, he interested himself in a serious endeavour to reconcile science and religion. Among his publications dealing with this subject are *The Survival of Man* (1909) and *Raymond, or Life and Death* (1916). He died on Aug. 22, 1940, at Lake, near Salisbury.

See his autobiography, *Past Years* (1931)

LODGE, THOMAS (*c.* 1557–1625), English miscellaneous writer, chiefly remembered as a lyric poet and the author of the prose romance *Rosalynde* (the source of *As You Like It*), was a son of Sir Thomas Lodge, lord mayor of London in 1562. Born between May 1557 and April 1558, probably in London, he entered the Merchant Taylors' school in 1571, Trinity college, Oxford, in 1573 (graduating in July 1577), and Lincoln's Inn, London, in April 1578. His earliest work (*c.* 1579) is an unlicensed pamphlet in reply to Stephen Gosson (*q.v.*), which Gosson answered in *Plays Confuted in Five Actions* (1582), censuring Lodge as "little better than a vagrant, looser than liberty, lighter than vanity itself." His mother's will (Sept. 1579) shows that he had soon wearied of the law and that his family found him spendthrift and not to be trusted with money.

An Alarum Against Usurers (1584) answered Gosson's attack on his character, and its exposure of the ways in which young heirs were lured into extravagance and debt almost certainly reflects personal experience. Lodge appended to the *Alarum* both a prose tale, *The Delectable Historie of Forbonius and Prisceria*, and a verse lament, *The Lamentable Complaint of Truth Over England*, and this collection foreshadowed the ways in which he chiefly employed his pen for the next 12 years: in verse (*Scillaes Metamorphosis*, 1589; *Phillis*, sonnets and other poems, 1593; *A Fig for Momus*, eclogues, satires and epistles, 1595); in romances (*Rosalynde*, 1590; *Robert, Second Duke of Normandy*, 1591; *Euphues Shadow*, 1592; *William Longbeard*, 1593; *A Margarite of America*, 1596); and in pamphlets (*Catharos*, 1591; *The Divel Conjured*, 1596; *Wits Miserie, and the Worlds Madnesse*, 1596; *Prosopopeia*, 1596). In 1594 he published *A Spiders Webbe* (last heard of in the sale of John Hutton's books, 1764) and also two plays: *The Wounds of Civill War* and *A Looking Glasse for London and England* (the latter written in collaboration with Robert Greene).

As an alternative to this effort to maintain himself by writing, Lodge tried the career of adventurer. In the dedications to *Rosalynde* and *A Margarite of America* he mentions two voyages: the first to Terceira and the Canary Islands, and the second to South America with Thomas Cavendish on his disastrous last voyage (Aug. 1591); but neither seafaring nor literary enterprise served to keep him from poverty and he found a more secure profession when he graduated in medicine at Avignon (Jan. 1598). He was incorporated M.D. of Oxford in 1602 and practised in the Netherlands, where he took refuge at times as a recusant, and in London, where he died in 1625. Apart from *A Treatise of the Plague* (1603) and *The Poore Mans Talentt* (a manual of domestic medicine, first printed by the Hunterian club, 1881), the works of the latter part of his life are translations: of selections from Luis de Granada (1601), of the works of Josephus (1602), of the prose works of Lucius Annaeus Seneca (1614), and of a French commentary on the *Semaine* of Du Bartas (1621).

Much of Lodge's work before 1600 was, in fact, surreptitious translation, the result partly of the stress laid on imitation in literary theory and partly of financial need, which encouraged mere compilation. The latter accounts for his poorest work (*Catharos* and *The Divel Conjured*); the former gives importance and quality to his best. But in spite of some crude hackwork, there is no doubt of the genuineness of his literary interests and abilities. He had no gift for drama or for finding copy without the aid of books, but in most of his verse and some of his romances he showed a capacity for selection and assimilation which was creative. The first and last of his verse collections (*Scillaes Metamorphosis* and *A Fig for Momus*) are historically important as forward-looking in both matter and style. Many of his well-known lyrics first appeared in his romances where the link between poem and story encouraged some interesting experiments. Of the romances, *Rosalynde*, deservedly popular on its own account, is rivaled only by *A Margarite of America*, an arresting and dramatically plotted tale combining Senecan motives with the artifice of Euphuism and Arcadian romance in a manner which cannot be entirely credited to its source. This was, according to Lodge, "a historie in the Spanish tong" which he found in the Jesuit college at Santos during his visit to Brazil and, although doubt has sometimes been cast on this claim, the Jesuit library was certainly pillaged by Cavendish's followers. Of the prose pamphlets, *Wits Miserie* is, with the *Alarum*, the most readable for its Nashe-like cameos of London life. It is this ready response to fashions of one kind and another that makes Lodge's work important: having "so written as he had read," he is representative of an age schooled to draw both matter and style from literary models, and the variety of his work (to which he so often drew attention) gives him a place in the history of an unusual number of literary kinds.

BIBLIOGRAPHY.—*The Complete Works*, ed. by Edmund Gosse, 4 vol. (Hunterian club, 1883), includes everything but the translations. On Lodge's life, *see* C. J. Sisson, *Thomas Lodge and Other Elizabethans* (1933); Alice Walker, "The Life of Thomas Lodge," *Review of English Studies*, vol. lxx (1933–34). (Ae. Wr.)

LODI, a town and episcopal see in the province of Milano, Lombardy region, Italy, is situated on the right bank of the Adda river, 30 km. (19 mi.) S.E. of Milan on the Milan-Rome railway. Pop. (1957 est.) 36,881 (comm.). It is an important centre of the dairy industry and is noted for its production of ceramics and wrought iron. Among buildings of special interest are the 12th-century Romanesque cathedral, which is being restored; the church of the Incoronata (1488–94); the Lombard Gothic church of S. Francesco, notable for its 12th- and 16th-century votive frescoes; the Ospedale Maggiore, established in the 15th century by a union of the town's hospitals and preserving the ancient cloister of the hospital of the Holy Spirit; and the Museo Civico and Laudense library, housing a series of illuminated 15th-century chant books.

Lodi was founded in the 5th century B.C. on the site of the suburb of Lodi Vecchio and obtained Roman citizenship in 89 B.C. Destroyed during the communal struggles of 1111 and by the Milanese in 1158, it was refounded on its present site by the emperor Frederick Barbarossa. Following the struggles between the Guelphs and Ghibellines it lost its independence to Milan (*q.v.*), with which its history was thereafter linked. On May 10, 1796, Napoleon defeated the Austrians at the battle of the bridge of Lodi, thereby gaining control of Lombardy.

LODZ, a *wojewodztwo* (province) in central Poland, bounded on the northeast by Warszawa province, on the northwest by Poznan and on the south by Kielce province. Area 17,065 sq.km. (6,589 sq.mi.); pop. (1960) 1,597,600.

The northern part of the province lies on the European plain and is drained by the Warta and its tributary, the Prosna. The southern part is in the Lodz highlands, formed of chalk marl. The region, formerly covered by forests and lakes, has been largely deforested (forests now occupy about 16% of the area) and cultivated despite poor soils. Agriculture has attained a high level, resulting in crop yields (rye, wheat, oats, barley, potatoes) larger than average for the country. Livestock breeding, particularly of sheep, pigs and cows, is well developed. Industry, the most important element in the province's economy, is centred mainly in and around Lodz city. Textile manufacture has long traditions there, with cotton as the most important branch. The city of Lodz (*q.v.*) has the greatest variety of factories, followed by Pabianice. Zgierz is mainly a centre for the wool industry and Aleksandrow for the production of knitted goods. Outside the Lodz industrial region, textile milling is carried on at Piotrkow Trybunalski (cotton) and Tomaszow Mazowiecki. The chemical industry is also important at Tomaszow Mazowiecki, and machine and furniture industries at Radomsko. Raw materials are provided by iron ore deposits near Leczyca, and brown coal is found in the Rogozno area.

Other towns in the *wojewodztwo* with populations exceeding 20,000 are Radomsko, Kutno, Zdunska Wola and Skierniewice. The Corpus Christi celebration in Lowicz (on the Bzura river, northeast of Lodz) is noted for its colourful local costumes. The whole area suffered very severe damage in World War I and had to face new economic problems. The German invasion and occupation of World War II brought fresh hardships to the population, especially the Jews. (T. K. W.)

LODZ is the second largest city in Poland and capital of Lodz *wojewodztwo* (province). The city itself has the status of an independent *wojewodztwo* and is the seat of a Roman Catholic bishopric. Pop. (1960) 708,400. It is situated on the northwestern edge of the Lodz highlands, on the watershed of the Vistula and Oder rivers 81 mi. S.W. of Warsaw. Lodz is an important railway junction on the Warsaw-Wroclaw line and has direct communications by rail and air with all the larger Polish towns. It is one of the largest centres of the cotton industry in the world.

Mentioned in 14th-century records as a village, Lodz acquired town rights in 1798. However, it remained for a long time a small insignificant settlement which had only 799 inhabitants in 1820. In that year, the government of the Congress kingdom decided to make it a centre for the textile industry and invited foreign weavers and artisans to settle there. After the customs barrier between Russia and the Congress kingdom was abolished in 1850, a great market for Lodz manufacture was opened up and by the end of the 19th century Lodz had become the leading cotton centre in Poland. The rapid expansion of the town took place during that period, and by 1913 it had 506,000 inhabitants. Despite the severe damage sustained during World War I, Lodz maintained its importance as a cotton centre. Other industries developed include the manufacture of wool, silk, jute, hemp, clothing, metal, chemicals, leather, paper and food processing.

As a large industrial centre, Lodz was an important core of the working-class movements, and the scene of activity of Polish Communist leaders. Occupied by the Germans (who incorporated it into Wartheland and renamed it Litzmannstadt) during World War II, it was relatively undamaged and its factories were reactivated after 1945. By the early 1960s about 120,000 persons were employed in the textile mills, about half of whom were in the cotton trade.

Because the city developed mainly in the 19th century, it is of little historic architectural interest. Nearby villages and settlements were absorbed through its rapid territorial expansion, resulting in somewhat chaotic development. Some districts, such as Baluty, which despite its 100,000 inhabitants has only village rights, form a maze of factories, apartment houses, former mansions of factory owners and workers' cottages. The main thoroughfare is Piotrkowska street, once a highroad to Piotrkow. Although situated on a watershed, the city suffers from lack of water, which is supplied by subartesian wells and a pipeline from the Pilica river. After World War II there was a marked improvement in communal services such as drainage, hospitals, local transportation and public parks.

Lodz has become an important cultural centre since World War II, and contains eight higher educational establishments (the university and technical university, both founded in 1945, and schools of music, plastic arts, medicine, drama, film and economics). It also has a scientific society and a number of research institutes, several theatres, an opera house, a music hall and a philharmonic hall. (T. K. W.)

LOEB, JACQUES (1859–1924), German-U.S. pioneer in experimental biology, was born at Mayen (near Coblenz), Ger., on April 7, 1859, and studied at Berlin and Munich before receiving an M.D. degree from the University of Strasbourg in 1884.

His work in biology began at the universities of Würzburg (1886–88) and Strasbourg (1888–90), and at the Naples biological station (1889–91). In 1891 he went to the United States, becoming successively professor at Bryn Mawr college, Bryn Mawr, Pa. (1891–92), The University of Chicago (1892–1902) and the University of California, Berkeley (1902–10). In 1910 he became a member of the Rockefeller Institute for Medical Research in New York city and continued in that position until his death on Feb. 11, 1924, while vacationing in Bermuda. Much of his experimental work was done at the Marine Biological laboratory at Woods Hole, Mass.

Popular interest, attended by some controversy, was attracted to Loeb's experiments on artificial parthenogenesis, beginning in 1899, when he succeeded in bringing about the development of larvae of the sea urchin from unfertilized eggs by exposing them to controlled changes in their environment; this work was later extended to the production of parthenogenetic frogs, which he raised to sexual maturity. In addition to artificial parthenogenesis, Loeb is remembered for his work on the physiology of the brain, animal tropisms, regeneration and the duration of life. In his later years he made important contributions to the theory of colloidal behaviour, applying the principles of J. W. Gibbs and of F. G. Donnan to the chemistry of proteins.

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LOEFFLER, CHARLES MARTIN TORNOW (1861–1935), U.S. composer whose symphonic, choral and chamber music is distinguished by a poetic lyricism in an impressionist style, was born at Mulhouse, Alsace, France, on Jan. 30, 1861. The name Tornow was a pseudonym of his father, a German writer and agriculturist who was employed intermittently in Russia, Hungary and

Switzerland when Loeffler was a child. At the age of 14 he was sent to Berlin, where he studied the violin with Eduard Rappoldi and Joseph Joachim and music theory with Friedrich Kiel. Later he went to Paris, where his teachers were Joseph Massart in violin and Ernest Guiraud in composition. He emigrated to the U.S. in 1881 and in 1882 was engaged as a violinist in the Boston Symphony orchestra, resigning in 1903 to devote himself entirely to composition.

Almost all of Loeffler's symphonic works were first performed by the Boston Symphony orchestra. They include *The Nights in the Ukraine,* for violin and orchestra (1891); *Fantastic Concerto,* for cello and orchestra (1894); *Divertimento,* for violin and orchestra (1895); *La Mort de Tintagiles,* for two viole d'amore and orchestra (1898); *La Villanelle du Diable,* for organ and orchestra (1902); *Poem,* inspired by Verlaine's *La Bonne Chanson* (1902; revised in 1918); *A Pagan Poem,* after an eclogue of Virgil, for piano and orchestra (1907); *Hora Mystica,* for male chorus and orchestra (1917); and three *Irish Fantasies,* for voice and orchestra (1922). Of these, the most enduring and musically significant work is *A Pagan Poem,* a fine evocation of antiquity in modern harmonies impressionistically treated.

Loeffler's symphonic poem, *Memories of My Childhood,* subtitled *Life in a Russian Village* (1924), was awarded the Chicago North Shore Festival association prize. His *Canticum Fratris Solis,* for voice and chamber orchestra, on a text of Francis of Assisi and commissioned by the Coolidge foundation, was first performed at the opening concert of the Coolidge series at the Library of Congress, Washington, D.C. (1925). His *Evocation,* for women's voices and orchestra, was commissioned for the inauguration of Severance hall, Cleveland (1931).

Loeffler's choral works also include *By the Rivers of Babylon,* for women's chorus with organ, harp, two flutes and cello (1907), and *Beat! Beat! Drums!* to Walt Whitman's poem of that title, for men's chorus in unison, six piccolos, three saxophones, brass, drums and two pianos (1917). In smaller forms, Loeffler wrote two rhapsodies for oboe, viola and piano (1905); *Music for Four Stringed Instruments* (1917); a string quintet; a string sextet; a *partita,* for violin and piano; and several songs and piano pieces. Loeffler died in Medfield, Mass., on May 19, 1935.

See Carl Engel, "Charles Martin Loeffler," *The International Cyclopedia of Music and Musicians* (1958). (N. Sy.)

LOESS. Typical loess is a soft, porous rock, pale yellowish or buff in colour; one characteristic property is its capacity to retain vertical or even overhanging walls in the banks of streams. These vertical walls exist in China, where they stand in some places 500 ft. high and contain innumerable cave dwellings; ancient roads, too, have worn vertically downward deep into the deposit, forming trenchlike ways. This character in the loess of the Mississippi region in the United States gave rise to the name "bluff formation." A coarse columnar structure is often exhibited on the vertical weathered faces of the rock. Another characteristic is the presence throughout the rock of small capillary tubules, which appear to have been occupied by rootlets; these are often lined with calcite.

Loess usually is calcareous; some geologists regard this as an essential property, and when the rock has become decalcified, as it frequently is on the surface by weathering, they call it loessloam. In the lower portions of a loess deposit the calcium carbonate tends to form concretions, which on account of their mimetic forms have been called loess dolls. Bedding is absent from typical loess. The mineral composition varies somewhat in different regions, but the particles are always small; they consist of angular grains of quartz, fine particles of hydrated silicates of alumina, mica scales and undecomposed fragments of feldspar, hornblende and other rock-forming silicates.

In Europe and North America loess deposits are associated with the margins of the great ice sheets of the glacial period; thus in Europe they stretch irregularly through the centre eastward from the northwest of France, and are not found north of the 57th parallel. Most geologists are agreed that the true loess is an aeolian or wind-borne rock, formed most probably during periods of tundra or steppe conditions. But it seems clear that certain deposits classed as loess in western Europe do not really belong to this category, being of alluvial origin and related to the brick earths of southeastern England. *See* Pleistocene Epoch; Wind Erosion and Deposition: *Dust Storms and Dust Deposits; see* also references under "Loess" in the Index. (F. J. P.)

BENJAMIN SHAUB

LOESS FORMATION NEAR PENTICTON, B.C.

LOEW, MARCUS (1870–1927), motion-picture executive and pioneer motion-picture theatre owner, was born May 8, 1870, in New York city, son of an Austrian immigrant. Leaving school at the age of nine to help support his family, he later found modest prosperity in the fur business.

Attracted by the new popularity of moving pictures Loew owned a chain of nickelodeons by 1905 and thereafter acquired many leading theatres for combined vaudeville and motion-picture exhibition.

In 1920 Loew's, Inc. purchased a production company named Metro Pictures Corp., and in 1924 the Goldwyn Pictures Corp. (from which Samuel Goldwyn had resigned) was absorbed. The name became Metro-Goldwyn-Mayer to represent the newly hired management group headed by Louis B. Mayer.

Loew died on Sept. 5, 1927, almost at the end of the silent film era. His estate was estimated at $30,000,000. Neither flamboyant nor notably original, Loew was a show-business consolidator who made possible some of Hollywood's finest film achievements.

See Bosley Crowther, *The Lion's Share* (1957). (R. D. MacC.)

LOEWI, OTTO (1873–1961), German pharmacologist and Nobel laureate, was born at Frankfurt am Main on June 3, 1873, and was educated at Strasbourg and Munich universities. After becoming doctor of medicine in 1896, he devoted himself to physiological chemistry and pharmacology. In 1898 he was appointed assistant in the pharmacological institute at Marburg, and in 1901–02 he spent some months at University college, London, under E. H. Starling. Returning to Marburg, he was made titular professor of pharmacology in 1904, but in 1905 he went to Vienna as associate professor. From 1909 to 1938 he was professor of pharmacology in Graz, Aus. In 1940, he went to the United States, becoming research professor at the College of Medicine of New York university. He died in New York city on Dec. 25, 1961.

In 1936 Loewi and his lifelong friend Sir Henry Hallett Dale received jointly the Nobel prize for medicine for discoveries relating to the chemical transmission of nerve impulses. Between 1921 and 1926 Loewi and his colleagues showed that stimulation of the nerves in the perfused frog's heart led to the appearance of a substance which could readily inhibit a second heart receiving the perfused fluid from the first. This substance was finally shown to be acetylcholine, which had been first isolated from bio-

logical material by Dale in 1914. Loewi's experiments provided the first definite proof that chemical substances were concerned in the transmission of nervous impulses. He also carried out important researches on diabetes, digitalis, adrenaline and the vegetative nervous system, and in 1908 he devised "Loewi's test" for pancreatic function. (W. J. Bp.)

LÖFFLER, FRIEDRICH AUGUST JOHANNES (1852–1915), German bacteriologist, one of the greatest names in the history of bacteriology, was born at Frankfurt an der Oder on June 24, 1852, the son of an army surgeon. He studied medicine at Würzburg university and at the Friedrich Wilhelm university in Berlin and, after serving in the Franco-German War, he obtained his M.D. degree at Berlin in 1874. After further service as an army doctor he became an assistant in the imperial health department (1879–84), where he was closely associated with Robert Koch. In 1888 he was appointed professor of hygiene at Greifswald and he was rector of that university, 1903–07. In 1913 he succeeded G. Gaffky as director of the Robert Koch Institute for Infectious Diseases in Berlin. He died in Berlin on April 9, 1915.

In 1884 Löffler discovered *Corynebacterium diphtheriae*, the causal organism of diphtheria, and simultaneously with P. Roux and A. Yersin he indicated the presence of diphtheria exotoxin. Among his other notable achievements were the discovery of *Pfeifferella mallei*, the causative organism of glanders (1882), the discovery of the cause of swine erysipelas and swine plague (1885), and of *B. typhi murium* (1891). In collaboration with P. Frosch he found that foot-and-mouth disease is caused by a virus, the first occasion on which a virus was recognized as the cause of an animal disease. (W. J. Bp.)

LOFOTEN AND VESTERÅLEN, a group of islands off the northwest coast of Norway, between 67° 30′ and 69° 20′ N. and between 12° and 16° 35′ E., part of the *fylker* (counties) of Nordland and Troms. The extreme length of the group from Andenes, at the northern tip of Andøy, to Røst is about 255 km. (158 mi.); the aggregate area is about 5,128 sq.km. (1,980 sq.mi.). The largest island in the group, and indeed in Norway (excluding Svalbard), is Hinnøy, 2,198 sq.km. (849 sq.mi.). Pop. (1962 est.) 86,400.

The islands are separated from the mainland by the Vestfjord, the Tjeldsund and the Vågsfjord, and are divided into two sections by the Raftsund between Hinnøy and Austvågøy. To the west and south of the Raftsund lie the Lofoten Islands proper, of which the most important are Austvågøy, Vestvågøy and Moskenesøy; east and north of the Raftsund are the islands of Vesterålen, the chief being Hinnøy, Langøy and Andøy. The islands, which are of granite or gneiss, are a partially submerged mountain range and are lofty and rugged. The highest points are Møysalen (4,153 ft.) on Hinnøy and Higrafstind (3,809 ft.) on Austvågøy near the Raftsund and the Trollfjord.

The long line of jagged peaks seen from the Vestfjord forms one of the most striking prospects on the Norwegian coast. The channels which separate the islands are narrow and tortuous, and generally of great depth; they have remarkably strong tidal currents, particularly the Raftsund and the famous Malstrøm or Moskenstrøm near Moskenes. Though the islands are situated within the Arctic circle, the climate is not rigorous and the coast is never frozen. The isothermal line which marks a mean January temperature of 0° C. (32° F.) runs south at the west side of the islands, passing east of Bergen onward to Göteborg, Swed., and Copenhagen, Den. The prevailing winds are from the southwest and west, the mean temperature is 5° C. (41° F.) and the annual rainfall varies between 31 and 47 in. In summer the hills have only patches of snow. Much of the interior is bleak cranberry moor. Cattle are reared; grass and potatoes, but no cereals, are grown.

The characteristic industry is the cod fishery carried on along the east coast of the Lofotens in spring. During the season this employs many thousands from northern and some southwestern parts of Norway. The fish, dried on racks during early summer, ordinarily are exported from Bergen, especially to west African countries, and the fish heads are ground to fish meal. Industries arising out of the fishery are the manufacture of cod-liver oil, canning and deep freezing. Herring is taken in large quantities in the fjords and surrounding waters of Lofoten and Vesterålen.

Svolvær, built on rocky islands off Austvågøy, is the chief town and principal port and trading centre; Kabelvåg is another fishing port. A church existed at Vågen (Kabelvåg) in the 12th century. Steamers connect the islands with Grimsby, Eng., Bergen and Kirkenes. A motor road across the Lofoten Islands was being constructed in the early 1960s. There are interisland ferry connections and ferry services between Hinnøy and the mainland via the Tjeldsund and the Vestfjord. During World War II Lofoten was the scene of British commando raids against the Germans. (L. H. Hg.)

LOG, MARITIME, an instrument for measuring the speed of a ship through the water. From its original meaning the term has come to be applied to the daily progress of a ship and also to the full written record of the voyage of a ship or flight of an airplane. The more exact term for such a written record is "logbook."

The oldest type of log of a practical nature was the "chip log." It consisted of the log chip, log reel, log line and log glass. The chip was a small piece of pie-shaped wood with a small lead weight on its circular side that caused it to float upright in the water and resist being towed. The log line was attached to the chip by a three-part bridle, one part fastened to a peg in the chip that could be pulled out by a jerk on the line when it was desired to haul in the chip. The part of the line, about 15 fathoms in length, next to the chip was called the "stray line" and its limit was marked by a piece of bunting. The remainder of the line was kept on the reel until used. It was marked off at intervals of 47¼ ft. by pieces of cord, called "knots," worked into the log line. The log glass was a 28-second sandglass. The measurements of the log line and time were based on the following equation:

$$\frac{47\frac{1}{4}\text{ ft.}}{6{,}080\text{ ft. (nautical mile)}} = \frac{28\text{ sec.}}{3{,}600\text{ sec. (hour)}}$$

To measure speed with the log, the chip with peg in place was dropped into the water from the stern and the log line was allowed to pay out from the reel. When the piece of bunting marking the end of the stray line unwound from the reel the sandglass was inverted. After 28 seconds had elapsed the number of knots that had passed overboard was counted. The number of knots that ran out in 28 seconds was the speed of the ship in nautical miles per hour. Some log lines were marked by bits of cloth to indicate fifths of a knot. For higher speeds a 14-second glass was used and the number of knots running out was multiplied by two.

The chip log gave the speed only at the time it was used. The desirability of knowing the distance run over an extended period of time brought into use many different types of patented rotating logs. In these the chip was replaced by a rotator, similar to a propeller, towed astern by a braided line. The revolutions of the rotator were transmitted by the braided line to a clockwork recording device on the stern of the ship where the result appeared on a dial as nautical miles made through the water. Because of the location of the recording dial on the stern rail, or taffrail, these logs are commonly known as taffrail logs. Many logs utilizing a rotator to indicate the distance traveled have been used, but all are liable to error if the rotator is fouled by floating weeds. At speeds greater than 15 knots in rough sea they are not accurate.

Logs installed in modern U.S. ships ascertain the ship's speed by means of a Pitot tube. A typical log built by the Pitometer Log corporation consists of a tube projecting through the bottom of the ship into undisturbed water. The tube is projected through a sea valve so it can be replaced if damaged or if the vessel enters shoal water. The tube has one forward-facing orifice called the dynamic-pressure orifice and two orifices at right angles to it called the static-pressure orifices. When the ship is stopped the pressure is the same in the dynamic and static connections but when the vessel steams ahead the dynamic pressure exceeds the static pressure. This difference in pressure varies as the square of the ship's speed.

Another part of the log consists of a small variable-speed electric motor driving a centrifugal water pump. In such a pump the dynamic pressure produced by the pump varies as the square of the speed of the motor. The pressure produced by the speed of the ship is exerted against a bellows which is balanced by pressure produced by the pump. Movement of the bellows operates the speed control of the motor making it exactly balance the pressure produced by the ship. With this accomplished, the speed of the pump and motor corresponds to the speed of the ship.

Attached to the shaft of the electric motor is a magneto which generates voltage proportional to the speed of the ship. This voltage is transmitted to the navigating bridge where it actuates the equivalent of a voltmeter whose graduated dial constantly indicates the speed of the ship in knots. The pump motor also drives a counting device which counts the revolutions made by the motor and transmits this information to the bridge as nautical miles steamed through the water. The dials on the bridge furnish the same information as the speedometer in an automobile. This type of log may also be arranged to draw a graph on a moving paper tape indicating the speed of the ship continuously during an entire voyage.

Since there is no continuous flow of water through the Pitot orifices the possibility of the openings being clogged with drifting material is slight, and since the actuating pressure is the difference between static and dynamic pressure there is no error caused by change in draft of the ship. (M. R. D.)

LOGAN, JAMES JOHN, also known by his Indian name TAH-GAH-JUTE (*c.* 1725–1780), was technically a Cayuga Indian because his mother was a member of that tribe. His father, Shikellamy, was purportedly a white Frenchman who had been taken by the Oneida as a child and had in manhood become a chief. Chief Shikellamy became Iroquois representative at the Delaware town of Shamokin in Pennsylvania and also a friend of the secretary of the colony of Pennsylvania, James Logan, whose name the chief's son assumed.

Logan moved to the Ohio valley after the French and Indian War and married a Shawnee. He was never a chief but he achieved renown among many Indian tribes, first because of his friendship with the white settlers, and later by reason of his ardent hatred of all white men. In 1774, at the beginning of Lord Dunmore's war against the Shawnee, Logan's family was treacherously killed by a frontier trader named Greathouse. That was when Logan declared war on the whites with such eloquence and with a particular venom directed against Capt. Michael Cresap, whom he blamed for the atrocious killing of his mother, sister and brother. From then until his death near Lake Erie at the hands of a relative, he pursued his vendetta, taking more than 30 white scalps. During the American Revolution, to further his hatred of Americans, he associated himself with the Mohawk auxiliaries of the British.

See Brantz Mayer, *Tah-Gah-Jute or Logan the Indian and Captain Michael Cresap,* 2nd ed. (1867). (J. H. Hl.)

LOGAN, JOHN ALEXANDER (1826–1886), U.S. senator and northern general during the American Civil War, was born in what is now Murphysboro, Ill., on Feb. 9, 1826. Without schooling until he was 14, he studied for three years in Shiloh college, then served in the Mexican War as a lieutenant of volunteers. He graduated from the law department of Louisville university in 1851 and began to practise law. He entered politics as a Douglas Democrat and was elected to the national house of representatives in 1858 and again in 1860. Logan resigned his seat in congress and entered the Union army as colonel of a regiment of volunteers that he had organized. He served under General Grant until the capture of Vicksburg, rising to the rank of major general of volunteers. He was commander of the army of the Tennessee at the battle of Atlanta but was later relieved of his command, apparently because General Sherman felt Logan did not pay enough attention to logistics.

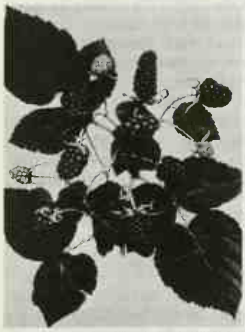
After the war Logan, now a Republican, resumed his political career. He was a member of the house of representatives in 1867–71, and of the U.S. senate in 1871–77 and again from 1879 until his death. He was always identified with the radical wing of the Republican party. His war record and his large personal following, especially in the Grand Army of the Republic (an organization of ex-soldiers that he helped to organize), contributed to his nomination for vice-president in 1884 on the ticket with James G. Blaine. When commander in chief of the Grand Army of the Republic in 1868–71, he successfully urged the observance of Memorial or Decoration day. He died at Washington, D.C., on Dec. 26, 1886. (N. A. G.)

LOGAN, a city of Utah, U.S., and seat of Cache county, is a college community and a distribution and marketing centre, on the Logan river, 80 mi. N. of Salt Lake City. Logan, with its many trees and gardens, is laid out at the mouth of scenic Logan canyon on terraces of prehistoric Lake Bonneville. It has an elevation of 4,535 ft. above sea level, with nearby Wasatch mountain peaks towering more than 5,000 ft. higher.

The city takes its name from the river, named for Ephraim Logan, a trapper of the 1820s. Believing Cache valley too cold for agriculture, Mormon colonizers did not arrive until 1855–56, and it was 1859 before Logan itself was founded; the city was incorporated in 1866. Grains and sugar beets were found to grow well, and subsequently dairying and stockbreeding thrived. A gray, twin-towered temple, completed in 1884, made Logan a Mormon religious centre. Utah State university, formerly the state agricultural college (founded 1888) has profoundly influenced the community. The Utah Northern railroad, built to Logan in 1873 and to Montana in 1877–81, was later incorporated into the Union Pacific system.

For comparative population figures *see* table in UTAH: *Population.* (D. L. M.)

LOGANBERRY (*Rubus loganobaccus*), a bramble fruit that originated in the garden of Judge J. H. Logan at Santa Cruz, Calif., in 1881. Raised from seed, it is thought to be a hybrid between the wild blackberry of the Pacific coast and the red raspberry. It is grown commercially in large quantities, especially in Oregon and Washington and in England and Tasmania. The loganberry or Logan is a vigorous, nearly trailing, blackberrylike plant with compound leaves of three to five leaflets, prickly canes and deep wine-red, tart, high-flavoured berries that separate from the stem as do the blackberries. The fruit is canned, frozen for preserve or pie stock, or made into wine. The Phenomenal, originated by Luther Burbank, is very similar to the Logan, but bears slightly larger fruit. The Young (Youngberry), Boysen (Boysenberry), Pacific and Cascade are related berries that have the high aroma and flavour of the Logan and of the native blackberry. Research by M. B. Crane and P. T. Thomas in England and Waldo and Darrow in the U.S. department of agriculture indicates that the Logan probably originated as a hybrid of an octoploid blackberry fertilized with diploid pollen of a red raspberry. Hybrids of this kind are similar in appearance to the Logan. L. H. Bailey proposed the species name for this cultivated blackberry. *See* also BLACKBERRY. (J. R. MAG.)



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LOGANBERRY (RUBUS LOGANOBACCUS)

LOGANIACEAE, a family of dicotyledonous plants including herbs, vines, shrubs and trees, chiefly tropical but with some representatives in temperate regions. More than 30 genera and about 600 species are recognized. The largest and most important genus is *Strychnos* in the tropics of both hemispheres, the seeds of various species, but especially those of *S. nux vomica,* yielding the drug and poison strychnine (*q.v.*). Many species of *Buddleia,* called butterfly bush, and one of *Gelsemium* (*q.v.*), the yellow or Carolina jasmine (jessamine) of the southeastern United States, are cultivated for ornamental purposes. (E. D. Mc.)

LOGANSPORT, principal town and seat of Cass county, north-central Indiana, U.S., 70 mi. N.N.W. of Indianapolis, at the confluence of the Wabash and Eel rivers. It is a trading centre for an agricultural area comprising Cass, Carroll, Pulaski, Fulton, Miami and White counties, and an important shipping point for livestock and grain.

Manufactures include air-operated and hydraulic labour saving equipment, die castings, electronic and electrical controls, automobile and airplane parts, metal stampings, screw products, hardwood lumber, fishing tackle, fire-fighting apparatus, mechanical rubber goods, metal springs and women's foundation garments.

Two of Logansport's public utilities, water and electricity, are municipally owned. A state mental hospital is located there.

Title to the land was acquired by treaty in 1826 from the Miami and Potawatomi Indians. The town was platted in 1828 and named after a Shawnee chief, the so-called Captain Logan (d. 1812), who was evidently an ally of the Americans in the War of 1812. It was incorporated as a town in 1831 and as a city in 1838. For comparative population figures *see* table in INDIANA: *Population.* (WI. BA.)

LOGARITHMIC DECREMENT is the measure of the rate of decay of any exponentially damped oscillation. It is the Napierian logarithm of the ratio of the first to the second of two successive current amplitudes in the same direction. The logarithmic decrement can also be considered as a constant of a simple radio circuit, being π times the product of the resistance by the square root of the ratio of the capacity to the inductance of the circuit. Measurement of logarithmic decrement is of great importance since it makes possible the determination of the equivalent resistance of the circuits under consideration, and also gives information concerning the lengths of the wave trains. The value of the sum of the decrements of two circuits may be obtained from their resonance curve.

LOGARITHMS. Invented in the early 17th century to speed up calculations, logarithms cut in half the time required for multiplication and were basic in numerical work for more than 300 years. The perfection of the desk calculating machine in the late 19th century and of the electronic computer in the mid-20th, made logarithms virtually obsolete for large-scale computation, though they are used in the 1960s for a few special purposes and indirectly as the basis for the slide rule. Meanwhile, however, interest has shifted from logarithms to the logarithmic function, which now holds an assured and significant place in both pure and applied mathematics.

The Nature of Logarithms.—The basic idea underlying logarithms may be seen in the following array of values:

$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4	8	16	32	64	Numbers
−3	−2	−1	0	1	2	3	4	5	6	Logarithms

Pick two numbers from the first row and multiply them; say, $2 \cdot 8 = 16$. The corresponding values in the logarithm row are 1, 3 and 4; notice that $1 + 3 = 4$. Multiplication of numbers in the first row corresponds to addition of the logarithms in the second row. Instead of multiplying 4 by 8 to get 32, look in the logarithm row to find 2 and 3 under numbers 4 and 8. Then add 2 and 3 to get 5 and look above the 5 to find 32. These two rows form a simple table of logarithms that can replace multiplication by addition. With a more complete table much tedious work of multiplication could be avoided. This is the basic idea that led to the invention of logarithms and made them such a valuable tool for computation.

To see the secret of the little logarithm table above, rewrite the numbers in the first row as powers of 2:

$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4	8	16	32	64	Numbers
2^{-3}	2^{-2}	2^{-1}	2^0	2^1	2^2	2^3	2^4	2^5	2^6	Numbers as Powers
−3	−2	−1	0	1	2	3	4	5	6	Logarithms

For example, $4 = 2^2$, $8 = 2^3$, $64 = 2^6$, $\frac{1}{2} = 2^{-1}$, and $\frac{1}{8} = 2^{-3}$ (*see* EXPONENT). These logarithms are seen to be the exponents when the numbers are expressed as powers of 2. In the equation $32 = 2^5$ the number 2 is called the base; 5 is the logarithm of 32 to the base 2 and is written $5 = \log_2 32$. More generally the two equations

$$x = b^y \qquad y = \log_b x \tag{1}$$

have the same meaning; the first serves to define the second. By this definition y is the logarithm of x to the base b if and only if $x = b^y$. The number x is also called the antilogarithm of y to the base b.

It is evidently easy to find logarithms of numbers that are simple powers of the base, and there are quite efficient methods for calculating logarithms of all numbers to as many decimal places as desired. Without going into these methods here, it is not hard to see that such logarithms could be approximated by elementary arithmetic and much labour. Suppose the logarithm of 5 to the base 2 (*i.e.*, $\log_2 5$) is wanted. By equations (1) this means that a y is sought such that $5 = 2^y$. Since $4 = 2^2$ and $8 = 2^3$, the logarithm of 5 must lie between 2 and 3. Moreover, since 4 lies much closer to 5 than does 8, it might be guessed that the logarithm is between 2 and 2.5. Try 2.5 or $\frac{5}{2}$; does $5 = 2^{5/2}$? It does not, since taking the second power of both sides gives $5^2 = 2^5$ or $25 = 32$, which is false. But since the right side is too big, we know that $\frac{5}{2}$ is too large, and the search is narrowed. Now try 2.4 or $\frac{12}{5}$; does $5 = 2^{12/5}$? If it does then $5^5 = 2^{12}$ or $3125 = 4096$; thus 2.4 is too big. If patience holds, next try 2.3 or $\frac{23}{10}$. If $5 = 2^{23/10}$, then $5^{10} = 2^{23}$, or $9{,}765{,}625 = 8{,}388{,}608$. This time the left side is larger and therefore 2.3 is too small. The first two digits in $\log_2 5$ have been found; it begins 2.3 . . . Evidently with enough paper, pencils and time additional digits could be found by these methods. Actually, the early makers of logarithm tables used methods only a little less crude than these and by immense labours constructed very complete tables.

That multiplication of any numbers m and n can be accomplished by adding their logarithms (*i.e.*, the logarithm of the product is the sum of the logarithms) can be expressed

$$\log_b mn = \log_b m + \log_b n \tag{2}$$

Experimentation with the table above can easily show that division of numbers can be accomplished by subtracting logarithms (*i.e.*, the logarithm of the quotient is the difference of the logarithms) or

$$\log_b (m/n) = \log_b m - \log_b n \tag{3}$$

But this is not all; powers and roots can also be found with logarithms. For example, the cube of 4 is 64 (*i.e.*, $4^3 = 64$), and from the table the logarithms of 4 and 64 are 2 and 6. Since $6 = 3 \cdot 2$, the logarithm of 4^3 can be found by multiplying the logarithm of 4 by 3. Study of the table will verify that the logarithm of a power can be found by multiplying the logarithm of the number by the index p of the power; *i.e.*,

$$\log_b n^p = p \log_b n \tag{4}$$

This means that to square a number, multiply its logarithm by 2; to cube multiply by 3, and so on.

Since logarithms transform multiplication into addition, division into subtraction, and taking powers into multiplication, it might be guessed that they would transform taking roots into division. This is the case; for example, to compute the square root of 16 find its logarithm (which is 4) and divide by 2. The result is 2, which is the logarithm of 4 as expected. In general, the logarithm of a root is the logarithm of the number divided by the index q of the root; *i.e.*,

$$\log_b \sqrt[q]{n} = \frac{1}{q} \log_b n \tag{5}$$

Since $\sqrt{n} = \sqrt[2]{n}$, square roots are given by $\log_b \sqrt{n} = \frac{1}{2} \log_b n$.

Logarithms work this way because they are exponents; and exponents are added for multiplying, subtracted for dividing, multiplied to take a power, and divided to take a root. These ideas may be expressed as laws of exponents:

$$\begin{aligned} b^x \cdot b^y &= b^{x+y} \\ b^x \div b^y &= b^{x-y} \\ (b^x)^p &= b^{px} \\ \sqrt[q]{b^x} &= b^{x/q} \end{aligned} \tag{6}$$

The x and y in equations (6) may be thought of as logarithms. Indeed, suppose that $m = b^x$ (*i.e.*, $\log_b m = x$) and $n = b^y$ (*i.e.*, $\log_b n = y$). Then by the first equation (6) $mn = b^x \cdot b^y = b^{x+y}$. But by equations (1) this last is equivalent to $\log_b mn = x + y$. Replacing x and y by their values gives the value for equation (2) as desired.

In a similar way the other rules can be proved. Moreover, though these examples have applied to the base 2 and to simple integral values of the logarithms, the proofs hold for all numbers for which equation (1) has meaning and for which the laws of exponents hold. Incidentally, since $\sqrt[q]{m} = m^{1/q}$ by the last equation (6), equation (5) may be considered a special case of equation (4). Also, since $b^0 = 1$, then $\log_b 1 = 0$ and $\log_b(1/n) = -\log_b n$. Since $m/n = m(1/n)$, equation (3) may be viewed as a special case of equation (2).

Common Logarithms.—The most convenient tables for numerical calculations are those of logarithms to the base 10 (called common logarithms). Their great advantage is that if a table gives the logarithms of numbers between 1 and 10, the logarithms of all other numbers can be found very simply. For example, a five-place table of logarithms gives the log of 2.41 as 0.38202. (It will help to have such a table at hand for following this discussion.) Suppose the logarithm of 24.1 is wanted. Since $24.1 = 2.41 \cdot 10$, then $\log_{10} 24.1 = \log_{10} 2.41 + \log_{10} 10$. But $\log_{10} 10 = 1$; thus the logarithm being sought is 1.38202. In general, each time the decimal point is moved one place to the right, the number is multiplied by 10 and its common logarithm increases by 1. Moving the decimal point to the left divides the number by 10 and decreases the logarithm by 1. The following table gives the common logarithms of simple powers of 10:

$\frac{1}{1000}$	$\frac{1}{100}$	$\frac{1}{10}$	1	10	100	1000	10,000	Numbers
10^{-3}	10^{-2}	10^{-1}	10^0	10^1	10^2	10^3	10^4	Numbers as Powers
−3	−2	−1	0	1	2	3	4	Common Logarithms

Numbers between those in this table have logarithms lying in between those given. Any two numbers with the same digits but with decimal points in different places, will have logarithms that differ by an integer.

Thus each common logarithm consists of two parts, an integer and a decimal less than 1. The integral part (called the characteristic) is determined by the position of the decimal point. It may be found from the common logarithm table above or by using the following simple rule. Count the number of places the decimal point must be moved to bring it just at the right of the leftmost nonzero digit, counting plus to the left and minus to the right; the result is the characteristic. For example, the characteristic for 2.41 is zero, since the decimal point is already at the right of the leftmost nonzero digit. The characteristic of 241 is 2, since the decimal point must be moved two places to the left; and the characteristic of 0.00241 is minus 3, since it must be moved three places to the right to bring it just to the right of the 2. The characteristics could also be found by noting that 2.41 lies between 1 and 10, 241 between 100 and 1000, and 0.00241 between $\frac{1}{1000}$ and $\frac{1}{100}$ in the table. Still another way to find the characteristic is to observe that it is equal to the exponent on 10 when the number is written in scientific notation (*e.g.*, $2.41 = 2.41 \cdot 10^0$, $241 = 2.41 \cdot 10^2$, and $0.00241 = 2.41 \cdot 10^{-3}$).

The decimal part (the mantissa) of the common logarithm is found from the table, disregarding the decimal point. To find the mantissa corresponding to 2.41, 241 or 0.00241 look in, say, a five-place table under 241 and find 38202, with the decimal point omitted. To find the square root of 241, write $\log 241 = 2.38202$; then divide by 2 to give the log answer of 1.19101. This log answer corresponds to the final numerical answer of 15.528. The digits in the final answer are found by reading the five-place table backward. In this case the usual table fails to show the mantissa .19101; however, it does give mantissas of .19089 (corresponding to the digits 15520) and .19117 (corresponding to 15530). Interpolation by proportional parts gives the digits 15528 for the final answer. (Thus in most tables it is necessary to interpolate at this point. Interpolation is also required to find the logarithm of any number that is not in the table; *see* INTERPOLATION AND EXTRAPOLATION.) Then the decimal point is placed to correspond to the characteristic, which is 1 in this case. It can also be checked by rough estimate; here $15^2 = 225$ shows that the square root of 241 must be a little more than 15.

When the characteristic is negative, it cannot be written with its minus sign in front of the mantissa without causing confusion. For example, the mantissa of the log of 0.00241 is .38202 and its characteristic is -3. Hence its logarithm is $-3 + .38202$, not -3.38202. To avoid this difficulty it is customary to write the minus sign above the characteristic (*e.g.*, $\bar{3}.38202$) or else to add and subtract 10 (*e.g.*, $7.38202 - 10$). For example, to find the square root of .00241, write $\log 0.00241 = (7.38202 - 10)$; then divide by 2 to give $3.69101 - 5 = \bar{2}.69101$. Corresponding to the mantissa of .69101 the table gives the digits 49092. Since the characteristic is -2, the answer is 0.049092. If the cube root had been wanted, the logarithm would have been written as $27.38202 - 30$ so that 3 would evenly divide the negative part.

In doing logarithmic calculations it is convenient to make a form for the work and to carry out the calculations methodically. A typical problem for which logarithms are useful is $\sqrt[3]{34.865}\,(0.0000081139)/\sqrt{0.044561}$. First make a very rough estimate to check the result. Rounding off drastically and expressing in a form more convenient for estimating gives $\sqrt[3]{35}\,(8 \cdot 10^{-6})/\sqrt{4 \cdot 10^{-2}}$ or approximately $3 \cdot 8 \cdot 10^{-6}/2 \cdot 10^{-1}$; giving an estimate of $1.2 \cdot 10^{-4}$. It is not expected to find an answer equal to this, but the estimate gives some idea of the rough magnitude and helps discover gross errors. Now make out a form, look up logs and do the calculations as follows:

$$\begin{aligned}
\log 34.865 &= 1.54239 \\
&\quad \div 3 \\
\log \sqrt[3]{34.865} &= 0.51413 \\
\log 0.0000081139 &= \underline{4.90923 - 10} \\
\log \text{ numerator} &= 5.42336 - 10 \\
\log 0.044561 &= 8.64896 - 10 \\
&\quad \div 2 \\
\log \text{ denominator} &= \underline{4.32448 - 5} \\
\log \text{ answer} &= 1.09888 - 5 = \bar{4}.09888 \\
\text{answer} &= 0.00012557
\end{aligned}$$

This answer compares well with the initial estimate of 0.00012.

Natural Logarithms.—A vast field of additional possibilities is opened by considering the logarithmic function defined by $y = \log_b x$. An attempt to find its derivative (*see* CALCULUS, DIFFERENTIAL AND INTEGRAL) leads to the following calculations:

$$\begin{aligned}
D_x \log_b x &= \lim_{h \to 0} \frac{\log_b(x+h) - \log_b x}{h} \\
&= \lim_{h \to 0} \frac{1}{h} \log_b(1 + h/x) \\
&= \lim_{h \to 0} \frac{1}{x} \cdot \frac{x}{h} \log_b(1 + h/x) \\
&= \frac{1}{h} \lim_{h \to 0} \log_b (1 + h/x)^{x/h}
\end{aligned}$$

Assuming that log is a continuous function (which it is), the problem reduces to finding the limit of $(1 + h/x)^{x/h}$ as h approaches zero; or what comes to the same thing, the limit of $(1 + 1/t)^t$ as t approaches infinity. This limit exists and is an irrational (also a transcendental) number e given exactly by the infinite series $e = 2 + \frac{1}{2}! + \frac{1}{3}! + \frac{1}{4}! \ldots + 1/n! + \ldots$, and by 2.71828 to five decimal places. The proof is tedious, but it can be found in many elementary calculus books.

This result leads to the equation $D_x \log_b x = (1/x)\log_b e$. The formula would be much simpler if the second factor on the right could be eliminated. But if b is taken equal to e, then $\log_e e = 1$ from equations (1). It is therefore convenient in calculus, and in all advanced mathematics, to use the logarithmic function to the base e. Logarithms to the base e are called natural logarithms and are usually designated by ln without explicit use of the base. Thus

$$D_x \ln x = \frac{1}{x} \tag{7}$$

It is equation (7) that makes the logarithmic function so important. Without it there would be no function with a derivative of x^{-1}, since the formula $D_x x^n = nx^{n-1}$ does not yield $1/x$ in the right member for any value of n.

Though natural logarithms are less convenient than common

logarithms for numerical work, the natural logarithmic function is the key to finding numerical values of common logarithms. Formula (7) makes it possible to write $\ln(1+x) = x - x^2/2 + x^3/3 - x^4/4 + \ldots + (-1)^{n+1}x^n/n + \ldots$ (*see* TAYLOR'S THEOREM) which converges for $-1 < x \leq 1$ and could be used to calculate natural logarithms to as great a degree of accuracy as desired. Although the convergence of this series is quite slow, other very rapidly converging series can be derived from it. Once natural logarithms have been found, common logarithms can easily be obtained from the formula for change of base explained in the next paragraph.

Suppose two bases a and b, with $m = \log_a x$ or $a^m = x$. Then $\log_b(a^m) = \log_b x$. But $\log_b(a^m) = m \log_b a$, and $m = \log_a x$. Hence a general formula for changing from one base to another is $\log_b x = \log_a x \log_b a$. Letting $x = b$ and noting that $\log_b b = 1$ leads to the equation $\log_b a = 1/\log_a b$. Using this result, letting $b = 10$, and $a = e$, will lead to the following formula for transforming from natural to common logarithms: $\log_{10} x = \log_e x\,(1/\log_e 10)$. This means that to find the common logarithm simply multiply the natural logarithm by a fixed factor $(1/\log_e 10)$ which equals 0.43439 to five-digit accuracy.

Existence of Logarithms.—It has been assumed here without proof that numbers have logarithms. That some numbers do is obvious in simple cases, and this discussion has argued for its general plausibility. However, in some cases there appear to be no logarithms. For example, since there is no real exponent such that $e^y < 0$, negative numbers would appear to have no logarithms. For definiteness consider only the base e and ask the question: For a positive number y does x exist such that $y = e^x$ (*i.e.*, such that $x = \ln y$)? The graph of $y = e^x$ is a continuous, everywhere-increasing curve, as shown in fig. 1. It follows that any horizontal line above the x-axis meets this graph in just one point (*i.e.*, given a positive y there is just one x that satisfies the equation). Hence the inverse function defined by $x = e^y$ or $y = \ln x$, that has a graph which is the mirror image in $y = x$ of the graph of $y = e^x$, is also continuous for all positive x, as indicated in fig. 1. For every positive x there is a corresponding $\ln x$. As x approaches zero, $\ln x$ approaches minus infinity since as x approaches minus infinity e^x approaches zero (*see* GRAPH).

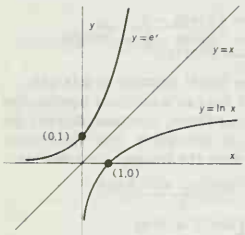

FIG. 1.—THE LOGARITHMIC FUNCTION AND ITS INVERSE. THE EXPONENTIAL FUNCTION

The proof of these statements is tedious, and an easier approach to the whole problem comes from making use of the equation (7). Since $1/x$ is a continuous function for all positive values of x, it means that the definite integral $f(x) = \int_1^x \frac{dx}{x}$ exists for all positive x. From the fundamental theorem of integral calculus, the derivative of $f(x)$ is $1/x$. Since by equation (7) this is also the derivative of $\ln x$, it means that $\ln x$ and $f(x)$ differ by a constant, which must be zero since $\ln 1 = f(1) = 0$. Hence it can be written that

$$\ln x = \int_1^x \frac{dx}{x} \qquad (8)$$

Figure 2 indicates the geometric meaning of this equation; *i.e.*, $\ln x$ is the area under the graph of $y = 1/x$ between 1 and x.

Equation (8) may be taken as the definition of $\ln x$. It then follows immediately that $\ln x$ exists for positive x, and all its properties can be derived, including equations (1).

Extension to Complex Numbers.—So far $\ln x$ has been defined only for positive numbers. To extend the domain to negative real numbers (or, more generally, to complex values) requires a definition of complex exponents. This extension may be made by the following definition (*see* COMPLEX NUMBERS; TRIGONOMETRY): $e^{i\theta} = \cos\theta + i \sin\theta$, where i is the square root of -1. If now the definition $e^{x+iy} = e^x \cdot e^{iy}$ is added, exponents are defined for all complex values and can be proved to have all the expected properties, including those listed in equations (6).

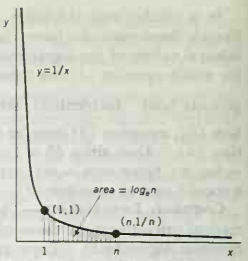

FIG. 2.—THE NATURAL LOGARITHM AS AN INTEGRAL

Since $e^{i\pi} = \cos\pi + i \sin\pi = -1 + i \cdot 0 = -1$, then $\ln(-1) = i\pi$ by equations (1), and a logarithm of a negative number has been found. But things are not so simple as in the case of positive numbers and real logarithms. Since sin and cos have periods of 2π, then $e^{i(\pi + 2n\pi)} = \cos(\pi + 2n\pi) + i \sin(\pi + 2n\pi) = -1$ for any integral n, and hence $\ln(-1) = (2n+1)\pi i$ for any n. Thus the definition does not give a unique value to the logarithm. More generally, if the equation $x + iy = e^{c+id}$ is solved for c and d, it is found that $c + id = \ln(x+iy) = \ln\rho + i(\theta + 2m\pi)$ where $\rho = |x+iy|$, and θ satisfies $\cos\theta = x/\rho$, $\sin\theta = y/\rho$. Since this holds for any integral m, any complex number (and this includes real numbers) has an infinite number of complex logarithms. When the number is real, one of these is a real number; otherwise all logarithms are imaginary. The logarithmic function plays an important part in the theory of functions of a complex variable (*see* FUNCTION; DIFFERENTIAL EQUATIONS, ORDINARY).

History of Logarithms.—Though the germ of the idea goes back at least as far as a work by Michael Stifel (1544), logarithms were invented independently by John Napier, who published a table in 1614, and by Joost Bürgi, who came out with a table of antilogarithms in 1620. These men were motivated by the hope of simplifying such computations as those required in astronomy and their invention arose from comparing arithmetic and geometric progressions. Since the theory of exponents had not been worked out, the simpler modern approach was not available to them; this makes their discovery all the more remarkable. Napier's logarithms (Nap. log) given by Nap. $\log y = 10^7 (\ln 10^7 - \ln y)$, were awkward for computations. For one thing, the logarithm decreased as the number increased. Napier and Henry Briggs soon thought of common logarithms, which immediately became popular.

Extensive tables of common logarithms were generally available before 1630. They were calculated by tedious repeated multiplications and the extraction of square roots. A clear construction of the theory came more slowly. As calculus developed, the logarithmic function appeared inevitably as the function that has a derivative of $1/x$. In 1668 Nicolaus Mercator derived the series for $\ln(1+x)$, which could have saved much of the work of preparing tables. It is easy to see why the logarithmic function attracted attention, quite apart from the use of logarithms in calculation. The differential equation $dy = y\,dx$, with a solution that is the exponential function (the inverse of the logarithmic function), states that the rate of change of y is proportional to y itself. Since this law of change is common to the growth of biological populations, the decay of radioactive substances, the accumulation of money at continuous compound interest and many other phenomena, the logarithmic function is inevitably involved in applied mathematics. Moreover the exponential function appears in an essential way in the solution of many differential equations, including all linear equations with constant coefficients.

Attempts to extend logarithms to negative numbers in the early 18th century led to considerable controversy among Gottfried Wilhelm Leibniz, Johann Bernoulli and Leonhard Euler. In 1742 William Jones gave the first systematic treatment of logarithms as exponents, and about 1747 Euler extended the theory to negative and complex numbers. However, it was not until the mid-19th century that the modern theory was completed and generally accepted.

See also SLIDE RULE; MATHEMATICAL TABLES; and references under "Logarithms" in the Index.

BIBLIOGRAPHY.—The theory and use of logarithms in calculation is covered in such elementary textbooks as A. P. Hillman and G. L. Alexanderson, *Algebra and Trigonometry* (1963), as well as in the instructions accompanying tables. The exposition of the logarithm as a definite integral appears in a number of calculus books, and the multivalued logarithmic function is treated in books on functions of a complex variable. For the interesting history of the discovery and development of the concepts, *see* any general history of mathematics such as F. Cajori, *A History of Mathematics* (1919), and *History of Elementary Mathematics* (rev. ed. 1917; reissued 1950); V. Sanford, *A Short History of Mathematics* (1930), or D. E. Smith, *History of Mathematics,* 2 vol. (1957). *See* also the *Napier Tercentenary Memorial Volume* (1915), which is rich in historical detail.
(K. O. M.)

LOGAU, FRIEDRICH, FREIHERR VON (1604–1655), German writer noted for his varied, witty and pithy epigrams, was born at Brockut near Nimptsch in Silesia in June 1604. He entered the service of the duke of Brieg, was made ducal councilor in 1644, and died at Liegnitz on July 24, 1655. His epigrams appeared in two collections, under the anagrammatic pseudonym "Salomon von Golaw," entitled *Erstes Hundert Deutscher Reimensprüche* (1638) and *Deutscher Sinngedichte drei Tausend* (1654). They satirize contemporary moral degeneration, court life, the German aping of French tastes, the falling away from religion, the lack of German national pride; and they reflect the sturdy independence and strength of character of their creator, who became, in 1648, a member of the Fruchtbringende Gesellschaft under the name of *Der Verkleinernde.* After his death he sank into obscurity; but his reputation was restored by G. E. Lessing and K. W. Ramler, who edited his *Sinngedichte* in 1759.

BIBLIOGRAPHY.—*Sämtliche Sinngedichte,* ed. by G. Eitner (1872); W. Heuschkel, *Untersuchungen über Ramlers und Lessings Bearbeitung Logauscher Sinngedichte* (1902); P. Hempel, *Die Kunst Friedrich von Logaus* (1917); S. H. Moore, "A Neglected Poet: Friedrich von Logau," *German Life and Letters,* vol. iii (1949–50).
(D. G. D.)

LOGGERHEAD (*Caretta caretta*), a large, reddish-brown carnivorous sea turtle (family Cheloniidae), reaching 300 lb. and a shell length of 3 ft., usually ranging in the warm coastal waters of the Atlantic and Pacific but straying widely outside tropical limits. The loggerhead musk turtle, of the family Kinosternidae, is a small land turtle (3 to 4 in. long) of the southeastern U.S. *See* also TURTLE.

LOGGIA, in architecture, is a room, gallery or hall open to the air on one or more sides, associated particularly with the Mediterranean and near eastern regions, where an open sitting room with protection from the hot sun was desired. Ancient Egyptian houses often had a loggia on their roofs, or an interior loggia facing upon a court. In medieval and Renaissance Italy the loggia was used frequently in conjunction with a public square or piazza. Thus the Loggia dei Lanzi, begun 1376, consists of three gigantic arches dominating one side of the main square of Florence. Another at Florence, the Loggia degli Innocenti, begun in 1419 after the design of Filippo Brunelleschi, marks the first appearance of the Renaissance revival of classic forms. The loggia was also an essential feature of villas and often had outstanding decoration, such as that of Raphael and his assistants in the Villa Farnesina at Rome.
(D. R. CN.)

LOGIA, a title used by New Testament scholars of the late 19th and early 20th centuries to describe a collection of "sayings of Jesus." Precedent for this use was sought in early Christian writings: early in the 2nd century Polycarp spoke of those "who pervert the *logia* of the Lord" and Papias said that "Matthew compiled the dominical *logia* in a Hebrew dialect"; Papias' own work was entitled *Expositions of the Dominical Logia.* It is highly doubtful, however, that these *logia* were "sayings of Jesus." Probably they were Old Testament passages regarded as oracles predicting the coming of the Messiah. When early Christians spoke of sayings of Jesus they used the word *logoi;* this is the term employed in the Greek "sayings of Jesus" discovered in papyrus fragments from Oxyrhynchus, Egypt, in 1897 and 1904. These "sayings," partly close to the Christian Gospels, partly quite different, were identified in 1952 by H. C. Puech as part of the apocryphal Gospel of Thomas, which consists of nothing but such sayings. It is an open question whether or not any of these sayings can be regarded as based on genuine traditions independent of the Christian Gospels.
(R. McQ. G.)

LOGIC is the systematic study of the structure of propositions and of the general conditions of valid inference by a method which abstracts from the content or *matter* of the propositions and deals only with their logical *form.* This distinction between form and matter is made whenever we distinguish between the logical soundness or validity of a piece of reasoning and the truth of the premisses from which it proceeds, and in this sense is familiar in everyday usage. However, a precise statement of the distinction must be made with reference to a particular language or system of notation, a *formalized language,* which shall avoid the inexactnesses and systematically misleading irregularities of structure and expression that are found in ordinary (colloquial or literary) English and in other natural languages, and shall follow or reproduce the logical form—at the expense, where necessary, of brevity and facility of communication. To adopt a particular formalized language is thus to adopt a particular system or theory of logical analysis. And the formal method may then be characterized by saying that it deals with the objective form of *sentences* which express propositions, and provides in these concrete terms criteria of meaningfulness, of valid inference, and of other notions closely associated with these—among which we mention the notions of logical compatibility, analytic or logical truth, probable inference, and degree of confirmation.

The topics of inductive and probable inference, confirmation, and degree of confirmation belong to *inductive logic,* and are treated in the articles INDUCTION and PROBABILITY. In this article we confine attention to the remaining part of logic, or *deductive logic.* And we also omit treatment of *modal logic,* partly because this branch of deductive logic (though its beginnings go back to Aristotle) is still in a much more unsettled state than the remainder. But works on modal logic and modality are included in the bibliography.

FUNDAMENTALS OF MODERN LOGIC

The Propositional Calculus is, in most developments, the most elementary branch of logic, on which the others are based. It deals with the *sentence connectives*: "and," "or," "if," "not," "if and only if," and others of similar character. And in order to analyze and exhibit the logical properties of the connectives it employs also propositional variables $p, q, r, \cdots$, which are to be thought of as variables replaceable by sentences.

In strictness the sentences by which the propositional variables are replaceable should be sentences of some appropriate formalized language (for instance, one of the functional calculi which are described below, or one of the systems of set theory). But for informal expository purposes we may employ also declarative sentences of the English language. Thus, with $\supset$ as notation for "if ... then," the expression $p \supset q$ of propositional calculus may be thought of as having (by substitution for p and q) such instances as the following: "If you are not satisfied, we will refund your money," "If there are any survivors of the disaster, we will be able by prompt action to rescue some," "If Vidkun Quisling was a patriot, then *n*-butyl mercaptan is a perfume."

Of the various systems of notation which are in use, we here adopt a particular one for purposes of exposition. We shall use the sign $\sim$ to denote *negation* ("$\sim p$" to mean "not p"), the sign $\supset$ to denote the *conditional* ("$p \supset q$" to mean "if p then q" or "not both p and not q"), the sign $|$ to denote *non-conjunction* ("$p|q$" to mean "not both p and q"), juxtaposition or a dot to denote *conjunction* ("pq" or "$p \cdot q$" to mean "p and q"), the sign $\equiv$ to denote the *biconditional* ("$p \equiv q$" to mean "p if and only if q"), the sign $\vee$ to denote *inclusive disjunction* ("$p \vee q$" to mean "p or q or both"), the sign $\not\equiv$ to denote *exclusive disjunction* ("$p \not\equiv q$" to mean "p or q but not both").—As the word "or" is ambiguous in ordinary English usage between inclusive disjunction and exclusive disjunction, the two signs $\vee$ and $\not\equiv$ are provided for the two meanings of the word. The signs $\supset$ and $\equiv$ may often conveniently be read as "implies" (or "implies that") and "is equivalent to" respectively; but these readings must be employed with a certain caution not to misunderstand them, since the terms

implication and equivalence in ordinary usage often suggest that there is some relationship between the logical forms of the propositions or the sentences involved, whereas the truth of $p \supset q$ and of $p \equiv q$ (upon substitution of particular sentences for p and q) requires no such relationship. The connective $\supset$ is also said to stand for *material implication*, distinguished from *formal implication* (defined below) and *strict implication* (a notion of modal logic). Similarly, $\equiv$ is said to stand for *material equivalence*.

There are various ways in which some of the sentence connectives named above can be defined in terms of others. If the sign of nonconjunction (*Sheffer's stroke*) is taken as primitive, all the other connectives can be defined from this one. Also, if the signs of negation and inclusive disjunction are taken as primitive, all the others can be defined in terms of these; likewise if the signs of negation and conjunction are taken as primitive. But because of its special role in the rule of *modus ponens* and in the *deduction theorem* (*see* below), we here prefer to include $\supset$ as one of the primitive connectives. Therefore we take $\sim$ and $\supset$ as primitive, and define the remaining connectives as follows:

$$\begin{array}{ll} [A \mid B] \rightarrow [A \supset \sim B] & [A \equiv B] \rightarrow [[A \supset B][B \supset A]] \\ [A B] \rightarrow \sim[A \mid B] & [A \vee B] \rightarrow [\sim A \supset B] \\ [A \cdot B] \rightarrow \sim[A \mid B] & [A \not\equiv B] \rightarrow \sim[A \equiv B] \end{array}$$

Here the bold capital letters stand for arbitrary *well-formed formulas* of the propositional calculus (in the technical sense defined below)—or, when appropriate, for arbitrary well-formed formulas of some more extensive formalized language containing the propositional calculus as a part. And the arrow is to be read "is defined as," or "is an abbreviation for."

To formulate the propositional calculus explicitly, we first list the primitive symbols. These are the two connectives $\sim$ $\supset$, the two brackets [ ], and an infinite list of propositional variables $p, q, r, s, p_1, q_1, r_1, s_1, p_2, \cdots$. Any finite sequence of the primitive symbols is a *formula*. But as some formulas are evidently not meaningful, we define a subclass, the *well-formed formulas*, by the following *formation rules*: i. A propositional variable standing alone is a well-formed formula. ii. If **A** is a well-formed formula, $\sim$**A** is a well-formed formula. iii. If **A** and **B** are well-formed formulas, [**A** $\supset$ **B**] is a well-formed formula.

Hereafter the bold capital letters shall stand for well-formed formulas of the propositional calculus—or later also well-formed formulas of other calculi or formalized languages—and the condition of well-formedness shall be understood without explicit repetition in every case.

In writing well-formed formulas we may abbreviate them by means of the definitions listed above; for instance, $[pq]$ is to be understood as an abbreviation of $\sim[p \supset \sim q]$, and $[p \equiv [p \vee q]]$ is to be understood as an abbreviation of $[[p \supset [\sim p \supset q]][[\sim p \supset q] \supset p]]$, *i.e.*, as an abbreviation of $\sim[[p \supset [\sim p \supset q]] \supset \sim[[\sim p \supset q] \supset p]]$. Also well-formed formulas may be abbreviated by omission of brackets, in accordance with the three following conventions: (1) A bold dot is used to indicate that the scope of an omitted pair of brackets extends from the point where the dot appears, forward to the end of the formula; for example, $p \supset \cdot q \supset \cdot r \supset s$ is an abbreviation of $[p \supset [q \supset [r \supset s]]]$. (2) In restoring omitted brackets, and so far as not otherwise indicated by bold dots, the scope of a pair of brackets belonging to a conditional, a biconditional, or an exclusive disjunction is to be made wider than the scope of a pair of brackets belonging to an inclusive disjunction or a non-conjunction, and the latter in turn wider than the scope of a pair of brackets belonging to a conjunction; for example, $\sim p \vee q \sim r \supset pq \vee rs$ is an abbreviation of $[[\sim p \vee [q \sim r]] \supset [[pq] \vee [rs]]]$, *i.e.*, of $[[\sim\sim p \supset \sim[q \supset \sim\sim r]] \supset [\sim\sim[p \supset \sim q] \supset \sim[r \supset \sim s]]]$. (3) Where neither of the two preceding conventions applies, brackets are restored in accordance with the convention of association to the left; for example, $p \supset [q \supset r] \supset \sim s \supset \cdot p \supset q \supset r$ is an abbreviation of $[[[p \supset [q \supset r]] \supset \sim s] \supset [[p \supset q] \supset r]]$.

It must be understood that these abbreviations are not an actual part of the formalized language—the propositional calculus, or better, the particular formulation of propositional calculus which we are here stating. *E.g.*, the formalized language expresses the inclusive disjunction of p and q by $[\sim p \supset q]$, and it is merely a device for our typographical convenience in writing about the formalized language, serving the purposes of brevity and perspicuity, that we sometimes abbreviate this as $[p \vee q]$, or as $p \vee q$. Especially, the rules of inference stated below are to be applied to the well-formed formulas themselves, and not to their abbreviations. As axioms of the propositional calculus we take the three following:

1. $p \supset q \supset \cdot q \supset r \supset \cdot p \supset r$
2. $\sim p \supset p \supset p$
3. $p \supset \cdot \sim p \supset q$

The assertion of the axioms is of course meant in the sense that they hold for any p, q, and r whatever. These particular axioms are due to Jan Lukasiewicz; they represent only one of many possible choices of axioms from which the same theorems follow by means of the two rules of inference below. Convenient verbal readings of the axioms, in which advantage is taken of the two readings of $\supset$, are as follows: 1. If p implies q, if q implies r, then p implies r. 2. If not-p implies p, then p. 3. p implies that, if not-p, then q.—Axiom 1 expresses the *transitive law of material implication*, and 2, the *law of Clavius*.

The *rules of inference* are the two following: I. *Rule of substitution*. From **A**, if **B** is any well-formed formula and **b** is a propositional variable, to infer the result of substituting **B** for **b** throughout **A**. II. *Rule of modus ponens*. From [**A** $\supset$ **B**], and **A**, to infer **B**.—In an application of I, we call **A** the *premiss*, and the result of the substitution the *conclusion*. In an application of II, [**A** $\supset$ **B**] is the *major premiss*, **A** is the *minor premiss*, and **B** is the *conclusion*.

A *theorem* of the propositional calculus is obtained from the axioms by a succession of applications of the rules of inference. Or more explicitly, a *proof* of a theorem is a finite sequence of well-formed formulas, of which the last one is the theorem in question, and each of which either is an axiom or is inferred from earlier formulas in the sequence by one of the two rules of inference; and a *theorem* is then any well-formed formula of which there is a proof.

For example, a proof may be constructed as follows, of the theorem $p \supset p$ (the *reflexive law of material implication*). Axiom 1 is first taken as premiss for an application of the rule of substitution. The substitution of $\sim p \supset p$ for q gives $p \supset [\sim p \supset p] \supset \cdot \sim p \supset p \supset r \supset \cdot p \supset r$, and from this by substitution of p for r (another application of the rule of substitution) is inferred $p \supset [\sim p \supset p] \supset \cdot \sim p \supset p \supset p \supset \cdot p \supset p$. This last is to be the major premiss in an application of *modus ponens*. Axiom 3 is the source of the minor premiss $p \supset \cdot \sim p \supset p$ (obtained by substituting p for q). Hence by *modus ponens* is inferred $\sim p \supset p \supset p \supset \cdot p \supset p$. Axiom 2 is then taken as minor premiss, and by another application of *modus ponens* is inferred $p \supset p$.

Other theorems are the following, which may be proved in the order named (though the proofs are generally not as easy as the example just given): $p \supset \cdot q \supset p$ (*law of affirmation of the consequent*), $\sim q \supset \sim p \supset \cdot p \supset q$ (*converse law of contraposition*), $\sim p \supset \cdot p \supset q$ (*law of denial of the antecedent*), $p \supset q \supset p \supset p$ (*Peirce's law*), $p \supset [p \supset q] \supset \cdot p \supset q$, $p \supset \cdot p \supset q \supset q$ (*law of assertion*), $p \supset [q \supset r] \supset \cdot q \supset [p \supset r]$ (*law of commutation*), $q \supset r \supset \cdot p \supset q \supset \cdot p \supset r$, $p \supset [q \supset r] \supset \cdot p \supset q \supset \cdot p \supset r$ (*self-distributive law of material implication*), $\sim\sim p \supset p$ (*law of double negation*), $p \supset \sim\sim p$ (*converse law of double negation*), $p \supset q \supset \cdot \sim q \supset \sim p$ (*law of contraposition*), $p \supset q \supset \cdot p \supset \sim q \supset \sim p$ (*law of reductio ad absurdum*), $\sim \cdot p \supset \sim p$ (*law of contradiction*), $p \vee \sim p$ (*law of excluded middle*), $pq \supset r \supset \cdot p \supset \cdot q \supset r$ (*law of exportation*), $p \supset [q \supset r] \supset \cdot pq \supset r$ (*law of importation*), $[p \supset q][p \supset r] \supset \cdot p \supset qr$ (*law of composition*), $\sim[pq] \equiv \sim p \vee \sim q$ and $\sim[p \vee q] \equiv \sim p \sim q$ (*De Morgan's laws*), $[p \supset q] \vee [q \supset p]$.

The last theorem in the foregoing list is sometimes spoken of as one of the "paradoxes" of material implication. It is not a paradox in the sense of an antinomy and is not inconsistent with important uses of $\supset$ as expressing an implication relation. But it shows a divergence of the meaning of $\supset$ from some of the

various meanings of the words "if ... then" in ordinary usage, and especially from their familiar but not very definite meaning in *conditions contrary to fact.* (To illustrate the latter we quote the conditional sentence, "If Vidkun Quisling had been a patriot, then *n*-butyl mercaptan would be a perfume," which must be distinguished from the corresponding sentence with a simple condition, quoted above, and indeed is clearly false.)

We shall speak of a *valid inference of the propositional calculus* not only within the propositional calculus itself but also within a more extensive formalized language containing the propositional calculus as a part. Namely a *substitution instance* of a theorem of the propositional calculus is any well-formed formula (of the more extensive formalized language) which results from a theorem of the propositional calculus by substituting specific well-formed formulas (of the more extensive language) for one or more of the propositional variables. And an inference from hypotheses A_1, A_2, $\cdots$, A_n to a conclusion B is called a valid inference of the propositional calculus if B can be obtained from the hypotheses A_1, A_2, $\cdots$, A_n, together with any number of additional premisses which are either theorems of the propositional calculus or substitution instances of theorems of the propositional calculus, by a succession of applications *of the rule of modus ponens only.*

Within the propositional calculus itself, if the inference from A_1, A_2, $\cdots$, A_n to B is a valid inference of the propositional calculus, it can be shown that $A_1 \supset \cdot A_2 \supset \cdot \cdots A_n \supset B$ must then be a theorem of the propositional calculus. This general result, which is not a theorem *of* the propositional calculus but a theorem *about* the propositional calculus, is known as the *deduction theorem.* We shall see below that it can be extended to other more extensive formalized languages.—It is in the sense that the rule of *modus ponens* and the deduction theorem are both fulfilled that we are able to think of and use $\supset$ as expressing an implication relation (in spite of the so-called paradoxes of material implication).

It is convenient to use such words as "theorem," "proof," "premiss," "conclusion" both for propositions, in whatever language expressed, and for formulas expressing propositions in some fixed formalized language. However, theorems about a particular formalized language are distinguished from theorems of the language by calling the former *metatheorems.* The deduction theorem is, *e.g.*, a metatheorem of the propositional calculus, in contrast with, say, Peirce's law, which is a theorem of the propositional calculus. The metatheorems of a formalized language are said to belong to the *metatheory* of the language; and though we shall here treat the metatheory informally, it may itself be organized as a formalized language, which is then called a *meta-language* of the first language as *object language.* (*See* METATHEORY; SEMANTICS IN LOGIC.)

We go on to explain some additional metatheorems of the propositional calculus.

The two primitive connectives (hence all connectives definable from them) denote *truth-functions: i.e.*, the *truth-value* (truth or falsehood) of $\sim p$ and of $p \supset q$ is uniquely determined by the truth-values of p and q. In fact the truth-value of $\sim p$ is falsehood when the truth-value of p is truth, and truth when the truth-value of p is falsehood. And (corresponding to the four theorems $p \supset \cdot q \supset \cdot p \supset q$, $p \supset \cdot \sim q \supset \sim \cdot p \supset q$, $\sim p \supset \cdot q \supset \cdot p \supset q$, $\sim p \supset \cdot \sim q \supset \cdot p \supset q$) the truth-value of $p \supset q$ is falsehood when the truth-value of p is truth and the truth-value of q is falsehood, and the truth-value of $p \supset q$ is truth in each of the three remaining cases. These determinations of the truth-value of $\sim p$ and of $p \supset q$ in terms of the truth-values of p and q, by using (say) 0 for truth and 1 for falsehood, may conveniently be displayed in the form of tables, which are then called *truth-tables* of negation and material implication.

The truth-tables enable us, given a well-formed formula of the propositional calculus and an assignment of a truth-value to each of its variables, to reckon out by a mechanical process the truth-value of the entire formula. (For example, if the values of p and q are both 1, the value of $p \supset q$ is 0, hence the value of $p \supset q \supset p$ is 1, hence the value of Peirce's law $p \supset q \supset p \supset p$ is 0.) If, for all possible assignments of truth-values to the variables, the calculated truth-value of the entire formula is 0, or truth, the formula is said to be a *tautology.* The test whether a well-formed formula is a tautology is effective, since in any particular case the total number of different assignments of truth-values to the variables is finite, and the calculation of the truth-value of the entire formula can be carried out separately for each assignment of truth-values to the variables.

Now it may be verified that the three axioms, 1–3, given above are tautologies, and that the two rules of inference preserve tautologies in the sense that if the premiss or premisses are tautologies the conclusion must be a tautology. Hence every theorem of the propositional calculus is a tautology. By a more difficult argument it may be shown that every tautology is a theorem. Hence the truth-table test for tautologies (just described) can be used to decide, for any given well-formed formula of the propositional calculus, whether it is a theorem. This is a solution of the *decision problem* of the propositional calculus.

As corollaries of the solution of the decision problem, it follows that the propositional calculus is *consistent* in the sense that A and $\sim$A cannot both be theorems, and *complete* in the sense that if A is not a theorem the addition of A as an extra axiom would result in inconsistency. By a different method it may be shown that the three axioms and the two rules of inference are *independent* in the sense that completeness is lost if any one of them is omitted.

In one sense the solution of the decision problem renders unnecessary the statement of axioms and rules of inference of the propositional calculus. For we might instead merely stipulate that every tautology shall be a theorem. However, this summary procedure provides no analysis of the logical relationships of the theorems among themselves, and no method by which to trace the consequences of a particular law of the propositional calculus or to formulate the situation which results when particular laws are rejected.

An example of the last is provided by the intuitionistic school of mathematics (*see* MATHEMATICS, FOUNDATIONS OF), which rejects the law of excluded middle and some other related laws of negation. To formulate the propositional calculus of mathematical intuitionism we may modify our above formulation as follows. Axiom 2 is replaced by the weaker axiom $p \supset \sim p \supset \sim p$, and there are then added the two further axioms: $p \supset \cdot q \supset p$, $p \supset [p \supset q] \supset \cdot p \supset q$. These axioms suffice for the intuitionistic laws of implication and negation. But as the definitions of conjunction and inclusive disjunction, given above, no longer serve to yield the characteristic properties of these connectives, it is necessary to introduce these two connectives as additional primitives, and to add also the axioms: $pq \supset p$, $pq \supset q$, $p \supset \cdot q \supset pq$, $p \supset p \vee q$, $q \supset p \vee q$, $p \supset r \supset \cdot q \supset r \supset \cdot p \vee q \supset r$. Then finally, after this last addition, the axiom $p \supset \cdot q \supset p$ may be dropped as not independent: in fact we can prove the theorem $p \supset \cdot p \supset \cdot q \supset p$ using only the axioms $p \supset \cdot q \supset pq$, $pq \supset p$, and the transitive law, and then $p \supset \cdot q \supset p$ follows by the axiom $p \supset [p \supset q] \supset \cdot p \supset q$.

Using this formulation of the intuitionistic propositional calculus we can show that not only the law of excluded middle is not a theorem, but also the law of Clavius, the converse law of contraposition, Peirce's law, and the law of double negation fail; but the introduction of any one of these as an added axiom would restore all the others as theorems. The "paradox" $[p \supset q] \vee [q \supset p]$ is still a consequence in the form $\sim[p \supset q] \supset \cdot q \supset p$, but not in the form containing the disjunction sign.

A Logistic System, or Calculus, is the purely formal part of a formalized language, taken in abstraction from any meaning or interpretation.

A logistic system is determined by giving its *vocabulary,* or list of primitive symbols, defining certain finite sequences of the primitive symbols to be *well-formed formulas,* listing certain well-formed formulas as *axioms,* and finally, stating *rules of inference,* by means of which a well-formed formula may on given conditions be *inferred* (as *conclusion*) from a set of one or more well-formed formulas (as *premisses*). A *theorem* of the logistic system is then defined to be a well-formed formula of which there is a *proof, i.e.*, a finite sequence of well-formed formulas each of

which is either an axiom or inferred from earlier formulas in the sequence by one of the rules of inference, the last formula in the sequence being the theorem.

It is usually required that the set of rules of inference shall be *effective*, in the sense that there shall be a definite procedure or test by which, whenever a particular proposed conclusion from given premisses is before us, we can always actually decide whether the proposed inference is correctly made in accordance with one of the rules of inference; further that the set of axioms shall be effective, in the sense that there shall be a test by which, whenever a particular well-formed formula is before us, we can always decide whether it is an axiom (this requirement is satisfied when the axioms are a finite list which has been written out in full, but may also be satisfied in some cases of an infinite set of axioms). For these two requirements it will generally be necessary that the definition of well-formedness shall also be effective, in the sense that there shall be a test by which, whenever a particular formula is before us, we can always decide whether it is well-formed or not.

The reason for these requirements lies in the nature of the notion of a proof—as it is commonly understood, or as it is needed for the purposes of deductive logic (and, as a special case, in connection with mathematical proof). Namely it is a part of the notion of proof that a proof shall carry final conviction of the theorem proved (*i.e.*, of course, for any one who admits the axioms and rules of inference on which the proof is based). But without the requirements of effectiveness, it might happen that some one confronted with a proof of a theorem (and admitting the axioms and rules of inference) might nevertheless continue to doubt the theorem, because of doubt that the alleged proof actually is a proof in accordance with the axioms and rules. In such a case the proposer of the proof might fairly be asked to give a supplementary proof that it is a proof—and for purposes of deductive logic, this supplementary proof ought then to be treated as part of the whole proof, and included with it when the process of proof is formalized by the logistic method.

Though in the light of the requirements just explained, the notion of being a proof, in a particular logistic system, must be effective, it is clear that in general the notion of being a theorem may not be effective. For a well-formed formula is established as a theorem if a proof of it is found, but the failure of a particular investigator to find a proof may not necessarily mean that there is no proof to be found. It may indeed be possible in particular cases, by special methods, to establish as a metatheorem that a certain well-formed formula is not a theorem. But this is not to say that there is a general test by which it is always possible, whenever a well-formed formula is given, to decide effectively whether or not it is a theorem.

Such a general effective test, by which to recognize any arbitrary given well-formed formula of a particular logistic system as being or not being a theorem, is called a *decision procedure* for the particular system. And the problem to find a decision procedure for a logistic system is called the *decision problem* of the system. As a particular example, we have seen (above) a solution of the decision problem of the full propositional calculus—or, as this particular logistic system is often called because of the character of the decision procedure, the two-valued propositional calculus. There exist also decision procedures for the intuitionistic propositional calculus, but none of them is as simple as that for the two-valued calculus. On the other hand there are logistic systems for which there is no solution of the decision problem, not merely in the sense that none has been found, but in the sense that it has been established as a metatheorem that none can exist; examples of such systems (which will be discussed below) are the pure functional calculus of first order and of all higher orders—but the singulary functional calculi of first and second orders (obtained from the corresponding pure functional calculi by omitting all functional variables which are more than singulary) do have decision procedures.

As already indicated, the two-valued propositional calculus, the intuitionistic propositional calculus, and other systems to be introduced below may be considered as examples of logistic systems. Each is namely a logistic system if regarded as determined by its vocabulary, its *formation rules* (defining the well-formed formulas of the particular system), its axioms, and its rules of inference, in abstraction from any meaning or interpretation. The logistic system becomes a formalized language if suitable meanings are given to its well-formed formulas, as is done informally in this article, and as may be done more accurately by providing definitions of *truth* and of *satisfaction* in the manner outlined in the article SEMANTICS IN LOGIC—or if *sense* as well as *denotation* is to be provided for (*see* the same article), then by *rules of sense*, which are similar in character to the rules that compose the step-by-step definition of satisfaction, but which deal directly with the sense.

In general, if a logistic system has any sound interpretation, *i.e.*, any non-trivial way of giving meanings to its well-formed formulas in conformity with the formation rules, axioms, and rules of inference, it will have many such. Thus the same logistic system is common to many different formalized languages, and the results (theorems and metatheorems) for the logistic system hold equally for all the formalized languages, with appropriate changes of interpretation.—The point may be illustrated by the case of the pure functional calculus of first order (which is treated below), each different domain of individuals providing a different sound interpretation and hence a different formalized language.

The method which makes use of a formalized language, based upon a logistic system with explicitly stated formation rules, axioms, and rules of inference, is known as the *logistic method*. For the treatment of logic by this method, and especially to distinguish it from the less fully formal method of the older logic, the names *symbolic logic, mathematical logic, theoretical logic, logistic* have variously been used.

The Functional Calculus of First Order has, besides the notations of the propositional calculus (propositional variables and sentence connectives), also notations for *propositional functions* and the *quantifiers*.

To explain these new notations and their meanings we return to the notion of a *sentence*, which we have already employed in explaining the use of propositional variables.

A *propositional form* is an expression which is like a sentence except that it contains a number of *variables*, of any kinds, at places at which a corresponding sentence must contain fixed names or terms (*constants*)—the difference being that a sentence may be said simply to be true, or false, but a propositional form must rather be said to be true, or to be false, *for* some *system of values* of its variables. To turn to elementary mathematics for examples, "$49 + 36 = 85$" and "$59 + 36 = 85$" are sentences, the first one true and the second one false. But "$x + 36 = 85$" is a singulary propositional form, the adjective *singulary* indicating that there is one variable of which values are to be considered. It may not be said to be true, or to be false, but rather it is true for the value 49 of x, and false for the value 59 of x; or in a different terminology (*see* SEMANTICS IN LOGIC), "$x + 36 = 85$" is *satisfied* by the value 49 of x, and by no other value of x. Similarly "$x^2 + y^2 = 85$" is a binary propositional form, which is true for (satisfied by) the pair of values 7, 6 of x, y; also true for the values 6, 7 of x, y; also true for the values 2, 9 of x, y; but false for the values 5, 8 of x, y. Even "$x + y - x = y$"—being a binary propositional form rather than a sentence—must not be said just to be true, but to be true *for* all values of x, y.

In the foregoing examples the variables are numerical variables, *i.e.*, variables whose values are numbers. As examples of propositional forms containing variables of other kinds we may cite the quaternary form, "The distance from P to Q is less than the distance from R to S," in which the values of the variables P, Q, R, S are points; and the singulary form, "If x is a man, then x is mortal," in which the values of x are, say, concrete material things.

As an extreme case, and as a matter of terminological convenience, it is usual to consider a sentence as being a kind of propositional form, namely a propositional form in which the number of variables is 0 (or more correctly, as we shall see below,

in which the number of free variables is 0).

As *universal quantifier* we shall use the notation consisting of a variable between parentheses; *e.g.*, if the variable is x, the notation is (x). The meaning is roughly indicated by saying that the universal quantifier corresponds to such English words as "all," "every"; or better indicated by saying that if a universal quantifier with some particular variable, say x, is prefixed to a singulary propositional form whose variable is x, the resulting expression is a sentence, which is a true sentence if and only if the propositional form is true for all values of x. For example, "(x) [if x is a man, then x is mortal]" is a sentence (of a certain ill-defined language which we here use for temporary illustrative purposes only, a half-formalized version of English); and in fact, on the best available evidence, it is a true sentence. Again, "(x) $[x + 36 = 85]$" is a false sentence. However, a universal quantifier may be prefixed also, with analogous meaning, to a propositional form which is more than singulary—or even, as a quite special but nevertheless allowable case, to a sentence. For example, "(y) $[x^2 + y^2 = 85]$" is a singulary propositional form; and since, as it happens, this singulary form is false for all values of x, the sentence "$(x)\sim(y)[x^2 + y^2 = 85]$" is true. Again "$(y)$ $[x + y - x = y]$" is a singulary propositional form, true for all values of x; and hence "$(x)(y)[x + y - x = y]$" is a true sentence. And again "$(x)[49 + 36 = 85]$" is a true sentence, because "$49 + 36 = 85$" is a true sentence.

As *existential quantifier* we shall use the sign $\exists$ followed by a variable, with parentheses enclosing both. The meaning corresponds roughly to that of the English word "some" (in the sense "at least one") or of the phrase "there is a." And if an existential quantifier with, say, the variable x is prefixed to a singulary propositional form whose variable is x, the resulting expression is a sentence, which is true if and only if the propositional form is true for at least one value of x. The usage is otherwise similar to that of the universal quantifier, as a few examples will suffice to illustrate. If the meaning of the numerical variables x, y is such that they include the negative as well as the positive numbers among their values, "$(\exists y)[x + y = 85]$" is a singulary propositional form which is true for all values of x, and therefore "$(x)(\exists y)[x + y = 85]$" is a true sentence. Also "$(\exists x)(\exists y)[x + y = 85]$" is true. But "$(\exists y)(x)[x + y = 85]$" is a false sentence, as there is no one number y such that $x + y$ is always 85 for every number x. On the other hand, "$(\exists y)(x)[x \times y = 0]$" is true, as there is one number y, namely 0, such that $x \times y$ is always 0.

When a quantifier with a particular variable is prefixed to a propositional form, all occurrences of that variable in the resulting expression, including the occurrence of the variable in the quantifier itself, are said to be *bound* occurrences of the variable. Other occurrences of a variable, not bound, are called *free* occurrences. It is not excluded that a propositional form may contain both bound and free occurrences of the same variable; in fact, if **A** is a propositional form containing free occurrences of a certain variable, and **B** contains bound occurrences of that variable, then $[\mathbf{A} \supset \mathbf{B}]$ and $[\mathbf{B} \supset \mathbf{A}]$ each contain both bound and free occurrences of the variable. The variables which have bound occurrences in a given propositional form are called the *bound variables* of the form, and those which have free occurrences in it are called its *free variables*.

Having these last definitions, we must now go back and make the following amendment to our first account of propositional forms as it was given above. The variables of which values are to be considered in a propositional form are only the free variables of the form. And the form is said to be true or to be false for some system of values of its free variables (or in the other terminology, to be satisfied or not satisfied by a system of values of its free variables). A propositional form is *singulary* if it has just one free variable, *binary* if it has just two different free variables, and so on, regardless of the number of bound variables. A sentence has no free variables; but it may have any number of bound variables, since the presence of bound variables does not prevent the sentence from expressing a particular proposition (making a particular statement or assertion).

For purposes of introductory exposition, we may describe a *propositional function* as obtained by abstraction from a propositional form. A binary propositional form, for instance, determines an association of a truth-value with each system—*i.e.*, each pair—of values of its free variables, since for each such pair of values the propositional form is either true or false. And if this scheme of association of truth-values with pairs of things is taken as an abstract correspondence, independent of its expression in any particular language or of any particular notation for it, we have a binary propositional function. If, say, F is a binary propositional function thus obtained from a binary propositional form, and a, b is a pair of things of appropriate kind, we use the notation $F(a, b)$ to express that truth is associated with the pair a, b in the abstract correspondence; hence we have that $F(a, b)$ if and only if the propositional form is true for the system of values a, b of its free variables.

Similarly, if F is a singulary propositional function obtained by abstraction from a singulary propositional form, we have that $F(a)$—or, as we shall say in words, that F *holds of* the *argument* a—if and only if the propositional form is true for the value a of its free variable. And generally, if F is an n-ary propositional function obtained by abstraction from an n-ary propositional form, we have that $F(a_1, a_2, \cdots, a_n)$—or in words, that F *holds among* the *arguments* $a_1, a_2, \cdots, a_n$—if and only if the propositional form is true for the system of values $a_1, a_2, \cdots, a_n$ of its free variables.

A propositional function obtained by abstraction from a propositional form must not be identified with the latter, since in fact different propositional forms may well sometimes determine the same scheme of association of truth-values with ordered sets of n arguments, that is, the same propositional function. A propositional form must also not be used as a name of the corresponding propositional function, since the propositional function is a fixed particular thing, of which no expression containing free variables may serve as name; but the propositional form with an abstraction operator prefixed (*see* ABSTRACT AND ABSTRACTION) is rather to be used as a name of the propositional function, where the abstraction operator, like the quantifiers, has the effect of changing free variables to bound variables. For example, if **A** is a singulary propositional form with free variable x, then $\hat{x}\mathbf{A}$ or $\lambda x\mathbf{A}$ (we shall here use the latter) is a name of the singulary propositional function obtained from **A** by abstraction.

Moreover, propositional functions must not be limited to those obtained or obtainable from propositional forms by abstraction, especially if only propositional forms belonging to one particular (formalized or other) language are considered. But abstractly, any scheme of the sort described (*i.e.*, by which truth-values are made to correspond to ordered sets of n arguments) is a propositional function, however it may have come to be known, or even if the particular propositional function never comes to be known.

It should be added that the term "propositional function" is used with various meanings and shades of meaning by different writers, the terminology being not yet fixed. Sometimes "propositional function" is used to mean what we here call a propositional form, or in a way that involves confusion between this and one of the more abstract meanings.

But as the term has just been explained, and as it will be used in this article, a singulary propositional function may be identified with a class or set, and a binary propositional function may be identified with a (binary) relation. Thus the notation "$F(a)$" may be read not only as "F holds of the argument a" but also as "a belongs to the class F"; and "$F(a, b)$" may be read as "the relation F holds between a and b" or "a bears the relation F to b."

In the functional calculus of first order, the arguments of the propositional functions considered are taken as belonging to a fixed domain, the domain of *individuals*. Any well-defined class of things may be chosen as the domain of individuals, subject to the one restriction that it shall not be empty, *i.e.*, that there shall be some individuals. (And we shall here use the term *domain of individuals* to mean a domain that is not empty.) But a definite domain of individuals must be fixed upon in order to have an in-

terpretation of the calculus and thus a particular formalized language.

Individual constants are symbols used as names of particular individuals. *Individual variables* are variables which have individuals as values, and which are therefore under appropriate circumstances replaceable by individual constants, in the same sense in which propositional variables (*see* above) are replaceable by sentences. Likewise, *n-ary functional constants* (or *n-ary predicates*, as they are also called) are symbols used to denote particular n-ary propositional functions. And *n-ary functional variab'es* are variables which have n-ary propositional functions as values, and which are therefore under appropriate circumstances replaceable by n-ary functional constants.

In our present formulation of functional calculus of first order we shall use as individual variables the letters x, y, z, t, u, v, w, x_1, y_1, z_1, t_1, u_1, v_1, w_1, x_2, $\cdots$; we shall use as propositional variables the same which were used in the propositional calculus; as singulary functional variables, F^1, G^1, H^1, F^1_1, G^1_1, H^1_1, F^1_2, $\cdots$; as binary functional variables F^2, G^2, H^2, F^2_1, $\cdots$; and so on for ternary functional variables, quaternary functional variables, $\cdots$. The superscripts 1, 2, 3, $\cdots$ upon the functional variables, distinguishing them as singulary, binary, ternary, $\cdots$, are necessary in principle, especially in connection with the semantics of the language, in order to avoid using the very same symbol with two or more different meanings. But in practice, and as an abbreviation, the superscript may usually be omitted as being uniquely determined by the context.

The *alphabetic order* of the individual variables is the order in which they were just listed, *i.e.*, x, y, z, t, u, and so on. Likewise in the case of the functional variables of each kind, the *alphabetic order* is that in which they were just listed.

The name *functional calculus of first order* is applied to any one of many (different but closely related) logistic systems, which differ only in regard to the list of primitive symbols. All of these systems include as primitive symbols a sufficient list of sentence connectives and quantifiers, and also the notation which was explained above (consisting of parentheses and commas) for the holding of a propositional function, among certain arguments or of a certain argument. The individual variables are, further, always among the primitive symbols. And the remaining primitive symbols must belong to one of the categories of propositional variables, functional variables, individual constants, or functional constants.

The *pure functional calculus of first order* has all the propositional variables and functional variables as primitive symbols, and no individual constants or functional constants. An *applied* functional calculus of first order contains individual constants or functional constants or both, among its primitive symbols. A *simple applied* functional calculus of first order is an applied functional calculus of first order in which there are no propositional or functional variables among the primitive symbols.

As primitive connectives and quantifiers for functional calculus of first order we shall here use the signs of negation and material implication, and the universal quantifier. However, as in the case of the propositional calculus, other choices are possible. (And in fact the article SEMANTICS IN LOGIC makes use of negation, inclusive disjunction, and universal quantification as primitive.)

The well-formed formulas are defined by formation rules, which we here state in such a form that they can be used equally for any of the different functional calculi of first order: $\mathfrak{i}_0$. A propositional variable standing alone is a well-formed formula. $\mathfrak{i}_1$. If $\mathbf{f}$ is a singulary functional variable or a singulary functional constant, and $\mathbf{x}$ is an individual variable or an individual constant, then $\mathbf{f}(\mathbf{x})$ is a well-formed formula. $\mathfrak{i}_n$. If $\mathbf{f}$ is an n-ary functional variable or an n-ary functional constant, and $\mathbf{x}_1$, $\mathbf{x}_2$, $\cdots$, $\mathbf{x}_n$ are individual variables or individual constants or both, not necessarily all different, then $\mathbf{f}(\mathbf{x}_1, \mathbf{x}_2, \cdots, \mathbf{x}_n)$ is a well-formed formula. ii. If $\mathbf{A}$ is a well-formed formula, $\sim\mathbf{A}$ is a well-formed formula. iii. If $\mathbf{A}$ and $\mathbf{B}$ are well-formed formulas, $[\mathbf{A} \supset \mathbf{B}]$ is a well-formed formula. iv. If $\mathbf{A}$ is a well-formed formula, and $\mathbf{x}$ is an individual variable, then $(\mathbf{x})\mathbf{A}$ is a well-formed formula.

Every well-formed formula in a functional calculus of first order is a propositional form or a sentence, as in the case of the propositional calculus and other formalized languages which we shall consider in this article. However, there are many important cases (not here treated) in which the well-formed formulas include formulas that are not propositional forms or sentences but, *e.g.*, names of propositional functions, or of numbers, or of concrete material things. And indeed it would not be unnatural, in the case of the functional calculi of first order, to take the individual constants, individual variables, functional constants, and functional variables to be well-formed formulas when they stand alone—although the standard convention, in this particular case, is rather that which is given by the formation rules above.

In abbreviating well-formed formulas of functional calculus of first order, we omit superscripts upon functional variables (as already described), we use the same conventions regarding omission of brackets which were explained above in connection with the propositional calculus, we use the same definitions (of $[\mathbf{A}|\mathbf{B}]$ etc.), also the definition of the existential quantifier,

$$(\exists \mathbf{x})\mathbf{A} \rightarrow \sim(\mathbf{x})\sim\mathbf{A},$$

where $\mathbf{x}$ is an individual variable, also further the following definitions:

$$\begin{array}{l}
[\mathbf{A} \supset_{\mathbf{x}} \mathbf{B}] \rightarrow (\mathbf{x})[\mathbf{A} \supset \mathbf{B}] \\
[\mathbf{A} \equiv_{\mathbf{x}} \mathbf{B}] \rightarrow (\mathbf{x})[\mathbf{A} \equiv \mathbf{B}] \\
[\mathbf{A} \wedge_{\mathbf{x}} \mathbf{B}] \rightarrow (\exists \mathbf{x})[\mathbf{AB}] \\
[\mathbf{A} \supset_{\mathbf{xy}} \mathbf{B}] \rightarrow (\mathbf{x})(\mathbf{y})[\mathbf{A} \supset \mathbf{B}] \\
[\mathbf{A} \equiv_{\mathbf{xy}} \mathbf{B}] \rightarrow (\mathbf{x})(\mathbf{y})[\mathbf{A} \equiv \mathbf{B}] \\
[\mathbf{A} \wedge_{\mathbf{xy}} \mathbf{B}] \rightarrow (\exists \mathbf{x})(\exists \mathbf{y})[\mathbf{AB}]
\end{array}$$

and likewise with three or more subscripts $\mathbf{x}$, $\mathbf{y}$, $\mathbf{z}$, etc., where the subscripts $\mathbf{x}$, $\mathbf{y}$, $\mathbf{z}$, ... must be individual variables and all different in each case.

The relation between propositional functions that is expressed, in accordance with the above definitions, by the sign $\supset$ followed by one or more individual variables as subscripts is called *formal implication* (the standard term, though the adjective "formal" has here a rather different meaning from that which we have given to it elsewhere). For example, in the case of singulary propositional functions, $F(x) \supset_x G(x)$ (*i.e.*, the well-formed formula which is thus abbreviated) is said to express that F formally implies G, or in different words, that $F(x)$ formally implies $G(x)$ with respect to x; and in the case of binary propositional functions, $F(x, y) \supset_{xy} G(x, y)$ expresses that F formally implies G, or that $F(x, y)$ formally implies $G(x, y)$ with respect to x and y.—In similar fashion the sign $\equiv$ followed by individual variables as subscripts is said to express the relation of *formal equivalence* between propositional functions.

Now by including rules of substitution among the rules of inference, it is possible to make a formulation of the pure functional calculus of first order in which the number of axioms is finite. But because of rather complicated explanations which would be necessary in connection with one of the substitution rules in particular (that for functional variables) we here employ a formulation without rules of substitution and with an infinite number of axioms. The infinite set of axioms is then given by means of five *axiom schemata*, which we shall state. And this procedure has the further advantage that the same five axiom schemata (though not the same infinite set of axioms) are sufficient for any one of the other first-order functional calculi, as well as for the pure calculus.

The first three of the axiom schemata are as follows:

1. $\mathbf{A} \supset \mathbf{B} \supset . \mathbf{B} \supset \mathbf{C} \supset . \mathbf{A} \supset \mathbf{C}$
2. $\sim\mathbf{A} \supset \mathbf{A} \supset \mathbf{A}$
3. $\mathbf{A} \supset . \sim\mathbf{A} \supset \mathbf{B}$

The first axiom schema means, *e.g.*, that if $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$ are any well-formed formulas of the first-order functional calculus under consideration (possibly all three different, or possibly some of them the same), then $\mathbf{A} \supset \mathbf{B} \supset . \mathbf{B} \supset \mathbf{C} \supset . \mathbf{A} \supset \mathbf{C}$ is an axiom. In the case of the pure first-order functional calculus, two of the axioms which are instances of the first axiom schema are, for instance, $p \supset q \supset . q \supset r \supset . p \supset r$ and $\sim q \supset [F(x) \supset G(x)] \supset . F(x) \supset G(x) \supset (x)H(x, y) \supset . \sim q \supset (x)H(x, y)$.

The fourth axiom schema is the following:

4. $\mathbf{A} \supset_{\mathbf{x}} \mathbf{B} \supset \cdot \mathbf{A} \supset (\mathbf{x})\mathbf{B}$, provided that **x** is an individual variable which is not a free variable of **A**.

In order to state the fifth axiom schema, it is necessary first to explain another metatheoretic notation. In using bold capital letters to stand for well-formed formulas, we shall sometimes add after the letter an indication of one of the free variables it may contain, providing by this device a convenient notation for the process of substituting one free variable for another. For example, if we use $\mathbf{A}x$ to stand for a well-formed formula which has or may have x as a free variable, then $\mathbf{A}y$ shall stand for the well-formed formula obtained from $\mathbf{A}x$ by substituting y for all free occurrences of x in $\mathbf{A}x$—provided, however, that if any of the free occurrences of x in $\mathbf{A}x$ are in a well-formed part of $\mathbf{A}x$ of the form $(y)\mathbf{C}$, then $\mathbf{A}y$ shall be obtained from $\mathbf{A}x$ by first substituting z for all bound occurrences of y in $\mathbf{A}x$ and then substituting y for all free occurrences of x in $\mathbf{A}x$, z being the first individual variable in alphabetic order that does not occur in $\mathbf{A}x$. In the special case that $\mathbf{A}x$ does not actually contain x as a free variable, $\mathbf{A}y$ is the same as $\mathbf{A}x$. And the same notation may be used also for substitution of a constant for a free variable, so that, *e.g.*, if **a** is any individual constant, $\mathbf{A}\mathbf{a}$ stands for the result of substituting **a** for all free occurrences of x in $\mathbf{A}x$.

Employing this notation, we state the fifth axiom schema:

5. $(\mathbf{x})\mathbf{A}x \supset \mathbf{A}y$, where **x** is an individual variable, $\mathbf{A}x$ is a well-formed formula which may have **x** as a free variable, and **y** is an individual variable or an individual constant.

To use the case of the pure functional calculus of first order for illustration, following are some examples of instances of axiom schema 5, which are therefore axioms:

$$(x)F(x) \supset F(y)$$
$$(y)F(y) \supset F(y)$$
$$(y)F(x, y) \supset F(x, x)$$
$$(x)(y)F(x, y) \supset (z)F(y, z)$$
$$(z)[F(z) \supset G(z)] \supset \cdot F(x) \supset G(x)$$
$$(z)[F(x) \supset G(x)] \supset \cdot F(x) \supset G(x)$$

To complete the formulation of first-order functional calculus as a logistic system (whether the pure first-order functional calculus or one of the others), it remains only to state the rules of inference. These are the two following: II. *Rule of modus ponens.* From $\mathbf{A} \supset \mathbf{B}$ and **A**, to infer **B**. III. *Rule of generalization.* From **A**, if **x** is any individual variable, to infer $(\mathbf{x})\mathbf{A}$.

In an application of the rule of generalization, the variable **x** is said to be *generalized upon*.

Where $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_n, \mathbf{B}$ are well-formed formulas of one of the functional calculi of first order, we say that the inference from the hypotheses $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_n$ to the conclusion **B** is a *valid inference of first-order functional calculus* if **B** can be obtained from the hypotheses $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_n$, together with the axioms of the particular functional calculus of first order, by a succession of applications of the two rules of inference, *modus ponens* and generalization, subject to the restriction that no variable shall be generalized upon which is a free variable of any of the hypotheses $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_n$. (The distinction which is made here between "hypotheses" and "premisses" may be ignored only if the hypotheses are without free variables.)

For example, from the single hypothesis $F(x)$ there is a valid inference to the conclusion $(y) \cdot \sim F(x) \supset F(y)$, namely by taking as major premiss the axiom $F(x) \supset \cdot \sim F(x) \supset F(y)$, which is an instance of axiom schema 3, and applying *modus ponens*, and then generalizing upon y. On the other hand there is no valid inference from the hypothesis $F(x)$ to the conclusion $(x)F(x)$, and indeed it is informally evident that the definition ought not to allow this as a valid inference—*i.e.*, from the hypothesis that a particular individual x belongs to the class F, it does not in general follow that all individuals belong to the class F.

There is not space to treat in detail particular theorems and valid inferences of first-order functional calculus. But some of the simplest of the latter will be mentioned below in the discussion of traditional logic. And we list here the following important metatheorems (omitting their proofs, with one exception):

The Deduction Theorem.—If there is a valid inference (of first-order functional calculus) from the hypotheses $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_n$ to the conclusion **B**, there is a valid inference also from the hypotheses $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_{n-1}$ to the conclusion $\mathbf{A}_n \supset \mathbf{B}$. Hence if there is a valid inference from the hypotheses $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_n$ to the conclusion **B**, then $\mathbf{A}_1 \supset \cdot \mathbf{A}_2 \supset \cdot \cdots \mathbf{A}_n \supset \mathbf{B}$ is a theorem. And, as a special case, if there is a valid inference from the single hypothesis **A** to the conclusion **B**, then $\mathbf{A} \supset \mathbf{B}$ is a theorem.

Tautologies.—Every *tautologous* well-formed formula is a theorem, *i.e.*, every well-formed formula which is a tautology of the propositional calculus or is obtained from such a tautology by substitutions for the propositional variables.

Substitutivity of Equivalence.—If $\mathbf{M} \equiv \mathbf{N}$ is a theorem, if **A** is a theorem, and if **B** is obtained from **A** by replacing **M** by **N** at one or more places (not necessarily at all occurrences of **M** in **A**), then **B** is a theorem.

Reduction to Prenex Normal Form.—There is an effective procedure by which, given a well-formed formula **A** of a first-order functional calculus, there may be found a well-formed formula **B** of the same first-order functional calculus, such that $\mathbf{A} \equiv \mathbf{B}$ is a theorem, and **B** is in *prenex normal form*—*i.e.*, **B** consists of a quantifier-free well-formed part, called the *matrix*, and of a preceding part which is called the *prefix* and which consists of a number of universal and existential quantifiers prefixed to the matrix, subject to the condition that the variables occurring in the quantifiers in the prefix shall be all different and shall all occur also in the matrix. (As special cases, the quantifiers constituting the prefix may be all universal, or they may be all existential, or the prefix may even be null so that **B** consists entirely of the quantifier-free matrix.)

Consistency.—**A** and $\sim\mathbf{A}$ cannot both be theorems of a first-order functional calculus. The proof of this is by considering, for any well-formed formula of first-order functional calculus, a corresponding well-formed formula of the propositional calculus which is obtained as follows. From the given formula of first-order functional calculus, first delete (universal) quantifiers, so as to obtain a quantifier-free formula, then replace every propositional variable and every well-formed part of the form $\mathbf{f}(\mathbf{x})$ or $\mathbf{f}(\mathbf{x}_1, \mathbf{x}_2, \cdots, \mathbf{x}_n)$—*cf.* the formation rules i_0, i_1, i_n—each by the propositional variable p. (For example, if the given formula is $(x)(y)F(x, y, z) \supset \cdot p \supset q \supset (\exists z)G(z)$, the deletion of quantifiers yields $F(x, y, z) \supset \cdot p \supset q \supset \sim\sim G(z)$, and hence the corresponding formula of the propositional calculus is $p \supset \cdot p \supset p \supset \sim\sim p$.) As the reader may verify, every axiom of first-order functional calculus has the property that the corresponding formula of the propositional calculus is a tautology; moreover, the rules of inference preserve this property, *i.e.*, if in an application of one of the rules of inference the premiss or premisses have this property, the conclusion must have it also; hence every theorem has this property. But **A** and $\sim\mathbf{A}$ cannot both have this property (indeed, of the two corresponding formulas of the propositional calculus, the second one is obtained from the first by prefixing the sign $\sim$, so that not both can be tautologies). Hence not both **A** and $\sim\mathbf{A}$ can be theorems.

The Metatheory of the Pure Functional Calculus of First Order contains many results of greater depth than the elementary fundamentals which have been discussed above. Only a few of these will be briefly indicated here.

A well-formed formula is said to be *satisfiable in* a particular non-empty domain if, when that domain is taken as the domain of individuals, the formula is satisfied by at least one system of values of its free variables which has individuals (of the domain in question) as values of the individual variables, n-ary propositional functions as values of the n-ary functional variables, and truth-values as values of the propositional variables. Similarly a well-formed formula is said to be *valid in* a particular non-empty domain if, when that domain is taken as the domain of individuals, the formula is satisfied by every such system of values of its free variables. A well-formed formula is said to be *satisfiable* if it is satisfiable in some non-empty domain, *valid* if it is valid in every non-empty domain. Evidently, **A** is satisfiable in a particular domain if and only if $\sim\mathbf{A}$ is not valid in that domain, and **A** is satisfiable if and only if $\sim\mathbf{A}$ is not valid.

The validity of a well-formed formula in a domain of individuals depends only on the number of individuals in the domain. And in fact well-formed formulas (*i.e.*, of the pure functional calculus of first order) can be classified as follows: there are those which are valid in no domain of individuals; for every positive integer n, there are those which are valid in domains of not more than n individuals but not valid in larger domains; there are well-formed formulas which are valid in every finite domain of individuals but not valid in an infinite domain; and there are the valid well-formed formulas. It can be shown that every well-formed formula belongs to one of these classes.—As examples we cite $(\exists x)(y) \cdot [F(x, y) \supset F(y, x)] \vee [F(x, x) \equiv F(y, y)]$, valid in domains of not more than three individuals, but not in larger domains, and $(\exists x)(y)(\exists z) \cdot F(z, x) \supset F(z, y) \supset \cdot F(x, y) \supset F(x, x)$, valid in all finite domains of individuals, but not in infinite domains.

The above statement includes the following theorem of Leopold Loewenheim: If a well-formed formula is valid in the domain of positive integers (*i.e.*, when the positive integers 1, 2, 3, $\cdots$ are taken as the individuals), it is valid. As a corollary, or as another form of the metatheorem, if a well-formed formula is satisfiable, it is satisfiable in the domain of positive integers.

It can be shown that every theorem of the pure functional calculus of first order is valid (since the axioms are valid and the rules of inference preserve validity). The converse of this is the completeness (meta)theorem of Kurt Goedel: Every valid well-formed formula is a theorem.

A class of well-formed formulas (finite or infinite in number) is said to be *consistent* if it does not contain formulas $\mathbf{A}_1$, $\mathbf{A}_2$, $\cdots$, $\mathbf{A}_n$ from which as hypotheses there is a valid inference to a conclusion $\mathbf{B}$ and also to $\sim\mathbf{B}$. A class of well-formed formulas is said to be *simultaneously satisfiable in* a particular non-empty domain if, when that domain is taken as the domain of individuals, the formulas are simultaneously satisfied by at least one system of values of the free variables. And a class of well-formed formulas is said to be *simultaneously satisfiable* if it is simultaneously satisfiable in some non-empty domain.

According to an extension of Loewenheim's theorem by Thoralf Skolem, if a class of well-formed formulas is simultaneously satisfiable, it is simultaneously satisfiable in the domain of positive integers. And according to a closely related metatheorem due to Goedel, if a class of well-formed formulas is consistent, it is simultaneously satisfiable.

TRADITIONAL LOGIC

The name *traditional logic* is given to that part of the ancient and medieval logic which survived the decline of scholasticism and long remained with little change as a traditionally important part of philosophy. Though historically an independent doctrine, with a viewpoint and method that differ from the logistic method explained above, it can be exhibited as a part of modern logic, and this is the course which we shall follow here. In doing this it is necessary to make certain changes (as noted below), of which some remove uncertainties or correct confusions of the traditional doctrine, and others, though not required from the point of view of traditional logic itself, are desirable in order to incorporate it into the body of modern logic and to give it its proper place in relation to the remainder.

Categorical Propositions are propositions of the traditional subject-predicate form, having a subject S and a predicate P. The four forms—All S is P, No S is P, Some S is P, Some S is not P—are traditionally designated by the letters A, E, I, O respectively. Examples are: All men are mortal (A), All men die (A), No man can serve two masters (E), Some prime numbers are odd (I), A large island is in the bay (I), All that glitters is not gold (O). Propositions of the forms A and I are called *affirmative*; E and O, *negative*; A and E, *universal*; I and O, *particular*.

The subject and predicate of a categorical proposition are together called the *terms* of the proposition. Thus in the third example above, the terms are the subject, man, and the predicate, able to serve two masters.

In writing categorical propositions in logistic form we shall use functional constants $\mathbf{s}$ and $\mathbf{p}$ to stand for the subject and predicate, so that the four forms appear as follows: $\mathbf{s}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

This manner of representing the categorical propositions is not faithful in all particulars to the traditional account. But among various possibilities it seems to be on the whole the best, and we shall employ it here, noting the four following points of divergence:

1. We have defined the notations $\supset_x$ and $\wedge_x$ in terms of the universal quantifier and the two primitive connectives $\sim$ and $\supset$, whereas the traditional account might be thought to be more closely reproduced if $\supset_x$ and $\wedge_x$ were primitive notations.

2. The traditional account associates the negation in E and O with the *copula*, that is, with the words "is" or "is not" that join the subject and predicate, whereas here we prefix the sign $\sim$ to the subformula $\mathbf{p}(x)$.—In regard to 1 and 2 it would be possible to reproduce the traditional account more closely by using four primitive notations A_x, E_x, I_x, O_x, where $[\mathbf{s}(x)\ A_x\ \mathbf{p}(x)]$, $[\mathbf{s}(x)\ E_x\ \mathbf{p}(x)]$, $[\mathbf{s}(x)\ I_x\ \mathbf{p}(x)]$, $[\mathbf{s}(x)\ O_x\ \mathbf{p}(x)]$ are to have the meanings of $\mathbf{s}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$ respectively (and the usual quantifiers and sentence connectives could then be defined in terms of these). But it seems preferable not to complicate the formulation of first-order functional calculus in this way.

3. The traditional account includes also, under A and E, propositions expressed in the forms $\mathbf{p}(\mathbf{a})$ and $\sim\mathbf{p}(\mathbf{a})$ respectively, where $\mathbf{a}$ is an individual constant. For example, "Socrates is mortal" is considered as expressing an A proposition, and "Socrates is not mortal," an E proposition, the subject being the *singular term*, Socrates. These *singular propositions*, as they are called, will be ignored in our account of opposition and immediate inference, but will appear in connection with the categorical syllogism as giving special forms (called *singular forms*) of certain syllogisms.

4. Some aspects of the traditional account require that A and E be represented as we have here, others that they be represented by the conjunctions $(\exists x)\mathbf{s}(x) \cdot \mathbf{s}(x) \supset_x \mathbf{p}(x)$ and $(\exists x)\mathbf{s}(x) \cdot \mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$ respectively. The problem of choosing between these two interpretations (or finding a satisfactory third alternative) is known as the problem of *existential import* of categorical propositions. In our account below we shall meet the difficulty by introducing $(\exists x)\mathbf{s}(x)$ as a separate premiss at those places where it is required.

Opposition, Immediate Inference.—According to the *square of opposition*, if the subject and predicate are fixed, A and O (*i.e.*, $\mathbf{s}(x) \supset_x \mathbf{p}(x)$ and $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$) are *contradictory*, E and I are *contradictory*, A and E are *contrary*, I and O are *subcontrary*, A and I are *subaltern*, E and O are *subaltern*. The two propositions of a contradictory pair cannot be both true and cannot be both false. Under the premiss $(\exists x)\mathbf{s}(x)$, the contrary pair, A, E, cannot be both true, the subcontrary pair, I, O, cannot be both false, and each of the propositions A and E has its subaltern proposition as a consequence.

Simple conversion of a categorical proposition consists in interchanging the subject and predicate. Thus the converses of $\mathbf{s}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$, and $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$ are respectively $\mathbf{p}(x) \supset_x \mathbf{s}(x)$, $\mathbf{p}(x) \supset_x \sim\mathbf{s}(x)$, $\mathbf{p}(x) \wedge_x \mathbf{s}(x)$, and $\mathbf{p}(x) \wedge_x \sim\mathbf{s}(x)$. Simple conversion is a generally valid inference only in the case of E and I.

Obversion of a categorical proposition is effected by replacing $\mathbf{p}$ by a functional constant $\mathbf{q}$ which denotes the negation of the propositional function (the complement of the class) that is denoted by $\mathbf{p}$, and at the same time inserting $\sim$ if not already present or deleting it if present. In terms of the abstraction operator, the functional constant $\mathbf{q}$ is $\lambda x{\sim}\mathbf{p}(x)$. Thus the obverse of $\mathbf{s}(x) \supset_x \mathbf{p}(x)$ is $\mathbf{s}(x) \supset_x \sim\mathbf{q}(x)$ (the obverse of *All men are mortal* is *No men are immortal*). Similarly, the obverse of $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$ is $\mathbf{s}(x) \supset_x \mathbf{q}(x)$, the obverse of $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$ is $\mathbf{s}(x) \wedge_x \sim\mathbf{q}(x)$, and that of $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$ is $\mathbf{s}(x) \wedge_x \mathbf{q}(x)$.

The name "immediate inference" is given to certain inferences from one categorical proposition as premiss to another as conclusion, all of them being valid inferences either of first-order functional calculus or of an extended calculus embracing the

abstraction operator λ. The immediate inferences include obversion of *A*, *E*, *I*, *O*, simple conversion of *E*, *I*, and subalternation of *A*, *E*—of which subalternation requires the additional premiss $(\exists x)\mathbf{s}(x)$. Other immediate inferences may be obtained by means of sequences of these; *e.g.*, given that all men are mortal we may take the obverse of the converse of the obverse and so infer that all immortals are non-men (called by some the contrapositive, by others the obverted contrapositive).

Conversion *per accidens*, or *by limitation*, of a proposition *A* may be described as consisting of subalternation followed by simple conversion. Thus from the premisses $\mathbf{s}(x) \supset_x \mathbf{p}(x)$ and $(\exists x)\ \mathbf{s}(x)$ it yields the conclusion $\mathbf{p}(x) \wedge_x \mathbf{s}(x)$. Conversion *per accidens* of *E* is also possible, by a simple conversion followed by subalternation.

Categorical Syllogism.—The name "categorical syllogism" is given to certain valid inferences of first-order functional calculus which involve as premisses two categorical propositions having a term in common—the *middle term*. Using functional constants **s**, **m**, **p** to stand for the *minor term*, the middle term, and the *major term* respectively, we give the traditional classification into figures and moods. In each case we give the *major premiss* first, the *minor premiss* immediately after it, and the conclusion last; in some cases we give a third (existential) premiss which is suppressed in the traditional account. Where in consequence of the admission of singular propositions (as noted above) two different forms of valid inference appear under the same figure and mood, we give the singular forms in a separate list.

First Figure

Barbara: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \mathbf{p}(x)$.
Celarent: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Darii: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Ferio: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

Second Figure

Cesare: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{s}(x) \supset_x \mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Camestres: $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{s}(x) \supset_x \sim\mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Festino: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.
Baroco: $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{s}(x) \wedge_x \sim\mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

Third Figure

Darapti: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(\exists x)\mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Disamis: $\mathbf{m}(x) \wedge_x \mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Datisi: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{m}(x) \wedge_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Felapton: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(\exists x)\mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.
Bocardo: $\mathbf{m}(x) \wedge_x \sim\mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.
Feriso (or Ferison): $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{m}(x) \wedge_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

Fourth Figure

Bamalip (or Bramantip): $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(\exists x)\mathbf{p}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Calemes (or Camenes): $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \sim\mathbf{s}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Dimatis (or Dimaris): $\mathbf{p}(x) \wedge_x \mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Fesapo: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(\exists x)\mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.
Fresison: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{m}(x) \wedge_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

Singular Forms

Barbara: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{m}(\mathbf{a})$; $\mathbf{p}(\mathbf{a})$.
Celarent: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{m}(\mathbf{a})$; $\sim\mathbf{p}(\mathbf{a})$.
Cesare: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{m}(\mathbf{a})$; $\sim\mathbf{p}(\mathbf{a})$.
Camestres: $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\sim\mathbf{m}(\mathbf{a})$; $\sim\mathbf{p}(\mathbf{a})$.
Darapti: $\mathbf{p}(\mathbf{a})$, $\mathbf{s}(\mathbf{a})$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Felapton: $\sim\mathbf{p}(\mathbf{a})$, $\mathbf{s}(\mathbf{a})$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

The last two singular forms, in which the middle term is singular, are classed separately as the *expository* syllogism.

Some add the five so-called weakened moods, Barbari, Celaront, Cesaro, Camestros, Calemos, to be obtained by subalternation of the conclusion from Barbara, Celarent, Cesare, Camestres, Calemes respectively. The five moods of the fourth figure are sometimes classed instead as indirect moods of the first figure, the major and minor premisses being interchanged, and the names being then given as Baralipton, Celantes, Dabitis, Fapesmo, Frisesomorum.

The names of the moods have a mnemonic significance, in which the first three vowels indicate whether the major premiss, minor premiss, and conclusion, in order, are *A*, *E*, *I*, or *O*, and some of the consonants indicate the traditional reductions of the other moods to the four direct moods of the first figure (*see* Logic, History of).

Hypothetical Syllogism, Disjunctive Syllogism, Dilemma.—Besides the categorical syllogism, the traditional logic treats also a number of other kinds of *mediate* inference (*i.e.*, inference from two or more premisses), including especially the *hypothetical syllogism* (or conditional syllogism), the *disjunctive syllogism*, and the *dilemma*. All of these can be exhibited as valid inferences of the propositional calculus, and we shall give them here in this form.

In particular, we shall render the words "if" or "if . . . then," as used in stating the traditional hypothetical (or conditional) propositions, by the sign $\supset$ of material implication, although this is certainly contrary to the intention of traditional writers. In the Port-Royal Logic, for example, the contradictory negative of *If you eat of the forbidden fruit you will die* is given as *Although you eat of the forbidden fruit you will not die*—whereas if material implication were intended, the contradictory should be rather, *You will eat of the forbidden fruit and you will not die*. Yet in the same work it is explained that a conditional proposition may be true although both parts of it (both the antecedent and the consequent) are false, provided only that the consequence is correctly drawn.

By this it is not meant that the consequent must follow logically from the antecedent, but, as is clear from the discussion and the examples given, that the consequent must follow from the antecedent together with known truths which are taken into consideration. However, this account overlooks that, if two propositions are both false, it is always possible to infer one from the other by means of appropriately chosen truths, which may then be supposed to be known and taken into consideration. It is in this way that the traditional account leads to material implication as the best means of representing it consistently within a more complete theory. An alternative amendment of the traditional account indeed suggests itself, by seeking a satisfactory logistic theory of an implication connective which shall reproduce more closely the ordinary usage of "if . . . then" in future conditions and conditions contrary to fact, but this has never been successfully carried out. (Compare the discussion of material implication in the first part of this article.)

There is also a question whether the word "or," as used in stating the traditional disjunctive propositions, shall be understood as denoting inclusive disjunction or exclusive disjunction. Here the traditional logic is more explicitly inconsistent—since, although most of the inferences are valid inferences under either interpretation of the word "or," one of them, the *modus ponendo tollens*, is valid only for exclusive disjunction, and the two complex dilemmas are valid only for inclusive disjunction. We shall use exclusive disjunction in *modus ponendo tollens*, but inclusive disjunction elsewhere.

In each entry in the following table the major premiss is given first, or the two major premisses in the case of the dilemmas, then the minor premiss, then the conclusion.

Hypothetical Syllogism

Modus ponens: $\mathbf{A} \supset \mathbf{B}$, $\mathbf{A}$; $\mathbf{B}$.
Modus tollens: $\mathbf{A} \supset \mathbf{B}$, $\sim\mathbf{B}$; $\sim\mathbf{A}$.

Disjunctive Syllogism

Modus tollendo ponens: $\mathbf{A} \vee \mathbf{B}$, $\sim\mathbf{A}$; $\mathbf{B}$.
Modus tollendo ponens: $\mathbf{A} \vee \mathbf{B}$, $\sim\mathbf{B}$; $\mathbf{A}$.
Modus ponendo tollens: $\mathbf{A} \not\equiv \mathbf{B}$, $\mathbf{A}$; $\sim\mathbf{B}$.
Modus ponendo tollens: $\mathbf{A} \not\equiv \mathbf{B}$, $\mathbf{B}$; $\sim\mathbf{A}$.

Dilemma

Simple constructive dilemma: $\mathbf{A} \supset \mathbf{C}$, $\mathbf{B} \supset \mathbf{C}$, $\mathbf{A} \vee \mathbf{B}$; $\mathbf{C}$.
Simple destructive dilemma: $\mathbf{A} \supset \mathbf{B}$, $\mathbf{A} \supset \mathbf{C}$, $\sim\mathbf{B} \vee \sim\mathbf{C}$; $\sim\mathbf{A}$.
Complex constructive dilemma: $\mathbf{A} \supset \mathbf{B}$, $\mathbf{C} \supset \mathbf{D}$, $\mathbf{A} \vee \mathbf{C}$; $\mathbf{B} \vee \mathbf{D}$.
Complex destructive dilemma: $\mathbf{A} \supset \mathbf{B}$, $\mathbf{C} \supset \mathbf{D}$, $\sim\mathbf{B} \vee \sim\mathbf{D}$; $\sim\mathbf{A} \vee \sim\mathbf{C}$.

The inferences from $\mathbf{A} \supset \mathbf{B}$ and $\mathbf{C} \supset \mathbf{A}$ to $\mathbf{C} \supset \mathbf{B}$, and from $\mathbf{A} \supset \mathbf{B}$ and $\mathbf{C} \supset \sim\mathbf{B}$ to $\mathbf{C} \supset \sim\mathbf{A}$ are sometimes added as *pure hypothetical* syllogisms, and the above simpler forms of the hypothetical syllogism are then distinguished as *mixed hypothetical*. Some older works, including the Port-Royal Logic, add a *copulative* syllogism, with major premiss $\sim \cdot \mathbf{AB}$, minor premiss $\mathbf{A}$ and conclusion $\sim\mathbf{B}$, or minor premiss $\mathbf{B}$ and conclusion $\sim\mathbf{A}$.

TYPE THEORY AND SET THEORY

In the functional calculus of first order there is provision only for individuals as arguments of propositional functions, and it is only individual variables which may be bound by quantifiers. Since the domain of individuals is fixed in advance, and since the classes and relations (and propositional functions generally) which are values of the functional variables are not among the individuals of the fixed domain, this imposes a limitation upon what can be expressed in the notation of the calculus. Indeed it may be thought that the propositions of logic have a character of universal generality which demands for its expression the use of variables of unrestricted range, whose values are not confined to a fixed domain but may be either individuals or classes or relations or anything else whatever. And just this was maintained in particular by Gottlob Frege.

However, the uncritical attempt to introduce such variables of unrestricted range leads to a system which is inconsistent, if besides the variables of unrestricted range, say $x, y, z, x_1, \cdots$, we employ also the usual sentence connectives and quantifiers, and a notation, say $\epsilon(x, y_1, y_2, \cdots, y_n)$, to mean that *x is an n-ary propositional function and holds among the arguments* $y_1, y_2, \cdots, y_n$, and adopt what seem to be the natural and obvious axioms and rules of inference. Namely in such a system the antinomy of Bertrand Russell or that of C. Burali-Forti (*see* ANTINOMY) can be reproduced formally, *i.e.*, in the form of proofs of contradictory theorems of the system. And in fact the significance of these antinomies lies less in their informal statement in words than in their influence upon the construction of logistic systems, through the possibility of their logistic formalization.

In order to obtain a system more comprehensive than functional calculus of first order without falling into antinomy, there are two directions which have been followed. One of these, the direction of type theory, avoids altogether the use of variables of unrestricted range, and introduces instead many different kinds of variables with different restricted ranges. The other, the direction of set theory, has variables of unrestricted range, but imposes restrictions in regard to the existence of sets determined by given conditions. (The word "set" is here used to mean a class which can belong to another class as a member of it, since some forms of set theory admit also classes which are not sets; but outside the context of set theory the words "class" and "set" are generally used synonymously.)

As typical of the two directions we shall describe briefly the simple theory of types, and a form of set theory which is based on the system proposed by Ernst Zermelo in 1908.

The Simple Theory of Types can be described as obtained from the pure functional calculus of first order by successive additions to it.

The first step is to modify the formation rule iv to provide that $(\mathbf{x})\mathsf{A}$ shall be well-formed when $\mathbf{x}$ is a propositional or functional variable as well as when $\mathbf{x}$ is an individual variable. The resulting system is the *pure functional calculus of second order*, if suitable axioms and rules of inference are provided (which will not be stated here, but are similar to those for functional calculus of first order).

Then functional variables of various higher types are adjoined. Namely if $c_1, c_2, \cdots, c_n$ are non-negative integers, then $(c_1, c_2, \cdots, c_n)$ is a type, and an infinite list of variables of this type is provided: $F^{(c_1, c_2, \cdots, c_n)}, G^{(c_1, c_2, \cdots, c_n)}, \cdots$. A formation rule provides that, if $\mathbf{f}$ is of type $(c_1, c_2, \cdots, c_n)$, then $\mathbf{f}(\mathbf{x}_1, \mathbf{x}_2, \cdots, \mathbf{x}_n)$ is well-formed on condition that each variable $\mathbf{x}_i$ is of the type indicated by the corresponding integer c_i, *i.e.*, that $\mathbf{x}_i$ is an individual variable if c_i is 0, $\mathbf{x}_i$ is a propositional variable if c_i is 1, and $\mathbf{x}_i$ is an m-ary functional variable of lower type (one of the variables $F^m, G^m, H^m, F_1^m, \cdots$) if c_i is $m+1$. The values of the variables of type $(c_1, c_2, \cdots, c_n)$ are propositional functions of the kind which is indicated by this formation rule. And the resulting system, if the new variables of higher types occur only as free variables, and if again suitable axioms and rules of inference are provided, is the *pure functional calculus of third order*. Upon further modifying the formation rule iv, to allow the new variables of higher types to occur also as bound variables, the *pure functional calculus of fourth order* is obtained.

Then the next step is to adjoin functional variables of still higher types; *e.g.*, one of these new types is $(0, (2, 3), (3))$, and if $\mathbf{f}$ is a variable of this type, then $\mathbf{f}(\mathbf{x}_1, \mathbf{x}_2, \mathbf{x}_3)$ is well-formed on condition that $\mathbf{x}_1$ is an individual variable, $\mathbf{x}_2$ is a variable of type $(2, 3)$, and $\mathbf{x}_3$ is a variable of type (3).

In this way, by successive adjunctions of functional variables of higher and higher types—with appropriate changes, at each stage, in the formation rules, axioms, and rules of inference—the pure functional calculi of all finite orders are obtained. The logistic system which embraces all of these in a single system is the *pure functional calculus of order* ω.

A notation $=$, to express that two things are the same or identical, may be introduced by definition:

$$\mathbf{x} = \mathbf{y} \rightarrow (F^e) \cdot F^e(\mathbf{x}) \supset F^e(\mathbf{y}),$$

where $\mathbf{x}$ and $\mathbf{y}$ are variables of the same type, and where the particular letter F is used, with type superscript e so chosen as to make $F^e(\mathbf{x})$ and $F^e(\mathbf{y})$ well-formed.

Finally, to the axioms of the pure functional calculus of order ω, there are added one special axiom, the *axiom of infinity*, and two special axiom schemata, which provide the *axioms of extensionality* and the *axioms of choice*.

The axiom of infinity is to the effect that the number of individuals is infinite. There are many ways in which an axiom having this as a consequence may be formulated in the notation of the system, of which the following (based on an idea of Kurt Schuette) is perhaps the briefest:

$$(\exists F)(x)(\exists y)(z) \cdot \sim F(x, x)\ F(x, y) \cdot F(z, x) \supset F(z, y)$$

The axioms of extensionality are that two n-ary propositional functions are identical if they hold among exactly the same ordered sets of n arguments:

$$\mathbf{f}(\mathbf{x}, \mathbf{y}, \cdots, \mathbf{u}) \equiv_{\mathbf{xy} \ldots \mathbf{u}} \mathbf{g}(\mathbf{x}, \mathbf{y}, \cdots, \mathbf{u}) \supset \mathbf{f} = \mathbf{g},$$

where $\mathbf{x}, \mathbf{y}, \cdots, \mathbf{u}$ is any ordered set of n different variables (which may be of various types, the same or different, n being any positive integer), and where $\mathbf{f}$ and $\mathbf{g}$ are variables of such type as to make $\mathbf{f}(\mathbf{x}, \mathbf{y}, \cdots, \mathbf{u})$ and $\mathbf{g}(\mathbf{x}, \mathbf{y}, \cdots, \mathbf{u})$ well-formed.

The axioms of choice, or *multiplicative axioms* as they are also called, are:

$$\mathbf{c}(\mathbf{f})\mathbf{c}(\mathbf{g}) \supset_{\mathbf{fg}} |\, \mathbf{f}(\mathbf{x})\mathbf{g}(\mathbf{x}) \supset_{\mathbf{x}} \mathbf{f} = \mathbf{g}| \supset (\exists \mathbf{h}) \cdot$$
$$\mathbf{c}(\mathbf{f}) \supset \mathbf{f} \cdot \mathbf{f}(\mathbf{z}) \supset_{\mathbf{z}} (\exists \mathbf{y}) \cdot \mathbf{f}(\mathbf{x})\mathbf{h}(\mathbf{x}) \equiv_{\mathbf{x}} \mathbf{x} = \mathbf{y},$$

where $\mathbf{c}, \mathbf{f}, \mathbf{g}, \mathbf{h}, \mathbf{x}, \mathbf{y}, \mathbf{z}$ are variables which must be no two the same, and of such types that the formula is well-formed.

For the simple theory of types without axiom of infinity a proof of consistency is possible which is similar to that given above for the functional calculus of first order, and which, although more complicated, employs only methods of essentially the same elementary character.

On the other hand it is a consequence of Goedel's incompleteness theorem (*see* the explanation below) that any proof of consistency of the system with axiom of infinity cannot be of such elementary character, but must employ methods of proof that in some sense surpass anything available in the simple theory of types itself.

The Set Theory of Zermelo can be described as obtained by adjoining additional axioms to a simple applied functional calculus of first order which has one binary functional constant ϵ and one individual constant Λ. The constant ϵ denotes the relation of membership in a set, so that $\epsilon(x, y)$ may be read as "x belongs to the set y" or "y is a set and x is a member of y." The constant Λ denotes the empty set (the set which has no members). The individual variables may in this theory be regarded as variables of unrestricted range, in the sense that the theory assumes the existence of no entities (sets or others) that cannot be values of the individual variables.

In writing well-formed formulas we shall abbreviate $\epsilon(\mathbf{x}, \mathbf{y})$ as $\mathbf{x}\epsilon\mathbf{y}$; *i.e.*, to state it as a definition: $\mathbf{x}\epsilon\mathbf{y} \rightarrow \epsilon(\mathbf{x}, \mathbf{y})$.

The notation $=$ may be introduced by a definition analogous to that given above in connection with the simple theory of types: $\mathbf{x} = \mathbf{y} \rightarrow \mathbf{x}\epsilon\mathbf{z} \supset_{\mathbf{z}} \mathbf{y}\epsilon\mathbf{z}$. A notation $\subset$, to express that one set is a part of (a subset of) another, may be introduced by a similar definition: $\mathbf{x} \subset \mathbf{y} \rightarrow \mathbf{z}\epsilon\mathbf{x} \supset_{\mathbf{z}} \mathbf{z}\epsilon\mathbf{y}$. In both cases $\mathbf{z}$ is to be chosen

as the first individual variable (in alphabetic order) which is different from both x and y.

To provide for the notion of an ordered pair, a notation $\{x, y, z\}$ may be introduced to express that z is the ordered pair of x and y: $\{x, y, z\} \rightarrow u\epsilon z \equiv_u \cdot [v\epsilon u \equiv_v v = x] \vee \cdot v\epsilon u \equiv_v \cdot v = x \vee v = y$, where u and v are to be chosen as the first two individual variables different from x, y, and z. Relations may then be dealt with in the theory by understanding a relation to be a set of ordered pairs.

The axioms of the theory are those of the functional calculus of first order, and in addition the following axioms and axiom schemata:

Axiom of extensionality: $z\epsilon x \supset \cdot z\epsilon x \equiv_z z\epsilon y \supset x = y$.

Axiom of the empty set: $\sim x\epsilon\Lambda$.

Axiom of pairing: $(\exists t) \cdot z\epsilon t \equiv_z \cdot z = x \vee z = y$.

Axiom of summation of sets: $(\exists t) \cdot z\epsilon t \equiv_z (\exists y) \cdot z\epsilon y \cdot y\epsilon x$.

Axiom of the set of subsets: $(\exists t) \cdot z\epsilon t \equiv_z z \subset x$.

Axioms of subset formation: $(\exists t) \cdot z\epsilon t \equiv_z \cdot z\epsilon x \cdot Az$, where Az is a well-formed formula which may have z as a free variable but does not have t as a free variable.

Axiom of choice: $y\epsilon x \cdot z\epsilon x \supset_{yz} [u\epsilon y \cdot u\epsilon z \supset_u y = z] \supset (\exists t) \cdot y\epsilon x \supset_y \cdot w\epsilon y \supset_w (\exists v) \cdot u\epsilon y \cdot u\epsilon t \equiv_u u = v$.

Axiom of infinity: $(\exists t) \cdot \Lambda\epsilon t \cdot x\epsilon t \supset_x (\exists y) \cdot y\epsilon t \cdot z\epsilon y \equiv_z \cdot z\epsilon x \vee z = x$.

Axioms of replacement: $y\epsilon x \supset_y (\exists u)[Ayz \equiv_z z = u] \supset (\exists t) \cdot z\epsilon t \equiv_z (\exists y) \cdot y\epsilon x \cdot Ayz$, where Ayz is a well-formed formula which may have y and z as free variables but does not have t or u as a free variable.

Axioms of excluded infinite regress: $(\exists x)Ax \supset (\exists x) \cdot Ax \cdot y\epsilon x \supset_y \sim Ay$, where Ax is a well-formed formula which may have x as a free variable but does not have y as a free variable.

The way in which the theory seeks to avoid antinomy may be seen in particular in connection with the axioms of subset formation. An uncritical formulation might well have included the stronger axiom schema $(\exists t) \cdot z\epsilon t \equiv_z Az$, providing for the existence of a set t of those things z (sets and others) which satisfy an arbitrary given condition Az. But this axiom schema would lead directly to the Russell antinomy, upon taking Az to be $\sim z\epsilon z$. The weaker schema actually used (the axioms of subset formation) provides only for the existence of a set t of those things z which belong to a previously given set x and satisfy the condition Az. This is not known to lead to antinomy; but $\sim(\exists t) \cdot z\epsilon t \equiv_z \sim z\epsilon z$ is a theorem.

Concerning the history of these axioms for set theory, *see* the paragraph about Zermelo in the article LOGIC, HISTORY OF. The axioms of replacement and of excluded infinite regress are additions to the original axiom system of Zermelo, and are sometimes omitted, as although they are independent and for some purposes important, there are also many purposes for which they are not needed.

On the other hand, if the axioms of replacement are retained in the form in which we have here stated them, they have the effect of rendering the axioms of subset formation non-independent; *i.e.,* the axioms of subset formation may then be omitted from the list on the ground that they can be proved as theorems by using the axioms of replacement.

An extension of the Zermelo set theory which is due to John von Neumann and Paul Bernays (*see* the paper of Bernays cited in the bibliography) adds, to the sets of the Zermelo theory, also classes which are not sets, *i.e.,* which cannot be members of other classes or sets. And for every condition Az expressed in the notation of the Zermelo theory there is a class of those elements z which satisfy Az—where an *element* is a set or anything capable of being a member of a set. (In particular there is, according to this extended theory, a class of elements z such that $\sim z\epsilon z$, but not a set of such elements.)

Two other, different, systems of set theory are treated by W. V. Quine, one in his paper cited in the bibliography, and the other in the 1951 edition of his book. The latter, due jointly to Quine and Hao Wang, is related to Quine's system of 1937. These are not forms of the Zermelo theory but seek to exclude the antinomies by different means.

Goedel's Incompleteness Theorem.—In contrast with the completeness theorem for the pure functional calculus of first order, all known systems of type theory or set theory which are of sufficient strength to provide a logical foundation of mathematics are incomplete. We state this incompleteness theorem, due to Goedel, in the slightly stronger form which was given to it by Barkley Rosser. On the hypothesis that the system in question—it may be in particular either the simple theory of types or any of the systems of set theory mentioned above—is consistent, there is a well-formed formula A which is a sentence (hence without free variables) such that neither A nor $\sim$A is a theorem.

The proof of the metatheorem proceeds by constructing a particular well-formed formula A, and then showing that, if the system is consistent, A cannot be a theorem, and $\sim$A cannot be a theorem. However, it can also be shown that, if the system is consistent, the proposition expressed by A is true. More accurately, we can show, by means that are formalizable in the system itself, "If the system is consistent, then _____," filling the blank with a statement of the proposition that is expressed by A. Hence the further metatheorem follows that the consistency of the system cannot be proved by means that are formalizable in the system itself. (This brief statement of the matter is incomplete, and some essential explanations which are here omitted will be found in the article MATHEMATICS, FOUNDATIONS OF.)

Both the incompleteness theorem and the further theorem about the possibility of a consistency proof have the striking feature that they hold not only for a particular system but for any arbitrary extension of it that may be obtained by adjoining additional axioms or rules of inference or both, provided only that the requirement is satisfied that the axioms and rules of inference shall be effective (as described in the first part of this article, in explaining the notion of a logistic system). Having a particular system, which we suppose consistent, and having constructed the sentence A which is then true but not a theorem, we may indeed strengthen the system by adding A to it as an axiom. But the resulting stronger system is still incomplete: in it a particular sentence B may again be constructed by the same method, and it may be shown on the hypothesis of consistency that neither B nor $\sim$B is a theorem, and that the proposition expressed by B is true.

See also references under "Logic" in the Index.

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LOGIC, HISTORY OF. In this article the history of logic is presented as follows:

I. Ancient Logic
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  1. Period of the "Old Logic" (Ars Vetus)
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29. Tarski
30. Carnap
31. Herbrand
32. Goedel

I. ANCIENT LOGIC

1. Aristotle.—The history of ancient logic begins with Aristotle. This is not to say that until Aristotle's time no one was capable of reasoning correctly. The works of Plato are full of interesting arguments, valid and invalid, and, indeed, the same may be said for nearly all of ancient literature—whether written by philosophers, mathematicians, scientists, historians, grammarians or even by poets—both before and after the discovery of the syllogism. However, in determining the scope of a history of logic, one should not fail to distinguish sharply between the use of logical principles, which may be attributed to anyone who reasons, and the *mention and study* of such principles. Only the latter is specifically the business of logic and accordingly is relevant to its history. It is true that the logician himself, like any other theorist, will have to construct arguments and proofs concerning his subject matter. Nevertheless, it is important even in his case to distinguish between the principles he mentions and those he uses. Thus, for instance, when Aristotle proves his various assertions about the syllogism he often argues in accord with inference patterns which are clearly not syllogistic and which, since he never discusses them explicitly, cannot be considered a part of his logic.

Most of Aristotle's contributions to logic are found in a group of treatises known in later times under the title *Organon* and consisting of the *Categories*, *De Interpretatione*, the *Analytics*, the *Topics*, and the *Sophistical Refutations*. These treatises also contain much that lies outside the field of logic. All of them are written in the abbreviated, notebook style which is typical of the entire Aristotelian corpus, and they abound in textual difficulties. The authenticity of the first two is open to doubt, and the order in which the various works were written is unknown. Yet despite such problems and obscurities one cannot fail to be impressed by the sure and masterful way in which Aristotle sets forth his remarkable discoveries in logic. Most of the relevant material is found in the *Prior Analytics* and the *De Interpretatione* (*Perihermenias*), and we shall therefore restrict ourselves to a quite summary treatment of the remaining portions of the *Organon*.

The *Categories* begins with a division of linguistic expressions into simple and composite. Examples of the composite are "A man runs," "A man wins"; of the simple, "man," "ox," "runs," and "wins." Aristotle then states that every simple expression means one of the following: substance, quantity, quality, relation, place, time, position, state, action, affection; and he devotes the remainder of the treatise to a discussion of these categories. Most of what is included is not directly relevant to the history of logic, but there are a few passages which bear upon the question of interpreting the important idiom "is predicated of," in terms of which syllogisms are typically stated by Aristotle. Unfortunately, the evidence afforded by these passages tends only to confirm what we gather from the *Analytics*, namely, that Aristotle was not fully clear whether he was speaking of a relation between a thing and a word, or between two things, or between two words. The difficulty is well illustrated by his statement of the one logical principle mentioned in the *Categories:*

> Whenever one thing is predicated of another as of a subject, everything said of what is predicated will also be said of the subject; for example, man is predicated of some particular man, and animal of man; thus animal will be predicated of the particular man also.

The *De Interpretatione* continues the classification of linguistic expressions and sets forth some elementary logical relations among declarative sentences of the simplest types. Sentences, as well as the nouns and verbs of which they are composed, are defined as certain species of significant sounds. Observing that some of them, *e.g.*, prayers, are neither true nor false, Aristotle dismisses these as "belonging to the study of rhetoric or poetry" and restricts the discussion to declarative sentences. These are divided into simple and composite: the simple either affirms or denies something of something, while the composite results from conjoining simples. Further restricting the subject to simple sentences, Aristotle divides them into eight groups, explaining as follows: Some things are universal, he says, and some are particular. By "universal" he means what is of such a nature as to be predicated of many things; by "particular," what is not of such a nature; thus Man is a universal, and Callias is a particular. Now some of our (simple declarative) sentences concern a universal as subject, and others concern a particular. For example, the positive and negative sentences "Socrates is white," "Socrates is not white" both concern a particular, viz., Socrates. Of those which have a universal subject, several kinds are distinguished. Such sentences as "Every man is white" and "No man is white," later known respectively as *A-* and *E-propositions*, are said to be of a universal character and about a universal subject. The words "every" and "no" are the marks of the universal character, and in these examples Man is the universal subject. There are two kinds of sentences which are not of a universal character but are nevertheless about a universal subject. First we have such sentences as "Some man is white" and "Not every man is white," later called *I-* and *O-propositions*, and described in the *Prior Analytics* as "particular" sentences. In addition there are sentences like "Man is white" and "Man is not white," called "indefinite" in the *Prior Analytics*.

An affirmation and a denial which have the same subject and predicate, but one of which is of a universal character while the other is not, are called "contradictories" by Aristotle. Thus, "Every man is white" and "Not every man is white" are contradictories, as are "No man is white" and "Some man is white." Of a pair of contradictories, exactly one must be true. An affirmation and denial which have the same subject and predicate and each of which is of a universal character are called "contraries." It is not possible for both members of a pair of contraries to be true, but it can happen that both of their contradictories are true. In other words, contraries may be simultaneously false. This is the case, for example, with the contraries "Every man is white" and "No man is white." In the centuries after Aristotle these relationships were presented schematically by means of the well-known Square of Opposition, which first appears in Apuleius' commentary on *De Interpretatione*.

The remainder of the treatise consists of an unsystematized miscellany of observations, some interesting, some obscure and confused. There is a discussion purporting to show that if one member of every pair of contradictory sentences is true and the other is false, then everything happens by necessity and nothing by chance. The argument is unclear, but it appears to rest in part upon a confusion between true sentences like "Necessarily, if 'Snow is white' is true, then snow is white" and their more idiomatic (as also in Greek) but strictly false counterparts, "If 'Snow is white' is true, then necessarily snow is white." On another subject, Aristotle makes the interesting point that the word "is" has a

different sense in "Homer is" from what it has in "Homer is a poet," and that the former of these sentences does not follow from the latter. In still another place he notices that some predicates will combine in a way in which others will not: thus, from "Socrates is two-footed" and "Socrates is a man" we can deduce correctly "Socrates is a two-footed man"; whereas from "He is good" and "He is a shoemaker" it would be incorrect to infer "He is a good shoemaker." This is reminiscent of the Platonic example: "He (a dog) is yours and he is a father. Therefore, he is your father." The core of Aristotle's logic is in the first seven chapters of Book I of the *Prior Analytics*. There, within the space of a very few pages, is set forth the theory of the syllogism, an intellectual discovery that was of unequaled magnitude for its time and which dominated the science of logic for 2,000 years.

Aristotle first describes the kinds of sentences which may be components of syllogisms. The classification is somewhat different from that given in *De Interpretatione*. Every premiss and conclusion, he says, affirms or denies something of something and thus is positive or negative. It will also be universal, particular, or indefinite. A universal sentence asserts that something belongs to all or none of something else; a particular sentence asserts that something belongs to some or not to some or not to all of something else; an indefinite sentence merely asserts, neither in general nor in particular, that something belongs or does not belong to something else, *e.g.*, that pleasure is not good. Strictly speaking, the foregoing is an account only of assertoric premisses; there are also problematic premisses, to the effect that something *may* belong to something else; and apodictic premisses, which state that something *must* belong to something else. These also are divided into six kinds, in the same way in which the assertoric premisses are so divided. It will be noticed that no mention is made of sentences with particular subjects (in later terminology, singular sentences, or singular propositions). They are entirely ignored in the *Prior Analytics*, and consequently the ancient and familiar example of a syllogism:

All men are mortal.
Socrates is a man.
Therefore, Socrates is mortal.

is quite un-Aristotelian. Furthermore, the indefinite sentences, too, are very nearly ignored by Aristotle. According to Alexander, the reason is that they are "equivalent" to particular sentences.

In preparation for his deductive exposition of the syllogistic Aristotle states the laws of conversion. The universal negative sentence converts into a universal negative; *e.g.*, if no pleasure is good, then no good will be pleasure. The universal and particular affirmative sentences convert, but into particular affirmatives; *e.g.*, if every pleasure is good, then some good is pleasure, and if some pleasure is good, then again some good is pleasure. The particular negative does not convert, since, for example, it does not follow that if some animal is not a man, then some man is not an animal. Using variables Aristotle states these laws in a general way and demonstrates them by procedures known as *ekthesis* and *reductio ad impossibile:*

> First, then, let the premiss *AB* be a universal negative. If *A* belongs to no *B*, then *B* will not belong to any *A*. For if it belonged to some *A*—for instance, to *C*—then it would not be true that *A* belonged to no *B*, for *C* is one of the *B*'s. And if *A* belongs to all *B*, then *B* will belong to some *A*. For if it belonged to no *A*, *A* would belong to no *B*, whereas it was assumed to belong to all *B*. And likewise if the premiss is particular. For if *A* belongs to some *B*, then necessarily *B* belongs to some *A*, since if it belonged to none, *A* would belong to no *B*. On the other hand, if *A* does not belong to some *B*, it is not necessary that *B* should not belong to some *A;* for example, let *B* be Animal and *A* be Man. For Man does not belong to every Animal, but Animal does belong to every Man.

The Aristotelian definition of "syllogism" is as follows: a syllogism is discourse in which, certain things being posited, something else follows necessarily from their being so. However, his definition is far too wide, applying to nearly all valid arguments, and it does not agree with his own practice. A much better idea of what is meant by "syllogism" may be derived from an examination of the syllogistic formulas actually set forth. The following literal translations will serve this purpose and will illustrate the methods of reduction. Important words which do not occur in Aristotle's abbreviated statements but which seem to be required by the sense and syntax are enclosed within parentheses. The scholastic names for the moods are due to Peter of Spain.

Barbara. For if *A* (is predicated) of all *B* and *B* of all *C*, it is necessary for *A* to be predicated of all *C*. (*An. Pr.* I, 25 b 37)

Celarent. Likewise, if *A* (is predicated) of no *B* but *B* of all *C*, (it is necessary) that *A* will belong to no *C*. (25 b 40)

Darii. Let *A* belong to all *B*, and *B* to some *C*. Then if "predicated of all" means what was said at the beginning, it is necessary for *A* to belong to some *C*. (26 a 23)

Ferio. And if *A* belongs to no *B*, but *B* to some *C*, it is necessary that *A* does not belong to some *C*. (26 a 25)

Cesare. Let *M* be predicated of no *N* but of all *O*. Then, since the negative converts, *N* will belong to no *M*. But *M* was assumed (to belong) to all *O;* so that *N* (will belong) to no *O;* for this has been shown previously. (27 a 5)

Camestres. Again, if *M* (belongs) to all *N* but to no *O*, neither will *N* belong to any *O*. For if *M* (belongs) to no *O*, then *O* (belongs) to no *M;* but *M* belonged to all *N;* therefore, *O* will belong to no *N;* for the first figure has been produced again. And since the negative converts, *N* will belong to no *O*. (27 a 9)

Festino. For if *M* belongs to no *N* but to some *O*, it is necessary for *N* not to belong to some *O*. For since the negative converts, *N* will belong to no *M*. But *M* was assumed to belong to some *O*, so that *N* will not belong to some *O;* for a syllogism in the first figure is obtained. (27 a 32)

Baroco. Again, if *M* belongs to all *N* but not to some *O*, it is necessary for *N* not to belong to some *O*. For if it belongs to all, and *M* is also predicated of all *N*, it is necessary for *M* to belong to all *O*. But it was assumed not to belong to some. (27 a 36)

Darapti. Whenever both *P* and *R* belong to all *S*, (it is true) that *P* will of necessity belong to some *R*. For since the affirmative converts, *S* will belong to some *R*, so that since *P* (belongs) to all *S*, and *S* to some *R*, it is necessary for *P* to belong to some *R*. For a syllogism in the first figure is produced. It is also possible to make the proof *per impossibile* and by *ekthesis*. For if both belong to all *S*, then if one of the *S*'s, *e.g.*, *N*, is taken, both *P* and *R* will belong to this, so that *P* will belong to some *R*. (28 a 17)

Felapton. And if *R* belongs to all *S*, but *P* to none, there will be a syllogism that of necessity *P* will not belong to some *R*. The same type of proof (will work) by converting the *RS* premiss. It might also be shown *per impossibile*, as in the previous cases. (28 a 26)

Disamis. For if *R* (belongs) to all *S* and *P* to some, it is necessary for *P* to belong to some *R*. For since the affirmative converts, *S* will belong to some *P*, so that since *R* (belongs) to all *S*, and *S* to some *P*, *R* will belong to some *P*. So that *P* (will belong) to some *R*. (28 b 7)

Datisi. Again, if *R* belongs to some *S* and *P* to all, it is necessary for *P* to belong to some *R*. For the same method of demonstration (will work). And it is also possible to demonstrate it both *per impossibile* and by *ekthesis*, just as in the previous cases. (28 b 11)

Bocardo. For if *R* (belongs) to all *S* and *P* does not belong to some, it is necessary for *P* not to belong to some *R*. For if to all, and *R* (belongs) to all *S*, *P* will also belong to all *S*. But it did not so belong. It is also proved without reduction, if one of the *S*'s to which *P* does not belong is taken. (28 b 17)

Ferison. For if *P* (belongs) to no *S*, but *R* belongs to some *S*, *P* will not belong to some *R*. For the first figure will be produced again when the *RS* premiss is converted. (28 b 33)

Fesapo and *Fresison*, premisses in reversed order. . . . such as, if *A* (belongs) to all *B* or to some, but *B* to no *C*. For when the premisses are converted it is necessary for *C* not to belong to some *A*. Likewise in the other figures: a syllogism always results from conversion of the premisses. (29 a 23)

There is some question as to how these formulas should be interpreted. Traditionally, "Aristotelian" syllogisms have been presented as arguments and not as conditional sentences. The well-known example of a syllogism in Barbara has the form of an argument consisting of two premisses and a conclusion:

All men are mortal.
All Greeks are men.
Therefore, all Greeks are mortal.

As J. Lukasiewicz emphasized, this cannot be obtained by substituting terms for variables in the Aristotelian formula. The difficulty is not only that Aristotle uses expressions like "*A* is predicated of all *B*" or "*A* belongs to all *B*" instead of "All *B* is *A*"; more important, nearly all of the Aristotelian formulas have the form of conditional sentences, and the word "therefore" almost never occurs. Thus, their instances cannot be arguments—at least, not of the usual type. On the other hand, however, Lukasiewicz himself is not very convincing when he argues that the "true" syllogisms are generalized conditionals; on this hypothesis Barbara, for example, would be:

For every *A*, *B*, *C*, if *A* is predicated of all *B* and *B* is predicated

of all C, then A is predicated of all C.

It will be noticed that some of the Aristotelian statements approximate this form, but that others do not. Aristotle's formulations of Darii and Cesare are not conditionals, and his statement of Felapton is clearly metalinguistic. Further, the sense of the word "necessarily," which occurs in nearly every one of the formulas, is not adequately represented by the prefix "For every A, B, C." Anyway, there is no evidence that Aristotle ever used quantifiers; he seems rather to have thought of variables simply as letters standing in place of terms. Further, a number of passages seem to indicate that, for Aristotle, the syllogisms are *instances* of the formulas containing variables and do not themselves contain variables. All of these obstacles stand in the way of accepting Lukasiewicz' interpretation.

Another, and closely related, difficulty concerns the question whether terms are classes or the names of classes. There are many places in which it appears that Aristotle regards terms as constituents of sentences, the latter being clearly regarded as significant sounds. But there are equally many places where he seems to be thinking of them as classes. Thus, he says "for one thing to be included as a whole in another, and for the other to be predicated of all of the one, are the same." Probably the truth is simply that Aristotle did not honour our much-valued distinctions between the use and mention of linguistic expressions and between arguments and conditional sentences. In asking whether he "really" meant syllogisms to be arguments or conditionals, and whether he "really" meant his logic to concern classes or names, we may be asking questions to which there are no appropriate answers.

The moods of the syllogism are grouped into three figures. Aristotle says that if we want to prove syllogistically that A belongs (or does not belong) to B, we have to take something common in relation to both, and this can be done in three ways: by predicating either A of C and C of B, or C of both, or both of C. "These," he continues, "are the figures of which we have spoken, and it is clear that every syllogism must be in one of these figures." Accordingly, Barbara, Celarent, Darii, and Ferio belong to the first figure; Cesare, Camestres, Festino, and Baroco to the second; and Darapti, Felapton, Disamis, Datisi, Bocardo, and Ferison to the third. There has been much discussion as to why Aristotle did not anticipate his followers in mentioning a fourth figure, *i.e.*, why he did not consider the possibility of proving A of B by predicating C of A and B of C. Numerous answers, none completely convincing, have been given. In any case, it is probable that Aristotle did recognize the existence of such syllogisms. For he allows interchange of the premisses of a syllogism and says that the result of converting the conclusion of a syllogism is again a syllogism; applying these operations to Barbara, Celarent, and Darii we obtain the moods Bramantip, Camenes, and Dimaris of the fourth figure. The remaining valid moods in this figure, Fesapo and Fresison, are given explicitly, although with their premisses in reversed order.

As I. M. Bochenski observed, "the assertoric syllogism is probably the most important discovery in all the history of formal logic, for it is not only the first formal theory with variables, but it is also the first axiomatic system ever constructed." (I. M. Bocheński, *Ancient Formal Logic*, North-Holland Publishing Company, 1951.) Aristotle axiomatizes his syllogistic in several ways. In the first of these he chooses as axioms the syllogisms of the first figure. They are said to be "perfect," *i.e.*, intuitively evident. He then proves the validity of the syllogisms in the second and third figures by reducing them to syllogisms of the first figure. The reductions are of two sorts: direct reduction and *reductio ad impossibile*. Direct reductions are made by converting one or more premisses of the syllogism to be proved, reversing their order if necessary, and then deriving the desired conclusion (or its converse) by means of the syllogism to which reduction is made. By this procedure Aristotle reduces Cesare and Camestres to Celarent; Festino, Felapton, and Ferison to Ferio; Darapti, Disamis, and Datisi to Darii. (*See* the translations above.) The other method proceeds as follows: from one of the premisses and the contradictory of the conclusion of the syllogism to be proved, one derives (using the syllogism to which reduction is being made) the contradictory of the other premiss, thus establishing that the conclusion follows from the premisses. Aristotle uses this method to reduce Baroco and Bocardo to Barbara. Then, after reducing all of the moods to those of the first figure, he further states that Barbara and Celarent alone would suffice as axioms. He proves this by showing how to reduce Darii and Ferio to syllogisms of the second figure and by reminding us that all syllogisms of the second figure are reducible to Barbara and Celarent. (We are told that Festino may be proved by a *reductio ad impossibile* to Celarent, as well as by a direct reduction to Ferio.) Elsewhere he observes that the moods of any of the three figures will serve equally well as axioms.

Aristotle arrives at the valid moods by a process of elimination. To show that there is no valid syllogism of a given type, he always produces a counter-example. He does this in a particularly expeditious manner, managing to deal with several possibilities at a time. We quote and explain a typical example.

> But if M is predicated of all N and O, there will not be a syllogism. Terms for the affirmative relation are substance, animal, man; for the negative relation substance, animal, number.

This is a condensed argument to show that in the second figure there is no valid mood of the form "If M is predicated of all N and O, then . . . ." It makes tacit use of the fact that any substitution of terms for variables which converts the premisses of a valid mood into true sentences will also convert the conclusion into a true sentence. Now suppose there were a valid mood with the indicated premisses and a negative conclusion. Then any substitution of terms for variables which makes the premisses true will also make this negative conclusion true, and will therefore make false the universal affirmative formula "N is predicated of all O," which is the contradictory of the particular negative and the contrary of the universal negative. But, as a matter of fact, substitution of the terms "substance," "animal," and "man" for "M," "N," and "O," respectively, makes the premisses and this universal affirmative formula true. Therefore, there is no valid mood with the indicated premisses and a negative conclusion. Analogously, since substitution of the terms "substance," "animal," and "number" makes the premisses and the universal negative formula "N is predicated of no O" true, there cannot be an affirmative conclusion. Therefore, there is no valid mood of the type under consideration. Often Aristotle does even better than this, dealing simultaneously with two pairs of premisses and thus eliminating eight possibilities at once.

After sifting out the valid moods of the syllogism Aristotle proceeds to make certain general remarks about them. He notices that in every syllogism at least one of the premisses must be affirmative and at least one must be universal. He points out further that a universal conclusion occurs only when both premisses are universal, while a particular conclusion may follow from premisses which are both universal or one of which is particular. Also, at least one of the premisses must be like the conclusion in being affirmative or negative. Many other less interesting points are made, such as that only Barbara has a universal affirmative conclusion.

We have confined our attention to the assertoric syllogism, *i.e.*, to such syllogisms as contain only assertoric components. Actually much the greater portion of *Prior Analytics* I is devoted to modal syllogisms, which contain problematic or apodictic premisses or both. Aristotle develops the theory of such syllogisms in a manner similar to that used for the assertoric syllogism. However, his treatment is incomplete and contains many errors; and the already complex subject is further complicated by the fact that he uses the modal operators "necessary" and "possible" in a number of different senses, some of which are very difficult to grasp. His contribution to modal logic is undoubtedly important, but a great deal of work remains to be done before it can be regarded as well understood.

The remainder of the *Prior Analytics* and all of the *Posterior Analytics* are devoted primarily to subjects which are not relevant to logic as presently conceived. The same is true of the *Topics* and the *Sophistical Refutations*. In the *Posterior Analytics* Aristotle investigates the nature of scientific knowledge. The *Topics*

attempts to lay down rules for arguing dialectically, *i.e.*, for establishing desired conclusions syllogistically from generally accepted premisses, and the *Sophistical Refutations* consists of a laborious discussion of fallacious arguments. Yet throughout these works there occur incidental remarks which, as Bocheński has shown, reveal that Aristotle was aware of many non-syllogistic laws of logic, including examples from what would now be described as the theory of identity and the calculi of predicates, relations, and propositions. Indeed, the science of logic has very few branches of which the beginnings, albeit sometimes faint, cannot be found somewhere in his writings.

2. Theophrastus.—Theophrastus, Aristotle's successor as head of the Peripatetic school, was evidently a logician of considerable ability. Unfortunately, we possess only a few fragments of his logical works, and in many of these his name is linked with that of his successor, Eudemos. These fragments, however, suffice to show that his work consisted mainly in the development and correction of Aristotelian doctrine. We know but few details. To the first figure of the assertoric syllogism he added five moods which, when the order of their premisses is reversed, are seen to be precisely the five moods of the fourth figure. (Lukasiewicz conjectures that he was led to do this by defining the first figure as that in which the middle term is the subject of one premiss and the predicate of the other.) He expressly identified the indefinite sentences with the particular. He objected, for some reason or other, to Aristotle's use of "*A* does not belong to some *B*" and "Not: *A* belongs to all *B*" as synonymous. Further, it may be conjectured that he used something like the Euler diagrams for the syllogism, since he paraphrases "No *S* is *P*" as "*S* is separate from *P*."

However, Theophrastus' most significant contributions were in the field of modal logic, where, according to Bocheński, he made two major changes: (1) the interpretation of "possible" as "not self-contradictory" instead of "contingent"; (2) the affirmation and consistent application of the principle that the conclusion always follows the weaker premiss. It is also likely that his investigations into hypothetical syllogisms anticipated, to some extent, the Stoic logic of propositions.

3. Stoics and Megarians.—In many respects ancient logic reached its zenith in the writings of the Stoic and Megarian logicians. The Megarian school was founded by Euclid, one of the followers of Socrates. Among his pupils were Eubulides, to whom the Liar paradox is ascribed; Ichthyas, the successor of Euclid as head of the school; and Thrasymachus of Corinth, the teacher of Stilpo. The best-known pupil of Stilpo was Zeno (*c.* 350–260 B.C.), founder of Stoicism. Zeno's successors were Cleanthes and Chrysippus, the latter of whom was the most productive logician of the school. ("If there had been no Chrysippus, there would have been no Stoa"; "If there is any logic in heaven, it is the logic of Chrysippus.") Another important branch of the Megarian school consisted of Eubulides, Apollonius Cronus, Diodorus Cronus, and Philo. Unfortunately, the writings of all these men have been lost, and it is therefore necessary for us to depend upon fragments quoted by later authors. The best of our sources are Sextus Empiricus and Diogenes Laërtius, although we also get bits of information from Cicero, Gellius, Galen, Boëthius, Apuleius, Alexander and the other Greek commentators, Origen, Proclus, Stobaeus, Epictetus, Seneca and a few others. Of these, only Epictetus and Seneca were favourably inclined toward Stoicism, and they were not interested in logic. The result is that our knowledge of the Stoic-Megarian logic has to be obtained principally from persons who were trying to show that it was of no value.

Nevertheless, the picture which can be pieced together from these fragmentary sources is one of a relatively sophisticated and formalized logic quite different from that introduced by Aristotle. It is a logic of propositions, while the syllogistic is a logic of classes or terms; *i.e.*, the values of the Stoic variables are propositions; those of the Aristotelian variables are terms or classes. Further, it is a logic of valid inference schemas, while the Aristotelian formulas are usually propositional forms of conditional type. Stoic-Megarian logic is very modern in a number of important respects. The usual sentence connectives are interpreted truth-functionally, as is customary nowadays, and various possibilities of defining them in terms of one another are noticed. Arguments are sharply distinguished from the corresponding conditional propositions. The inference schemas which make up the calculus are never confused with the meta-rules for their reduction to one another. The whole logic is conceived in terms of a semantic distinction very similar to G. Frege's distinction between the sense and the denotation of linguistic expressions. In general, it is drawn upon lines very familiar to modern students of the subject.

Stoic semantics rests upon a fundamental distinction among three things: (1) the linguistic sign or sound, *e.g.*, the name "Dion," (2) the existent object denoted by the sign, which in this example would be Dion himself, and (3) the meaning of the sign. The first two of these three things are always bodies, say the Stoics, but the third factor is not a body. It is what Greeks but not Barbarians are able to grasp when they hear Greek words spoken. The technical term for these meanings or senses is "Lekta." On the Stoic view, it is with Lekta, and not with the linguistic expressions thereof, that logic is concerned.

The Lekta are classified in great detail. First, they are divided into deficient and complete. The deficient Lekta are subjects and predicates, a subject being the sense of a proper or class name, while a predicate is the sense of a verb. Complete Lekta are propositions, questions, imperatives, oaths, salutations, etc. Of course, the interest of logic is confined to propositions, which are defined as complete Lekta which are assertoric. They are elsewhere differentiated from other complete Lekta by the property of being true or false. A proposition is the sense of a declarative sentence; if atomic (*see* below) it is somehow composed of the subject and predicate which are the senses of the components of the sentence.

Propositions are divided into atomic and molecular. An atomic proposition is composed of subject and predicate without the help of a logical connective. A molecular proposition always contains at least one connective and consists either of two occurrences of a single proposition (as in "If it is day, then it is day") or of different propositions (*e.g.*, "If it is day, then it is light"). Atomic propositions are either definite (*e.g.*, "This man is walking"), indefinite (*e.g.*, "Somebody is walking"), or intermediate (*e.g.*, "Socrates is walking"). Types of molecular proposition include the negation, conditional, conjunction, disjunction, and several others. The negation of a proposition is said to be formed by prefixing "not," and emphasis was placed upon "prefix." (What this spatial terminology can mean when applied to propositions, as contrasted with sentences, is not explained.) Thus, they said, the correct negation of "It is day and it is night" is "Not both: it is day and it is night," which is of course quite different from "It is day and it is not night." A conditional proposition is one that is formed from two occurrences of a single proposition or from different propositions by means of the connective "if" (*e.g.*, "If it is day, then it is light"). The part immediately following the "if" is the antecedent, and the other part is the consequent, even when the conditional is stated backwards, *e.g.*, "It is light if it is day." A conjunction is a molecular proposition compounded by means of the connective "and," *e.g.*, "It is day and it is light." Similarly, the parts of a disjunction are joined by "or," *e.g.*, "It is day or it is light."

There was a great controversy among the Stoics and Megarians about the meanings of conditionals. Callimachus reports, "Even the crows on the rooftops are discussing the question as to which conditionals are true." Sextus states and illustrates the four main proposals. He arranges these from the weakest (material implication) to the strongest, at each step cleverly producing an example which is true in all the preceding senses but false in the sense at hand.

For Philo says that a true conditional is one which does not have a true antecedent and a false consequent; *e.g.*, when it is day and I am conversing, "If it is day, then I am conversing"; but Diodorus defines it as one which neither is nor ever was capable of having a true antecedent and a false consequent. According to him, the conditional just mentioned seems to be false, since when it is day and I have become silent, it will have a true antecedent and a false consequent; but the following conditional seems true: "If atomic elements of things do not exist, then atomic elements of things do exist," since it will always have the false antecedent, "Atomic elements of things do not exist," and the true consequent, "Atomic elements of things do exist."

And those who introduce "connection" or "coherence" say that a conditional holds whenever the denial of its consequent is incompatible with its antecedent; so that, according to them, the above-mentioned conditionals do not hold, but the following is true: "If it is day, then it is day." And those who judge by "suggestion" declare that a conditional is true if its consequent is in effect included in its antecedent. According to these, "If it is day, then it is day" and every repeated conditional probably will be false, for it is impossible for a thing to be included in itself.

It will be noticed that Philo has defined what is now called "material implication." This definition seems to have been the one which found the greatest favour with the Stoics. It occurs in many of the fragments, sometimes even in what amounts to truth-table form:

> Since, then, there are four possible combinations of the parts of a conditional—true antecedent and true consequent, false antecedent and false consequent, false and true, or conversely true and false—they say that in the first three cases the conditional is true (*i.e.*, if the antecedent is true and the consequent is true, it is true; if false and false, it again is true; likewise, for false and true); but in one case only is it false, namely, whenever the antecedent is true and the consequent is false.

The view of Diodorus is not as clear as that of Philo, but from his definition of the "possible" as "that which either is or will be true" we can determine that a conditional holds in the Diodorean sense if and only if it holds *at all times* in the Philonian sense. For example, "If it is day, then it is light" holds in the Diodorean sense provided that for every value of t the propositional form "If it is day at time t, then it is light at time t" is a true Philonian conditional. The third sense mentioned in Sextus' list is what is now called "strict implication"; the fourth is nowhere taken up again.

Two basic types of disjunction were recognized by the Stoics: exclusive and inclusive. Exclusive disjunction was most used, and it is the only type of disjunction involved in the Stoic calculus of propositions. An exclusive disjunction is true if and only if exactly one of the disjuncts is true, *e.g.*, "It is day or it is night." For inclusive disjunction we possess no clear truth-functional definition, but there are illuminating examples, such as "Socrates is walking or Socrates is conversing." There seem also to have been non-truth-functional definitions, according to one of which a disjunction is not true unless the disjuncts are incompatible. As to conjunction, the case is simpler. A conjunction is true if and only if both parts are true. A negation is true if and only if what is negated is not true.

Chrysippus, in reference to the statement "If anyone is born under the Dog Star, then he will not drown in the sea," recommends that it be expressed as follows: "Not both: someone is born under the Dog Star and he will drown in the sea," thus showing that he knew how to express material implication by means of negation and conjunction. There is also some evidence that the Stoics knew how to define exclusive disjunction in terms of negation and equivalence.

As with Aristotle's syllogistic, however, the most interesting aspect of the Stoic logic of propositions is its arrangement into a deductive theory. The elements of the Stoic theory are arguments, not propositions, where an argument is regarded as a system of propositions containing premisses and a conclusion. Arguments of five types are taken as basic, and all others are declared provable in terms of these. The basic types are represented by the following five schemas:

I. If the first, then the second.
   The first.
   Therefore, the second.
II. If the first, then the second.
   Not the second.
   Therefore, not the first.
III. Not both the first and the second.
   The first.
   Therefore, not the second.
IV. The first or the second.
   The first.
   Therefore, not the second.
V. The first or the second.
   Not the first.
   Therefore, the second.

For an example of a proof in the system, consider the following schema:

1. If both the first and the second, then the third.
2. Not the third.
3. The first.
   Therefore, not the second.

The Stoic proof given by Sextus makes use of the following meta-rule: "If we have premisses which yield a conclusion, then we have in effect also the conclusion among the premisses, even if it is not explicitly stated." From 1 and 2, by a basic argument of type II, we get

4. Not both the first and the second.

which, according to the meta-rule, can now be considered as one of the premisses. From 3 and 4 we then obtain the conclusion by a basic argument of type III.

We know that there were four meta-rules by means of which such proofs were to be carried out. Unfortunately, we possess only two (or possibly three) of these rules. The first was "If from two propositions a third is deduced, then either of the two together with the denial of the conclusion yields the denial of the other," and the third was "If from two propositions a third is deduced and there are propositions from which one of the premisses may be deduced, then the other premiss together with these propositions will yield the conclusion." Perhaps the rule used in the example above is another version of this one. The Stoics seemed to think that their system was complete, *i.e.*, that every valid argument in the calculus could be reduced to a chain of arguments of the five basic types. Without knowing all four of the meta-rules we are not in a position to evaluate this claim.

Examples of Stoic proofs are very few in number. However, numerous arguments are mentioned and schematized without proof. For instance, there is the schema

Either the first or the second or the third.
Not the first.
Not the second.
Therefore, the third.

Chrysippus said that even dogs make use of this sort of argument. For when a dog is chasing some animal and comes to the junction of three paths, if he sniffs first at the two paths down which the animal did not run, he will rush off down the third path without stopping to smell. Another schema is

If the first, then the second.
If the first, then not the second.
Therefore, not the first.

A Stoic example of an argument of this type is

If you know that you are dead, then you are dead.
If you know that you are dead, then you are not dead.
Therefore, you do not know that you are dead.

The Stoic and Megarian logicians, like logicians of all times, were greatly interested in paradoxes, the most famous of which was the Liar. This important antinomy was the subject of much writing in antiquity, including perhaps 28 books by Chrysippus alone. In fact, there is an ancient epitaph which says that Philetas of Cos died from spending his nights thinking about it. The Liar appears in several forms. Alexander gives "The man who says 'I am lying' is both telling the truth and lying." Cicero's version is "If you say that you are lying and tell the truth, then you are lying." Gellius asks, "When I am lying and say that I am lying, am I lying or telling the truth?" A closely related paradox, often called "the Epimenides," first appears in the Apostle Paul's *Epistle to Titus*. Paul there reminds Titus that even the Cretan prophet (identified by commentators as Epimenides) said that all Cretans were liars, gluttons, and evil beasts. He adds that what Epimenides said was *true!* No clear solution to any of these formulations is to be found in extant ancient literature.

4. The Last Period.—The history of ancient logic after Chrysippus is a subject still awaiting exploration in the second half of the 20th century. In the imperfect state of knowledge it appears that there were no logicians worthy of being mentioned in the same breath with Aristotle, Diodorus and Chrysippus. The period was not a creative one, new problems and methods being entirely

lacking, and what literature there was consisted primarily of commentaries and compendiums. In this connection, the contemporaries Galen and Apuleius (*c.* A.D. 150), whose handbooks are extant, deserve mention. Among the commentators, Alexander of Aphrodisias, a Peripatetic of the 3rd century A.D., was clearly a competent logician. His commentary on the *Organon* remains down to the present as perhaps the best exegetical account of this work. Of the later Greek commentators on Aristotle, Simplicius must be listed as one of the few who wrote intelligently about matters of logic. Martianus Capella, author of a Latin handbook of great importance for the transmission of ancient logic to later times, should also be mentioned.

Anicius Manlius Severinus Boëthius (*c.* A.D. 480–524), the last Roman philosopher, was not a very good logician but is nevertheless highly important because of his influence on the middle ages. He wrote a number of books on logic, including *De Syllogismo Hypothetico*, *De Syllogismo Categorico*, and the commentaries on *De Interpretatione*. In these works we find Aristotelian logic presented in a terminology and manner now known as "traditional." Thus, the syllogisms are stated as arguments and not in conditional form. The Square of Opposition appears in its usual form, and many other details of classical logic occur for the first time in Boëthius.

In the *De Syllogismo Hypothetico* we find a number of formulas best interpreted as theorems or rules of the propositional calculus. Some of them appear to be absurdly erroneous, but Van den Driessche has shown that Boëthius occasionally used "if" in the sense of material *equivalence*. In the light of this explanation, such formulas as

> If not-*a*, then *b* implies *c*: but
> *b* implies *c*; therefore, not-*a*.

are seen to be valid, after all.

With Boëthius, ancient logic comes to a close. (B. Ms.)

II. LOGIC IN INDIA

1. Origins.—The origins of formal logic in India lie in exegesis and debate. By perhaps the 4th century B.C. the school of exegetes or interpreters of Vedic texts (*mimamsa*) began to furnish technical terms and a few basic concepts that were to be used later in logic. Actual logical operations are first found in the patterns of debate, called in some schools *nyaya*, which crystallize about the 2nd century B.C. The opening argument of the Buddhist *Kathavatthu* of this period falls into such a formal pattern. It contains a refutation that may be summarized thus:

> If my first statement (*a*) was true, then you should consent to my second (*b*). You are wrong to say that *a* is true but *b* is not true. If *b* is not true, then *a* is not true. You are wrong to say that *a* is true but *b* is not true.

This is certainly an approach to propositional logic, as Stanislaus Schayer has pointed out. But it is consistent with the practical nature of such texts that while logical operations are actually performed no general rules are yet given for their performance.

These patterns of debate were often very lengthy, their form being chosen for psychological or rhetorical effect. According to the Jain author Bhadrabahu (1st century B.C.) the best pattern is one of ten members, which he lists as follows: (1) general thesis, (2) particular thesis, (3) general reason, (4) particular reason, (5) counter-argument, (6) denial of the counter-argument, (7) example, (8) doubting the example, (9) laying the doubt, (10) conclusion. It is from such a pattern as this that the classical Indian syllogism, likewise called *nyaya*, arises.

2. The Old Nyaya (Pracina-nyaya).—The major school of Indian logic takes its name from the syllogism. The oldest writings of the school, the *Nyayasutras*, may go back to the time of Christ but acquired additions perhaps as late as A.D. 200. The early period of the school is characterized by intense and beneficial argument between orthodox (Hindu) and Buddhist logicians. Important contributions to logic were also made by the physicists (*vaiseshika*) in the early period and from the 5th century onward by the Jains.

The classical Indian syllogism is found in the earliest Nyaya texts. It consists of five members and shows clearly its origin from a pattern such as Bhadrabahu's (*see* above). It has become a syllogism by the expansion of the "example" to include a statement of universal concomitance or pervasion (*vyapti*). In the following example the particular argument is directed against the exegetes, who claimed that the word of the Veda is eternal.

1. Thesis: Word (is) non-eternal,
2. Reason: because (it possesses) the property of being produced.
3. Example: What possess(es) the property of being produced (is) seen to be non-eternal, as a pot. What possess(es) the property of not being produced (is) seen to be eternal, as the soul.
4. Application: It (viz., word) (is) like this (viz., possesses the property of being produced).
5. Conclusion: Therefore, word (is) non-eternal.

The original of the above contains no finite verb. According to commentators the last three members only are assertions. In the first two the terms are simply brought together without anything yet being asserted of the truth or falsity of the collocation.

This syllogism contains three parts (*ansa*) or terms. (1) The *paksha* (field), viz., the subject of thesis and conclusion. It is called a field because the other two parts occur (*vartete*) in it. In the above example *paksha* = word. (2) The *hetu* (reason proper). In the example *hetu* = the property of being produced. (3) The *sadhya* (that which is to be proved). The early Nyaya argues about just what the *sadhya* is, *e.g.*, whether in the above example it is "the non-eternality of word" or "word-as-non-eternal" or, what was finally agreed on, simply "non-eternality."

This analysis shows how the classical Indian syllogism differs both from those of Aristotle, the terms of which are classes, and from the formulas of propositional logic. The *paksha* is normally a single individual; *hetu* and *sadhya* are regularly properties, expressible in Sanskrit by an abstract noun. The translation of the third member as "$F(x) \supset_x G(x)$" may refer to the same facts in a given instance as the Indian original, but the facts are not arranged in the Indian way. The letter F refers by an indissoluble expression to two notions which are quite distinct to the Indian logician: the *hetu* and the relation by which the *hetu* occurs. In the later development of Nyaya either of these notions may be qualified independently of the other.

The Buddhist Vasubandhu (4th century A.D.) distinguishes between inference for others (*pararthanumana*, *i.e.*, formal debate), which requires the presence of all five members, and inference for oneself (*svarthanumana*), which requires only the first three. The syllogisms of later textbooks are regularly given in the three-membered form. Prasastapada the physicist and the Buddhist Dinnaga (both *c.* A.D. 400) give systematic lists of fallacies.

Dinnaga is the first to give a "wheel of reasons" (*hetucakra*), that is, a systematic list of possible *hetus*. His list is based on the distribution of the *hetu* with respect to the *sapaksa* (objects other than the *paksha* but like it in being loci of the *sadhya*) and the *vipaksa* (objects other than the *paksha* and unlike it in not being loci of the *sadhya*). There are nine possible distributions, as the *hetu* may occur in all, part of, or none of either of these areas.

This wheel of reasons is vastly increased by Uddyotakara (*c.* A.D. 600) of the orthodox Nyaya, who gives 176 possible *hetus*. The increase is occasioned in the first instance by the addition of cases where *sapaksha*, *vipaksha*, or both simply do not exist. Thus, as an example of the third type: "Everything is eternal, because it (is) an object of knowledge." Other refinements of Uddyotakara are to distinguish cases where the *hetu* occurs in all, part, or none of the *paksha* itself, where the *hetu* is complex, *e.g.*, "Word (is) non-eternal, because while it (is) nameable it (is) an object of knowledge," etc.

The Buddhist Dharmakirti (7th century) propounds a further division of *hetus* into: (1) Those which possess a common nature with the *sadhya*, *e.g.*, "This is a tree, because it is a *Simsapa* (tree)." (2) Those which are an effect of the *sadhya*, *e.g.*, "This hill possesses fire because it possesses smoke." (3) Those which are cases of nonperception, *e.g.*, "There are no Simsapas here, because we perceive no trees." It is of this third class, which includes

inferences from negative premisses and inferences leading to negative results, that Dharmakirti's analysis is most elaborate. He lists 11 varieties.

The Old Nyaya is summed up from an orthodox standpoint by Vacaspati Misra, who wrote his *Nyayasucinibandha* in A.D. 976. The date A.D. 841, given in many books, is due to an error in identifying the era.

3. The New Nyaya (Navya-nyaya).—Udayana (11th century) and others were instrumental in altering the Nyaya to the form which it assumes in the hands of Gangesa (14th century according to the evidence adduced by Dinescandra Bhattacaryya). Gangesa for the first time expressly refers to his school as the New Nyaya. In the centuries which followed, other schools also contributed to logic, notably the pluralistic Vedanta of south India (*e.g.*, Jayatirtha and Vyasatirtha), the neogrammarians (*e.g.*, Nagesa Bhatta), and the Jains. The following account is limited to the New Nyaya since its contributions appear to be the most important.

The chief innovations of the New Nyaya are three: a new method of universalization, rendered possible by the concept of limitation (*avacchedakata*); the discovery of a number of laws similar to the theorems of propositional logic; a new interest in the definition of relations and the use of these relations in operations of considerable complexity.

The method of universalization springs from a dissatisfaction which had always been felt with quantifiers. "All things which possess smoke possess fire" had troubled even the old logicians and for more reasons than one. There was the formal difficulty of binders. Mountain fire does not occur in a kitchen nor kitchen fire on a mountain. Deeper than this was a problem of knowledge. Even if interpreted without cross-connection, such statements refer to facts which the Naiyayikas claim are impossible to be known except by inference. And inference cannot serve as the basis for inference. What we perceive, say the Naiyayikas, are the generic principles (*jati* or *vibhajakopadhi*) that reside in the individual manifestations with which the senses come in contact. If a universal statement is to serve as the basis of inference, it should be phrased in accordance with the facts presented by perception. The New Nyaya method of so phrasing statements appears clumsy in English translation and can best be shown by a graduated example.

For "All that possesses smoke possesses fire" let us first substitute the equivalent expression "No case of smoke occurs in what is not a locus of fire." And for this let us substitute again: "The absence of smoke which occurs in the locus of a generic absence of fire is a generic absence." The terms to be universalized are now (*a*) generic absence of fire and (*b*) generic absence (of smoke). Absence *a* is said to be such that its counterpositiveness (*pratiyogita*, the nature of the thing which it denies) is limited (*avacchinna*) by fireness (*vahnitvavacchinna-pratiyogitanirupitabhava*). That is to say, we are denying not this or that case of fire but any case you choose of an entity inhered in by fireness. Absence *b* is said to be an absence whose counterpositiveness is limited by smokeness.

Notice that in these substitutions, which sound so clumsy in English, the Sanskrit expression is a single compound word. The literal rendering of *vahnitvavacchinna-pratiyogitanirupitabhava* would be fireness-limited-counterpositiveness-described-absence. It is this syntactical peculiarity which allows the New Nyaya to operate with such terms somewhat as the modern logician operates with the symbols *p* and *q* or *F* and *G* where these symbols stand for whole propositions or functions. Accordingly, we find in the New Nyaya definitions of conjunction, disjunction, and implication which cover the facts referred to by sentence connectives as well as class connectives. One must bear in mind, however, that a translation of these definitions into logistic notation is never an exact one. The New Nyaya units are never precisely propositions or classes; they are the referenda of abstract nouns. New Nyaya techniques are parallel in many respects to those of modern logic; thus, where the western mathematician or logician speaks of a class of classes the Naiyayika speaks of the abstract of an abstract; but parallel lines do not actually meet.

This New Nyaya method of universalizing by abstraction offers a quite satisfactory substitute for quantification so long as the number of terms and length of operations is not too great. Limits are imposed by human memory and corporeal breath but these limits are fairly wide. In formal debate Naiyayikas of the present day will use words that run to 300–400 syllables and take more than a minute each to pronounce.

As counterpositiveness is limited by an abstract determining the nature of the entity denied, so are causeness, effectness, etc., limited by abstracts which determine or show the precise selection of things caused or effected. A further step is taken by the technique of relational limitors. The counterpositiveness of absence limited by fireness is said to be limited also by the relation contact when we deny the presence of fire in a locus such as hearth, by a relation objectivity if we deny that fire is an object of knowledge, by identity if we deny that fire is water, etc. In this way the New Nyaya comes to investigate the relations between entities, and by simplifying all complex relations into chains of relations of two terms each, it is able to analyze situations of considerable complexity.

The New Nyaya reaches its height of analytical power with Raghunatha Siromaṇi (*c.* 1475–*c.* 1550). This philosopher is as famous for the innovations he introduced in metaphysics, where he overthrew Nyaya tradition for a system much closer to Vedanta, as he is for his logic. Raghunatha constructs definitions of concomitance and pervasion (*vyapti*) that will fit cases of compound and complex *hetu* and *sadhya*. In his analysis of relations he comes on a discovery of the true nature of number. It is typical of his school that he does not distinguish abstracts or classes (*e.g.*, pairs, triples) from the corresponding cardinal numbers (*e.g.*, 2, 3). He distinguishes the relation by which twoness is connected with the components of pairs (the relation of inherence) from the relation by which twoness is connected with the pairs as abstracts. The latter relation, called *paryapti* (which may be translated literally by coining the phrase "circumtaining relation"), corresponds to what Frege in 19th-century Europe expressed by saying that a number belongs to a concept; it represents in another form Frege's insight that, *e.g.*, the number 2 should be attached to the concept, *satellite of Mars*, rather than to the concrete physical objects, Deimos and Phobos.

The creativeness of the New Nyaya, like that of all schools of Indian philosophy, declines from the beginning of the 18th century, but competent Naiyayikas and a few brilliant ones are still to be found in Benares, Calcutta, Mysore and in the district of Nadia in Bengal, the birthplace of Raghunatha.

See also INDIAN PHILOSOPHY. (D. H. H. I.)

III. SCHOLASTIC LOGIC

Medieval scholastic logic is characterized by its dependence on classical tradition, by its use of the Latin language and by the influence of Christian theology. While tradition and the Latin language had a more direct bearing on its formation and development, theology influenced it rather indirectly, partly by demanding a well-developed logic for the discussion of theological questions, partly by positing a few logical and semantical problems of its own; for example, the problem of the truth or falsity of propositions concerning future contingent facts, or the problem of formality of logical discourse in terms of the divine Persons of the Holy Trinity. The Latin language, however, was of far greater importance than theology in the development of medieval logic. Essentially and entirely, the logic of the schoolmen was based on a "natural" language which, with the help of the grammarians (mostly Priscian and his medieval disciples like Elyas), was analyzed, reduced to rules and adapted to the needs of logic. Consequently the language of scholastic logic is richer, or rather more complicated and more involved in the subject matter, than the artificial languages of modern logic. But above any other factor, it was tradition that guided the development of scholastic logic.

Primarily through Boëthius and Apuleius, the early schoolmen believed themselves in uninterrupted contact with ancient logic; what they actually had, however, was but a fragment of the whole.

It was only toward the end of the 12th century that the total body of Aristotelian logic became known; and at the same time the Arabian philosophers—notably Averroës, the great commentator on Aristotle—became available to the schoolmen, while elements of Stoic logic still continued, transmitted primarily from Cicero through Boëthius and Apuleius.

By way of summary, it can be said that scholastic logic began to develop in the 12th century, reached maturity in the 14th and 15th centuries, and declined rapidly from the 16th to the 18th centuries. It is impossible to fill this bare outline with complete details. Modern scholars, thanks to the pioneer work of Jan Lukasiewicz, were, at mid-20th century, only on the verge of bringing to light the highly developed logic of the 14th and 15th centuries—a logic that up to a few decades before had been completely lost.

1. Period of the "Old Logic" (Ars Vetus).—Fragments of ancient logic were transmitted to the scholastics through the works of the church fathers, primarily St. Augustine. The main sources, however, were Porphyry's *Isagoge*, or *Introduction to the Categories of Aristotle*, and the *Categories* and *Perihermenias* (*De Interpretatione*) of Aristotle.

Later, when other logical treatises of Aristotle became known, these three works were grouped together under the title of *Ars Vetus* (Old Logic), while the newly discovered works were called *Ars Nova* (New Logic).

Another part of the logical heritage from antiquity was Cicero's *Topics*, to which must be added the commentaries of Boëthius on the works included in the *Ars Vetus*, his *Introduction to the Categorical Syllogism*, his treatises *On Topical Differences* and *On Hypothetical Syllogisms* and a few minor works, together with the *Perihermenias* of Apuleius of Madauros who also treated the categorical syllogism.

Thus the logicians of the early middle ages—thanks to Cassiodorus and the Benedictine monks who preserved what they could of ancient learning—had at their disposal a classification of terms; a theory of definition and division; an analysis of sentences; the truth and falsity both of simple categorical sentences and of modal sentences and a theory of their oppositions, a theory of the categorical syllogism and of the hypothetical (mostly conditional) syllogism; and a theory of dialectical or topical inferences. Through Cicero, Boëthius, and Apuleius, fragments of Stoic logic were also available to the early scholastics, and Apuleius provided the additional help of a primitive systematization of logic. The most conspicuous deficiency of early medieval logic, measured according to the standard of Aristotelian logic, was the lack of any treatment of the modal syllogisms and of any theory of demonstration.

The history of logic from the end of the ancient world up to the 11th century can be summarized in the one main fact that this partial legacy from antiquity was at least tenaciously preserved and slowly and thoroughly absorbed.

The real development of scholastic logic began with Peter Abelard (1079–1142) and his school. Although contemporary writers speak much of the great activity in logic during this time, and although many logical tracts are still extant in manuscript, little is actually known about the logic of the period. Abelard's *Glosses to Porphyry*, the *Categories* and *Perihermenias* are the only complete texts edited, and they deal more with semantical and philosophical problems (universals) than with logic. His *Dialectica*, substantial parts of which were published by Cousin, seems completely dependent on Boëthius and Apuleius for its logic; in fact it amounts to little more than a systematization of the Boethian legacy.

There are five parts: (I) On the Parts of Speech (*Oratio*), On the Predicables, On the *Categories*, and On the Content of *Perihermenias;* (II) On Categorical Propositions and Syllogisms, or the *Prior Analytics;* (III) Topics; (IV) On Hypothetical Propositions and Syllogisms, or the *Posterior Analytics* (!); and (V) On Divisions and Definitions.

It may be remarked in passing that Abelard was quite aware that it was his logic and his daring application of it to theological problems rather than the scandal of his private affairs that brought him into conflict with St. Bernard (*Odiosum me reddit mundo logica*).

John of Salisbury, a disciple of Abelard, and a great admirer of the *Topics* or *Dialectics*, gives in his *Metalogicon* (*Et quia logicae suscepi patrocinium, Metalogicon inscriptus est liber;* ed. by Clemens C. I. Web, p. 3, Oxonii 1929) many details about the enormous activity in logic that was then going on. He mentions Adam of Little Bridge (*de Ponte Parvo*), an Englishman named after the place where he taught in Paris, who also wrote a textbook, an *Ars dialectica* or *Ars discernendi*. He tells a remarkable story about one of Adam's disciples, William of Soissons, who apparently composed a *machina*, a calculus of logic. According to John of Salisbury, this man learned from Adam of Little Bridge certain quite remarkable consequential rules for the proof of which he used his "machine"; for instance: From one impossible (sentence?) every impossible follows. Although John refuses to accept this, it nevertheless seems to be the forerunner of the later scholastic consequential rule: From an impossible anything follows.

There were about 12 handbooks of logic in use at this time, but they seem to have been more or less of the same type. In any case none of them gained general recognition, and none is accessible to us in printed form.

2. Period of the "New Logic" (Ars Nova).—Around 1200, according to Alexander Neckam (d. 1217), the school at the Little Bridge in Paris required the reading of the *Ars Vetus*, and in addition, Aristotle's *Topics*, *Sophistical Refutations* and the two *Analytics*, these last constituting the *Ars Nova*. From then on the scholastics had at their disposal the entire *Organon* of Aristotle, They immediately began the work of assimilation, and it can be safely stated that around the middle of the 13th century the whole of Aristotelian logic had been completely absorbed and was being extensively used by the schoolmen, notably also by the theologians.

The process of assimilating the *Organon* was greatly helped by the influx of oriental literature into the Latin occident. Long before the scholastics became acquainted with the whole of the *Organon*, the Arabians, through the help of the Syrians, had absorbed Aristotelian logic. It is said that al-Farabi (d. 950), "the Second Philosopher" (Aristotle being "the First Philosopher," Avicenna, "the Third"), directed his attention largely toward the logic of Aristotle and introduced it into the culture of Islam. He overcame the violent reaction of the Islamic theologians and paved the way for "the Third Philosopher," Avicenna (Ibn Sina, d. 1037 in Persia). The part of Avicenna's *Logic* that was translated into Latin toward the end of the 12th century is but an insignificant fragment of his well-developed treatise. His complete original work never directly reached the scholastics, and like the entire "hellenizing Arabian philosophy," as M. Horten calls it, remained foreign to orthodox Arabian philosophy and theology. Most important, as far as scholastic logic is concerned, was the work of Averroës (Ibn-Rushd, d. 1198 in Spain). His excellent and faithful commentaries—the scholastics used to call him simply "the Commentator"—for which he in turn exploited the earlier Greek commentaries—appeared in the first half of the 13th century at Paris and Oxford.

As far as logic is concerned, it seems that the influence of the Jewish philosophers on the scholastics was nil or at most negligible. Even the classical definition of truth as conformity of thought with reality (*adequatio rei et intellectus*), which Thomas Aquinas attributed to Isaac Israeli, is actually not to be found at all in Israeli's *Book of Definitions*. The formula is of Arabian origin.

Thus, through acquaintance with the culture of the east, the schoolmen obtained access to a wealth of material which they used extensively and well. But parallel to this opening up of sources from Arabian philosophy went the direct contact with the Greek sources of Aristotle and his commentators. Thus the revival of the ancient Aristotelian logic was complete. This abundance of newly acquired material was brought together in the voluminous work of Albertus Magnus. He wrote no sum of logic, to be sure, but he paraphrased the whole *Organon* of Aristotle, including also the additions made by Boëthius, by drawing from the Arabian

sources. How far he went independently beyond this scope is difficult to say at present. His logic, as far as syllogistics and the modal logic is concerned, is essentially that of the Aristotelian commentators.

Several near-contemporaries of Albertus Magnus also made important contributions to the development of logic. Robert Grosseteste (d. 1253), bishop of Lincoln, wrote a commentary to the *Posterior Analytics* which had great influence and was widely used. St. Thomas Aquinas (d. 1274) wrote an important commentary to *Perihermenias*, making use of the translations from the Greek furnished by William of Moerbeke. One of his followers, Giles of Rome (d. 1316), composed valuable commentaries to all the works of the *Organon*. Robert Kilwardby (d. 1279), the fellow Dominican and opponent of St. Thomas, also produced commentaries to logical writings, as did Duns Scotus (d. 1308) and the so-called Averroists such as Boethius of Dacia (*c.* 1285).

It is not easy to state just how far these logicians went beyond the matter they had at hand. Clearly, their commentaries did not simply repeat or explain, but sifted and developed as well. The confusing state of the Aristotelian logic of modalities, which was keenly felt by some logicians, was to a certain extent overcome by the distinction of Theophrastus' *sensus divisus* or the modality of the thing, and the *sensus compositus*, or the modality of the dictum. A similar advance can be noted in syllogistics in general. From Averroës the schoolmen learned to enumerate all possible combinations in each figure and to eliminate the invalid moods. Beyond this, nothing definite can be said until further research has been completed.

It is worthy of note, however, that these commentaries to the classical treatises strictly followed the line of development presented in the treatises themselves, taking little or no cognizance of the current of Terministic logic that finally absorbed the Aristotelian. This is true even of those commentaries written by logicians who also wrote original tracts completely in line with Terminism.

3. Rise of Terministic Logic.—Genuine scholastic logic did not originate from the revival of Aristotelian logic, but rather had its roots in earlier tradition, inaugurated by Boëthius and Apuleius and developed by Abelard and his successors in constant contact with grammar. It was the logic of speech (*scientia sermocinalis*), in differentiation from, though not in opposition to, the logic of second intentions. This was the logic that remained basic not only in the sense that it was obligatory for beginners, but also in the sense that it was the starting point for an enormous and original productivity in logic. This logic of the Terminists or Summulists took definite shape, as far as is known at present, toward the middle of the 13th century, and was given its classical form by Petrus Hispanus (Peter of Spain, later Pope John XXI, d. 1277), whose famous textbook remained in use until the 17th century. Terminism was developed primarily by the artists (philosophers) rather than by the theologians, who were relatively late in taking the leading part in it; there are, however, traces of Terministic logic in all the great theologians of the 13th century, beginning with Alexander of Hales (d. 1245).

Terministic logic led its own life, was in constant contact with the logic of the commentators, and was confined neither to the Realists nor to the so-called Nominalists, for it was indifferent to metaphysical implications.

Of the numerous summulae composed during the 13th century, only two have been printed in modern times—those of William of Shyreswood (d. after 1267) and Peter of Spain—and a few others have been described. Their relation to Apuleius is evident from the fact that all of them start with a discussion of propositions (*Perihermenias*) and include compound propositions. Their indebtedness to the grammarians is obvious from the introduction of semantical problems; their character as textbooks is likewise evident from the introduction of mnemonic verses, some of which have survived up to the present (for instance, *Barbara celarent*), and the discussion of sophismata. The pattern of these textbooks for beginners is essentially the same. They open with a tract on propositions, then deal with terms (at least with the five predicables of Porphyry), then with the categorical syllogism, followed by topical rules and ending with fallacies. However, within this framework and sometimes scattered throughout, as in Peter's *Summulae*, there is found a group of additional tracts which constitute the most important contribution of the Summulists. They were called in the middle ages the *Parva Logicalia*, or the tracts on the properties of terms. These properties are the semantical relations of terms in the context of propositions: *suppositio, copulatio, appellatio, ampliatio*, and *restrictio*, to which are added *distributio* and the corresponding properties of relative terms. *Suppositio* is the use of a term that stands for something in a proposition. According to the older, Realist, logicians, a term signifies that for which it is instituted by convention, that is, for a concept or for a nature; but it stands for (*supponit*) that for which it is actually used in a proposition. Hence *suppositio* is the most general property of a term. The predicate term calls for (*appellat-appellatio*) verification for the time indicated by the tense of the verb; the verb itself and true adjectives have *copulatio* (binding); a term may be restricted (*restrictio*) in its scope by the tense of the verb or by the adjectives, or enlarged (*ampliatio*) in a similar way, and may be distributed (*distributio*) by quantifiers, and refer back to another term when it is a relative pronoun. Thus in the sentence: "Every white man was an animal," the terms "white" and "was" have *copulatio;* "animal" has *suppositio,* for it stands for the nature "animality" in every man; and it also has *appellatio,* since it calls for existing men, but only according to the form of the verb—that is, at some past time it must have been true to say: "This white," pointing at a man who is now or was white, "is an animal." The term "man" is restricted by the adjective "white" to stand for fewer individuals than it is able to stand for alone, and the term "white man" is distributed for every individual man who is white.

Of all these properties, it was *suppositio* that received the fullest treatment and the most extensive development. The *supposita* (individuals in a broad sense) for which a term can stand are, according to the Realists, either individuals, or the nature signified by the term, or the term itself. In the first case it is called personal *suppositio*, in the second, simple *suppositio,* and in the third, material *suppositio*. The first two apply to terms in use, the latter to terms in mention. Further distinctions are made, such as common *suppositio* (of a common term) and discrete (of a singular term or its equivalent); natural *suppositio* (the standing of a common term for anything it can stand for), and accidental *suppositio* (the standing of a common term for that which the context requires). Accidental *suppositio* is either simple or personal, and personal *suppositio* is further subdivided into confused and distributive (when a term stands for every individual), determinate (when a term stands for at least one individual), and confused only (when a term is bound or "immobilized" by the essence signified by another term).

It is obvious that semantical and intensional considerations prevailed among the Summulists, although the foundation for an extensional interpretation was laid and to a certain extent developed. It remained for the following period to develop this fully.

The Summulists' interest in semantical relations also led them to study the syncategorematic terms as distinct from the categorematic, which distinction probably goes back to the Stoics. While categorematic terms have a definite object that they signify by convention, syncategorematic terms (*e.g.,* the conjunctions "and," "or," "if-then," etc., the signs of negation and predication such as "no" and "is," etc., the quantifiers "every," "none," "some," etc.) have signification only with categorematic terms, but not alone. This led the Summulists already to understand them as logical operators or functors (*officiales*), and thus they advanced from a semantical to a syntactical interpretation of them. The great interest of the Summulists in these terms is apparent from the fact that they treated them extensively in several independent tracts, and also by the fact that they gave considerable attention to another type of logical literature, the *Sophismata,* which dealt mainly with the same matter. *Sophismata* (which seem to have originated in the school of Abelard) are not always false arguments; they are rather ambiguous sentences that owe their ambiguity precisely to the syncategorematic terms contained in them.

In the medieval texts they are always treated in the same manner; the *positio* of the sophisma (one sentence) is followed by the *probatur* (it is proved) etc., and the *improbatur* (it is disproved) etc., and terminated by the *solutio* of the *probatur* or of the *improbatur* or of both. The study of such tracts was an excellent means of obtaining practice and skill in the application of logical rules.

It may be well to add here that for the same reason—for practice in logic—the so-called *Obligatio* was introduced and developed. *Obligatio* has almost the same meaning as axiomatics in the modern sense, for the *Respondens* binds himself to the acceptance of a proposition and its consequences, and has to guard against the contradictions in the original sentence (the *positio* or *petitio*) or its opposite (the *depositio*), and in the consequences assuming pertinent or impertinent sentences. One kind, the *impositio*, deals with the use of symbols (for propositions or terms) and its limitations.

4. Classical Period of Scholastic Logic.—The classical period of scholastic logic which began, roughly speaking, *c.* 1300, achieved the synthesis of the entire Aristotelian logic with the Terministic logic and systematized that synthesis on the basis of consequential rules. It is impossible to mention the names of all those who deserve credit for this splendid accomplishment, but at least a few of the greatest among them require some comment.

It is becoming more apparent, as research progresses, that the main impetus of the new movement came from Oxford—or in any case from England—with Roger Bacon (d. after 1292) as a forerunner. Sutton, perhaps the Dominican Thomas Sutton (*c.* 1300), composed a tract on consequential rules which was quoted and commented on later by Albert of Saxony. Judging from Albert's comments, the tract was marked by a high degree of formality. The two outstanding men of this period, however, were the so-called Nominalist, William Ockham (Occam), and the Realist, Walter Burley. They had immediate followers among equally great logicians, partly at Oxford, where the Mertonians (William Heytesbury; Richard Swineshead, "the Calculator," who was highly praised by Leibniz; John Dumbleton; Ralph Strode; and Richard Ferabrich) held sway; and partly at Paris, where Jean Buridan and Albert of Saxony were leaders.

Ockham (*c.* 1300–1349) composed three sums of logic, two of which are still unedited. The first and longest is known as the *Summa Logicae*. It is written not for beginners, but for theological students, and as such is a work of maturity. In the spirit of the Terminists, Ockham arranges the entire *Organon* of Aristotle into three parts: (I) On Terms; (II) On Propositions; (III) On Argumentation (the syllogism in general, the demonstrative syllogism, the Topical rules, the fallacies). To the first section are added the *Parva naturalia;* to the second, a discussion of compound propositions; to the third, after the Topical rules, a tract on *Obligatio* is added. Ockham gives only brief mention to hypothetical syllogisms, but he treats *in extenso* of modal syllogisms and mixed syllogisms in a manner that leads far beyond Aristotle. Although he formulates the general consequential rules in the section dealing with the Topical rules, he speaks of them in all three parts of the *Summa,* clearly implying that he considers them the basis of syllogistics.

The step that made Ockham's implication explicit was taken by Walter Burley (*c.* 1275–1345), a staunch adversary of Ockham in many respects but one with him in the purely formal treatment of logic. The bulk of his *De puritate artis logicae* was written after Ockham's *Summa.* As far as is known, this is the first work in the history of logic that places the consequential rules first and reduces syllogistics to a subdivision thereof.

Of the continental logicians, one of the most important was Jean Buridan (*c.* 1295–1366), who rewrote the *Summulae* of Petrus Hispanus, revising the theory of *suppositio* and putting it before the treatment of syllogistics, and adding a tract on demonstration.

Buridan's disciple, Albert of Saxony (*c.* 1316–90), rector of the University of Paris and afterward of the newly founded University of Vienna, and later archbishop of Halberstadt, integrated in his *Perutilis Logica* Burley's concept of logic (whom he often quoted in his other works), with Buridan's improvement, into the system of William of Ockham. Thus was finally completed a system of scholastic logic which would seem to be unsurpassed by that of any other schoolman. This highly condensed and nevertheless complete logic contains six tracts. The first deals with terms; the second, with *suppositio* (adding many rules); the third, with propositions; the fourth, with consequential rules; the fifth, with fallacies; the sixth, with *Insolubilia* (insolvables, antinomies) and *obligatio*. In the first three tracts, Albert follows Ockham closely as to arrangement and content, though the second part is much better organized and considerably extended. The fourth tract, however, combines the thought of Ockham, Burley and Buridan, welding together in an ingenious system (and in this order) the general consequential rules of simple categorical propositions, of modal propositions, the consequential rules of categorical, hypothetical, modal and mixed syllogisms and the topical consequential rules. Again syllogistics is subordinated to a general theory of consequential rules.

In this work, as in all the others of the period and of subsequent periods, it is characteristic that the theory of consequential rules is treated as of primary importance. Two other dominant characteristics are a mainly extensional interpretation of the theory of *suppositio* in combination with a perfect sense for the formality of logic.

This character of the formality of logic is clearly and succinctly expressed by Albert, following Burley. The syncategorematic elements of discourse are the form; they are the skeleton of logical discourse and are clearly understood as being the constants on which the formal validity of inferences rests. The categorematic terms are understood as the material elements; variables are used for them and the rule of uniform substitution applied. Thus the inference: "A man is running, therefore an animal is running," is not valid. For the substitution made in: "If *a* is *b*, then *c* is *b*," not by *a*/man, *b*/running, *c*/animal (which would yield the true inference), but by *a*/man, *b*/running, *c*/tree, will make it a false inference. However, the inference, "If *a* is *b*, then what is *b* is *a*," is formally valid. It is also expressly stated that the position of terms or propositions belongs to the form. Hence it is not the same to say: "*Socrates ab homine differt*" ("Socrates differs from a man") and "*Socrates differt ab homine*" ("Socrates differs from man"). The former is true and the latter false. To be "formally true," "logically true" and "universally true" are interchangeable expressions. Since the syncategorematic terms as the syntactical constants of logical discourse are fixed by definition, though not by a definition of a thing (*quid rei*) but of the meaning of the term (*quid nominis*), because there is nothing corresponding to them in the object world, the famous and much misunderstood distinction between that which is true because of the expression (*de virtute sermonis*) and that which is true according to the intention of the author, calls for a rigorous analysis of ordinary speech and its reduction to exact language. In fact, it was one of the main tasks of scholastic logicians to codify laws for the complicated Latin language in order to make it a vehicle for valid inferences.

The negation of terms (yielding infinite nouns and verbs), of simple and modal categorical propositions, and of compound propositions (called hypothetical), is consistently carried through. The contradictory opposite of an expression or a sentence is always obtained by adding the sign of negation to the term itself or to the principal element of the proposition. In the latter case, this is either the verb or the modality or the main statement-connective. Lacking adequate symbolism—only term and proposition variables are used—the scholastics scrupulously insisted that the sign of negation must precede that which it is supposed to deny. Hence, a typical negation of a conditional sentence would be: "Non, si *a* est *b*, *b* est *c*."

It was partly through this device for negation and partly because of their interpretation of the "vel," the "or-conjunction," that the schoolmen, long before Augustus De Morgan, formulated the laws that bear his name. It seems that England discovered them, just as it rediscovered them; for Ockham and Burley are both in complete and perfect command of them as understood by modern logicians—that is, as applying to unanalyzed propositions.

According to Burley, the negation of: "*a* et *b*" ("*a*" and "*b*" being proposition variables) is "non: *a* et *b*," and this is equivalent to: "non *a* vel non *b*"; and the negation of: "*a* vel *b*" is "non: *a* vel *b*," and this is equivalent to: "non *a* et non *b*."

In a surprisingly extensive form, the conditional propositions and inferences between them were studied during this period and developed into a whole system. Sometimes they were united in tracts usually entitled: *De Consequentiis*, of which the earliest seems to be that of Thomas (?) Sutton. Others were written by Ralph Strode and Jean Buridan—at least there is a printed text attributed to him. These tracts contain the basic theses or laws of modern propositional calculus and some of the theory of quantification, but they are not formulated as laws or theses—though sometimes used as such—but are rather formulated in a metalanguage and as rules for inferences, using as names for variables or substitutions for them "antecedent" and "consequent."

The term "consequence" can be equated with "conditional proposition," though some logicians restrict it to mean logically, that is formally, valid inference. The *officialis* or operator "*si*" (if-then) is understood sometimes in the Diodorean, sometimes in the Philonian, sense; in the latter sense definitely by John of Cornwall (Pseudo-Scotus), most probably also by Ockham. Lately Ernest A. Moody devoted a special study to consequential rules and formulated more than 60 of them, corresponding to the rules given by the scholastics, and corresponding also to theses of the propositional calculus in *Principia Mathematica* and in C. I. Lewis's system of strict implication (Lewis and Langford, *Symbolic Logic*). If to these are added the modal consequences, the number goes far beyond 100, and if the syllogistic consequences of all forms are added, the number goes far beyond 1,000.

Though all the classical scholastic logicians speak of syllogistical consequences, at least one of them was aware that a syllogism in the form received from the Aristotelian commentators is not a consequence, that is, not a conditional proposition, but a juxtaposition of categorical propositions. And since as such a syllogism is neither true nor false, the denial of the conclusion of a syllogism does not infer the denial of the premisses. In order to make the rule: "From the denial of the consequent follows the denial of the antecedent" applicable to syllogisms, we must transform them into compound conditional propositions of which either the antecedent or the consequent is composed of two categorical propositions joined by the connective "and."

The theory of consequential rules deeply penetrates the entire theory of *suppositio*. The definitions of various forms and subdivisions of *suppositio* are given by formal consequences which are called "descent." The scholastics made use of four different quantifiers which are defined as follows: The universal quantifier ("every") allows the descent from a common term to copulative propositions in which the common term is particularized (*singularizatio*), and all individuals are enumerated for which the common term stands. In a similar way the particular quantifier ("some") allows the descent to a disjunctive proposition, the collective quantifier ("all") to *one* proposition, in which the term is singularized and its elements joined by "and"; the disjunct or confused quantifier to *one* categorical proposition in which the term is singularized and its elements joined by "or." For example: "Every man is an animal" is equivalent to: "This man is an animal, and that man is an animal," and so on for every individual man that is an animal. "Some man is an animal" is equivalent to: "This man is an animal or that man is an animal, etc." "All Apostles are twelve" is equivalent to: "This Apostle and that Apostle and so on for all the Apostles, are twelve." "Every man is an animal," is equivalent to: "Every man is this or that or that, etc., animal." Later scholastics also studied the relations between the various quantifiers.

During this period, and certainly beginning with Ockham, a semantical definition of truth and falsity on the basis of the theory of *suppositio* was elaborated. In its simplified form it runs: "A proposition is true if subject and predicate stand for the same or do not stand for the same as is denoted by that (affirmative or negative) proposition." Hence the proposition: "A man is white" is true if, and only if, there is a thing of which it can be said that this is a man and this same is white.

The theory of *suppositio* also solves the problem of the so-called existential import. Hardly any of the scholastics understood a categorical universal affirmative proposition as equivalent to a conditional proposition, although they understood the latter as a consequence from the former. A scholastic universal proposition is simply invested with existential import and in order to make the *conclusio ad subalternatam* valid, it is not necessary to add an existential proposition. Later scholastic logicians added a conditional to the descent, for instance: "Every man is an animal, therefore this man, if he exists, is an animal, etc." Or they added the so-called *constantia*, that is, the proposition: "and these are all . . ." However, since the scholastics were keenly aware of the problem and moulded their theory of *suppositio* accordingly—which theory varied, for the Realists admitted the existence of universal things and the Nominalists denied it—and since many admitted the *suppositio naturalis* which was often understood as being of necessary matter, they paid attention to the problem of the conversion of propositions, and were extremely cautious about the conversion by contraposition and in the use of infinite terms (that is terms like "not-man," "not-stone").

The various and varied discussions of the logical antinomies can only be hinted at here. No more than passing mention can be made even of Raimon Lull (*c.* 1235–1315), whose *Ars Magna* and his method of combination (*mixtiones*) so deeply influenced Leibniz, for there is no authentic interpretation of the work of this challenging thinker who was both mystic and logician.

5. Decline of Scholastic Logic.—Toward the end of the 14th century, the decline of scholastic logic set in. The ravages of Black Death, the wars between France and England, the western schism, all acted unfavourably on the scientific culture of the late middle ages. Yet it is remarkable that especially scholastic logic managed for more than a century to maintain its high standard. Its worst enemies arose from the ranks of the Humanists who preferred classical style, poetry, and rhetoric to the rigour of the "barbaric" Latin of scholastic logic. Nevertheless it was Italy, the centre of Humanism, that produced the best logicians of the period. Paul of Venice (d. 1429), an alleged Averroist but certainly of the school of the Nominalists, composed a *Logica Magna* and *Parva*. The former is a truly monumental work, not only in regard to its size, but in the thoroughness of its formal treatment of logic as well. Paul admits only simple conversion as formally valid, applies quantification also to material *suppositio*, and has a most interesting discussion of the semantical antinomies. A more succinct and highly systematized logic, composed entirely in the form of theses, was produced by his disciple, Paulus Pergulensis (d. 1451).

During this time many commentaries were written, mostly on the *Summulae* of Petrus Hispanus, or on Buridan (for example, the very important commentary of Dorp). Some writers also commented on the *Logica Parva* of Paul of Venice, and on a few others of lesser importance. These commentaries are of value for historical notes. It seems that the Realists, during this period, confined their activities to writing commentaries, although toward the turn of the 15th century they began to produce original tracts, largely based on the revised order of the *Summulae* of Petrus Hispanus. Of the Scotists, mention should be made of the commentaries of Johannes Magistri (*c.* 1400), of Johannes de Monte (*c.* 1450) and especially of Petrus Tartaretus (rector at Paris, 1490), who also composed an excellent little tract on the Descent. Of the Thomistic tradition, the logic of St. Vincent Ferrer (written 1372) merits attention, and the more extensive work of Chrysostom Javellus (d. 1538), both of which continue the realistic Terminist logic.

Under the impact of the Reformation and the new philosophies, the so-called Nominalistic logic, and in general the extremely formalized logic of the 14th and 15th centuries, disappeared from the scene. With the Counter Reformation, toward the end of the 16th century, a kind of scholastic renaissance took place, but it disregarded much of the former achievement, going back primarily to the philosophy of St. Thomas and Duns Scotus. Johannes a Sancto Thoma (1589–1644) composed a logical tract that has

drawn some attention from modern scholars; and the works of Silvester Maurus, S.J. (1619–87), and Bartholomew Mastrius, O.F.M. Conv. (1602–73), have also won the notice of recent writers.

The 17th century saw the complete disintegration of scholastic logic. Subsequent degeneration was so rapid that by the middle of the 18th century it was dead to all practical purposes.

See also the separate articles on many of the logicians mentioned in this section. (PH. B.)

IV. MODERN LOGIC

In this section we outline the development of deductive logic from the 16th to the middle of the 20th century. The history of inductive logic is treated in the articles INDUCTION; PROBABILITY; and SCIENTIFIC METHOD.

1. Ramée.—Pierre de la Ramée, or Petrus Ramus, whose anti-Aristotelian position was widely influential, is perhaps the first of the post-scholastic logicians who deserves mention here. One of the earliest noteworthy works on logic in a modern language is his *Dialectique* of 1555, though other works are in the traditional Latin. His *Dialecticae Libri Duo* of 1556, long used as standard (John Milton's *Artis Logicae Plenior Institutio*, 1672, is, *e.g.*, but a revised edition of it), has a much modified and abbreviated version of the older logic, omitting the immediate inferences altogether and greatly simplifying the rules of the categorical syllogism. In an altered classification into moods or kinds, a special place is provided for syllogisms having two singular premisses, including not only the two moods of the expository syllogism (*see* LOGIC) but inferences involving a singular predicate, such as: Octavius is heir of Caesar, I am Octavius, therefore I am heir of Caesar; Judas that wrote the Epistle was the brother of James, Judas Iscariot was not the brother of James, therefore Judas Iscariot was not the Judas that wrote the Epistle.

Propositions with singular predicates had been treated by Ockham, Pseudo-Scotus, and other scholastics—as well as the expository syllogism, by some as confined to the third figure, so that the singular middle term occurs only as subject, but by others as admitting moods also in other figures. And indeed Pseudo-Scotus already maintained that syllogisms with singular premisses should be brought into the Aristotelian form by rereading in the following way: Everything which is Octavius is heir of Caesar, everything which is I is Octavius, therefore everything which is I is heir of Caesar. The Ramistic treatment of these singular inferences as non-Aristotelian was later countered on similar grounds by Thomas Spencer (*The Art of Logick delivered in the precepts of Aristotle and Ramus*, London, 1628) and, more sharply, by the mathematician John Wallis (*q.v.*) in his Cambridge thesis of 1639, published in 1643, and in his *Institutio Logicae* of 1687. Wallis reached the conclusion that singular propositions are to be assimilated to universal propositions for purposes of the syllogism, on the ground that the predicate of a singular proposition and of a universal proposition are alike predicated of all, of the whole rather than a part of the subject. Following, not necessarily Wallis, but earlier writers generally, the authors of the Port-Royal Logic (*see* below) give a similar account of singular propositions, so that it is said that all propositions can be reduced to the four forms *A, E, I, O*. And this remained the generally accepted doctrine until the traditional point of view was superseded by the development of modern logic in the 19th and 20th centuries.

2. Jungius.—Joachim Jungius, in his *Logica Hamburgensis* of 1638, brought forward and discussed a number of forms of inference that are not reducible to the traditional immediate inferences and syllogisms. Relations especially are involved in these, and if widespread attention and study had been given to the matter, the logic of relations might have been developed two centuries in advance of the actual event. But Jungius remained without important influence, except upon Leibniz, and his contributions to logic were ignored by his successors or (*e.g.*, by Wallis) dismissed as reducible to the traditional doctrine.

One of these forms of inference which Jungius considers is that of the so-called *oblique inferences*, which had already been treated by Aristotle. An example is: The square of an even number is even, 6 is an even number, therefore the square of 6 is even. The significance of this, as it appeared in the light of much later developments, may be seen by attempting to reduce to traditional syllogistic form as follows: Every even number has an even number as square, 6 is an even number, therefore 6 has an even number as square. In this way the conclusion has 6 as its subject. And if we wish then to infer, in another syllogism, that 36 is the square of 6 and therefore 36 is even, we must first transform the conclusion so that it will have as its subject, the square of 6. The inference which is missing from the traditional catalogue of forms is the immediate inference (if we wish to call it that) from the proposition, 6 has an even number as square, to the proposition, the square of 6 is an even number.

To make the issue clearer we may put the inferences into modern notation, using $e(x)$ to mean that x is even, and $s(x, y)$ to mean that the square of x is y. The first inference is then from the premisses $e(x) \supset_x \cdot s(x, y) \supset_y e(y)$ and $e(6)$ to the conclusion $s(6, y) \supset_y e(y)$, and the second inference then uses the additional premiss $s(6, 36)$ to draw the conclusion $e(36)$. Relational inferences of this sort—here illustrated in a case so simple as to be almost trivial—are as a matter of fact essential to nearly all important mathematical reasoning.

Other examples of Jungian relational inferences are the following. A circle is a figure, therefore who draws a circle draws a figure: $c(x) \supset_x f(x)$, therefore $c(x) \wedge_z d(x, y) \supset_y \cdot f(x) \wedge_z d(x, y)$. A reptile is an animal, therefore Who created every animal created every reptile: $r(x) \supset_x a(x)$, therefore $a(x) \supset_x C(x, y) \supset_y \cdot r(x) \supset_x C(x, y)$. David is the father of Solomon, therefore Solomon is the son of David; *i.e.*, upon supplying a tacit premiss, $f(x, y) \supset_{xy} s(y, x) . f(S, D)$, therefore $s(D, S)$. (This last had been considered also by Galen.)

3. Geulincx.—Arnold Geulincx published in 1662 *Logica Fundamentis Suis, a quibus hactenus collapsa fuerat, Restituta.* Though the title indicates the author's intention to restore neglected fundamentals, this is not just a reproduction of the scholastic logic but an original work. Following are some points of special interest. The doctrine of *suppositio*, largely ignored by other logicians of the period, is here reproduced in altered terminology and with some alteration in content; the possibility of using the same term with different kinds of *suppositio* is treated as being (with a suitable exception to allow for syllogistic inference) a form of equivocacy, and the device is mentioned in particular of underlining in manuscript or using a distinct style of type in print, to distinguish "grammatical" (*i.e.*, material) *suppositio* and "logical" (*i.e.*, simple) *suppositio* from others. It is argued that negation may be applied only to propositions, and not to terms. Detailed rules (not new except in viewpoint) are given for the reduction of negations, including what are now known as the De Morgan laws of the propositional calculus, the law of double negation, and such reductions as that of *not all not* to *some, i.e.*, of $\sim(x) \sim$ to $(\exists x)$. Treatment of the categorical syllogism is brief but adequate, and is supplemented by mention of the inference known as the anti-syllogism (example: Peter is not an animal, therefore either Peter is not a man or some man is not an animal). What would now be called valid inferences of the propositional calculus are especially well handled, in spite of the handicap of doing it entirely in words, without the aid of special symbols other than the use of capital letters to stand for propositions. Disjunction is explained clearly as inclusive, and *modus ponendo tollens* is rejected (in contrast with the uncritical acceptance of this inference by Ramus and by the Port-Royal Logic). The copulative syllogism (*see* LOGIC) is treated by use of the appropriate De Morgan law to reduce it to *modus tollendo ponens*. No reduction of the negation is given in the case of conditional propositions, but negations of such propositions are considered, and the following inferences are allowed: from $\sim \cdot \mathbf{A} \supset \mathbf{B}$ to $\sim \cdot \sim \mathbf{B} \supset \sim \mathbf{A}$; from $\mathbf{B} \supset \mathbf{C}$ and $\sim \cdot \mathbf{A} \supset \mathbf{C}$ to $\sim \cdot \mathbf{A} \supset \mathbf{B}$; from $\mathbf{A} \supset \mathbf{B}$ and $\sim \cdot \mathbf{A} \supset \mathbf{C}$ to $\sim \cdot \mathbf{B} \supset \mathbf{C}$; from $\mathbf{A} \sim \mathbf{B}$ to $\sim \cdot \mathbf{A} \supset \mathbf{B}$.

Geulincx considers at one point the inference: Every white man is white, every white man is a man, therefore some man is white. He notes that the premisses are necessary, but the conclusion contingent. And he rejects the inference on the ground that the

word "white" is used equivocally—in the conclusion to refer to the present time, and in the premisses absolutely, *i.e.*, without reference to time—so that the syllogism has four terms. The weakness of this is that there are still only three terms in the premisses, and on the traditional doctrine a conclusion should follow in Darapti. But it remained for Leibniz some decades later to give more serious consideration to the problem of existential import.

4. Port-Royal Logic.—Port-Royal Logic or *La Logique ou l'Art de Penser*, the original title, was written by Antoine Arnauld and Pierre Nicole, possibly with the collaboration of some others, and was first published in 1662. It was, like Ramus, long and widely used (both Latin and English translations appeared in England) and though the authors follow Ramus in the fourfold division of logic into idea, judgment, reasoning and method, they restore the Aristotelian-scholastic treatment of opposition, conversion and the categorical syllogism.

An important original contribution of the Port-Royal Logic is the distinction between *comprehension* and *extension—of ideas*, as the authors say—or *of concepts*, or *of terms*, as is more usually said by later writers. The comprehension of a concept consists namely of all those attributes which are contained in it and cannot be removed from it without destroying it—as, *e.g.*, the authors say, the idea (concept) of a triangle contains extension, figure, three sides, three angles, the equality of the sum of these three angles to two right angles, etc. And the extension of a concept consists of the subjects to which it extends, or of what were traditionally called the inferiors of a general term—so that, *e.g.*, the extension of the concept of a triangle consists of all the different species of triangles: isosceles, right, obtuse, etc. This distinction was widely adopted by later writers and became a standard part of the traditional logic. Along with Mill's connotation and denotation of names it may be thought of as a forerunner of Frege's distinction of sense and denotation (*see* SEMANTICS IN LOGIC; CONNOTATION; and DENOTATION).

The Port-Royal Logic also contains the first publication of the ideas of Blaise Pascal (*q.v.*) about the nature of definition. Namely it was Pascal who first observed that every demonstrative science must begin, not only with unproved propositions (*see* AXIOM, and POSTULATE) but also with undefined terms, or *termes primitifs* as they are called in the Port-Royal Logic. Pascal also restricts definitions in mathematics to nominal definitions, *définitions de nom*, which consist merely in the giving of a name to something which has been clearly designated in terms completely known; the use and purpose of such definitions is the abbreviation of discourse; they are entirely free, and never subject to being contradicted; and, as Pascal wrote in a letter to Le Pailleur, one may equally well define something impossible as something actual. These ideas were taken up by the authors of the Port-Royal Logic, who lay great emphasis on the need for careful definition as a means of avoiding confusion of thought. However they retain also the notion of a real definition, or *définition de chose*, as a proposition which explains the nature of a thing by means of its essential attributes, and which is therefore capable of being confirmed or disputed. And the idea, which arose much later, that primitive terms and axioms (or postulates) are, like nominal definitions, arbitrary, is not to be found in the Port-Royal Logic; on the contrary the authors demand, following Pascal, that primitive terms shall be completely known, and axioms completely evident.

5. Saccheri.—Giovanni Girolamo Saccheri's *Logica Demonstrativa* of 1697 and 1701 also requires mention, though the author is (deservedly) better known for the partial anticipation of non-Euclidean geometry in his *Euclides Vindicatus* of 1733 (*see* GEOMETRY, NON-EUCLIDEAN). The *Logica* provides a treatment of the traditional logic in the form of a series of demonstrations based on postulates and definitions, in the manner of works on geometry. Two points are emphasized which afterward played an important role in the *Euclides Vindicatus*, namely: (1) the law of Clavius (*see* LOGIC) and the associated method of proving a proposition by showing it to be a consequence of its own negation; and (2) the distinction between nominal definitions and real definitions, on the basis that the former merely state the meaning of a term, whereas the latter carry also the assertion of existence.

(1) is the *consequentia mirabilis* of 17th-century scholastic writers. Geronimo Cardano (*q.v.*) writes in his *De Proportionibus* of the striking character of this method of proof, which he thought to be his own discovery. Knowledge of the method came to Saccheri through Christopher Clavius, by whose name the law is sometimes known, and who, in commentaries on Euclid and on Theodosius, points to its use by Euclid, by Theodosius, and by Cardano. But Saccheri was the first to exploit this method of proof systematically—in his *Logica* and in *Euclides Vindicatus*.

Significant in (2) is that definitions are always of terminology, and real definitions are distinguished from nominal by the added demonstration or assumption of existence. Otherwise Saccheri had been anticipated by Pascal and in the Port-Royal Logic, in regard to the nature of nominal definitions and the fallacy of misusing a nominal definition in the role of a real definition. (But Saccheri, in his Latin terminology and in his notion of nominal definition, is evidently following Ockham and other scholastics rather than Pascal.)

6. Leibniz.—Gottfried Wilhelm von Leibniz (*q.v.*; Leibnitz) brought forward already in a work published in his youth (*Dissertatio de Arte Combinatoria*, 1666) the project of constructing a universal exact system of notation, a symbolic language, in which all concepts would be so analyzed into their ultimate constituents, by the notation itself, that it would be the means for a fundamental knowledge of all things. This project of a *lingua characteristica universalis* was partly based on the ideas of Lull, to whom Leibniz refers. Leibniz continued to advocate it throughout his life, later adding as an important part the project of a *calculus ratiocinator*, or calculus of reasoning. And though the total program of Leibniz, as just described, is no doubt not even theoretically fulfillable, the *calculus ratiocinator* remains an important forerunner of the logistic method in logic.

Leibniz's contributions to logic remained largely unpublished during his lifetime. The most important waited publication much more than a century. But Raspe's *Oeuvres Philosophiques de Leibniz*, published in 1765, contains a purely descriptive paper about the *lingua characteristica universalis*, a paper which treats the difficulty concerning existential import, and the *Nouveaux Essais sur l'Entendement Humain*.

In the paper on existential import, Leibniz is led to hold that all four of the categorical forms *A*, *E*, *I*, *O* are to be understood on the basis of a tacit presupposition that the terms which enter are existent (are not empty). This Leibnizian solution of the difficulty has often been adopted since; and if class variables are used to formulate the traditional logic of categorical propositions, the solution may be put in the form of restricting the range of values of the variables to *non-empty* classes. There is, however, the objection that this seriously reduces the applicability of the traditional logic, as it may be impracticable to ascertain in advance that all terms are existent, and syllogistic reasoning may serve a substantial purpose even in cases in which it is possible or probable that some of the terms are empty.

In a passage in the *Nouveaux Essais*, Leibniz discusses the relational inferences of Jungius, correctly remarking that they cannot be reduced to any traditional syllogism except by a *changement des termes* which renders the total process of inference asyllogistic (*see* above).

The same work also contains a statement of the law of identity in the form, "*A* is *A*," or "All *A* is *A*." This law must not be credited exclusively to Leibniz—since Leibniz refers to its use by Ramus to treat the Aristotelian conversions as special cases of categorical syllogisms—and since indeed this possibility was known in the 13th century, and there is mention already by Boëthius of what John Locke (in 1690) called "identical propositions." But it was Leibniz who first ascribed to the law of identity a special status as a "primitive truth of reason."

In many of his works Leibniz seems to overestimate the importance of one or both of the laws of contradiction and identity. In the *Nouveaux Essais* Leibniz avoids saying that these laws are alone a sufficient basis for the whole of logic, and even may be thought to imply the contrary. But elsewhere he is less cautious,

especially in writings that were not intended for publication. Thus in *Réflexions sur l'Essai de l'Entendement Humain de Mr. Locke* (published with Locke's letters in 1708) and in the reply to the first letter of S. Clarke (published in 1717 after Leibniz's death) it is said that the law of contradiction, so stated as to include the law of identity, suffices to demonstrate either all truths independent of experience or all principles of mathematics. It would seem that Leibniz at times really hoped that all necessary truths might be demonstrably reduced to these very simple ones—though indeed with the aid of certain principles of inference, especially the syllogism in Barbara (*cf.* the letter quoted by J. E. Erdmann, vol. 1, p. 81). But some of his successors made the idea into an unsupported and almost meaningless item of doctrine—*see* THOUGHT, LAWS OF.

Leibniz's actual attempts at the construction of a *calculus ratiocinator* were made in the period from 1679 to 1690 and are published, some in Erdmann's *Opera Philosophica* (vol. 1, 1840) and C. I. Gerhardt's *Philosophische Schriften* (vol. 7, 1890), the remainder in L. A. Couturat's *Opuscules et Fragments Inédits* (1903). These show beginnings from which the modern treatment of logic might well have developed. But their content remained unknown for 150 years, and historically only the generalities of Leibniz's program exerted any influence.

In the century following Leibniz there were many attempts at a logical calculus, of which the most widely known and discussed were those of Gottfried Ploucquet (in 1763) and of Johann Heinrich Lambert (*q.v.*) (in 1767, and in a number of fragments published in *Lamberts Logische und Philosophische Abhandlungen*, vol. 1, 1782). Lambert's are noteworthy as containing some beginnings of a logic of relations. But none of the attempts produced a satisfactory calculus, and the main trend of opinion was against this direction.

7. Euler.—Leonhard Euler (*q.v.*), in his *Lettres à une princesse d'Allemagne* (vol. 2, 1770), illustrated his treatment of the categorical syllogism by using the interiors of three circles to represent the minor term, the middle term and the major term. Thus $\mathbf{s}(x) \supset_x \mathbf{m}(x)$ is pictured by showing the circle for **s** entirely within that for **m**, and $\mathbf{s}(x) \supset_x \sim\mathbf{m}(x)$ by showing the two circles as non-overlapping, etc. This method of visually checking the validity of syllogisms was brought into general use through its adoption by Euler, and came to be known as the *Euler diagram*, though the device did not originate with Euler. Such circle diagrams had been employed in special cases by Johann Christoph Sturm (*Universalia Euclidea*, 1661); and they were used by Leibniz to treat the categorical syllogisms systematically, in a fragment not published until 1903; but their first systematic use for this purpose in a published treatise seems to have been by Johann Christian Lange (*Nucleus Logicae Weisianae*, 1712).

8. Kant.—Immanuel Kant (*q.v.*) contributed little to logic. Indeed it was his opinion that logic had made no important step either forward or backward since Aristotle, and seemed to all appearance to be finished and complete (*Kritik der reinen Vernunft*, preface to 2nd ed., 1787). But his influence was great because of his reputation in other fields. In particular the general acceptance of the term, *analytic*, for propositions that are true on logical grounds alone is traceable to Kant, although Kant's own definition of the term would restrict it to a narrow subclass of such propositions, and although the term, *analytic*, and its opposite, *synthetic*, had been used already by Christian August Crusius in 1747. The now familiar contention that "existence is not a predicate" is due to Kant, who used it (*op. cit.*) as an objection against the so-called ontological proof of the existence of God; but a satisfactory positive analysis of the notion of existence had to await the introduction of the quantifiers by Frege and Mitchell.

9. Hegel.—Georg Wilhelm Friedrich Hegel (*q.v.*), in *Wissenschaft der Logik* (1812–16), denounces the Leibnizian project of a universal symbolic language as shallow and senseless, and singles out for special attack Ploucquet's recommendation of his calculus as making possible the mechanical performance of logical inference without danger of error if the rules of the calculus are followed. Hegel is similarly critical of the Euler diagrams, and even of the long-established formal treatment of the syllogism as it appeared in the traditional logic of his day. It is not without some justice that he reproaches the latter with being in an ossified and contemptible state. But Hegel represents, as an extreme example, the tendency which long prevailed to hold logic itself in low esteem and to devote the greater part of a work on logic to other subjects, especially to topics in epistemology and metaphysics that bear upon the traditional logic or are suggested by it.

10. Bolzano.—Bernard Bolzano's *Wissenschaftslehre* of 1837 contains many original contributions of which the importance was long overlooked, and its proper place in the history of logic came to be seen only in the light of much later developments. In this brief account we confine attention to a single point, Bolzano's treatment of the notion of analyticity.

Bolzano introduces notions of analyticity in a *wider* and in a *narrower* sense; but of these only the latter is free from serious objection, and will be described here. It will be convenient to state Bolzano's definition with respect to a formalized language, though it must be remembered that Bolzano did not have this means available, and such restatement of his definition gives it an appearance of greater rigour than was possible for Bolzano himself. We may take this language to be the set theory of Zermelo (*see* LOGIC), with a large number of individual constants added, corresponding to the words of various kinds that appear in an English dictionary, so that the language becomes (theoretically) usable for purposes of ordinary discourse as well as for expressing propositions of pure logic and of mathematics. Also we state the definition as for an *analytically true sentence*, although Bolzano deals rather with the proposition ("Satz an sich") expressed by a sentence; and we employ the terminology explained in the article LOGIC, instead of Bolzano's own. From any sentence let a corresponding propositional form be obtained by replacing every extra-logical constant (Bolzano says extra-logical concept) by a variable, two or more occurrences of the same constant being replaced always by the same variable, and different constants by different variables. A sentence is then analytically true (in the narrower sense) if either: (1) the corresponding propositional form is true for all values of the variables; or (2) the sentence can be reduced to one satisfying condition (1), by a series of steps which consist in replacing an occurrence of an individual constant by a synonymous constant or a well-formed part by a synonymous well-formed part.

This definition is not without its difficulties. In particular no explication is offered of the notions of synonymy and of being true for all values of the variables (or satisfied by all values of the variables—*see* SEMANTICS IN LOGIC), but these notions are taken for granted; indeed the notion of synonymy is not explicitly present at all, but is implicit in the treatment of propositions rather than sentences, and its role is indicated only by some examples. Bolzano himself calls attention to the possibility of dispute as to which constants, or concepts, shall be recognized as logical and which as extra-logical (though in the case of the particular language which we have here selected for the purpose of illustration, it might be possible so to control the vocabulary of added individual constants that all constants but A and ϵ would be clearly extra-logical). In spite of such difficulties, Bolzano must be credited with having proposed the first definition of a distinction between analytic and synthetic propositions that deserves serious consideration from the point of view of its logical adequacy.

A minor point is that Bolzano completed Kant's classification of propositions into analytic (analytically true) and synthetic by adding a third category of the analytically false.

11. Mill.—John Stuart Mill's *A System of Logic, Ratiocinative and Inductive* (1843) is remembered for its contributions to inductive logic, which are outside the scope of this article, and for its introduction of the distinction of CONNOTATION and DENOTATION, which is treated in the articles of those titles.

12. Algebra of Logic.—The algebra of logic had its beginning in publications of George Boole (*q.v.*) and Augustus De Morgan (*q.v.*) which appeared simultaneously in 1847. There are two main divisions.—The algebra of classes has three basic operations, the logical sum (or union) $F + G$ of two classes F and G, the

logical product (or intersection) FG of F and G, and the complement F' of a class F. In the notation introduced in the article LOGIC, $F + G$ may be explained as meaning $\lambda x[F(x) \vee G(x)]$, FG as meaning $\lambda x[F(x)G(x)]$, and F' as meaning $\lambda x \sim F(x)$. The notation 0 was used for the empty class; and 1 for the universal class, *i.e.*, the class which coincides with the domain of individuals so that all individuals belong to it. And equations and inequalities were written, such as $G + H = F' + G'$ to mean that the logical sum of G and H is the same as the logical sum of the complements of F and G, or $FG \neq 0$ to mean that the logical product of F and G is not empty, or $F \leqq G$ to mean that F is contained in G in the sense that all individuals belonging to F belong also to G.—The algebra of relations has six basic operations, the logical sum $F + G$ of two relations F and G, the logical product FG, the contrary F' (or $-F$), the relative sum $F \dagger G$, the relative product $F;G$, and the converse $\breve{F}$. These may be explained as meaning respectively $\lambda x\lambda y[F(x, y) \vee G(x, y)]$, $\lambda x\lambda y[F(x, y)G(x, y)]$, $\lambda x\lambda y \sim F(x, y)$, $\lambda x\lambda y(z)[F(x,z) \vee G(z,y)]$, $\lambda x\lambda y(\exists z)[F(x,z)G(z,y)]$, $\lambda x\lambda y F(y,x)$. The notation 0 was used for the empty relation, 1 for the universal relation, 0' for the relation of diversity (which holds between x and y if and only if x and y are different individuals), 1' for the relation of identity. And again equations and inequalities may be written.

The three basic operations of the algebra of classes, and the six basic operations of the algebra of relations, obey laws which are of much the same kind as familiar laws of the algebra of numbers (and in part coincide with them). By using these a formal algebra or calculus of classes may be set up, and an algebra of relations. These were the first successful calculi of logic. As treated by 19th-century writers, neither is yet a logistic system in the sense of modern logic, but a calculus in a less rigorous sense.

Various notations were used by different writers. And when the two algebras were incorporated into *Principia Mathematica* (*see* below) as parts of the logistic system of that work, the authors, partly following Giuseppe Peano, changed the old notations completely. In the algebra of classes the logical sum, logical product, and complement are expressed by $F \cup G$, $F \cap G$, and $-F$ respectively, and the notations 0, 1, $\leqq$ are changed to Λ, V, $\subset$ respectively. In the algebra of relations the same notations are used with a dot added, as $F \dot{\cup} G$, etc.

The method of Boole, in 1847 and in 1854, is not an algebra of classes in the sense described above, but an application of ordinary numerical algebra to the logic of classes—as is possible if the logical sum of F and G is written as $F + G - FG$, and the complement of F is written as $1 - F$. Yet Boole was able to obtain in this way the essential results of the algebra of classes, and indeed worked them out more fully than De Morgan. In De Morgan's *Formal Logic* of 1847 are, however, some beginnings of the algebra of classes in the more proper sense, including in particular the De Morgan laws $(FG)' = F' + G'$, $(F + G)' = F'G'$ (it was only later that De Morgan's name came to be applied also to the analogous laws of the propositional calculus). From these beginnings the algebra of classes developed into its classical form through contributions by William Stanley Jevons (*q.v.*) (*Pure Logic*, 1864, and later works), Charles Sanders Peirce (in a series of papers beginning in 1867), Ernst Schroeder (*Der Operationskreis des Logikkalkuls*, 1877), John Venn (*Symbolic Logic*, 1881), and Platon Poretsky (in papers published in the period from 1884 to 1908).

The algebra of relations had its beginnings in publications by De Morgan (*Syllabus of a Proposed System of Logic*, 1860, and a paper in the *Transactions of the Cambridge Philosophical Society*, vol. 10, 1864) and received its major development at the hands of Peirce (in papers beginning in 1870) and Schroeder (in *Algebra der Logik*, vol. 3, 1895).

The standard reference work on the algebra of logic is Schroeder's three-volume *Algebra der Logik* (1890–1905). However, Schroeder's axiomatic basis of the algebra is deficient, and should be replaced, in the case of the algebra of classes by E. V. Huntington's (*Transactions of the American Mathematical Society*, vol. 5, pp. 288-300, 1904), and in the case of the algebra of relations by Tarski's (*The Journal of Symbolic Logic*, vol. 6, pp. 73-89, 1941).

There is a sense in which the algebra of logic has also a third division, the algebra of propositions, though not always clearly distinguished from the algebra of classes. Boole had already considered the alternative of interpreting the variables of his algebra as propositional variables instead of class variables. But the first true calculus of propositions appears in papers of Hugh MacColl, beginning in 1877; and in particular it was MacColl who rediscovered the so-called De Morgan laws of the propositional calculus (known already to the scholastics). The second volume of Schroeder's *Algebra* has a combined algebra of classes and propositions.

13. Peirce.—Charles Sanders Peirce (*q.v.*), besides the matters already mentioned, has the credit of having taken the first steps in many things which afterward became important in the development of logic. These include the first definition of the notion of simple order (1881); the first treatment of the propositional calculus as a calculus of two truth-values (1885); the definition of $=$ (1885) which is given above in the article LOGIC (though this had been partly anticipated by Leibniz's informal definition, "Things are identical of which one can be substituted for the other with preservation of truth"); and the definition of finiteness (1885) which would be expressed in modern notation as follows: G is a finite class if $(F) \cdot F(x, y)F(x, z) \supset_{xyz} y = z \supset \cdot F(x, z)F(y, z) \supset_{xyz} x = y \supset \cdot G(x) \supset_x (\exists z)[G(z)F(x, z)] \supset \cdot G(z) \supset_z (\exists x)[G(x)F(x, z)]$. Peirce also initiated in 1881 the method of treating the foundations of arithmetic which was afterward developed by Julius (Wilhelm Richard) Dedekind (*Was sind und was sollen die Zahlen?*, 1888) and Giuseppe Peano (*Arithmetices Principia*, 1889).

The *Insolubilia* were discussed by Peirce (1869, 1901) with direct reference to the medieval sources. It is quite possibly through Peirce that the Liar first came to the attention of Bertrand Russell, but it required the independent discovery of Richard's antinomy (*see* below) to make clear the importance of what are now known as the *semantical* antinomies or paradoxes.

In a paper of 1880, in treating the categorical syllogism, Peirce says that traditionally the affirmative (categorical) propositions imply that their subjects are existent, while the negative ones do not; but he will assume rather that particular propositions imply the subjects existent, universal propositions not. Indeed this change of the convention about existential import is strongly indicated from the point of view of the algebra of classes; it was implicit in a short note published by Arthur Cayley in 1871, but was first made explicit from this point of view by Peirce, and by Venn in 1881. It is true that under the changed convention, certain traditional inferences (*e.g.*, conversion *per accidens*, syllogism in Darapti) require an added existential premiss to validate them. But the convention which Peirce describes as the older one also renders some of the immediate inferences invalid without an added existential premiss, those namely (including contraposition) that involve obversion of a negative proposition.

14. Brentano.—Franz Brentano, in his *Psychologie vom Empirischen Standpunkte* of 1874, made it a part of his psychology of judgment that every proposition can be reduced to an (affirmative or negative) existential proposition, so that, *e.g.*, "Some man is ill" and "All men are mortal" are said to have the same sense as "An ill man is" and "An immortal man is not" respectively. In modern notation the four categorical forms *A*, *E*, *I*, *O* thus become $\sim(\exists x) \cdot s(x) \sim p(x)$, $\sim(\exists x) \cdot s(x)p(x)$, $(\exists x) \cdot s(x)p(x)$, $(\exists x) \cdot s(x) \sim p(x)$. Hence quite independently of the algebra of logic (to which he was opposed) Brentano arrived at the same doctrine of existential import which was later introduced by Peirce as described above, and at the same modification of the traditional logic, including rejection of the syllogisms in Darapti, etc. But Brentano seems to defend his own revision of the traditional rules as the only right one, whereas Peirce sees more clearly that it is a matter of choosing the convention under which the formal treatment of logic can proceed most efficiently.

An exposition of Brentano's logical innovations was published by J. P. N. Land in the first volume of the British periodical *Mind* in 1876. And a detailed treatment of immediate inference and the syllogism from Brentano's point of view is in Franz

Hillebrand's *Die Neuen Theorien der Kategorischen Schluesse* of 1891.

15. Frege.—Gottlob Frege is the founder of modern logic in a sense in which neither Leibniz nor De Morgan and Boole can be so considered, and as such is unquestionably the greatest logician of modern times. The essential steps in the introduction of the logistic method were taken in his *Begriffsschrift* of 1879. In the same work there appear for the first time the propositional calculus in its modern (logistic) form, the notion of a propositional function, the use of quantifiers and the logical analysis of proof by mathematical induction in terms of the notion of a hereditary property—or hereditary class, as we shall here prefer to say.

This last was important in Frege's definition of an inductive cardinal number, and thus provided the basis for the derivation of arithmetic from logic which was described and defended in his *Grundlagen der Arithmetik* (1884) and carried through rigorously in the first volume of his *Grundgesetze der Arithmetik* (1893). To state the definition in the slightly modified form in which it was later used by A. N. Whitehead and Bertrand Russell in *Principia Mathematica*, let us call two classes G and H similar if there is a one-to-one correspondence between them, *i.e.*, if $(\exists F) \cdot F(x, y)F(x, z) \supset_{xyz} y = z \cdot F(x, z)F(y, z) \supset_{xyz} x = y \cdot G(x) \supset_x (\exists z)[H(z)F(x, z)] \cdot H(z) \supset_z (\exists x)[G(x)F(x, z)]$. As the cardinal number of a class G, we might think to take the concept, or property, of similarity to G. But if a property is understood (as usual) in intension, this has the defect that the cardinal numbers of two different but similar classes will not be actually identical. Hence we are led to take the corresponding extension, *i.e.*, to define the cardinal number of G as the class of classes which are similar to G. The cardinal number of H is successor of the cardinal number of G if, for some class H_1 similar to H, $(\exists y) \cdot H_1(y) \cdot G(x) \equiv_x \cdot H_1(x) \sim x = y$; a class of cardinal numbers is hereditary if all successors of cardinal numbers belonging to it also belong to it; the cardinal number of the empty class Λ is the number 0; and the inductive cardinal numbers (the non-negative integers) are those which belong to every hereditary class to which 0 belongs.

From an antinomy due to Georg Cantor, concerning the question of the greatest (infinite) cardinal number, Russell extracted the simpler antinomy which is now known by Russell's name (*see* Antinomy), and communicated it to Frege in 1902. As the antinomy can be put into the form of a demonstration of contradictory theorems from Frege's logical axioms, Frege felt that one of the foundations of his construction had been shattered. Indeed it must have seemed to Frege and his contemporaries that his great work was a failure. For although Frege's axioms can be amended to remove the inconsistency—and Frege himself made some suggestions in this direction in the Appendix to the second volume of his *Grundgesetze der Arithmetik* (1903)—it must then seem that the axioms have been artificially designed for a purpose, and it is less easy to maintain that they have been taken once for all from a realm of eternal truth. It is only in the perspective of time that we are able to see that Frege's positive contributions far outweigh the inconsistency of the particular system in which they were embodied.

Independently of Frege, the use of quantifiers was suggested also by O. H. Mitchell, to whom the idea is credited by Peirce in his paper of 1885.

Other important contributions of Frege are the distinction of *sense* and *denotation* (*see* Semantics in Logic), and the device of systematically employing quotation marks to distinguish the *mention* of a term, expression or symbol from its *use*. The latter distinction is in a sense obvious, and was already recognized among the medieval distinctions of *suppositiones;* yet failure to observe it has been the source of much confusion, in Frege's day and since.

16. Venn.—John Venn, besides contributions already mentioned, introduced in 1880 the *Venn diagram*. This is a modification of the Euler diagram (*see* above) in which the three circles are so drawn as to overlap in all possible ways, thus dividing their plane into eight regions; and to represent the given premisses, some of these regions are shaded as a sign that the classes they stand for are known to be empty, and others are marked with a star as a sign of non-emptiness. If an inference is to be dealt with (not necessarily syllogistic) that involves n basic classes, $n > 3$, the corresponding regions may be drawn as ellipses or other more complicated shape, instead of circles, and so placed as to divide their plane into 2^n regions; and then the same process of shading and starring is followed.

17. Peano.—Giuseppe Peano is important for his influence on Russell, and for his contribution in devising a scheme of logical notation which is more convenient than those of Peirce, Schroeder and Frege, and much of which (through its adoption by Russell) is still in use. Peano's postulates for arithmetic (*see* Postulate) are due to Dedekind in all but the point of view of taking them as postulates. His *Formulaire de mathématiques*, written with the aid of collaborators and published in five "volumes" (or editions) from 1894 to 1908, is intended as a compendium of mathematics, developed from its postulational beginnings with the aid of Peano's logical notation. His treatment of logic had begun to go beyond the algebra of logic but he did not yet have the logistic method.

18. Burali-Forti.—Cesare Burali-Forti stumbled upon the antinomy which now bears his name (*see* Antinomy), in a paper of 1897 in which he seems to have been not aware that he had revealed antinomy at all.

This antinomy and that of the greatest cardinal number were known already to Cantor but had not been published, and it was through Burali-Forti's paper that there first came to general attention the threat to the foundations of mathematics that is constituted by the antinomies.

19. Russell.—Bertrand Russell (*q.v.*) adopted Frege's thesis that arithmetic is a branch of logic, in the sense that all the terms of arithmetic can be defined with the aid of logical terms only (*see* the brief statement above as to how, in part, this is to be done), and all the theorems of arithmetic can be proved from logical axioms only. And the same thesis was extended by Russell to the whole of mathematics—a doctrine which later came to be known as *logicism*. The project of carrying this out is the subject of Russell's *The Principles of Mathematics* (1903). The theory of types as a means of avoiding the inconsistency of such a system as Frege's, though the idea of it was discussed in the *Principles*, was first put into satisfactory form by Russell in a paper of 1908, and on this basis the detailed logicistic development of a large part of mathematics is in the three volumes of Whitehead and Russell's *Principia Mathematica* (1910–13). Thus Whitehead and Russell succeeded where Frege failed. But the theory of types compels the use of the axiom of infinity—which plays no role in Frege's work—and some have objected that this is not properly an axiom of logic.

The type theory of *Principia* is the so-called *ramified theory of types* (concerning which *see* Mathematics, Foundations of). The reduction of this to the simple theory of types was mentioned by Leon Chwistek in 1921; independently of Chwistek, it was advocated more seriously by F. P. Ramsey in 1926, and thence came into general use through its adoption by Rudolf Carnap (*Abriss der Logistik*, 1929) and Kurt Goedel (1931).

Another major contribution of Russell is the device (1905) by which descriptive phrases such as "the 32nd president of the U.S.A." may be eliminated if desired (*see* Semantics in Logic). A technical improvement of Russell's device, important especially when it is employed in a formalized language, was introduced by W. V. Quine in 1940.

20. Zermelo.—Ernst Zermelo stated the axiom of choice in 1904—the use of which in mathematical reasoning had previously been tacit and unrecognized. The first formulation of axioms for set theory was by Zermelo in 1908. Zermelo's axioms involve, however, an unexplained notion of a "definite property." Different proposals for overcoming this difficulty were made by A. A. Fraenkel and Thoralf Skolem in 1922 and 1923, of which Skolem's has the advantage that it leads more directly to logistic formalization of Zermelo's verbally stated axioms. The axioms of set theory as given in the article Logic are obtained from those of Zermelo by

Skolem's method, with addition of the axioms of replacement, due to Fraenkel, and the axioms of excluded infinite regress due to John von Neumann (later introduced independently also by Zermelo).

21. Richard.—Jules Richard published in 1905 the antinomy now known by his name. Semantical paradoxes related to Richard's were afterward proposed by various other authors, including the paradox of Kurt Grelling in 1908 (*see* SEMANTICS IN LOGIC).

22. Hilbert.—David Hilbert's contributions to logic arose from his work in the foundations of mathematics (*see* MATHEMATICS, FOUNDATIONS OF). Important among them are the program of proof theory and in particular of a metatheoretic consistency proof, dating from 1905, and in connection with this the sharp distinction between object language and meta-language (in Hilbert's terminology, between mathematics and metamathematics). *Grundlagen der Mathematik* (1934, 1939), a comprehensive treatise of modern logic containing Hilbert's ideas in their final form, was written in collaboration with Paul Bernays, to whom the detailed content of the work is largely due.

23. Brouwer.—Luitzen Egbertus Jan Brouwer is the founder of mathematical intuitionism (*see* MATHEMATICS, FOUNDATIONS OF; and THOUGHT, LAWS OF). His publications in this field began with his dissertation in 1907 and a paper on the law of excluded middle in 1908 and extended through 1954. The logistic formalization of intuitionism is, however, due to Arend Heyting (1930) and others.

24. Lewis.—Clarence Irving Lewis was led by the "paradoxes" of material implication (*see* LOGIC) to seek a notion of implication, *strict implication,* which shall correspond rather to the relation of logical consequence in the sense that, if $<$ is the sign of strict implication, and if **A** and **B** are any sentences, $\mathbf{A} < \mathbf{B}$ shall be true if and only if **B** is a logical consequence of **A**. Lewis's publications about the matter begin in 1912. But the first satisfactory formulation of a propositional calculus with strict implication was in 1920. The book of Lewis and C. H. Langford, *Symbolic Logic* (1932), treating the subject at length, has become a classic in the field of modal logic, and the starting point of many more recent investigations.

25. Loewenheim.—Leopold Loewenheim in a paper of 1915 proved the theorem which is now known as Loewenheim's theorem (*see* LOGIC), and several other important results in the metatheory of the functional calculus of first order.

26. Skolem.—Thoralf Skolem, besides the contribution to set theory already mentioned, gave a new and better proof of Loewenheim's theorem, established the extension of this theorem which is stated in the article LOGIC, contributed results connected with the decision problem of the functional calculus of first order (some of which were later important in the proof of Goedel's completeness theorem), and discovered also the following metatheorem, that no set of postulates, finite in number or enumerably infinite, expressible in the notation of a simple applied functional calculus of first order can be adequate for arithmetic in the sense of characterizing completely the system of non-negative integers.

27. Post.—Emil L. Post's dissertation of 1920, published in 1921, contains the first comprehensive metatheoretic treatment of a logistic formalization of the two-valued propositional calculus, including proofs of consistency and completeness; also the first formulation of a many-valued propositional calculus from a point of view which is abstract in the sense of being concerned with the form of the calculus independently of any particular interpretation.

28. Lukasiewicz.—Jan Lukasiewicz, in a paper of 1920, introduced a three-valued propositional calculus based on Aristotle's doctrine of future contingents (*see* THOUGHT, LAWS OF). This was later generalized to an analogous *n*-valued propositional calculus, different from that of Post. Much important work is also due to Lukasiewicz in the two-valued propositional calculus, and in the history of logic.

29. Tarski.—Alfred Tarski contributed extensively to two-valued and many-valued propositional calculus, taking his departure from the work of Lukasiewicz. However, his most noteworthy contributions, beginning in 1930, are to the general metatheory of logistic systems, a domain in which many important new ideas are due to him. Especially semantics, in the sense of the metatheoretic treatment of notions related to those of meaning and truth, is the creation of Tarski (*see* SEMANTICS IN LOGIC). Much of the more recent work of Tarski has been in the boundary region between logic and mathematics, or has applied methods and results of modern logic to special branches of mathematics.

30. Carnap.—Rudolf Carnap, in his *Der logische Aufbau der Welt* (1928), *Testability and Meaning* (1936–37) and many other publications, was a pioneer in the systematic application of the methods of modern logic in epistemology and philosophy of science —making in this a contribution to philosophic method which in the eyes of many exceeds in importance his support of a particular philosophical outlook (that of logical positivism, *q.v.*). Carnap's contributions to the study of the metatheory of logistic systems begin in his *Logische Syntax der Sprache* (1934, published, 1937, in English with some additions as *The Logical Syntax of Language*). In a paper of 1935, somewhat later than Tarski but independently (and in a different terminology), Carnap introduced the idea of syntactical definitions of the semantical notions of truth and satisfaction, and in particular was the first to make such definitions for the full simple theory of types, as distinguished from a functional calculus of finite order. And concerning Carnap's contributions to intensional semantics, *see* SEMANTICS IN LOGIC.

31. Herbrand.—Jacques Herbrand in his short life—he was killed in a mountain-climbing accident in 1931 at the age of 23—made extensive contributions to Hilbertian proof theory and to the metatheory of the functional calculus of first order. The most important of these cannot be stated here. But the deduction theorem of first-order functional calculus should be mentioned as Herbrand's.

32. Goedel.—Kurt Goedel proved the completeness theorem of the pure functional calculus of first order (1930), and the famous incompleteness theorem (1931). For these, *see* LOGIC and (especially for the latter) MATHEMATICS, FOUNDATIONS OF.

The bearing of the incompleteness theorem on Hilbert's program of a metatheoretic consistency proof for mathematics is obvious; but more far-reaching is the consequence that no single logistic system, satisfying certain very general conditions, can tenably claim to embrace only logical truth *and* the whole of logical truth (if indeed the latter phrase has a meaning at all).

Also due to Goedel (1940) is the metatheorem that if the system of set theory with omission of the axiom of choice (*see* LOGIC) is consistent, it remains so upon addition of the axiom of choice or an axiom expressing the generalized continuum hypothesis or both. (For a statement of the continuum hypothesis *see* MATHEMATICS, FOUNDATIONS OF.) As Goedel pointed out, his result is applicable alike to various forms of set theory and to type theory.

See also references under "Logic, History of" in the Index.

(AO. C.)

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LOGICAL POSITIVISM, a philosophical doctrine first formulated in Vienna in the 1920s, according to which scientific knowledge is the only kind of factual knowledge and all traditional metaphysical doctrines are to be rejected as meaningless. The school differs from earlier empiricists and positivists (David Hume, Ernst Mach) in holding that the ultimate basis of knowledge rests upon public experimental verification rather than upon personal experience. It differs from Auguste Comte and J. S. Mill in holding that metaphysical doctrines are not false but meaningless—that the "great unanswerable questions" about substance, causality, freedom and God, are unanswerable just because they are not genuine questions at all. This last is a thesis about language, not about nature, and is based upon a general account of meaning and of meaninglessness. All genuine philosophy (according to the Vienna group) is a critique of language; and (according to some of its leading members) its result is to show the unity of science—that all genuine knowledge about nature can be expressed in a single language common to all the sciences. Philosophy is not a theory but an activity. The proper task of philosophers is linguistic—unless we add that it is their business also to persuade men to adopt a "scientific" attitude to moral and political questions.

The Vienna circle, which launched its first manifesto in 1929, had its origin in discussions among physicists and mathematicians before World War I. The general conclusion was reached that the empiricism of Mill and Mach was inadequate since it failed to explain mathematical and logical truths, or to account satisfactorily for the apparently *a priori* element in natural science. In 1922, Hans Hahn at Vienna university laid before his students the *Tractatus Logico-Philosophicus* of Ludwig Wittgenstein, published in the previous year. This work introduced a new general theory of meaning derived in part from the logical inquiries of Giuseppe Peano, Gottlob Frege, Bertrand Russell and A. N. Whitehead. It gave the Vienna group its logical foundation and drew in the philosophers Moritz Schlick, Rudolf Carnap, Friedrich Waismann, Otto Neurath and (at Berlin) Hans Reichenbach and Walter Dubislav. The group conducted its campaign in the journal *Erkenntnis* (Leipzig, 1931–40) and, after most of the members of the group had moved to the United States, in an elaborate *International Encyclopedia of Unified Science* (Chicago, 1938 *et seq.*), published with the help of Charles Morris and other U.S. associates. Carnap at Chicago, Reichenbach in California, Philipp Frank at Harvard, Waismann in England and many others, continued the work of the school in a series of systematic works and a stream of papers and monographs. In the meantime disciples had been found in many other countries: in Poland, among the mathematical logicians; and in England, where A. J. Ayer's *Language, Truth and Logic* (1936; rev. ed., 1946) provided an excellent introduction to the views of the group. In England, however, the direct influence of Wittgenstein proved very much more powerful. Wittgenstein had come to England from Austria before World War I and had spent some time at Cambridge, discussing logic with Bertrand Russell. The *Tractatus Logico-Philosophicus* expresses and generalizes the conclusions that he had reached upon philosophical questions. In 1929 Wittgenstein returned to Cambridge and taught and worked there (with a few intermissions) until his retirement in 1947. During this later period Wittgenstein himself subjected the doctrines of the *Tractatus* to fundamental criticism and produced what was in effect a new account of philosophy. The later philosophy was disseminated by his students (and by copies of his own informal notes) and profoundly affected the course of English philosophical thought. His *Philosophical Investigations* (Ger. text with Eng. trans., 1953) appeared posthumously. While the name "logical positivism" is commonly applied to Wittgenstein's later philosophy as well as to the *Tractatus*, it is certain that a wide gulf separates it from the philosophy which the Vienna circle based in part upon the *Tractatus*.

Characteristic Views of the Vienna Circle.—The following views may be regarded as characteristic of the Vienna school:

Philosophy as a Critique of Language.—It is evident that some of the great philosophers (Locke, Spinoza) explicitly undertook the criticism of language, but it has generally been held that this was not their chief task. Philosophers have usually attempted to assert a view about the world; to state not only the limits of the possible, but also the nature of being or of the universe as we know it. Wittgenstein's *Tractatus* attempted to show that reality *as a whole* cannot be described and that the limits of the possible (or "of what can be said") are *shown* in the language as a whole. But what is shown in the language as a whole cannot itself be *said* in language. According to the Vienna school the traditional metaphysical philosophies purport to ask the questions that cannot be answered (*e.g.*, Can one really know material substances?). Here, although experimental evidence may seem to be relevant, it always proves to be beside the point. Metaphysical statements have no verification: metaphysical questions are *Scheinprobleme*. There are of course many questions which philosophers have asked (*e.g.*, about the physiology of perception) which concern particular matters of fact. These however belong to science and not to philosophy. The sole remaining task of philosophy is the analysis and clarification of language. This involves an account of "meaningful" and "meaningless," "true" and "false," "valid inference," etc. as these terms are applied to contingent and to necessary statements—to the propositions of science and history and to the theorems of logic and mathematics. An understanding of such matters will enable us to show how a given metaphysical question arose and why it is meaningless. It is characteristic of the Vienna group, as of the *Tractatus*, that particular metaphysical puzzles are to be settled by reference to a general theory about language.

The Doctrine of Tautology.—This doctrine derives from the *Tractatus*. The only necessary propositions are those which are true by definition; which are so framed that they cannot be denied without inconsistency. Thus "All men are rational" is held to assert with regard to *anything* that either it is a man or it is not rational. But this follows from our actual use (or one actual use) of "man" and "rational." The necessary proposition cannot but be true since it asserts every possible state of affairs: it is true which-so-ever of its constituents are true and true which-so-ever of its constituents are false. There is a sense therefore in which all necessary propositions say the same thing—that is, *nothing at all*. And the Vienna group held that in general any necessary truth is derivable from some rule of language: its only necessity is its being prescribed by rule in a certain system. This was most easy to show in the case of mathematics, but some attempt has been made to codify the physical sciences and even branches of biology. With regard to nontechnical necessary propositions (*e.g.*, "Whatever has a beginning in time must have a cause"; and "The same surface cannot be red all over and blue all over at the same time") it was recognized that our ordinary language is not itself capable of exact formulation as a calculus: but attempts were made to construct an artificial language in which all necessary statements could be demonstrated by appeal to formulas (*e.g.*, Carnap's *Der logische Aufbau der Welt*, 1928).

The Verification Principle.—The fundamental purpose of language is the making of statements about the world. The earlier works of the logical positivists distinguish sharply between "atomic propositions," each of which refers to a single atomic fact, and derivative propositions or hypotheses, which assert some truth-functional combination of atomic facts (*e.g.*, a disjunction of two such facts, a conjunction of a set of such facts). An atomic statement is true if it corresponds to an atomic fact (by which was originally meant a simple observation); a hypothesis is true if the atomic propositions that it asserts are true and the atomic propositions that it denies are false. "The meaning of a statement is the method of its verification" (Waismann). The verification test does not require actual verification but only verifiability in principle, nor is complete verification envisaged in most cases: in all cases it must be possible to collect experimental evidence which determines the truth or falsity of some of the atomic propositions involved (*i.e.*, which tells for or against the hypothesis). The verification test excludes a hypothesis which asserts every possible combination of its atomic constituents: such a "hypothesis" is in fact a tautology or necessary statement. The same test excludes a hypothesis which denies every possible combination: such a "hypothesis" is excluded as being a contradiction or nonsense. But the test also excludes "hypotheses" which do not mean (*i.e.*, from which one cannot validly infer) any set of atomic statements. For where this is the case no evidence is available by which its truth or falsity can be shown. For example, Berkeley argued that the assertion of material substance is nonsensical, since it cannot be "cashed" in any statements about ideas of sense: whereas the assertion that "a tree exists in the park" or "I have two hands" can be so "cashed."

Form and Content.—The earlier writers (especially Moritz Schlick) were perplexed by the metaphysical problem of how it is possible to communicate at all if our genuine statements are really about our own experiences. How can I be sure, for example, that another person verifies my statement by reference to the same kind of experience as I do? Schlick attempted to avoid the difficulty by his doctrine of form and content: what we communicate by language is not experience but knowledge, and knowledge is the form of which experience is the content. This very difficult doctrine evidently refers to two striking facts about our common use of language: (1) users of a given language employ a common syntax and a common set of definitions; and (2) they also (generally speaking) apply descriptive words on the same occasions even when their experiences come to them through different senses (sight, touch, etc.). This, it is commonly held, one can know without beginning to know what experiences lead people to make use of the language. Schlick maintained that we understand what a man means (in the only sense in which meaning can be communicated; *see* SEMANTICS IN LOGIC) if we know (1) the syntactical connections of his words with related expressions in the language (especially if we know *the* definition of his terms in terms which are simple or indefinable); and (2) if we know how he uses the simple terms (*i.e.*, on what occasions he would apply them). This communicable meaning is called form: *for a given person*, no doubt, it is the form of his own experience-content: but while it is nonsense to speak of community of experience, it is not nonsense to speak of community of structure.

Protocol-Statements.—The doctrine of form and content failed to satisfy. Carnap argued that the question of the relation of an expression to experience (or content) is either meaningless or can be translated into a question about the relation of one expression (or type of expression) to another. Thus a question about how an empirical proposition is to be verified (or what it means) ought to be tackled by showing its connection not with experiences, but with statements of a peculiar and fundamental kind, the so-called *Protokollsätze*. Such statements would be described by other philosophers as an observer's account of what he actually perceives at a given moment: Carnap describes them by specifying the kinds of expression that can occur in them. Then the last word about the meaning of an empirical proposition is given in showing the kinds or classes of protocol-statements which (if they were made) would logically entail the truth or probability of the statement. This is also the last word about its truth, since, according to the theory, it makes no sense to add "provided that the protocol-statements were made *truly*." For the protocol-statements have to be taken as indubitable: science rests upon the reports actually made by observers. And Carnap improved the occasion by putting forward the general thesis that statements or questions about the relation of language to experience (which belong to the "material mode of speech") are always a source of metaphysical muddle and can always be replaced by statements or questions about the rules connecting one type of expression with another—statements in the "formal mode of speech." From this, Carnap passed later to the development of a hierarchy of languages.

Physicalism.—The doctrine of protocol-statements was subsequently modified. In the first place, the attempt to show the one-sided dependence of all empirical statements upon some set of protocol-statements came to be regarded as a quaint metaphysical survival: Neurath argued that real language knows no vocabulary of direct experience and that the reports which are actually employed in verifying empirical statements are framed in ordinary language. Second, protocol-statements are not indubitable: not only may we have to select between conflicting reports, we may also decide to reject a report rather than modify an empirical theory or generalization. Neurath preferred to view protocol-statements in the same sort of way as the indications of thermometers or measuring rods: that a thermometer records a high temperature and that an observer says he is getting very hot are both facts (if they are facts) about the physical world and expressed in "physical-object-language"; and either may need correction. Science is possible (it was agreed) because in fact the reports of different observers in the same circumstances do in general agree, and because reports made by the same or different observers upon the evidence of different senses (sight, touch, etc.) also in general correspond. Logical positivists (or many of them) thus passed easily from a quasi-phenomenalistic philosophy to a quasi-materialistic philosophy, and from a correspondence theory of truth to a coherence theory—modified in some cases by the introduction of arbitrary or conventional choice.

The Emotive View of Ethical Expression.—Having delivered philosophers and scientists from "the misery of metaphysics," the group proceeded to demolish all kinds of philosophical morality—except possibly their own. So-called statements about what things are right or good cannot be verified (in the manner explained above) and are therefore without meaning. They are simply expressions of attitudes and ought not to be regarded as conveying knowledge or even opinion. The characteristic value words may serve to move or to persuade: they cannot serve to convince us of facts, since they are indefinable in factual terms. This view, reminiscent of Hume, had already been put forward in England by C. K. Ogden and I. A. Richards (*The Meaning of Meaning*, 1922): it was more or less generally adopted by the Vienna group and their English and American disciples, although Schlick (*Fragen der Ethik*, 1930) argued at length for a typical hedonistic utilitarianism. The "logic" or methodology of persuasive argument was fully examined by Charles Stevenson (*Ethics and Language*, 1945) more from the point of view of the Cambridge analytical school than from that of the Vienna group.

Particular Doctrines of Wittgenstein.—In the foregoing account of the Vienna group emphasis has been put on Wittgenstein's *Tractatus Logico-Philosophicus;* undoubtedly the general doctrine of tautology and the doctrine that philosophy is analysis of language are to be found in the *Tractatus*. Two other doctrines to be found there received less attention from the Vienna group: (1) the account of how a simple statement means a simple fact—the "relation of representation"—and the general doctrine of how communication is possible by means of different kinds of signs; and (2) the doctrine that tautologies do not say, but only show, the structure of language—that the characteristic structure of language cannot be said in language. Wittgenstein admits a use for the tautological principles of formal logic—while asserting provocatively that contradictions would have served the same purpose—but is prepared to dismiss as nonsense all those philosophical statements in which the structure of language is elucidated or its limits

traced. This self-denying ordinance was not taken seriously by the Vienna group, who attempted to circumvent it by the introduction of the "formal mode of speech" and the hierarchy of languages.

In his later discussions and in the *Investigations,* Wittgenstein denounced all attempts to build systems of philosophy—even negative systems: he declined to offer any general theory of meaning and was particularly mistrustful of theories which take mathematics or natural science as the ideal. It is possible to trace in his later writings analogues of logical positivist principles: for example, that philosophy is a critique of language. But the doctrines are only analogues, and no conclusion can be reached about his views from a study of the writings of the Vienna circle.

Logical positivism in the United States has found allies among the pragmatists and (naturally enough) among the logicians and scientists. The philosophy of Wittgenstein has been associated with the Cambridge school of G. E. Moore (the defense of common sense and of ordinary language) and has a very wide following in England.

See also biographies of philosophers referred to above and references under "Logical Positivism" in the Index.

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LOGISTICS. In U.S. military administration, a term loosely applied to a wide range of noncombatant activities, especially those connected with supply, transportation, construction and the care and evacuation of sick and wounded. In a nonmilitary sense, long archaic, logistics was the Greek science of computation (from *logistikos,* "skilled in calculating"); it is also a branch of logic closely related to mathematics. Until World War II the term was not generally used outside the United States, but in the 1960s it became increasingly common in defense circles in NATO countries, particularly Great Britain and Canada. Its nearest counterpart in British military terminology is "administration," an even broader term embracing all military activities not directly associated with strategy (*q.v.*) and tactics (*q.v.*). Though still defined in this sense in American military dictionaries, "administration" has been largely replaced by "logistics" in ordinary military usage in the U.S.; when used, "administration" generally has the layman's meaning of "management."

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I. CHANGING USES OF THE WORD

In its military sense, the word logistics has been used so loosely, and in such a variety of specific and general applications, as to defy precise definition. For some writers in the late 18th and early 19th centuries it appears to have conveyed such disparate meanings as "strategy" and "philosophy of war." For others in the same period it had come to signify military staff work in general.

1. Jomini.—The first serious effort to define the word with some precision and to fix the place of logistics in the science of war was made by Baron Antoine Henri Jomini (*q.v.*), the celebrated student of Napoleon's campaigns and foremost authority on the military art in the first half of the 19th century. In his *Précis de l'art de la guerre,* published in 1836, Jomini divided the art of war into five branches—strategy, grand tactics, logistics, engineering and minor tactics. Logistics, the third branch, he defined as "the practical art of moving armies," by which he meant not merely the mechanics of transportation, but the staff work, administrative arrangements and even reconnaissance and intelligence involved in moving and sustaining organized military forces. Engineering, defined as the art of fortification, did not include, in Jomini's scheme, nontactical types of construction (building of roads, cantonments, etc.), which presumably came under the heading of logistics. Jomini thought of logistics, in fact, as comprising virtually all military activity, apart from combat and the planning of combat, involved in "the execution of the combinations of strategy and tactics."

In particular, Jomini associated logistics with the work of the military staff. According to him, the word had been derived from the title of the *maréchal* (or *major général*) *des logis* in French armies of the late 17th and 18th centuries, who, like their Prussian counterpart, the *quartiermeister,* had originally been charged with routine administrative arrangements for marches, encampments and troop quarters (*logis*). With the growing complexity of military administration in the 18th century, the more gifted of these officials (like Pierre-Joseph de Bourcet, from whose campaign plans Napoleon later profited) had become the equivalent of chiefs of staff to the high-born and often inept commanders of the day, and had developed an efficient staff system along the lines of the modern general (or "capital") staff. Since Jomini's time, other writers have traced the origin of "logistics" to the title of the *logista,* an administrative official in Roman and Byzantine armies.

The Greek word *logistikos,* mentioned above, also has an obvious functional relationship to it. Whatever the origin of the word, Jomini saw logistics as the central function of the commander's staff, which in his own time had come to play a crucial role in translating the commander's ideas and will into concrete action. Generalship, he insisted, was inseparable from good staff work, and a good general must also be a good logistician. For future generals Jomini left an engaging picture of Napoleon, his own logistician, sprawled on the floor, marking off with a pair of dividers on the map the marches of the several corps that were to converge on tomorrow's objective.

Despite the enormous influence of Jomini's writings on military thought during the long middle span of the 19th century, the word "logistics" gained only a limited currency in French (*la logistique*) and in English as a rather academic term used occasionally by the learned. German writers, including Jomini's great contemporary Karl von Clausewitz, used it not at all. Jomini's broad conception of the term was generally forgotten; in military parlance its meaning came to be restricted to supply, transportation and quartering of troops. In the 1880s Alfred T. Mahan introduced it into U.S. naval usage, and in the decade or so before World War I the navy's concern with the economic foundations of its expansion began to broaden the connotation of the word to include for the first time the processes of industrial mobilization and the functions of a wartime economy in supporting military operations, spheres of activity that in Jomini's day had seemed little related to the conduct of war.

2. Thorpe.—This broader conception of logistics was reflected in a little book published in 1917 by an obscure marine corps officer,

George Cyrus Thorpe, under the title *Pure Logistics*. Thorpe argued that the whole sphere of warmaking fell naturally into three subdivisions, strategy, tactics and logistics, and that since the first two by common understanding were concerned with the actual conduct of war by the fighting forces, the logical function of logistics was to provide all the means, human and material, for the conduct of war. It therefore embraced, Thorpe insisted, not merely the traditional functions of supply and transportation in the field, but also war finance, ship construction, munitions manufacture and other aspects of war economics.

Thorpe's conception of logistics did not win immediate acceptance, however, either in his own service or in the U.S. army, which also became involved in economic mobilization during World War I and was responsible during the 1920s and 1930s for planning for industrial mobilization in a future war. At the army's general services school at Ft. Leavenworth, Kan., logistics was defined as late as 1926 in traditional terms as "that part of the military art which embraces the details necessary to the movement and supply of troops in military operations."

3. World War II.—The word logistics came into sudden vogue in the U.S. during World War II at a time when paradoxically it had almost disappeared from military use in Europe. With wide usage came further confusion of meaning. The army service forces, comprising most of the army's supply and service agencies in the United States, defined logistics (largely in terms of its own functions) to include virtually all aspects of administration except training. During the war and after, in all the military services, the logistics label was attached indiscriminately to numerous staff and operating agencies exercising a variety of functions in the field of administration, and the army created several types of "logistical" field commands. Official definitions changed from year to year, and differed among the services. Army dictionaries belatedly recognized the term for the first time in 1944, in the traditional narrow sense; field service regulations did not follow suit until 1949. The navy, by contrast, before 1950 had embraced a conception of the term as broad as that propounded by Thorpe in 1917, even defining a separate sphere of "civil" logistics to cover industrial mobilization for war.

4. Postwar Definitions.—In 1948 the three unified military services agreed on an official definition that listed virtually all military activities dealing with the provision and administration of matériel, personnel and facilities. Two years later they added to the list training and welfare activities, and also the phrase "acquisition or furnishing of services." These additions seemed to give logistics a scope as broad as that of military administration itself, and marked the high point in the development of official interservice definitions of the word. After 1950 the trend was back toward narrower, more traditional conceptions. By the early 1960s logistics still included all aspects of transportation; the acquisition, construction and operation of military facilities; the entire range of matériel functions, from design and procurement through distribution and final disposition; and services (still unspecified). But of the once long list of personnel functions only hospitalization and evacuation remained.

Official definitions have scarcely affected usage, which remains stubbornly inconsistent and loose. In its narrowest application, logistics may mean simply military supply and transportation. At the other extreme, it may comprehend the provision in the broadest sense of men and matériel for military operations, including all the planning, administration and services therein involved, and reaching far back into the mobilization of the nation's economic resources for war. As one epigrammatic definition puts it, logistics is often likened to "the military element in the nation's economy and the economic element in its military operations."

Not all the specialists whose skills are thus blanketed consider themselves logisticians, however. To the radio operator or electronics technician, to the nuclear physicist or public information officer, to the personnel administrator, to the file clerk, even to the military engineer, logistics is likely to appear as a vague conglomeration of activities somewhere outside his own area of specialization. Most of the military specialists whose duties bring them in contact with or even within sound of combat feel a strong aversion to the label of logistics because of its traditional noncombatant connotations. The word belongs, in fact, primarily to the vocabulary of the staff planner, for whom it serves as a convenient symbol to apply to whatever combination of noncombatant activities happens to be under consideration at the moment. Even in the language of staff planning, where "logistics" has become a familiar and overworked word, it is likely to be paired with a more precisely definable one, producing such locutions as "logistics and administration," or, inexplicably, "logistics and supply." Rarely in working military parlance does the occasion arise to use the word in its broadest sense. Where logistics stops and something else begins is, in fact, a question of serious concern only to the military theorist and the writer of official definitions.

II. ELEMENTS OF LOGISTICS

Viewed historically and analytically, logistics consists of four principal elements. Supply and transportation form the hard core, the primary functions by which armed forces are enabled to exist and to perform their essential tasks of moving and fighting. In addition, men and matériel alike depend for effective performance on a variety of services, such as repair and maintenance of weapons and equipment. The fourth element, closely related to services, is administration, considered in its general meaning as the function of organizing, co-ordinating and managing military activities.

1. Supply.—Supply is the function of providing the material needs of military forces. (It does not include the provision of men, which ordinarily is not considered an aspect of logistics.) In a narrow sense, supply refers only to distribution and the related function of storage. Broadly construed, it covers all stages in the life of an item of supply or equipment except its actual use or consumption; it includes design and development, manufacture, procurement, storage, distribution, salvage and final disposition. With these go such services as testing, maintenance, repair, packing and packaging, warehousing and veterinary service. Supply is also a planning-administrative process, paralleling the physical processes listed above and including such activities as contracting, pricing, scheduling, allocation and control of raw materials, components and facilities, industrial relations, conservation, inspection, stock control, administering of supply policies and procedures, requisitioning and the processing of requisitions. All these functions and processes fall into four broad phases: (1) production, in its nontechnical sense, including all steps in the creation of finished items of matériel; (2) procurement or acquisition of finished items by the military authorities from producing agencies; (3) distribution through the channels of supply; and (4) dominating the whole, the balancing of supply and demand, *i.e.*, the determination of requirements and assets, and the scheduling of objectives in production and distribution.

While the character of military supply has varied with the changing technology of warfare, it has always had the basic aim of providing military forces the essential material means that enable them to live (food, water, clothing, shelter and medical supplies), to move (vehicles and transport animals, fuel and forage) and to fight (weapons, defensive armament and materials, other combat equipment and the expendables of fire or missile power). In all three categories are items such as clothing, vehicles and weapons, that are used repeatedly, and therefore need only be replaced when lost, destroyed or worn out; and materials such as food, fuel and ammunition, that are expended or consumed, and therefore must be continuously or periodically resupplied. From these characteristics are derived the classifications of initial issue, replacement and resupply. Other more technical classifications are used in various countries and services. The U.S. army uses five main classifications: (1) subsistence and forage; (2) equipment and other items issued to organizations and individuals on the basis of allowance tables; (3) fuels; (4) equipment and materials of irregular issue; and (5) ammunition. The British army recognizes two broad classes: (1) supplies, which include all the expendables except ammunition; and (2) stores, which include ammunition and military hardware in general.

Food, Forage and Fuel.—Historically, food and forage made up most of the bulk and weight of supply requirements until the 20th century, when with mechanization and the growth of air power forage largely yielded to fuel. The demand for food is unremitting and undeferrable; since man himself, as a consumer of food, has changed little or not at all, it is the one constant of logistics. While a man can live without food for as long as five weeks, he becomes militarily useless long before that limit is reached; if deprived of water he succumbs in four or five days. A man's daily ration makes a small package—the U.S. army ration in World War II weighed only six pounds—but an army of 50,000 men may consume in one month as much as 4,000 tons of food.

Animals require much more: the standard grain and hay ration in the U.S. army in the 19th century was about 25 lb., and the daily forage for a corps of 10,000 cavalry weighed as much as the food for 50,000 men. Forage requirements tended, moreover, to be self-generating, since the animals needed to transport it also had to be fed. The number of animals accompanying armies varied widely. Napoleon described as an ideal, which he himself failed to attain, a supply train of no more than 500 wagons in an army of 40,000 men; with a corps of 7,000 cavalry, this would amount to about 10,000 animals. Northern armies in the American Civil War, whose transport was probably more lavish than the historical average, commonly numbered half as many animals as soldiers. A force of 50,000 men thus might require more than 300 tons of forage daily. This was more than twice the weight of gasoline that an equivalent force of three World War II infantry divisions, using motor vehicles exclusively, needed to operate for the same length of time. In the latter case, moreover, fuel requirements diminished markedly when an army was not moving, while the premechanized force had to feed its animals whether moving or not. The expendables of movement in the 20th century, however, include fuel for rail and water transport as well as for motor vehicles and in addition the immense fuel requirements of modern air power. In World War II fuel and food made up more than half the total resupply and replacement needs of U.S. forces (not including fuel for transoceanic shipment), and almost 80% of their resupply of expendables. Food amounted to only 8% and 12%, respectively.

Ammunition and Equipment.—Before the advent of mechanization, complex weapons and massive firepower in the late 19th and 20th centuries, equipment replacement and ammunition resupply needs were relatively small. Missile power, in the ages before the invention of gunpowder, was limited by the difficulty of bringing large supplies of missiles to the battlefield. Much depended, in a protracted battle, on the speed with which spent arrows and javelins could be gathered up and turned against their original owners; the ancient slinger (effectively employed by Hannibal against the Romans) had an important advantage over the bowman in using a projectile that was both more portable and more readily obtainable.

For five centuries after the invention of gunpowder the provision of ammunition was not a major logistical problem. Not until the use of field artillery on a large scale in the 18th century, and the development of quick-firing shoulder arms in the 19th, did ammunition begin to constitute a substantial proportion of resupply needs. As late as 1864, in the Atlanta campaign of the American Civil War, Gen. William T. Sherman's average daily ammunition requirements amounted to only one pound per man, as against three pounds for rations; Confederate forces, according to their chief of ordnance, expended on the average only half a cartridge per man per day.

The immense increase of firepower in the 20th century upset the historic ratios. In World War II the average ammunition requirements of U.S. forces overseas amounted to 14% of their total resupply and replacement needs, and 21% of their expendables. Earlier, in World War I, and again in the Korean War ammunition expenditures were higher. Replacement requirements also climbed in the 20th century, particularly in the lavishly equipped U.S. army, but only moderately as compared with the swelling tonnages of expendable supplies. Replacement of equipment and miscellaneous nonexpendables for U.S. forces in World War II absorbed only 13% of their total resupply and replacement requirements.

2. Transportation.—While strictly speaking a logistical service, transportation is usually considered an independent function of logistics because of the vital importance of movement (both of matériel and personnel) as a basic function of military forces. In the distribution phase of supply, transportation is, of course, the dominant element. (*See* TRANSPORT, MILITARY.)

For 5,000 or 6,000 years of organized warfare, before the development of steam propulsion and the internal-combustion engine, armies depended for mobility on two sources of energy: the muscles of men and animals, and the force of the wind. On land they used men and animals to haul and to carry; on water they used oar-driven or sail-propelled vessels. Among these various modes the balance of advantage and disadvantage was often delicate, involving numerous variables. Movement by water was exposed to the hazards of storm and the vagaries of wind. Transports were vulnerable to attack by enemy warships; they were also limited in their carrying capacity, and expensive to hire or buy. Large overseas expeditions could be undertaken only by comparatively wealthy states, unless, as in the case of the Scandinavian rovers of the 8th and 9th centuries, the warriors were themselves mariners and seafaring was rooted in the economy. Only rarely was a force transported over water powerful enough to overcome a strong land-based foe—as the Persian invaders of Greece learned at Marathon in 490 B.C.—and its subsequent support was likely to be precarious.

On the other hand, armies have usually been able to move faster by water than by land. The natural roadway of the sea offers less friction and fewer obstacles to movement over its surface than even good roads, and military history contains few examples of good roads. In the 19th and 20th centuries construction of larger ships and the development of steam and other forms of propulsion made water travel largely independent of wind and weather, and made it possible to transport and sustain overseas larger forces than ever before. On land technological change was also under way. More and better roads were built, particularly in Europe and the United States, and the railroad, after the mid-19th century, enabled whole armies for the first time to move long distances more rapidly than a man could walk. Motor vehicles and more road building in the 20th century extended the conquest of rough terrain. The airplane, finally, freed military movement, for relatively small forces and limited amounts of matériel, from bondage to earth altogether. Yet the costs of mobility on land—in equipment, materials and energy—were high and military movements, except by small forces with little impedimenta, were still confined to narrow ribbons of rail and road constructed in advance. In large parts of the world these were largely lacking, and the technology of military movement was still primitive. Even in the mid-20th century, in short, movement by water retained the advantages inherent in its nonresistant medium.

On land, the soldier himself has always been the basic and indispensable burden carrier. As a matter of simple logistical economy, he represents large available carrying capacity at no extra cost. His equivalent, in an army of 50,000 men, would be 1,250 wagons drawn by 7,500 horses or mules; a difference of only five pounds in his individual load could add or subtract a requirement for 125 wagons and 750 animals. Since the days of the Roman legionary, the soldier's load has averaged, until recently, from 55 to 60 lb. Exceptions were few and conspicuous. Oliver Cromwell reduced the load of his New Model army to less than 40 lb. per man; the troops of Revolutionary France endured physical discomfort and developed foraging into a system in order to discard most of the personal impedimenta that had burdened the typical 18th century soldier; "Stonewall" Jackson's foot cavalry in the Civil War carried only musket, ammunition, a blanket or rubber sheet, a frying pan, a few personal necessities and on occasion three days' rations. The ratio between armament and vital needs in the soldier's load has varied widely, but the modern soldier has tended to relegate most of his food to vehicle transport, while carrying a heavier burden of weapons and ammunition. Recent research has discredited the traditional practice of using augmented training loads to develop endurance, and has emphasized the necessity of

reducing combat loads to a minimum, since fear and fatigue both drain muscular power. In most armies following World War II the soldier's load was drastically reduced, in the U.S. army to about 40 lb.

Before the age of steam, armies supplemented the soldier's carrying capacity both with additional manpower and with animal power. Each had its advantages, but the balance was fairly even. A team of six horses ate about as much as 40 or 50 men, but the men could carry more on their backs than the horses could haul, and considerably more than the horses could carry. Men could negotiate rougher terrain, and they required less care. On the other hand, when men were used as carriers their loads had to be distributed in small packages, and men proved less efficient than animals when teamed to haul heavy and bulky loads. (The one-man cart, an ancient means of conveyance, was used to good effect by the Koreans and Chinese in the Korean War and has a significant role in the logistics of the Chinese and Soviet armies.) The horse and mule, besides, have less strength and stamina, though more agility than the ox, which through the ages has been the primary beast of burden. As a mount for the warrior, making the most of its speed and height, the horse has served a more useful function, and one with logistical aspects as well, since mounted troops, whether they fought as infantry or cavalry, could move rapidly for short distances. With such rare exceptions, however, as the far-ranging cavalry armies of the Mongols in the 13th and 14th centuries, large cavalry forces were shackled, like infantry, to their slow-moving transport and to their bases. In general, animal transport has predominated in the military experience of the western world, where manpower has usually been scarce, while in the orient, where manpower is plentiful, men have been used even more than animals as military beasts of burden. Both forms of transportation continue to be used in the mid-20th century, wherever mechanical transport is insufficient or breaks down or runs out of fuel. In the Korean War the porter with his A-frame probably carried more tonnage than was carried by any other mode of land transport.

3. Services and Administration.—This is the shadowland where logistics merges into areas of military activity to which usage has generally not accorded the name. History and the activities themselves unfortunately recognize no line of functional demarcation that might suggest a distinction between logistical and non-logistical services and administration. Even the ancient distinction between combat-related and noncombatant activities has grown fuzzy in modern warfare, where so many specialized and unviolent skills (artillery fire direction, for example) may enter into the process of killing.

Services may be defined as activities designed to enable personnel or matériel to perform their appropriate functions more effectively; administration may be defined as the managing and ordering (as opposed to the actual performance) of a function or process—hence also the operation of an organization or installation. Since services themselves must be administered, both purposes are usually combined in the same activity.

The list of military services and administrative activities in modern warfare is long. Those associated with supply have already been mentioned. Transportation, itself a service, involves a subordinate service, stowage of freight, as well as the administering of troop and freight movements, control of traffic and documenting of shipments. Seven other major service-administrative areas can be discerned: (1) communications; (2) the construction, repair and maintenance of facilities (housing, depots, railroads, etc.), including operation of utilities and leasing and disposal of real property; (3) personnel services (medical, spiritual, legal, personal, informational, recreational) and administration (recruitment, induction, classification, assignment, maintenance of records, separation); (4) dissemination of public information; (5) finance and fiscal management; (6) military justice and discipline; and (7) military government. Administration itself, finally, has its own related service: the study and development of improved methods of management.

Even though not all these activities fall within the sphere of logistics by current usage and definitions, they may be referred to collectively, for present purposes, as logistical services. Most of them are of recent origin, reflecting both the complex technology of modern warfare and the institutional complexity of modern society. Over the long run of military history, the logistical services considered necessary to keep soldiers, animals and equipment in fighting trim were generally of a rudimentary sort. From the earliest times, however, they posed a serious logistical problem. First, they added to armies and their lines of communications substantial, sometimes immense, numbers of people whose primary business was not to fight and who, if not properly organized, often impeded fighting. The soldier seldom possessed the technical skills required to perform any but the simplest logistical services; in some ages, as a member of the warrior class, he was even prohibited by social prerogative from performing them. The classic accompaniment of armies, consequently, has been its long train of noncombatants, often far outnumbering the fighting men.

Logistical services also added to the baggage of armies a growing burden of specialized equipment, tools and materials required for performance of the services. Services tended to generate more services: service equipment itself had to be serviced, sometimes by additional equipment manned by additional technicians, and service personnel themselves required services. Logistical services thus meant more people to be fed, clothed and sheltered, and more people and baggage to be transported. This is the problem of what the British call the "administrative tail"; it is as old as military history.

III. POWER VERSUS MOVEMENT

The potential effectiveness of a military force lies in three attributes—power, mobility and range—*i.e.*, the ability to fight, to move freely and rapidly and to move far. Each depends on physical ingredients that must be provided and transported, and on logistical services that also place a burden on supply and transportation. Since logistical capabilities are almost always limited, power, mobility and range must compete for the available supply, transportation and services. This competition over the ages has tended to focus on transportation, which for an army in the field almost invariably determined the amount and kind of supplies that could be made available, as well as the scale of services that could be provided, at the time and place needed. Given a fixed amount of transport, the amount of supplies and services it can deliver to a force in the field depends in the main on the distance it must travel in performing these functions. Three methods have been used, in combination and with varying emphasis: (1) self-containment, in which all that the force needs is carried along with it; (2) local supply, in which supplies and services are obtained from sources nearby or along the route of march; and (3) supply from bases, in which supplies are brought as needed from more distant sources.

1. Self-containment.—The idea of complete independence from external sources of supply has always exerted a powerful fascination. For many a commander plagued by supply troubles the hard-hitting, fast-moving, streamlined, self-contained "flying column" was a glittering ideal, which somehow never quite materialized. Self-containment in equipment, service personnel and even ammunition or missiles was the historical rule until the great expansion of fire power and of replacement requirements in the last century. Even in the 20th century, replacement of equipment and resupply of ammunition has normally been intermittent rather than continuous. Few military forces have been able to operate for long without frequent resupply of food, forage and fuel. The disintegration of the French army after its defeat at Blenheim in 1704, and of Napoleon's Grande Armée in the retreat from Moscow in 1812, resulted largely from exhaustion of accompanying supplies and inability to subsist on the countryside.

By its nature, self-containment is the least economical of all methods of supply. The available transportation is fully loaded only once at the beginning of the movement, and serves thereafter as a rolling warehouse, which is steadily depleted as the force eats into its food and fuel or forage. Thus only a fraction of the available capacity is put to use. Self-containment, in fact, offers few advantages other than that of moving by an unpromising, possibly

unguarded route, without delays or detours to replenish supplies. Hannibal gained this advantage when he crossed the Alps into northern Italy in 218 B.C., circumventing the Romans barring the easier coastal route—but in doing so he lost almost half his entire force. Gen. John Burgoyne's invasion of New York from Canada in 1777 with a virtually self-contained force bogged down in hostile country and ended in disaster at Saratoga. In general, self-containment requires the sacrifice of both fighting power and range of movement in a striving for mobility which may itself be defeated by the sheer weight of the expendable supplies that must be carried.

2. Local Supply.—Until modern times, supply from local sources (including captured stores) in the regions where armies operated was the commonest method of resupplying food and forage and of providing labour and other simple services. In fertile country, an army could usually meet at least a large part of its immense cumulative demand for the major expendables, at low cost in transportation and without sacrificing power or range. When efficiently organized to reduce delays and diversions, local supply even permitted a high degree of mobility. Normally, however, an army living off the country tended to straggle and to load itself down with loot. If it moved too slowly or was pinned down by the enemy, it might sweep the region bare and starve. In winter or in desert mountains local supply offered meager fare. And a hostile population, as Napoleon discovered in Russia and in Spain, could bring disaster to an army that had to scrounge for its food.

Yet, even when the troops could be fed by other means, the animals usually had to shift for themselves, for the burden of transporting forage any considerable distance could be prohibitive. Local supply of forage was in fact almost universal throughout the centuries before the advent of mechanized transport. Moreover, cattle driven along with an army could transform forage into food for the troops—a supply technique as ancient as biblical times and still common in the late 19th century. Unwieldy and slow-moving though it was, the accompanying herd had the great merit of transporting itself, and unlike the wagon train it dwindled as it was consumed. It was the forage requirement, far more than the problem of food supply, that served, as a general rule until recent times, to confine large-scale military operations to relatively settled, fertile regions and to the months of the growing seasons.

When mechanical transport replaced animals, one of the great continuities of military history was broken. Mechanized armies can operate in winter and desert areas as long as they have fuel. But when that is gone, they grind to a halt, for empty gasoline tanks cannot be replenished from fields and pastures. Mechanization closed the door to both self-containment and local supply as practicable logistical systems. Until power can be packaged in capsules or, like forage, gathered along the route of march, the door is likely to remain closed.

3. Supply From Bases.—The alternative to self-containment and local supply is continuous or periodic resupply and replacement from stores amassed in advance at accessible points. Each of these, or all together, constitute a supply base, a term also applied to a whole area embracing an army's sources of supply. In the past, supply from bases offered two main advantages over local supply: (1) bases were relatively secure from attack, and (2) they could be stocked with any desired quantity of war material. On the other hand, supply from bases involved, and still involves, three serious disadvantages. First, the movement of supplies over the routes, or lines of communications joining them to the army, may itself be interrupted or cut off by the enemy, and these supply lines, because of their length, are exceptionally difficult to defend. Second, an army shackled to its bases lacks flexibility and moves slowly, primarily because of the administrative friction and inertia involved in organizing a regular flow of supply from base to army. Finally, the transportation costs of maintaining the flow of supply even over short distances are heavy. These costs rise geometrically as the distance between army and base increases, since in order to deliver a load of supplies each vehicle must travel to the base and return, and additional food, forage and fuel must be carried for the personnel, animals and vehicles engaged in the movement. This geometrical increase in expendable requirements for moving up supplies over a lengthening gap between a base and an advancing army progressively encroaches upon and eventually cancels out the capacity to deliver supplies to the army, regardless of the amount of transport used. With animal-drawn transport, the point of no return is reached very quickly. General Sherman, looking back over his experience in the American Civil War, concluded that an army thus supplied could not operate effectively more than 100 mi., or about five days' march from its base.

With mechanized transport, the theoretical operating radius is greatly extended. The U.S. army truck-and-trailer used in World War II, with $3\frac{1}{2}$ times the capacity of a Civil War-type army wagon, could travel as far on 100 lb. (13.3 gal.) of fuel as the horse- or mule-drawn wagon could travel on 750 lb. of forage. Thus, whereas in the Civil War as much as 75% of the transport used to sustain an army operating 100 mi. from its nearest base might have to be assigned to carry forage for the animals hauling the supplies, only 3% of the trucks used to supply a World War II army operating at the same range were needed to carry their own fuel. In both cases, the ultimate limit on the operating range of armies was theoretically absolute. In practice, armies using animal-drawn transport could evade the limitation by resorting to local sources for part of their forage, while for the modern mechanized army the ultimate limit was so great—perhaps 3,000 mi.—that it never became operative.

IV. LOGISTICAL SYSTEMS BEFORE 1850

The combination of local supply for food and forage and of self-containment in hardware and services appears often in ancient history as the logistical basis for operations by forces of moderate size. Three of these operations are familiar to every schoolboy—the 4,000-mi. march of Xenophon's Ten Thousand, the even longer campaign of Alexander the Great from Macedonia to the Indus and Hannibal's campaigns in Italy. The larger armies of ancient times—like that of Xerxes in the invasion of Greece in 480 B.C.—seem to have been supplied by depots and magazines along their routes of march. The Roman legion combined all three methods of supply into a marvelously flexible system. The legion's ability to march fast and far owed much to superb roads and to an efficiently organized supply train, which included mobile repair shops and a service corps of engineers, artificers, armourers and other technicians. Supplies were requisitioned from local authorities and stored in fortified depots; labour and animals were drafted as required. At need, the legion could carry in its train and on the backs of its soldiers up to 30 days' supply of provisions. In the First Punic War a Roman army marched an average of 16 mi. a day for four weeks.

One of the most efficient logistical systems ever known was that of the Mongol cavalry armies of the 13th century. It rested mainly on self-containment and local supply, supplemented by bases. In normal movements the Mongol armies divided into several corps and spread widely over the country, accompanied by trains of baggage carts, pack animals and herds of cattle. Routes and camp sites were carefully selected for accessibility to good grazing and food crops; food and forage were stored in advance along the routes of march. On entering enemy country, the army abandoned its baggage and herds, divided into widely separated columns and converged upon the unprepared foe at great speed from several directions. In one such approach march a Mongol army covered 180 mi. in three days. Commissariat, remount and transport services were carefully organized. The tough and seasoned Mongol warrior could subsist almost indefinitely on dried meat and curds, supplemented by occasional game; when in straits, he might drain a little blood from a vein in his mount's neck. The Mongol pony, bred on the steppe, could dig for forage through a light snow. Every man had a string of ponies; baggage was held to a minimum; equipment was standardized and light.

In the early 17th century Gustavus Adolphus of Sweden and Maurice of Nassau restored to European warfare a mobility not seen since the days of the Roman legion, mainly by careful organization of supply. The Swedish armies were based on prestocked magazines, but they also had compact supply trains with

well-organized services, a flexible tactical organization and light, standardized artillery. An important feature of Gustavian logistics was a system of orderly requisitioning that contrasted with the indiscriminate looting and devastation characteristic of the warfare of the day.

The formalized warfare of the 18th century was based on an elaborate and ritualistic system of logistics that sacrificed both range and mobility. This was the period of the rolling magazine, and of intricate systems of fortified depots and defended lines of communications. The growing size of armies, increasing use of artillery and greater attention to the creature comforts of a mercenary soldiery, all combined to place heavier burdens on transport. The retinues of baggage and servants accompanying higher officers assumed monumental proportions. At the same time, a widespread revulsion against the depredations and inhumanity of the religious wars in the preceding period brought sharp curbs on looting and other abuses; local supply took the form of carefully regulated requisitioning administered through municipal and provincial authorities under terms often defined by treaty. Since soldiers were expensive, there was a tendency to avoid battles (which, when they occurred, were bloody), and campaigns tended to degenerate into sluggish maneuvers with the primary aim of threatening or defending bases and lines of communications. War became an appendage of logistics in which, as Frederick the Great remarked, "the masterpiece of a successful general is to starve his enemy."

The era of the French Revolution and the Napoleonic domination of Europe (1789–1815) brought back both mobility and range to European military operations, along with an immense increase in the size of armies and the destructiveness of warfare. Logistics became simpler and in many respects cruder. French armies, operating on the principle that "war must support war," largely abandoned the rolling magazine, the elaborate system of supporting depots of the preceding period and even the requisition system. Baggage trains were pared down to the essential needs of fighting power and mobility. The soldier was often heavily burdened with weapons, ammunition and necessities formerly carried by the train; his greatcoat, for example, now served as his tent. Even so, he marched faster and farther (partly by virtue of an accelerated march cadence) than his opponents and predecessors. The system leaned heavily on the willingness of the patriotic citizen soldier (who in a few years became a veteran) to scrounge for himself, to do without and to suffer and die for lack of the rudiments of medical care. Napoleon himself avowedly counted on a brief campaign climaxed by a resounding victory to solve most of his logistical problems. The system, such as it was, tended to degenerate. Baggage trains grew larger; in the invasion of Russia in 1812 they were unable to keep up with the pace of advance and left the troops dependent upon a devastated countryside. In Spain too the logistics of local supply and self-containment broke down.

V. LOGISTICS IN THE INDUSTRIAL ERA

1. The Revolution in Warfare.—Between 1850 and 1950 the conditions and methods of logistics were transformed by a revolution in warfare more fundamental than any that had occurred in the preceding 6,000 years. The revolution had four facets: (1) the mobilization of mass armies; (2) a revolution in weapons that vastly increased firepower; (3) an economic revolution that provided the physical means needed to feed, munition and transport mass armies; and (4) a revolution in the techniques of management and organization, which enabled nations to mobilize their economic and human resources and to coordinate their use in a war effort often referred to, in the 20th century, as total.

These interrelated developments did not occur all at once. Armies of unprecedented size had appeared in the latter years of the Napoleonic Wars. But for almost a century after 1815, the world saw no similar mobilization of military manpower except in the American Civil War. Meanwhile, however, the rapid growth of populations (in Europe, from 188,000,000 in 1800 to more than 600,000,000 in the 1960s) was creating a virtually unlimited reservoir of manpower. By the latter part of the 19th century most nations were building up large standing armies backed by even larger reserves, and the great 20th-century wars saw the mobilization by each major power of armies numbering many millions.

The revolution in weapons had also started earlier, with a series of inventions and scientific developments dating at least back to the latter part of the 18th century. Its impact upon armaments, in the form of weapons in widespread use, was not felt until about the middle of the 19th century. The rifled percussion musket, rifled and breech-loading artillery, heavy ordnance of very large calibres and steam-propelled and armoured warships were all coming into general use in the 1850s and 1860s. The details of the technological revolution, which proceeded with gathering momentum thereafter, cannot be summarized here. Each successive conflict brought forth a fresh crop of new and deadly weapons, but it remained for mass armies in the 20th-century world wars to realize the full potentiality for destruction that the new technology embodied.

By the mid-19th century the Industrial Revolution had already given a number of industrialized nations—especially Great Britain, France and the United States—the capacity to produce munitions, food, transport and many other items in quantities no commissary or quartermaster had ever dreamed of. In the American Civil War, the abundant munitions output of the still budding and only partially mobilized industrial economy of the Northern states dimly suggested the latent capabilities that might have been realized. But in general the wars of the 19th century hardly scratched the surface of the immense warmaking potential already in being. The generally limited character of all the conflicts between 1815 and 1914 can probably be attributed to the distribution of power and the nature of the international rivalries in this period. But even had these factors not tended to limit war objectives and to curb the mobilization of latent military power, it may be doubted whether managerial knowledge and techniques then in existence would have sufficed to carry out such a mobilization. It was, in fact, only in the crucible of World War I at the cost of colossal blunders and waste of effort that these techniques began to be learned.

Thus the full implications of the revolution in warfare were not revealed until the 20th century. Long before 1914, however, new instruments and techniques of logistics had begun to emerge.

2. Transportation and Communication.—The railroad, the steamship and the telegraph had a profound impact on logistical methods during the last half of the 19th century. From the Crimean War on, telegraphic communication was an indispensable tool of command, intelligence and operational co-ordination, particularly in controlling rail traffic. In the 20th century it yielded to more efficient forms of electronic communication—the telephone, radio, radar, television and telephotography.

Railroads spread rapidly over western and central Europe and the eastern United States between 1830 and 1860. They were used, mainly for troop movements, in the suppression of the central European revolutions of 1848–49, on a considerable scale in the Italian War of 1859, and extensively in the American Civil War, where they also demonstrated their capacity for long hauls of bulky freight in sustaining the forward movement of armies. One of the revelations in this conflict was the speed with which torn up or blown up track could be repaired, and this remained true even after rail lines and junctions became prime targets for air bombardment in the 20th century.

In Europe, from 1859 on, the railroads shaped the war plans of all the general staffs, the central feature of which was the rapid mobilization and concentration of troops on a threatened frontier at the outbreak of war. In most countries railroad building was planned with this end in view. Germany's strategic rail net in the centre of Europe enabled it to exploit to the full the advantage of interior lines. In 1870 it was able to concentrate 550,000 troops, 150,000 horses and 6,000 pieces of artillery on the French border in 21 days, and its recognized efficiency in mobilizing influenced the war plans of all the European powers in 1914. In both world wars Germany's railroads enabled it to shift troops rapidly between the Russian and the western fronts.

In the 19th century, steam propulsion and iron ship construction

also introduced new logistical capabilities into warfare—the latter by breaking down earlier limitations on the size of seagoing ships, the former by freeing sea-borne transportation from the vagaries of the wind. Steamships moved troops and supplies in support of overseas operations in the Mexican War of 1846–48 and on a much larger scale in the Crimean War of 1854–56; river steamboats played an indispensable logistical role in the American Civil War.

The complement of the railroad was the powered vehicle that could travel on ordinary roads and even unprepared surfaces, within the operating zones of armies, forward of railhead. This was a 20th-century development, a combination of the internal-combustion engine, the pneumatic tire and the endless track. Motor transport was first used on a large scale in World War I, along with animal-drawn transport, and in World War II it became, next to the railroad, the dominant means of land movement. Another innovation was the pipeline, used to move water in the Palestine campaign of World War I, and extensively in World War II to move oil and gasoline to storage points close to the combat zones. More revolutionary was the development of air transportation. In World War II, units as large as a division were carried in one movement by air over and behind enemy lines, and resupplied by the same means. Cargo aircraft maintained an airlift for more than three years from bases in India across the Himalayas into China; during the last eight months of operation it averaged more than 50,000 tons per month—an airline of communications for a whole theatre of operations. But the fuel costs of such an operation were exorbitant. Despite the development of gigantic cargo aircraft, air transportation remained primarily a means of emergency movement when speed was an overriding consideration.

3. The Growth in Quantity.—The most conspicuous logistical phenomenon of the great 20th-century wars was the enormous quantity of matériel used and consumed. One cause was the growth of firepower, which was partly a matter of increased rapidity of fire of individual weapons, partly a higher ratio of weapons to men—both multiplied by the vast numbers of men now mobilized. A Civil War infantry division of 3,000 to 5,000 men had an artillery complement of up to 24 pieces; its World War II counterpart, numbering about 15,000 men, had 328 artillery pieces all capable of firing heavier projectiles far more rapidly. A World War II armoured division had an armament of nearly 1,000 pieces of artillery. Twentieth-century infantrymen, moreover, were armed with semiautomatic and automatic weapons instead of the single-shot muzzle-loaders used by most troops in the Civil War.

The upward curve of firepower was reflected in the immense amounts of ammunition required in large-scale operations. Artillery fire in the Franco-German War, and in the Russo-Japanese War, for example, showed a marked increase over that in the Civil War. But World War I unleashed a firepower whose existence had hardly been hinted at in the previous conflicts. In this holocaust British and French forces expended during one average month more than twice as much artillery ammunition as did the Union forces during the entire four years of the American Civil War, and in the seven-day battle of the Somme in 1916 British artillery fired about 4,000,000 rounds, or roughly 125 times as many as the Union artillery in the three-day battle of Gettysburg. In World War II the U.S. procured only about 4 times as many small arms as it had in the Civil War, but 43 times as much small-arms ammunition. The Confederacy fought through the four years of the Civil War on something like 5,000 or 6,000 tons of gunpowder; American factories in one average month during World War I turned out almost four times this quantity of smokeless powder. Again, in one year of World War II, 7,000,000 tons of steel went into the manufacture of tanks and trucks for the U.S. army, 4,000,000 tons into artillery ammunition, 1,000,000 tons into artillery and 1,500,000 tons into small arms—as contrasted with less than 1,000,000 tons of pig iron used by the entire economy of the Northern states during one year of the Civil War. To the ammunition expenditures in the 20th-century world wars were added, moreover, the immense tonnages of explosives used in air bombardment. It must be remembered, finally, that ammunition and explosives remained a relatively small item among the military expendables; the weight of fuel and food was perhaps four times as great.

With growth in quantity went a parallel growth in the complexity of military equipment. The U.S. army in World War II used about 60 major types of artillery above .60 calibre, from the 20-mm. automatic aircraft cannon to the 16-in. coast artillery gun. For 20 different calibres of cannon there were about 270 types and sizes of shells. The list of military items procured for U.S. army ground forces added up to almost 900,000, and each end item contained many separate parts; fire control instruments for some anti-aircraft guns contained as many as 25,000 precision-made parts. To convert and expand a nation's peacetime industry to the production of such an arsenal posed staggering technical problems. Manufacturers of automobiles, refrigerators, soap, soft drinks, bed springs, toys, shirts and microscopes had to learn how to make guns, gun carriages, recoil mechanisms and ammunition.

4. The Determination of Requirements.—To design and manufacture a weapon in quantity took from 18 months to two years or more, the so-called lead time of logistical planning. The operation in which the weapon was used was rarely planned in detail more than six months in advance. From this circumstance was derived the central problem of logistical planning: how to predict, without operational plans, what would be needed to carry on a war, in time to produce and make the matériel available when needed. In World War II the U.S. army developed elaborate administrative processes for accomplishing this feat, involving hundreds of statisticians and technical experts, electrical computing machinery and an army of clerical personnel.

Fundamentally the method was simple. Instead of "guestimating" the needs of all possible future operations not yet planned or conceived, requirements were calculated item by item for the army as a whole, on the basis of general expectations as to its composition, rate of expansion and overseas deployment, and the areas where it would operate. Requirements were grouped under the following headings: (1) initial equipment for each soldier and troop unit that the army expected to mobilize; (2) replacement equipment to cover expected losses in use and in combat, as indicated by analysis of past experience; (3) consumption and expenditure requirements for expendable supplies, also based on past experience; and (4) distribution requirements for both equipment and supplies needed to "fill the pipeline" in the army's worldwide system of supply (*i.e.*, quantities stocked in depots, in transit, and lost in transit), and thus ensure ready availability when and where needed. Reserves were also provided to cover unforeseen needs, and specific bills of requirements added for planned operations and for certain projects (*e.g.*, the reconstruction of a port) that could be foreseen. In general, the aim of the system was to provide a diversified fund of war material of all kinds, from which, it was hoped, specific needs could be met as they arose. The British in World War II used a somewhat different method which emphasized the calculation of requirements for forces in each theatre of operation.

5. The System of Staged Resupply.—Long before mechanization relegated local supply to a minor role in the support of modern armies, growing supply requirements had made armies dependent on more or less continuous resupply from bases. The *étappen* system of the Prussian army in 1866 was essentially a modification of the rolling magazine of the 18th century. Behind each army corps trailed a series of supply trains, shuttling continuously between the advancing troops and the nearest magazines in the rear. The magazines were repeatedly moved forward to keep within one or two days' march of the advance, and were in turn replenished by a lengthening chain of magazines extending back as far as the railhead. Only a small train accompanied the troops, carrying a basic load of ammunition, rations and baggage; each soldier carried three days' emergency rations. The system was geared to a steady, slow advance on a rigid schedule and a predetermined route, and the individual soldier was still heavily laden. Yet no alternative method seemed possible, since in 1866 and again in 1870–71 Prussian forces were able to obtain no more than a third of their supplies locally.

Staged, continuous resupply became the basic logistical sys-

tem for all armies in the industrial era, and for large, well-equipped forces sustained reliance on self-containment and local supply virtually disappeared. Accompanying loads were limited mainly to fighting equipment and a small reserve of fuel and ammunition, and soldiers carried a day or two of emergency rations. The administrative tail of magazines and shuttling transport stretching far back to the army's sources of supply became a regular feature of modern land warfare. In World War II, supplies moving to U.S. armies overseas normally passed through seven or eight major stages, besides numerous intervening ones: from a depot in the U.S. to a port of embarkation, to an overseas port, to a rear-area depot and perhaps to an intermediate or advanced depot, to a regulating station, to an army-area supply point, to a division or regimental supply point and finally to the troops.

Under this system, even though it was frequently described as a pipeline, supplies never flowed continuously from ultimate source to consumer. The object was to stock reserves of material as far forward as safe and practicable, making possible regular supply of food and fuel, and immediate provision of ammunition, replacement equipment and services when needed. Before any major operation, large reserves had to be accumulated close behind the front; the build-up of U.S. war matériel in the British Isles preceding the Normandy invasion of 1944 went on continuously over a period of two years, and involved the shipment of 16,000,000 tons of cargo across the Atlantic from the United States. In essence, the system strove to convert supply from bases into an approximation of local supply, by moving the bases close to the troops.

Behind the armies, in the continental European theatre in World War II, spread the rear-area administrative zone, a vast complex of depots, traffic regulating points, railway marshaling yards, troop cantonments and rest areas, repair shops, artillery and tank parks, oil and gasoline storage tanks, airfields and headquarters—through which ran the lines of supply stretching back to ultimate sources. In the Pacific, the administrative zone covered vast reaches of water, and most of the bases were on islands. Communication and movement in this theatre depended largely on shipping, supplemented by aircraft, and one of the major logistical problems was moving forward bases and reserves as the fighting forces advanced. Late in the war, supply ships often sailed all the way from the U.S. west coast, bypassing intermediate bases, to forward areas where they were held as floating warehouses until their cargoes were exhausted.

The system of staged resupply gave modern armies considerable range of movement and sustained offensive power, but it crippled their mobility. The natural habitat of the system was the creeping or sealed front of World War I, though many offensives on the western front bogged down, after gaining a few miles, through failure of supplies to keep up with the advance. World War II brought back maneuver and rapid movement, but mobile forces remained tied to their bases; they could move only so far and so long as their supplies could be carried to them. Both the capabilities and limitations of the system were dramatically demonstrated when the U.S. 3rd army plunged across France in the summer of 1944, only to halt after four weeks because the racing armoured spearheads had outrun the capacity of their methodically shuttling transport. Even though used on a lavish scale, motor vehicles could not keep them supplied with the quantities of fuel required.

One of the striking lessons of World War II, often obscured by the tactical achievements of air power and mechanized armour, was the great power that modern logistics gave to the defense. In 1943 and 1944 the ratio of superiority enjoyed by Germany's enemies in output of combat munitions was about 2½ to 1; the whole apparatus of Germany's war economy was subjected to relentless attack from the air, and had in addition to make good the enormous losses of material resulting from a succession of military defeats. Yet Germany was able, for about two years, to hold its own, primarily because its waning logistical strength could be concentrated on sustaining the firepower of forces that were stationary or were retiring slowly toward their bases, instead of on the immensely expensive effort required to support a rapid forward movement.

6. Logistical Specialization.—For many centuries the soldier was a fighting man and nothing else; he depended on civilians to provide the services that enabled him to live, move and fight. Even the more technical combat and combat-related skills, such as fortification, siegecraft and the service of artillery, were traditionally civilian. After the mid-19th century, with the rather sudden growth in the technical complexity of warfare, the military profession faced the problem of assimilating a growing number and variety of specialized noncombatant skills. Many of the uniformed logistical services date from this period; examples are the British army's transport corps (later Royal army service corps), hospital corps, and ordnance corps and the U.S. army's signal corps. In the American Civil War the Union army formed a railway construction corps, largely civilian in composition and operation but under military control. Prussia a little later created a railway section in the great general staff and a combined military-civilian organization for controlling and operating the railroads in time of war.

Not until the 20th century, however, did organized military units performing specialized logistical services begin to appear in large numbers in the field. By the end of World War II, what was called "service support" comprised about 45% of the total strength of the U.S. army. Only three out of every ten soldiers had combat functions, and even within the ranks of a combat division, one man out of four fell into the noncombatant category. Even so the specialized services that the military profession succeeded in assimilating were only a small fraction of those on which the combat soldier depended. Throughout the vast administrative zones behind combat areas and in the national base, armies of civilian workers and specialists manned depots, arsenals, factories, communications centres, ports and the other apparatus of a modern society at war. Military establishments employed a growing number of civilian administrators, scientists, management and public relations experts and other specialists. Within the profession itself, the actual incorporation of specialized skills was limited, in the main, to those directly related (or exposed) to combat, such as the operating and servicing of military equipment, though even here the profession had no monopoly. Soldiers also served as administrators and supervisors over civilian specialists with whose skills they had only a nodding acquaintance. On the whole, the fighting man at mid-20th century belonged to a shrinking minority in a profession made up largely of administrators and noncombatant specialists.

VI. LOGISTICS IN THE NUCLEAR AGE

The dropping of the first atomic bombs in Aug. 1945 and the subsequent emergence of nuclear and thermonuclear weapons systems employing long-range missiles as well as manned aircraft inaugurated a new era in warfare, which promised to demand radical changes in logistics and logistical systems as well. But the new weapons were not immediately used in war; the limited conflicts of the 1950s employed, in the main, the weapons and logistical methods of World War II.

1. Korean War.—The major conflict in this period, the war in Korea (1950–53), was reminiscent in many ways of the positional warfare in Italy in World War II. For U.S. forces, the near-disastrous retreat to the Pusan perimeter at the outset of the war recalled the tragedy of Bataan early in 1942. In many other respects, the war seemed an extension of World War II—even to the stocks of munitions left over from that conflict without which the UN operations of the first year could hardly have been supported. Late in the war, U.S. forces began to use new model trucks, but they represented no new departure in design. Weapons were also mostly World War II models, in some cases improved versions.

UN forces had an excellent base in nearby Japan, whose factories made a major contribution by rebuilding U.S. World War II matériel. Both Japan and South Korea's major port of entry, Pusan, were free from Communist air attack throughout the war. Chinese bases north of the Yalu enjoyed a similar immunity from UN air raids. This curious circumstance greatly simplified the supply problems of UN forces, enabling them to

funnel through Pusan supply tonnages comparable to those handled by the largest ports in World War II, and to concentrate depots and other installations in the Pusan area to a degree that would have been suicidal without complete air superiority.

The expenditure of artillery ammunition by UN forces at times soared above the highest levels attained in World War II, and the available supply often fell dangerously low. Output of ammunition in the U.S. was meagre, because of the long lead time needed to reach quantity production and of the expectation that the war would not last long. Actual shortages on the firing line were primarily a result of inadequate transportation facilities in Korea. UN forces also suffered at the beginning of the winter of 1950–51 for lack of winter clothing which had not been moved forward soon enough. The numbers of service troops never seemed to be adequate, although they were considerably greater than was normal in World War II, and were supplemented by large numbers of Korean labourers—more than 150,000 in the fall of 1951. Korean porters made a major contribution to the UN transport service in rugged terrain which trucks could not negotiate.

Communist supply lines, though heavily bombarded by UN air forces, functioned remarkably well; troops and supplies were moved by night, local labour and transportation were used extensively and the Chinese soldier proved, as he had often done during World War II, that he could endure an incredible amount of privation, subsist on very little food and still fight well. The Communist logistical system, technically primitive, enabled the Communist forces to mount heavy offensives, but they could not be sustained for more than three or four days. On the UN side, the most brilliant logistical exploit was the "amphibious operation in reverse" by which the X corps was evacuated from Hungnam in Dec. 1950. In a period of two weeks, under constant enemy attacks, about 105,000 troops, 98,000 Korean civilians, 17,500 vehicles and 350,000 tons of cargo were loaded in 193 vessels.

By World War II standards, the Korean War was a limited conflict (except for the two Korean belligerents, on whose soil it was fought). It involved only a partial, or "creeping" economic mobilization in the U.S., the major UN participant, and a modest mobilization of reserve manpower. Yet this was no small war. During the three years that it lasted, about 37,200,000 measurement tons of cargo were poured into the South Korean ports, or more than three-fourths of the amount shipped to U.S. army forces in all the Pacific theatres from Dec. 1941 to Aug. 1945. And the combined UN forces reached a peak strength of almost 1,000,000 men, of whom more than a third consisted of U.S. and other non-Korean contingents. Communist forces were considerably larger. (*See* also KOREAN WAR.)

2. Management.—Logisticians were much concerned in the post-World War II period with improvements in management aimed at greater economy and efficiency. This was no new trend, for World War II had seen a major effort, especially in the service forces and air forces of the U.S. army, to bring order and reasonable economy into operations which, because of their unprecedented magnitude, tended to breed waste and duplication. In the postwar years the slashing of military appropriations, the increasing cost of military hardware in a period of rapid technological change and growing international tensions all combined to put heavy pressure on the armed services to squeeze more military strength from the defense dollar—to get, as the saying went, "more bang for a buck."

To a considerable extent, the methods adopted to improve management in logistics were those used in the business world, though in many cases they had actually developed, and in some cases had their origin, in the military establishments. Civilian management firms, hired to survey these establishments, gave a strong impetus to the organization of logistical activities along "functional" lines, as opposed to the traditional organization by commodity groups with headquarters of the general-staff type—though the attempt to do so was successfully resisted in many quarters. Under the unified military establishment in the U.S., all activities were grouped into major and subsidiary "programs," with orderly schedules of objectives which were continuously matched against performance. Unification also spurred efforts to break down the uneconomical compartmentation of logistical activities under each armed service. Large groups of related functions (*e.g.*, military transportation by land, water or air, or procurement of subsistence, clothing or medical supplies) were placed under the control of one of the armed services or a single interservice agency. In overseas commands certain logistical activities were also "unified" for all three services.

In the technology of logistical administration, an innovation of revolutionary implications was the introduction of completely automatic electronic data processing machinery. Applied to such large-scale operations as the processing of supply requisitions and control of inventories, this development held promise of reducing to small proportions the factor of time in many areas of logistical activity, of centralizing control to an unprecedented degree and of slashing administrative manpower requirements.

Another significant development was "operations research" or "operations evaluation," a form of scientific study and investigation which used advanced mathematical techniques in the analysis of repetitive operations, particularly those involving the use and performance of military hardware, with a view to developing more efficient methods and procedures.

Operations research was applied to many areas of military and business operations, but proved especially productive in the analysis of logistical activities.

3. Logistics in Nuclear War.—For logisticians, however, the fundamental dilemma posed by the "quantum jump" in weapons technology after World War II was the absence of any comparable development in the apparatus or methodology of logistics. No technical innovation perfected and applied during this period, in transportation, supply or administration had an impact upon the conduct of war remotely comparable to that produced in the 19th and early 20th centuries by the railroad, the telegraph, the internal combustion engine or mass production. On the other hand, the new weapons, with their immense destructiveness and range, threatened to sweep away every vestige of the logistics developed to meet the demands of the industrial era. None of the elaborate apparatus of rear-area administration, lines of communications or even sources of supply required in the two world wars of the 20th century seemed likely to survive the firepower that could now be brought to bear against it, and no effective defense against this firepower had yet appeared.

The problem was, indeed, under attack from many angles. New logistical doctrine stressed dispersion, and much study went into the determination of how small a concentration of personnel or structures constituted a "profitable target." In the future war, the communications zone would be wide and deep; installations would be small, widely dispersed, duplicated on a large scale to avoid irretrievable loss, and, as far as possible mobile; depot stocks would be mixed instead of specialized; automatic data processing machinery would permit rapid supply action by remote control; a variety of small, mobile cargo carriers would be available, combining the functions of storage and movement, and capable of traveling on any terrain; cargo would also be carried by helicopter and aircraft that could use water runways; "roll-on-roll-off" seagoing and submersible carriers would discharge their cargoes rapidly on small beaches and immediately put out to sea; all movements of troops and cargo would be spread among numerous alternate routes. Combat units, small, mobile, lean, stripped down to the bare essentials of equipment and services, would resupply themselves from small dispersed magazines, or be resupplied by aircraft and fast-moving supply columns.

Yet all this, by the early 1960s, was still hardly more than a planner's vision. At best, it held promise of reducing to some degree the inherent vulnerability of the surface-bound installations and transport on which military forces in the foreseeable future were likely to depend for most of their logistical support. Dispersion and duplication were enemies of economy and efficiency, and the more advanced new means of movement, storage and handling were expensive, intricate and difficult to produce in quantity. The net effect could only be to increase the costs of logistical support and to diminish the yield in delivered supplies and services.

The central problem of logistics in the nuclear era, as before, was one of weight and bulk—the historic barriers to mobility and range, and the primary causes of vulnerability to the new firepower. With substantial reductions in weight and bulk of impedimenta and supplies, the pace of supply movements would quicken, armies could thin out the density of their rear-area installations and lines of communications, and the self-contained, hard-hitting "flying column" might return to warfare. Some promise of a real breakthrough in this area was offered by the application of atomic energy to transportation. Atomic-powered vehicles, whether on land, on the sea, under water or in the air, would consume virtually no fuel, and in World War II fuel had accounted for from two-thirds to three-fourths of the weight of all supply requirements. The first atomic-powered submarines and surface vessels appeared in the 1950s, and nuclear submarines, by the 1960s, had become a regular component of the U.S. navy. A further reduction of transportation requirements was inherent, too, in the new weapons themselves, which replaced many times their own weight and bulk in the older types of explosives and delivery instruments.

The growing range of firepower, moreover, involved a corresponding diminution of the distances over which the ingredients of firepower and logistical support had to be transported. Intercontinental missiles and bombers, based in a nation's home territory, theoretically could eliminate altogether the need for advanced air and missile bases, along with the defending forces, lines of communications and administrative establishments that supported them. By the 1960s all the major powers had to reckon with the possibility that the sources of logistical support might, in any case, be wiped out, and lines of communication rendered inoperable by the initial strikes and counterstrikes of an all-out nuclear war. In such a case, the ensuing "broken-backed" conflict, if hostilities continued at all, would have to be waged by surviving forces in being with whatever weapons, supplies and transport remained. It could readily be envisaged that warfare under these circumstances might eventually revert to more primitive pre-industrial forms.

Logistical planners still had to reckon, however, with the probability of limited wars, with or without nuclear weapons, and with such present realities as limited budgets and interservice competition for funds and priorities. Development of new tools for logistics lagged behind the development of new weapons. The motor vehicles, ships, railroads and air transports in general use by the 1960s were not significantly different from those used in World War II. Despite plans for dispersion, mobility and automated supply procedures, military forces remained dependent on the system of staged resupply from bases, elaborate service support and ponderous administration that had characterized the logistics of the industrial era.

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LOGOGRAM AND SYLLABARY. Under this heading are included systems of writing that utilize logograms, or signs for words, and syllabograms, or signs for the syllabic components of words. (For systems of writing that utilize letters or signs for the smallest elements of language, namely phonemes, *see* ALPHABET.)

The systems of writing that utilize logograms and syllabograms may be divided into two classes: (1) logosyllabic writing, which utilizes in about equal measure signs both for words and for syllables; and (2) the syllabic writing, which either contains only signs for syllables or utilizes syllabic signs more than logographic signs.

Logosyllabic Systems.—This term includes full systems of writing, which represent actual units of language, such as words and syllables. They are to be distinguished sharply from primitive systems, which express vaguely defined ideas or meanings. The latter are called pictographic, ideographic or semasiographic systems and are forerunners of writing. (*See* WRITING; PICTOGRAPHY.)

Full systems of writing originated in the vast mass of land extending from the eastern shores of the Mediterranean sea to the western Pacific. In this large area seven original systems of writing developed, all of which could claim independent origin: (1) Sumerian in Mesopotamia, 3100 B.C.–A.D. 50; (2) proto-Elamite in Elam, 3000–2200 B.C.; (3) proto-Indic in the Indus valley, *c.* 2200 B.C.; (4) Chinese in China, 1300 B.C.–present; (5) Egyptian in Egypt, 3000 B.C.–A.D. 400; (6) Cretan in Crete and Greece, 2000–1200 B.C.; and (7) Hittite in Anatolia and Syria, 1500–700 B.C.

New systems of writing come to light from time to time through the efforts of excavators. The proto-Armenian inscriptions, which have been discovered in great numbers in Armenia, are too little known to warrant their addition to the list. The undeciphered Phaistos and Byblos writings are most likely syllabic and thus fall under the classification of syllabic writings. The mysterious Easter Island inscriptions, on which much effort has been spent by many imaginative minds, probably represent pictorial concoctions for magical purposes. Finally, the Amerindian systems of the Mayas and the Aztecs do not represent full writing, since even in their most advanced stages they never attained the level of development characteristic of even the earliest phases of the seven systems.

Sumerian System.—The home of cuneiform writing was in Mesopotamia, in the basin of the Tigris and Euphrates rivers. The term cuneiform means literally "wedge form," from Latin *cuneus*, "wedge," plus *forma*, "form," and owes its origin to the wedgelike appearance of the little strokes. The decipherment of cuneiform was initiated in the first half of the 19th century by Georg Friedrich Grotefend and Sir Henry Creswicke Rawlinson; by the end of the century it was possible to read with relative ease the various forms of cuneiform in which many languages of the ancient near east were written. Chief among these were Sumerian, spoken in southern Mesopotamia by a people of disputed ethnic and linguistic affiliation, and Akkadian, a Semitic language spoken in all of Mesopotamia, which included two main dialects, Babylonian and Assyrian. Toward the end of the 3rd millennium B.C. the Sumerian language died out, giving way to Akkadian.

Throughout its history the material par excellence of Mesopotamian writing was clay. As the rounded forms of pictures could not easily be incised on clay with a stylus, the signs acquired an angular form consisting of a few separate strokes of the stylus. The natural pressure of the stylus on one of its corners produced the appearance of wedges. Cuneiform was later used on other materials, such as stone and metal.

The Mesopotamian cuneiform system included about 600 logograms, out of which about 100–150 signs, depending on time and area, were used syllabically. The normal Mesopotamian syllabic writing contained signs of the type *ta, tu, tam, tum*. At no time did any of the Mesopotamian syllabaries contain signs for all the possible syllables in the languages for which they were used. The attempt to express linguistic forms with the fewest possible signs resulted in various economizing measures. No Mesopotamian system distinguished between voiced, voiceless and emphatic consonants in the case of signs ending in a consonant. Thus, the sign IG had the value *ig, ik* and *iq*, just as the sign TAG might have stood for *tag, tak* and *taq*. In addition, some older systems, such as Old Akkadian and Old Assyrian, did not even distinguish the quality of the consonant in signs beginning with a consonant. Thus, in these systems the sign GA had the value of *ga, ka* and *qa*. In all cuneiform systems many signs ending in *i* might stand also for those ending in *e*, as in the sign LI with the values *li* and *le*.

Syllables which were not represented by a sign in the syllabary might be represented by signs with similar consonants, as, for instance, in expressing the syllable *rin* with the sign which had a normal value *rim*. When there were no signs with similar consonants, a syllable was written in Sumerian in a way not paralleled in any other syllabic system; the syllable *ral*, for which no separate sign existed, was written as *ra-al*, while in other known syllabic systems this syllable would be written *ra-l(a)*, *ra-l(e)* or the like. (*See* also SUMERIAN LANGUAGE; AKKADIAN LANGUAGE.)

Egyptian System.—The name of the hieroglyphic writing of the Egyptians is derived from the Greek *hieroglyphika grammata* and owes its origin to the belief that it was used chiefly by the Egyptians for sacred purposes (*hieros*, "sacred," *glyphein*, "to incise"). By 1822 the hieroglyphic writing was successfully deciphered by the Frenchman Jean François Champollion, chiefly on the basis of comparison with the Greek inscription on the Rosetta stone (*q.v.*). The hieroglyphic form of writing, used chiefly for public display purposes, was not the writing of everyday practical life. For such purposes the Egyptians developed two forms of cursive writing, first the hieratic and then the demotic. The Egyptian system consisted of about 700 signs, of which about 100 were used syllabically. The syllabary consisted of about 24 signs, each with an initial consonant plus any vowel, such as the sign m^x with the values m^a, m^i, m^e, m^u and $m^{(x)}$, and of about 80 signs, each with two consonants plus any vowel(s), such as the sign t^xm^x with the values t^am^a, t^im^i, t^em^e, t^um^u, t^am^i, t^em^i, $t^am^{(a)}$, $t^em^{(e)}$, $t^{(a)}m^a$, etc. This characterization of the Egyptian nonlogographic writing as consisting of signs expressing one or two consonants plus any vowel is in disagreement with the views of many Egyptologists, who say it is simply consonantal or even alphabetic. (*See* I. J. Gelb, *A Study of Writing*, pp. 76–81 [1952].) (*See* EGYPTIAN LANGUAGE; HIEROGLYPHS.)

Hittite System.—The decipherment of the Hittite hieroglyphic writing was achieved in the 1930s through the combined efforts of several scholars. Knowledge of Hittite has not reached the level of Sumerian or Egyptian. The term hieroglyphic was taken over from Egyptian writing, and it simply implies that Hittite writing, like Egyptian, was picture writing; it does not imply that the Hittite hieroglyphic system was borrowed from the Egyptian hieroglyphic or that it was in any way related to it. Hittite hieroglyphic writing was in use from about 1500 to 700 B.C. in a large area extending from central Anatolia to northern Syria. Its language was related to, but by no means identical with, cuneiform Hittite, a language preserved in the cuneiform writing borrowed from Mesopotamia. Both of these languages and writings were used simultaneously in the Hittite empire, but while cuneiform Hittite was limited to the area around Bogazköy, the capital of the empire, and died out soon after 1200 B.C., hieroglyphic Hittite was used throughout the empire and continued as a living tongue up to about 700 B.C. Hittite writing consisted of about 450 signs, of which about 60 were used syllabically. The syllabic signs were of the type *ta*, *ti*, *te*, *tu*, each representing a syllable beginning with a consonant and ending in a different vowel. (*See* HITTITES.)

Chinese System.—Of the four main systems of writing, Chinese is the only one which did not have to be deciphered in modern times, because knowledge of it was passed from generation to generation. Chinese writing made its appearance about the middle of the 2nd millennium B.C., during the Shang dynasty, as a fully developed phonetic system. In its outer form the writing has changed greatly during its long history, but the inner characteristics of the oldest inscriptions hardly differ from those of recent times. The oldest Chinese inscriptions are the oracle texts on animal bones and tortoise shells, and some short texts on bronze vessels, weapons, pottery and jade. The signs in the Shang period were limited in number, no more than about 2,500, and in the majority of them the pictorial character is still clearly recognizable. But the signs developed a linear form, and in later writings it is impossible to recognize the pictures they originally represented.

Chinese writing does not have a full syllabary comparable to the syllabaries in the other three (major) systems. As the words of the Chinese language are regularly expressed by word signs, it is only in writing foreign words and names that the necessity arose to use word signs in a syllabic function. Thus, "Jesus" is written as *Yeh-su*, "English" as *Ying-chi-li*, "French" as *Fa-lan-hsi*, "telephone" as *te-li-feng*. There are no set word signs for certain syllables, as there are in the near eastern systems; for example, "Jesus" might also be written *Ya-su*; "telephone," *te-lu-fung*. The characteristic tendency of Chinese toward abbreviation may be noted in the use of *Ying* for "English" (besides *Ying-kuo-jen* for "Englishman," that is, "English-country-man"), *Fa* for "French" (besides *Fa-kuo-jen*) or *Lo* for "Roosevelt" (besides *Lo-ssu-fu*). Frequently, words spelled out syllabically acquired a logographic spelling; for example, the above-mentioned *te-li-feng*, "telephone," is now usually written as *tien-hua*, "electricity talks." Chinese writing is said to consist of about 50,000 signs, of which an unspecified number are used in a syllabic function. This extraordinary development of Chinese logography constitutes a unique phenomenon in the history of writing. (*See* CHINESE LANGUAGE.)

Proto-Elamite, Proto-Indic and Cretan Systems.—All these systems are either completely or largely undeciphered. The proto-Elamite writing first appeared at Susa, the capital of ancient Elam, and can be dated roughly to the so-called Jemdet-Nasr period after 3000 B.C. The earliest examples are found on several hundred clay tablets, perhaps business records. Not even one of the several hundred signs can be read certainly. Some number signs and the existence of a decimal system have been determined with some assurance. A more developed form of proto-Elamite writing, also undeciphered, occurs on about a dozen stone inscriptions from the Old Akkadian period around 2200 B.C. The later type of writing consisted of a very limited number of signs (only 55 have been discovered) differing greatly in form from those of the previous period.

Seals with peculiar signs, which have aroused intense interest throughout the world, have been found sporadically during the 20th century at various sites in the Indus valley. In 1924 the archaeological department of the government of India undertook the first systematic excavation of the ancient sites today called Harappa and Mohenjo-Daro, and a considerable number of texts were discovered. More inscriptional material of the same nature was uncovered at Chanhu-Daro. At these sites cultures of great antiquity were unearthed, about which, strangely enough, Indic tradition says nothing. The still undeciphered writing consists of about 250 signs found on short seal inscriptions, pottery and copper tablets. The relative chronology of this proto-Indic writing was established by comparative stratigraphy with the help of Mesopotamian finds. The writing made its appearance in the second half of the 3rd millennium B.C. and, after a few centuries, disappeared as suddenly as it had appeared.

The origin and development of the Cretan writing are best illustrated by the epigraphic finds made at the beginning of the 20th century by Sir Arthur Evans at Knossos, in Crete. Other sites in Crete (Mallia, Hagia Triada) and in Greece (Mycenae, Orchomenus, Pylos, Thebes, Tiryns), as well as in the Aegean islands, have yielded epigraphic material that supplements the knowledge derived from the Knossos material.

The two major classes of Cretan writing are the Hieroglyphic and Linear. The undeciphered Hieroglyphic A and B are probably of the standard logosyllabic type. Linear B is predominantly syllabic, as is the still undeciphered Linear A system. (*See* MINOAN LINEAR SCRIPTS; INDUS CIVILIZATION.)

Syllabic Systems.—Four syllabic systems developed from the logosyllabic systems discussed above: the cuneiform syllabaries from the Mesopotamian cuneiform; the West Semitic syllabaries from the Egyptian; the Aegean syllabaries from the Cretan; and the Japanese syllabary from the Chinese.

Cuneiform Syllabaries.—Mainly during the 2nd millennium B.C. the cuneiform writing of the Sumerians and Akkadians was borrowed by many peoples surrounding Mesopotamia, such as the Elamites of Iran, the Hurrians of northern Mesopotamia and Syria, the Hittites of Anatolia and the Urartaeans of Armenia. Only the Hittites took over the Mesopotamian logosyllabic system in approximately the form it had at its original home. All others simplified their cuneiform writings considerably by limiting their

systems to syllabic signs plus a small number of logograms for the most common nouns.

West Semitic Syllabaries.—In contrast to the East Semitic group of languages, represented only by Akkadian, all other Semitic languages, such as Phoenician, Hebrew, Aramaic, Arabic and Ethiopic, belong to the West Semitic group. This linguistic grouping is paralleled by a grouping based on graphic considerations. The Akkadians used cuneiform writing, while all other Semites used writing that was first developed on the Egyptian model in the middle of the 2nd millennium B.C. in the Syro-Palestinian area and reached its climax about 1000 B.C. in the Phoenician writing of Byblos, from which it spread to the surrounding West Semitic peoples.

All the West Semitic writings used a limited number of syllabic signs, 22 to 30, each of which expressed an initial consonant plus an inherent but unindicated vowel. With the development of separate vocalic signs in the first centuries A.D., the originally syllabic signs of the West Semitic writings became alphabetic, and the West Semitic writings became alphabets. (*See* also SEMITIC LANGUAGES.)

Aegean Syllabaries.—Under the syllabic writings of the Aegean area can be included the still undeciphered Cypro-Minoan and the deciphered Cypriote syllabaries of the island of Cyprus, the undeciphered syllabary of the disk of Phaistos in Crete and the undeciphered syllabary on about ten stone and metal inscriptions from Byblos.

The number of syllabic signs used in the Aegean systems varies from 56 to 90, and the signs are regularly of the type *ta, te, ti, tu, to,* that is, an initial consonant plus a different vowel. The difference between voiced, voiceless and aspirated consonants is not indicated in the writing. This type of syllabic sign is found in the Cretan, as well as in the hieroglyphic Hittite, writings discussed above.

Japanese Syllabary.—After a few centuries of cultural and commercial contact between China and Japan, the Chinese system of writing seems to have made its appearance in Japan in the 5th century A.D. The Chinese word signs were simply taken over by the Japanese and read not with their Chinese values but in Japanese. Thus, for example, the Chinese word sign *nan,* "south," was read in Japanese as *minami,* "south." The Chinese writing may have been well suited to a monosyllabic and isolating language in which grammatical forms are normally expressed by syntactical position rather than by special formatives. However, such writing was not suited to Japanese, which is polysyllabic and agglutinative and expresses grammatical forms by means of special formatives. Therefore, some of the Chinese word signs soon came to be employed as syllabic signs expressing the grammatical formatives of the Japanese language. Originally, the choice of the syllabic signs was unsystematic, and it was not until about the 9th century that a stable syllabary with 47 signs was developed, each expressing a consonant plus a vowel, with the difference in voice being fully indicated. In introducing a full syllabary the Japanese have never given up the logographic apparatus borrowed from Chinese, which they use along with their syllabary. (*See* JAPANESE LANGUAGE.)

Writings of Modern Primitive Societies.—Several systems, such as those of the Cherokees and Alaska Eskimos in America and of the Vai and Bamum Negroes in Africa, were developed in modern times under the influence of western civilization. Starting as a primitive logography, they passed through a logosyllabic stage, ending with syllabaries consisting of 85 (Cherokee) to 226 (Vai) signs.

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LOGOGRAPHI, in Greek *logographoi,* writers of *logoi* or compositions of any sort, especially in prose. In Attic Greek the word signifies "professional speech writers"; in modern usage (since G. F. Creuzer, *Die historische Kunst der Griechen in ihrer Entstehung und Fortbildung,* 1803) it refers to pre-Herodotean writers of chronicles, from the doubtfully historical Cadmus of Miletus (*q.v.*) to Pherecydes Leros. All these make extensive use of mythology, but their attempts at systematization and criticism are primitive. Their dialect is Ionic. Mention may be made of the following: Hecataeus of Miletus (*q.v.*); Acusilaus of Argos, who paraphrased in prose (correcting the tradition where it seemed necessary) the genealogical works of Hesiod; Charon of Lampsacus (*c.* 450), author of histories of Persia, Libya and Ethiopia, of annals of his native town, and of the chronicles of Lacedaemonian kings; Xanthus of Sardis in Lydia (*c.* 450), author of a history of Lydia; Hellanicus of Lesbos (*q.v.*); Hippys and Glaucus, both of Rhegium, the first the author of histories of Italy and Sicily, the second of a treatise on ancient poets and musicians; and Damastes of Sigeum, author of genealogies of the combatants before Troy (an ethnographic and statistical list), and of short treatises on poets, sophists and geographical subjects. The work of Stesimbrotus of Thasos "On Themistocles, Thucydides and Pericles," though belonging to the same period, did not belong to the same category. It was really a political pamphlet, the first known of its kind, directed against the democratic imperialism of Athens.

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LOGOS, a common term in ancient philosophy and theology. It expresses the idea of an immanent reason in the world, and, under various modifications, is met with in Indian, Egyptian and Persian systems of thought. But the idea was developed mainly in Hellenic and Hebrew philosophy, and the term is significant in the Gospel of St. John in the New Testament.

THE HELLENE LOGOS

To the Greek mind, which saw in the world a *kosmos* ("ordered whole"), it was natural to regard the world as the product of reason, and reason as the ruling principle in the world. So a Logos doctrine was more or less prominent from the dawn of Hellenic thought to its eclipse. It rises in the realm of physical speculation, passes over into the territory of ethics and religion and makes its way through three well-defined stages. These are marked off by the names of Heraclitus of Ephesus, the Stoics and Philo.

Heraclitus.—The idea of Logos acquires its first importance in the theories of Heraclitus (6th century B.C.), who, trying to account for the aesthetic order of the visible universe, broke away to some extent from the purely physical conceptions of his predecessors and discerned at work in the cosmic process a *logos* analogous to the reasoning power in man. On the one hand the Logos is identified with *gnome* and connected with *dike,* which latter seems to have the function of correcting deviations from the eternal law that rules in things. On the other hand it is not positively distinguished either from the ethereal fire, or from the *heim armene* and the *ananke* according to which all things occur. Heraclitus holds that nothing material can be thought of without this Logos, but he does not conceive the Logos itself to be immaterial. Whether it is regarded as in any sense possessed of intelligence and consciousness is a question variously answered. But there is most to say for the negative. This Logos is not one above the world or prior to it, but in the world and inseparable from it. Man's soul is a part of it. It is *relation,* therefore, as Friedrich Schleiermacher expresses it, or reason, not speech or word. And it is objective, not subjective, reason. Like a law of nature, objective in the world, it gives order and regularity to the movement of things and makes the system rational.

The failure of Heraclitus to free himself entirely from the physical hypotheses of earlier times prevented his speculation from influencing his successors. With Anaxagoras a conception entered which gradually triumphed over that of Heraclitus, namely, the conception of a supreme, intellectual principle, not identified with the world but independent of it. This however was *nous,* not

Logos. In the Platonic and Aristotelian systems too the theory of ideas involved an absolute separation between the material world and the world of higher reality, and though the term Logos is found the conception is vague.

With Plato the term selected for the expression of the principle to which the order visible in the universe is due is *nous* or *sophia*, not *logos*. It is in the pseudo-Platonic *Epinomis* that *logos* appears as a synonym for *nous*. In Aristotle again, the principle which sets all nature under the rule of thought, and directs it toward a rational end, is *nous*, or the divine spirit itself; while *logos* is a term with many senses, used as more or less identical with a number of phrases, *hou heneka* ("final cause"), *energeia, entelecheia, ousia, eidos, morphe*, etc.

The Stoics.—In the reaction from Platonic dualism, however, the Logos doctrine reappears in great breadth and is a capital element in the system of the Stoics (*q.v.*). With their teleological views of the world they naturally predicated an active principle pervading it and determining it. This operative principle is called both Logos and God. It is conceived of as material and is described in terms used equally of nature and of God. There is at the same time the special doctrine of the *logos spermatikos*, the seminal Logos, or the law of generation in the world, the principle of the active reason working in dead matter. This parts into *logoi spermatikoi*, which are akin, not to the Platonic ideas, but rather to the "material" *logoi* of Aristotle. In man too there is a Logos which is his characteristic possession, and which is *endiathetos*, as long as it is a thought resident within his breast, but *prophorikos* when it is expressed as a word. This distinction between Logos as *ratio* (reason) and Logos as *oratio* (oratory), so much used subsequently by Philo and the Christian fathers, had been so far anticipated by Aristotle's distinction between the "outside" *logos* and the *logos* "in the soul." It forms the point of attachment by which the Logos doctrine connected itself with Christianity. The Logos of the Stoics is a reason in the world gifted with intelligence, and analogous to the reason in man.

(X.)

THE LOGOS IN JUDAISM AND CHRISTIANITY

The problem of the Logos in the New Testament is that the fourth evangelist, in opening his Gospel with the statement, "In the beginning was the Word" (Logos), is undoubtedly recalling the opening words of Genesis, "In the beginning God created the heaven and the earth, ... And God said . . . ." but, in using the Logos absolutely to denote a divine hypostasis, is employing the term in a manner which is without parallel in the Bible and cannot be derived directly from the Old Testament.

The Hebrew Logos.—In the Old Testament "the word of the Lord" is another way of saying "God speaks," and means any communication of God to man, especially through a prophet (II Sam. xxiii, 2). "The word of the Lord came to . . ." can stand at the head of a prophetic book. In Hebrew thought the word carried with it the idea of activity and power. The word does not describe or comment, but effects what it utters (Isa. lv, 10–11). It judges, destroys and delivers (Jer. v, 14; Ps. cvii, 20). It is thought of as having a quasi-independent existence and an inherent power, especially in blessing and cursing (Zech. v, 3–4).

Alongside the word in the prophets, which is occasional, appears later the word in the Law, which is authoritative for all Israel for all time (Deut. xxx, 11 ff.). Later still the activity of the word in revelation is extended to cover the work of creation (Ps. xxxiii, 9). Subsequently Judaism sought to avoid anthropomorphism and stressed the transcendence of God over his creation, but maintained his contact with the world and his activity in creation and revelation by postulating divine agents, Wisdom, Word and Torah (Law). In the successive stages of the Wisdom literature a doctrine of Wisdom (grammatically feminine in gender) is developed. She has some sort of independent existence, is the divine artificer and draws men to God (Prov. viii, 14 ff.); she is identified with her supreme manifestation among the nations, namely the Torah possessed by Israel (Ecclus. xxiv, 7–23); and she is herself the presence of God, is before all light and is identified with the word of God (Wisdom of Solomon vii, 22–30, ix, 1–2, xviii. 15). The identification of Wisdom with Torah was particularly the work of the rabbis, who speak of the Law in personal terms as divine and pre-existent with God, as light and life and as the source of truth. It is possible to parallel most of the statements about the Logos in the Johannine prologue with almost identical statements made either about Wisdom in the Wisdom literature or about the Torah in the rabbinic writings. While these agencies are to a greater or lesser degree personified, Jewish thought stopped short of hypostatization, and they are not conceived as independent metaphysical entities. The Johannine Logos is such an entity and would therefore appear to have its origin in a wider sphere than the Old Testament or orthodox Judaism. Its introduction in the prologue without explanation indicates that readers were expected to be familiar with it and that it had a considerable currency. Such a currency would correspond with the philosophical eclecticism and religious syncretism of the period.

Philo and Hellenistic Religion.—A notable example of such syncretism from the Jewish side was the Alexandrian Jew Philo (*q.v.*). He was not an original thinker but a compiler and, to judge from signs that he has incorporated material from predecessors in the same field, is the sole survivor of a widespread Jewish "philosophy" centred on, but not confined to, Alexandria. It aimed at converting the Greek world by presenting Judaism as the true philosophy by means of an allegorical and speculative interpretation of the Old Testament. (*See* JEWISH PHILOSOPHY.)

In Philo's voluminous works the term Logos occurs about 1,300 times, but it is impossible to harmonize the bewildering variety of his statements about the Logos into a single and consistent doctrine. At times he is dependent on Stoicism (*e.g.*, for such concepts as "the seminal Logos" and the "immanent and expressed Logos") but, unlike the more consistent type of Stoicism, differentiates the Logos from God as his work or image (*De specialibus legibus*, i, 81). He is dependent on Platonism when he identifies the Logos with the *kosmos noetos* or intellectual universe as a model for creation, or with the *topos* ("place") of the ideas considered as expressions of the mind of God. In general, Philo's Logos is a cosmological principle and, despite its frequency, hardly plays a living part in his theology, being an accommodation to Greek thought with the purpose of distinguishing between God as existing in himself and God as acting toward the cosmos. Although he speaks of it in personal terms (*e.g.*, as first-born son), the Logos can hardly be said to be personified, except where, in exposition of Old Testament texts, it is identified with figures such as Aaron and Melchizedek. The Logos is divine but not God, is with God, is light (*De somniis*, i, 75), water (*De posteritate Caini*, 127), manna (*Legum allegoriae*, iii, 172 ff.) and shepherd (*De agricultura*, 51). Thus there is a close similarity of symbolism between Philo and the fourth evangelist, and they move in the same world of thought; but a comparison of their writings makes any direct dependence highly improbable. Philo speaks generally of "the divine Logos" or "the Logos of God" rather than of "the Logos" absolutely.

The evidence of syncretistic religion outside Hellenistic Judaism is difficult to assess, being found in, or deduced from, sources which are widely different in character and of disputed date (*e.g.*, the *Hermetica* and the Mandaean literature), are generally later than the 1st century A.D. and may in some cases be Christian or have been exposed to Christian or to Jewish influence. Moreover, fresh material, as it becomes available, tends to modify previous judgments. Thus the view that the Aramaic *memra* ("word") in the Targums on the Old Testament provides no parallel to the Johannine Logos is certainly correct, since the *memra* in the Targums is not a divine hypostasis but a theological device for avoiding the mention of the divine name; yet the "Gospel of Truth" discovered in the Jung codex contains elaborate speculation on the divine name as a divine hypostasis, which may go back to a 1st-century Judaism of a more heterodox kind than that of the Targums. Second-century Gnostic systems exhibit a mythological figure under various guises, such as Son of God, Image of God, *Nous*, *Anthropos*, among which is Logos. This figure has a cosmological function as mediator between the unknowable God and the world, brings gnosis to men and, in some cases, rescues men from a hostile

world. The fourth Gospel has this element of emphasis on the function of Logos as Saviour in common with such systems, as well as a general similarity of language and ideas, but lacks their speculation or polemic on the origin of the world or of darkness, and is not likely to be dependent on them. In Gnosticism Logos is one among many aeons, while the Johannine Logos is the one and only mediator.

The New Testament.—The affinities of the fourth Gospel may thus be various, but the clearest allusions are to Genesis, Wisdom and the Torah. Such polemic as there is in the prologue concerns the relation between the Logos and the Torah. This is evident from the conjunction of the statements that the incarnate Logos was "full of grace and truth" and that "the law was given by Moses, but grace and truth came by Jesus Christ" (i, 14–17). The character and functions of the Torah as pre-existent with God, as the source of life and the illumination of men, are transferred to Jesus, and thereby the Logos is for the first time fully personified. The term Logos will then owe less to current philosophical and religious speculation than to Christian theological reflection upon the person of Christ. The same path was trodden by other New Testament writers to the point where they might well have used the term itself. For St. Paul the Gospel is the word of God, which is also the word of Christ (II Cor. ii, 17; Col. iii, 16), which is Christ himself, in whom the fullness of the Godhead dwells (Col. i, 25–27, ii, 9) and who is the agent of creation (I Cor. viii, 6). In the Epistle to the Hebrews Jesus, who qualifies by an earthly career for an eternal priesthood, is presented as the author and sustainer of the universe and as the image of God (Heb. i, 1–4); and the author of the Apocalypse (Rev. xix, 13) identifies the exalted Christ with the Word of God, which elsewhere in his book means the revelation of God through Christ. The fourth Gospel represents the climax of such theological reflection. In this Gospel outside the prologue *logos* is used of individual statements made by Jesus (ii, 19–22); these are not, however, sporadic statements, but constitute together a single *logos* or message, which conveys truth and eternal life (v, 24, viii, 31, 43) and which is itself the *logos* of God (xiv, 24, xvii, 14). Further, for the evangelist this *logos* is not simply that which Jesus proclaims, but is inseparable from his person; he is the content of his own message and is himself the light, life and truth which he gives. Thus the identification of Jesus with the Logos is a short and almost inevitable step and will have been taken not by way of applying current metaphysical thought to the Gospel but in order to present in its widest cosmic significance—no doubt by means of a term which would be widely recognized—the person of Christ as Son of God and revealer of the Father.

Although the title Logos is confined to the prologue this does not imply that the prologue is an afterthought loosely attached to the Gospel, since what is predicated of the Logos in the prologue, viz., that he is pre-existent, life, light, is rejected by his own and gives grace and truth to those who receive him, is predicated of Jesus in the Gospel.

The Early Church.—The Logos doctrine which played a major, and in some respects an unfortunate, role in the earliest attempts of the primitive church to state Trinitarian belief was not a further development of the thought of the fourth Gospel but represents an importation from current philosophical thought and terminology. This was due to the apologists, whose aim in the face of a hostile world was to make the divinity of Christ intelligible to that world, to claim the world for Christ as its creator and to set forth Christianity as superior to, or the heir to, all that was best in pagan philosophy. Christ as the pre-existent Logos (1) reveals the Father to men and is the subject of the Old Testament manifestations of God; (2) is the divine reason in which the whole human race shares, so that Socrates and others who lived with reason were Christians before Christ; and (3) is the divine will and word by which the worlds were framed. Theophilus borrows the Stoic terms "immanent" and "expressed" Logos to denote Christ first as pre-existent with God before creation and then as uttered or generated for the purpose of creation; and the same idea is present in Athenagoras.

The apologists tended to start with Christ as a cosmological figure rather than as the revealer of the Father or as redeemer, and it was impossible for them to avoid an impersonal conception of him as an attribute or function of God, or as a thought in the mind of God, which acquired self-expression and personality only in being uttered for the purpose of creation. They therefore inevitably subordinated him to God. Justin describes the Logos as flame derived from fire and as "numerically another thing." Subordination was carried further by Origen, who starts from a Greek philosophical conception of God as passionless and incomprehensible and, in attempting to do justice to such passages of Scripture as "the Father that sent me is greater than I," differentiates God as "cause" from the Logos as "caused" and calls the latter "a creature," although this was mitigated by his doctrine that the Son is eternally generated by the Father. Arianism pushed one side of Origen's thought to extremes and, working almost exclusively with the pagan idea of God as the immutable absolute and concentrating entirely on the cosmic function of the Logos, declared that since the Logos was susceptible of suffering he could not be God and that there was a time when he did not exist. Meanwhile there was another doctrine of the Logos in the church which was eventually able to escape the dangers of subordinationism. The Logos does not appear to have figured greatly in Gnosticism until Basilides, Valentinus and Heracleon, who were under Christian influence. It was possibly in opposition to their systems that St. Irenaeus and Tertullian developed a doctrine which started from Christ as the Son who reveals the Father through incarnation and redemption and used the term Logos for the more limited purpose of relating Christ as Son to the universe as its creator. It was this tradition in Athanasius and his followers which, when combined with Origen's doctrine of the eternal generation of the Son, led to the defeat of Arianism and ultimately to the conclusion that the scriptural and specifically Christian understanding of the Godhead was better expressed in terms of the relation of an eternally begotten Son to the Father than in terms of the relation of a pre-existent Logos to God.

See also references under "Logos" in the Index.

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LOG ROLLING: *see* BIRLING.

LOGROÑO, a Spanish city and province situated in the middle valley of the Ebro river. The city, which is the provincial capital (pop. [1960] 61,292 [mun.]), stands on the Ebro (the route from the Mediterranean to the Atlantic), 118 km. (73 mi.) E. of Burgos by road. It is an ancient walled town, built on a hill, and has both old and modern quarters. It owed its origin and growth to its position on the pilgrim route to Compostela as much as to its production of wool. It is a trade centre for the agricultural district, and its wine is well known. Its industries include sawmilling, furniture, textiles and food processing.

LOGROÑO PROVINCE was formed in the administrative reorganization of Spain in 1833; formerly it was divided between Castile and Navarre. It contains nine judicial districts and 184 municipalities. Area 50,350 sq.km. (1,944 sq.mi.). Pop. (1960) 229,852. The dominant physical features are the Ebro and the mountains of the Sistema Ibérico, containing, among others, the sierras de Urbión (7,507 ft.), Cebollera (7,026 ft.) and La Demanda (6,342 ft.). Cameros is the mountainous zone, crossed by the Glera (or Oja), Najerilla, Iregua, Leza, Cidacos and Alhama rivers. La Rioja is the fertile lowland zone and contains such cities as Santo Domingo de la Calzada and Nájera.

The principal crops of the rich agricultural region are cereals, vines and, above all, horticultural produce from the irrigated *vegas* of La Rioja (153,000 ac.). The province was an important wool-producing area in the middle ages. There is a vegetable-conserving industry. (M. B. F.)

LOHENGRIN, the knight of the swan, hero of the German version of a legend widely known in literature from the middle ages onward. The legend assumes different forms in different literatures, but the common framework, the oldest part of which probably derives from the fairy tale "The Seven Swans," is the

story of a mysterious knight who arrives in a boat drawn by a swan to protect a noble lady in distress, defeats her enemy and marries her, forbidding her, however, to ask his origin or his name; she later forgets her promise, and he leaves her, never to return.

The original home of the legend is unknown. The earliest known reference to it occurs in the 12th-century history of the crusades by William of Tyre, the source of the French version. In this *Roman du chevalier au cygne*, one of the *chansons de geste* (*q.v.*) based on the first crusade, the knight of the swan is called Helyas. He is the son of King Oriant of Lillefort, and the story of his brothers' metamorphosis into swans and his own escape from this fate follows the tale of the seven swans persecuted by a wicked grandmother. Helyas marries Beatrix of Bouillon in circumstances parallel to those in which Lohengrin marries Elsa of Brabant (*see* below). Their grandson, Godfrey, becomes ruler of Jerusalem, and from this historical event stems the adaptation of the whole story to the glorification of the house of Bouillon.

In English, a late 14th-century alliterative romance, *Chevalere Assigne*, retells the first part of the *Roman du chevalier au cygne* and takes over the explanation that one of the knight's brothers did not regain human shape but remained a swan, accompanying his brother Enyas (the "Chevalere Assigne") on his travels. The same story is told in the opening of *Helyas—Knyght of the Swanne*, a prose romance adapted from the French by Robert Copland in 1512, which relates the history of the knight, his brother the swan and his marriage into the Bouillon family.

The German story first appears at the end of Wolfram von Eschenbach's epic *Parzival* (*c.* 1210). Elsa, a young princess of Brabant, refuses all offers of marriage, saying that she will only give herself to a man sent by God. From the temple of the Holy Grail arrives a knight in a boat pulled by a swan, and he is hailed by the princess as her God-sent husband. He marries her, but makes her promise that she will not ask his name or origin. She pledges her word but some years later asks the forbidden question. The swan returns, and the knight goes back to the Grail castle. His name was Loherangrin, the son of Parzival, king of the Grail.

The story is expanded into an epic of some 760 strophes in the anonymous Middle High German *Lohengrin*. This was the main source used by Wagner for his opera. The opening is in a Thuringian dialect, but most of the poem is the work of a Bavarian poet who gives the story a historical context in the age of the German king Henry the Fowler (876?–936) and elaborates the realistic content at the expense of the romantic legend. *Lohengrin*, composed between 1275 and 1290, is related to the contemporary poem known as the *Wartburgkrieg:* here the story is put into the mouth of Wolfram von Eschenbach who is made to recite it during the famous singers' contest at the Wartburg, seat of the Thuringian landgraves: certain gaps in the story of the *Wartburgkrieg* can be filled from passages in *Lohengrin;* and the ten-line stanza known as *Klingsors Schwarzer Ton* is common to both works. Other medieval German versions of the story, which ultimately rest on the same passage from Wolfram's *Parzival*, include Konrad von Würzburg's *Schwanritter* (based on a French model) and the anonymous 15th-century epic *Lorengel*, which still uses *Klingsors Schwarzer Ton*.

Through its alignment with a specific historical period, its integration into the Wartburg story and its association with the Holy Grail and thence with the Arthurian legend, the Lohengrin story has become part of German popular tradition. In particular it has become linked with the town of Cleves, whose rulers took the swan as their crest, and where the *Schwanenturm* on the castle and a statue of the knight and his swan perpetuate its memory.

See R. Jaffray, *The Two Knights of the Swan* (1910); R. Heinrichs, *Die Lohengrindichtung und ihre Deutung* (1905). Both contain details of text editions and further critical studies. (Rd. J. T.)

LOIN, that part of an animal lying between the upper part of the hipbone and the last of the false ribs on either side of the backbone; hence the butcher's term for a piece of meat cut from that part of the body. The upper part of a loin of beef is known as the "surloin," commonly corrupted into "sirloin." In the plural the word is a term for the lower part of the human body at the junction with the legs. It is more or less synonymous with flank, or that portion of the body bounded by the lower ribs, the backbone and the pelvis.

LOIRE, a *département* of central France, formed in 1793 of the old district of Forez and portions of pre-Revolutionary Lyonnais (*q.v.*) and Beaujolais. Area 4,799 sq.km. (1,853 sq.mi.). Pop. (1962) 696,348. It is bounded north by Saône-et-Loire, east by Rhône and Isère, southeast by Ardèche, south by Haute-Loire, west by Puy-de-Dôme and northwest by Allier. Most of the *département* consists of uplands formed of ancient crystalline rocks, rising west and east of the Loire valley to the mountains of Forez and Lyonnais, which reach culminating heights of about 5,000 ft. The Loire river, crossing the *département* from south to north, connects the downfaulted basins of Forez and Roanne, and traverses the crystalline highlands between in a gorgelike valley. The flat floors of these basins, covered with sedimentary material brought down from the surrounding highlands, are not very fertile and in their natural state were badly drained. Only after the mid-19th century was the Forez basin extensively reclaimed for farmland. The southeastern part of the *département* includes the synclinal depression of St. Étienne, etched out of relatively soft sedimentary rocks that include Coal Measures. On the highlands, which suffer from a cold, inclement climate and poor, acid soils, heath is extensive, but there is comparatively little forest. Where the waste has been reclaimed for farmland, pastoral activities prevail. The chestnut, once widely grown, no longer plays an important role in the rural economy. Urban development has provided a market for milk and meat, as well as for poultry products. Even in the lowlands agriculture is dominated by fodder crops. Grain is not extensively grown, and the vine is practically absent.

The chief wealth of the *département* is industrial, and the small coal field of St. Étienne has a historical importance for the location of industry out of all proportion to its present status in production. The easily accessible, outcropping coal seams were worked even in the middle ages. Although the seams are heavily faulted and the resources were never great, they provide coal of high quality, including some excellent for coking. With the advent of coke smelting, the area rapidly became the chief coal-mining district of France and the chief seat of the iron industry about the middle of the 19th century. It was the scene of the earliest railway lines in France. Production of coal has long passed its peak and is now small and declining. Iron smelting is no longer carried on, the only blast furnaces being situated off the coal field to the east and outside the *département* of Loire. A new coking plant, however, was installed after World War II at La Silardière. There are steelworks, and secondary metalworking and engineering industries remain important. Armaments, bicycles, automobiles, engine parts, hardware and electrical apparatus are typical products. Metal industries concerned with small articles such as locks, springs and files are often still organized in small workshop units rather than large factories. Small-scale and even domestic units persist side by side with factory organization in textiles, the other basic industrial activity of the area. The silk industry was introduced in the 16th century as a scattered rural activity. In modern times factory organization has developed with the application of power and most of the industry, which is especially concerned with the manufacture of ribbons and elastic web, is concentrated on or near the coal field. However, the use of electricity is again stimulating dispersal into the highland valleys that lie within the sphere of influence of Lyons. Throughout the *département* looms working for the Lyons textile interests are to be found. At Montbrison and elsewhere in the Forez basin are outlying establishments of metalworking and textile industries. Lacemaking is an old-established occupation of the Forez. Roanne (*q.v.*) is an important centre of cotton weaving, working up yarn brought from northern France. Mixed cotton and silk fabrics have become especially important. Urban growth has taken an elongated form, which corresponds to the coal field, from Firminy past St. Étienne. St. Chamond and Rive-de-Gier to the Rhône valley beyond the eastern limit of the *département*. St. Étienne (*q.v.*) is the chief node and shopping centre and is the capital of the *département*, which comes under the ecclesiastical, educational and juridical administration of Lyons. St. Étienne, Montbrison and Roanne are the centres of

the three *arrondissements* that comprise the *département*. There are important road and rail links between the Rhône and Loire valleys through St. Étienne. (Ar. E. S.)

LOIRE-ATLANTIQUE (until 1957 Loire-Inférieure), a maritime *département* of western France, formed in 1790 from the southernmost part of the ancient duchy of Brittany (*q.v.*), together with the district of Retz in Vendée south of the Loire river. It thus lies astride, though mainly north of, the Loire estuary, and is bounded north by the *départements* of Morbihan and Ille-et-Vilaine, east by Maine-et-Loire and south by Vendée. Area 6,980 sq.km. (2,695 sq.mi.). Pop. (1962) 803,372. The broad lower valley of the Loire there cuts across the southward extension of the ancient crystalline rocks of the Armorican massif to enter the Bay of Biscay by a large estuary, encumbered by extensive sandbanks. The northern part of the *département* is drained independently by westward-flowing tributaries of the Vilaine. The northwest-southeast grain of the geological outcrops is shown by ribs of higher ground, notably the Sillon de Bretagne, and by the course of the Sèvre Nantaise, an important left-bank tributary that enters the Loire just below Nantes. Although the whole of the *département* is low-lying, the soils are generally poor. Some woodland and heath persists, but most of the land is enclosed as little fields, bounded by hedges, under grass and fodder crops, and the main emphasis of farming is upon cattle. Most of the *département* lies within the northern limit of the vine, which runs inland a little north of the Loire valley. Some alluvial land is intensively used for market gardens. In the Pays de Retz, south of the Loire, Lake Grand-Lieu, a shallow sheet of water of variable extent surrounded by marshes, is the scene of fishing and wild-fowl shooting. North of the Loire estuary there are extensive brine fields in the Pays de Guérande, behind the narrow peninsula by which former rock islets are attached to the mainland. On the seaward side La Turballe and Le Croisic are little sardine-fishing ports. These older activities of the district are being overshadowed by the development of the tourist industry, and La Baule-les-Pins on the sandspit has one of the finest natural bathing beaches on the French coast. The Angevin iron-ore deposits extend into the north of the *département* and are worked on a small scale in the vicinity of Châteaubriant. Tin is mined at Abbaretz, and elsewhere there are granite and slate quarries.

The main wealth of the *département* is associated with the Loire estuary, with its industrial ports. The old-established port of Nantes (*q.v.*), situated on the right bank at the head of the estuary, where sea and river navigation meet, flourished especially during the 17th and 18th centuries as one of the main centres of trade with France's colonies across the Atlantic. Its subsequent decline in status among French ports has been partly offset by modern industrial development. It has important engineering establishments, including marine engineering and locomotive works, as well as industries concerned with processing imported commodities. Extensive dredging is necessary to maintain the shipping channel among the sandbanks of the estuary up to Nantes, and after 1857 the outport of St. Nazaire (*q.v.*), 30 mi. to the west, was developed, with docks and long jetties that jut into the river mouth. It is a centre of naval shipbuilding and was used during World War II by the Germans as one of their main submarine bases. As such it suffered heavy bombardment, and the town was devastated in 1943. Nantes was also severely damaged during World War II, but the reconstruction provided the opportunity for the port layout and equipment to be modernized. Mineral oil has come to dominate the trade, and a large refinery has been established above St. Nazaire at Donges. At Trignac there is a fully integrated iron-and-steel works, and at La Basse-Indre there are other steel mills, chiefly concerned with the production of plates for shipbuilding. The canal from Nantes northwest through Brittany to Brest no longer carries much traffic. Nantes, ever since Roman times the leading urban centre of the area, is the seat of the *préfecture* of the *département* and of the bishopric, but the *département* comes under the *académie* and court of appeal at Rennes, the ancient capital of Brittany. The *département* is divided into four *arrondissements*, centred upon Nantes, St. Nazaire, Châteaubriant and Ancenis. Apart from the castle and the great cathedral at Nantes, other noteworthy buildings in the *département* include the ruins of a medieval fortress with a Renaissance château alongside at Châteaubriant, the well-preserved ramparts and gates of the little town of Guérande, and a timber market-hall and attractive 13th-century castle at Clisson, overlooking a bridge across the Sèvre Nantaise. (Ar. E. S.)

LOIRE RIVER (ancient Liger), the longest river of France, is 1,020 km. (634 mi.) from source to mouth and has a maximum rate of discharge only exceeded, among French rivers, by the Rhône. With its tributaries it drains an area of about 47,000 sq.mi. or more than one-fifth of France. Its course may be divided into three major sections:

1. Upper section: the Massif Central. The river rises at about 4,300 ft. in the Cévennes, actually flowing southward initially from the region of Mont Mézenc, but after 10 mi. it turns to flow generally northward, in a valley cut deeply in granitic rocks, toward the basin of Le Puy. There it encounters an area of Tertiary sediments, together with rocks of recent volcanic origin, but the Tertiary cover is thin and the underlying granites are exposed in places. At Le Puy the elevation of the river is about 2,000 ft. It leaves the basin by a series of fine gorges through granites, and after about 80 mi. reaches the Plaine du Forez at about 1,200 ft. Like the basin of Le Puy, this is another enclosed lowland area floored by sandy Tertiary beds and river alluvium across which the Loire has entrenched its course. The Plaine du Forez terminates in the north against a mass of Carboniferous slates and igneous rocks, through which the Loire cuts a picturesque gorge with waterfalls, such as the Saut-de-Pinay, at a height of 1,000 ft. The river then enters a third basin of Tertiary rocks, that of Roannais. The floor of this basin slopes gradually northward with the river deeply incised. The river skirts a southerly projection of the old rocks of Morvan below Digoin, and the Tertiary basin widens to join with the Limagne.

2. Middle section: the Paris basin. Nearly half the course of the Loire is over the Secondary and Tertiary rocks of the Paris basin. Below Decize the Loire reaches Jurassic rocks, first crossing a small outcrop of Lias clay around Nevers. Just below Nevers, at a height of 525 ft., the Loire is joined on the left bank by its longest tributary, the Allier (*q.v.*). Its course then lies through a region of low hills of the Middle and Upper Jurassic series (Côtes du Nivernais on the east), across a narrow belt of Gault clay and, below Cosne-d'Allier, into the Chalk country (Collines de Sancerrois and Puisaye on either side of the river). After a further 20 mi. it reaches the main Tertiary outcrop of the southern Paris basin. The Chalk reappears around Blois and forms the valley sides for 110 mi. down to Les Ponts-de-Cé, where the Loire finally leaves the Paris basin. Throughout its course in the Paris basin, the river flows in a broad trench up to 6 mi. wide but occasionally narrowing to about 1 mi.; *e.g.*, below Blois. The river is characteristically braided and meandering; in summer, the season of low water, the channels are rarely more than a few feet deep, and many banks of sand and gravel, fringed with willows and osiers, appear. But in winter the river becomes a raging torrent, with a discharge at times exceeding 300,000 cu.ft. per second. Hence much of the valley is diked below Blois, and bridges need to be lengthy and strongly built. At Tours the main road bridge is 1,400 ft. long. Between Tours and Saumur the river is joined by three important left-bank tributaries, also rising in the Massif Central: the Cher, Indre and Vienne (*qq.v.*). The characteristic appearance of the countryside of the middle Loire is green and well wooded; oak forest is most widespread, though in a few sandy upland areas birch and pine are more common, together with bracken and gorse. Along the rivers, poplars, alder and willow provide attractive borders. A great deal of the country is cultivated, including a considerable amount of meadowland and many orchards and vineyards; there are also tracts of parkland surrounding the famous châteaux.

3. Lower section: the Loire in Brittany. The river enters a region of old rocks (southern Brittany) at Les Ponts-de-Cé, 90 mi. from the sea but only 46 ft. above sea level. Four miles downstream it is joined by the large right-bank tributary of the Maine (*q.v.*). From there to the bend at Ingrandes it occupies a trench

up to 2 mi. wide cut in Paleozoic slates. Below Ingrandes the valley widens in Coal Measure shales toward Ancenis, but then contracts again to a narrow section (about ½ mi. wide) in Pre-Cambrian schists around Champtoceaux. Downstream to Nantes the valley is somewhat wider in shales. Below Nantes a ridge of granite approaching the north bank maintains a relatively narrow valley. Even at Le Pellerin, 10 mi. below Nantes, the valley floor is only 1 mi. wide. The estuary, containing much marshland but dredged and diked where necessary, begins at Le Pellerin. The valley sides are still well marked, and St. Nazaire on the north shore is built on another outcrop of granitic rock.

Navigation and Commerce.—The Loire has only poor navigation above Nantes because of the great difference in discharge between summer and winter, the shallowness of the river in summer and the variable channels of its middle course. The main flood period is November–April, following winter rains and snow melt in the Massif Central, when much sand and gravel is brought down to choke the channels. The maximum discharge at Nevers is about 190,000 cu.ft. per second; at La Charité, 340,000; and at Nantes, 210,000. From the estuary up to Nantes a minimum depth of 30 ft. is maintained, but upstream the mean depth is usually less than 3 ft. and the minimum depth in many places is as little as 1 ft. Consequently, there is no regular navigation for about half the total length of the river. Yet the need for an east-west waterway across central France has often been stressed, and efforts were made after World War I to control the river and stabilize one main channel. By the 1960s the efforts had been only partially successful. The main stretch used for river craft is from the estuary up to the Vienne confluence just above Saumur. In the Massif Central section a lateral canal was constructed from Roanne downstream to Briare with a minimum depth of 6½ ft., but apart from traffic connected with the textile industries of Roanne, it is not greatly used. Another canal links Briare with the Seine river system and formerly handled quantities of timber, limestone and gravel for transmission to northeastern France and other parts of the Paris basin.

Several large towns lie at bridging points on the Loire, among them Nevers, Orléans, Blois and Tours, the largest town in the southern half of the Paris basin, located on a low-lying neck of land 1½ mi. wide between the Loire and the Cher. In the lower section of the river, Nantes is an ancient port and was the leading port of France in the 18th century. The river channel below Nantes is subject to severe silting, and in the 19th century a canal was cut along part of the left bank, but this has since been abandoned. Dredging has greatly improved navigation, and ships of 30 ft. draft can dock at most stages of the tide. Nantes handles nearly 4,000,000 tons of freight annually, of which over half consists of crude oil en route to local refineries. It is the lowest bridging point of the Loire. St. Nazaire on the estuary was originally a fishing port, but now possesses important docks which serve ships unable to negotiate the estuary up to Nantes. Its main function is as an outport, and it handles principally coal, oil and other raw materials. (C. Em.)

LOIRET, a *départements* of north central France, formed in 1790 out of the ancient province of Orléanais (*q.v.*). It is bounded north by Seine-et-Oise, northeast by Seine-et-Marne, east by Yonne, south by Nièvre and Cher, west by Loir-et-Cher and northwest by Eure-et-Loir. Area 6,812 sq.km. (2,630 sq.mi.). Pop. (1962) 389,854. The *départements* is low-lying and is traversed from east to west in a sweeping arc by the broad valley of the Loire river from above Briare to below Beaugency. The northern portion of the *départements* is drained by left-bank tributaries of the Seine, the Loing and the Essonne. The Loiret, which gives its name to the *départements*, is a short stream which emerges from springs south of the Loire in the park of the Château de la Source and after a course of only 8 mi. returns to the Loire a large quantity of water lost by seepage higher up the valley. The valley of the Loire, 4 mi. wide at Orléans, with a flat floor covered by light, sandy alluvium, is a strip of extremely intensive cultivation. Divided into small plots, the land is devoted to market gardens, nurseries and rich meadows, with vineyards and orchards along the valley sides. Beyond the well-defined *val*, with its dense population of small holders, are extensive areas where an overspread of Tertiary debris brought down from the siliceous rocks of the Massif Central to the south is responsible for infertile soils, poor drainage and long persistence of woodland and waste. Within the great curve of the Loire valley is part of the marshy, mere-studded district of Sologne, on the right bank is the Forêt d'Orléans and in the northeast of the *départements*, east of the Loing valley, is another infertile district, Gâtinais. North of the Forêt d'Orléans, however, the limestone platform emerges and its *limon* soil gives the rich grain lands of Beauce (*q.v.*). Another fertile tract reminiscent of Beauce extends west of Montargis between Gâtinais and the Forêt d'Orléans.

There is little industry in the *départements* but Orléans has a variety of light manufactures including agricultural implements, and in the 1950s an important development of rubber manufacture took place nearby at La Chapelle-St. Mesmin. The towns are primarily agricultural market centres, with added importance attaching to those at historic crossings of the Loire, notably Gien and Orléans. Before the improvement of land communications in the 19th century the Loire waterway was of great importance in France and Orléans flourished as a river port, situated on the great northward bend of the river. The main railway line from Paris to the southwest and the arterial road cross the Loire there. In the southeast of the *départements*, Briare is the northern end of the lateral canal of the Loire and thence the Canal de Briare, completed in 1642, connects the Loire with the Seine by the Loing valley. These waterways are no longer active, such traffic as persists being mainly southward-bound coal. At Sully-sur-Loire is a fine medieval château, rebuilt in the early 17th century by Henry IV's famous minister, the duc de Sully. The great Romanesque abbey church at Saint Benoît-sur-Loire, on the site of the earlier Benedictine abbey to which the relics of the saint were brought in the 7th century, and the fine 9th-century church of Germigny-des-Prés nearby are noteworthy reminders of the cultural importance of the Val de la Loire in the early middle ages.

Orléans (*q.v.*), the capital of the *départements*, is the centre of the bishopric that is coextensive with it. Orléans, Montargis and Pithiviers are the centres of the three *arrondissements* into which the *départements* is divided. The *départements* is served by the appeal court at Orléans, but for administration of education it comes under the *académie* of Paris. (Ar. E. S.)

LOIR-ET-CHER, a *départements* of north central France, was formed in 1790 from the Dunois, Vendômois and Blésois portions of Orléanais (*q.v.*), with the addition of portions of Touraine and Perche. It is bounded north by Eure-et-Loir, northeast by Loiret, southeast by Cher, south by Indre, southwest by Indre-et-Loire and northwest by Sarthe. Area 6,422 sq.km. (2,480 sq.mi.). Pop. (1962) 250,741. The Loire river crosses the centre of the *départements* from northeast to southwest past Blois. North of its valley the *départements* extends across the limestone platform of Petite Beauce to the valley of the Loir river and beyond to the hills of Perche. South of the Loire the flat, ill-drained district of Sologne reaches almost to the valley of the Cher river, which crosses the southernmost part of the *départements*. The *val*, or broad trench of the Loire valley, floored with light, sandy alluvium, is a patchwork of small holdings. Favoured by a soft climate, with mild, damp winters and warm, sunny weather persisting late into autumn, it is intensively cultivated with fruit, vegetables and vines. Even before the development of modern communications it had become an area of specialized vine growing, using the navigable waterway to distribute its products. Although wine is still important, the area under the vine is much less than before the phylloxera plague of the late 19th century, and an increasing amount of the valley floor is devoted to market gardens. Asparagus is an important crop on the more sandy tracts there and to the south in parts of the Sologne that have been reclaimed. North of the valley Petite Beauce, like Beauce itself, is rich grain land because of the fertile *limon* soil that covers the flat limestone platform, but to the southwest, with a change to less fertile soils, it gives way to the Gâtine de Touraine. The *départements* is agricultural, with no important mineral wealth, little manufacturing and few towns. The Loire is no longer much used for navigation. Blois (*q.v.*), dominated by

the great castle that was a favourite royal residence in the 16th century, is the capital of the *département*, the centre of the bishopric and by far the largest town, although its population is about 30,000. Vendôme, in the Loir valley, and Romorantin, on the southern edge of the Sologne, with Blois are centres of the three *arrondissements* into which the *département* is divided. The *département* comes under Paris for the administration of education and under the court of appeal at Orléans. Some of the most magnificent and justly famous Renaissance castles of France are situated in the *département*. The great castle of Blois, surrounding a vast courtyard, houses a fine art collection. Chambord has a grandiose façade and four massive round towers rising above the Cosson river. Chaumont (once owned by Catherine de Médicis), Avaray, Menars, Cheverny and Beauregard are other fine examples of 16th- and 17th-century châteaux, with rich furnishings and decorations. Vendôme has the ruins of a feudal castle and also a fine belfry in its church of the Trinity, and Romorantin, besides the ruins of a royal residence of the 15th and 16th centuries, has many picturesque old houses. Much of the old part of Blois, which was especially rich in old domestic architecture, was destroyed in 1940. (Ar. E. S.)

LOISY, ALFRED FIRMIN (1857–1940), French Catholic theologian, biblical scholar and founder of modernism in France, was born on Feb. 28, 1857, of peasant parents in Ambrière (Haute-Marne). In 1874 on his own decision he entered the seminary at Châlons-sur-Marne and was ordained priest in 1879. While at the Institut Catholique from 1881 his study of the Bible, together with the influence of E. Renan's lectures, caused him to doubt Roman Catholic dogma. In 1889 he became professor of Sacred Scripture at the Institut, but the publication in his periodical *L'Enseignement biblique* of his critical views on the development of the Old Testament canon and the historical value of Gen. i, 1 caused his dismissal in 1893. As chaplain to the Dominican girls' school at Neuilly and afterward in seclusion at Bellevue he published numerous articles on historical aspects of the Bible, one of which, *La Religion d'Israël* (1900), was condemned by the cardinal archbishop of Paris, F. M. B. Richard. In 1900 Loisy became lecturer at the École Pratique des Hautes Études and in 1902 published his *Études évangéliques* and *L'Évangile et l'église* in reply to A. von Harnack's *Wesen des Christentums;* he combined an eschatological interpretation of early Christian teaching with justification of later ecclesiastical development. Although the latter publication was condemned by Cardinal François Richard (1903), Loisy published in 1903 his voluminous commentary on the Fourth Gospel, which he regarded as an allegorical account of Christian faith written at the end of the 1st century. The same year this and four other works were placed on the Index, and Loisy resigned his lectureship. After his *Les Evangiles synoptiques* (1907–08) Loisy was excommunicated, having previously received several warnings. As professor of the history of religions at the Collège de France (1909–30), he continued his controversial writings under the influence of German form criticism, moving gradually further away from traditional Christianity toward a faith in the creative power of humanity, but finally returning to the adoration of God as spirit. In 1912, 1916, 1920, 1923 and 1924 respectively he published his commentaries on Mark, Galatians, the Acts, Revelations and Luke. His *Les Mystères païens et le mystère Chrétien* (1919 [1914]) and *La Religion* (1917) maintain the influence on Christianity of pagan religions. He died on June 1, 1940. *See* also Modernism, Roman Catholic.

See F. Heiler, *Der Vater des Katholischen Modernismus* (1947); M. D. M. Petre, *Alfred Loisy, His Religious Significance* (1944); A. Houtin *et al., Alfred Loisy* (1961). (W. G. Kü.)

LOJA, the southernmost highland province of Ecuador, bounded on the west by Peru, on the north by El Oro and Azuay, on the east by El Oriente and on the south by Peru. The area of the province is 4,538 sq.mi., and its population (1960 est.) was 304,700. Its capital is Loja. The population is concentrated in the basin of Loja and the valley of the Río Catamayo. In the area surrounding the city of Loja the chief land use is for growing maize (corn) and feeding dairy cattle. Wheat, barley and potatoes are grown on the steep mountain slopes, and irrigated sugar cane is raised in the deeper valleys. Beef cattle are pastured in the mountains southwest of the capital, with sheep on the higher slopes. Woolen blankets are woven in the towns. The Inter-American highway extends southward as far as Loja. (P. E. J.)

LOJA, a town in Granada province, region of Andalusia, Spain, 58 km. (36 mi.) W. of Granada by road. Pop. (1960) 25,976 (mun.). Loja lies in the plain of the Genil river between the steep cliffs of the Sierra del Hacho and the Sierra de Loja or de las Cabras. It is a picturesque town and occupies a key position on the route to Granada. It has walls and a fortress, and there are churches and other monuments of the 16th century. It is on the railway from Granada to Algeciras. The main crops are cereals, olives and vegetables. Many factories manufacture olive oil. The town is of Roman origin and was important under the Moors. (M. B. F.)

LOKEREN, a town in the province of East Flanders, Belg., is situated on the Durme river, 22 km. (14 mi.) E.N.E. of Ghent. Pop. (1961) 25,818. The church of St. Lawrence (1721) has a carved pulpit by T. Verhagen and a modern carillon. Other notable buildings include the town hall (1761) and several Flemish Renaissance houses. Lokeren's early importance dates from the granting of a weekly market in 1555. Hat manufacturing, important in the early 19th century, slowly declined and was replaced by *couperie de poils*, the shearing of rabbits and the preparation of their fur for use in felt manufacture. By the beginning of World War II, Lokeren enjoyed an almost complete monopoly of this trade. Other industries include textile and rope manufacture. Lokeren is connected by rail with important points in Belgium. (V. V.)

LOKI, in Teutonic mythology, a cunning trickster. He is represented as the companion of the great gods Odin and Thor, helping them by his cunning but sometimes causing embarrassment to them and to himself. He also appears as the enemy of the gods, entering their banquet uninvited and demanding their drink; he is the principal cause of the death of the god Balder (*q.v.*). He is punished by being bound to a rock. The character has many points of resemblance with Prometheus and Tantalus (*qq.v.*).

The figure of Loki remains obscure; there is no trace of a cult and the name does not appear in place names. (K. C. K.)

LOLLARDS, in late medieval England, a name given to holders of certain religious tenets deriving from the teachings of John Wycliffe (*q.v.*). The term comes from Middle Dutch *lollaerd*, "a mumbler" or "mutterer"; it had been applied before Wycliffe's time to the Flemish Beghards and other continental groups suspected of combining pious pretensions with heretical belief. As early as 1382 it was used in an anti-Wycliffite sermon by the Irish Cistercian Henry Crump, while in 1387 the bishop of Worcester, Henry Wakefield, gave it official currency in a mandate against five heretics.

Early History.—The earliest Lollard group consisted of the Oxford scholars who showed allegiance to Wycliffe's doctrines *c.* 1380; they were headed by Nicholas of Hereford of Queen's college, to whom is attributed the first Lollard translation of the Scriptures. His associate Philip Repingdon, an Augustinian canon of St. Mary-in-the-Fields, probably carried the movement to Leicester, where by 1382 William Swinderby led a group of lay adherents and went forth to preach in neighbouring towns. Though Wycliffe himself was still writing at Lutterworth, no solid evidence supports the tradition that he personally sent out "poor preachers." In Nov. 1382 Archbishop William Courtenay assembled convocation at Oxford and there forced the academic Lollards into submission. Repingdon conformed with enthusiasm and ultimately, as bishop of Lincoln, became an active persecutor. Hereford was excommunicated, fled to Rome and appealed in vain against his sentence; arrested on his return, he recanted and by 1393 had also become a champion of orthodox belief. In 1390–92 Swinderby was still being pursued by authority and sheltered by sympathizers in the Welsh marches. At this stage the prime agent was Wycliffe's former secretary John Purvey, who probably compiled the second

translation of the Bible, one far more attractive and idiomatic than that by Hereford. Despite Courtenay's apparent triumph, the sect continued to multiply among townsmen, merchants, gentry and even among the lower clergy. Several knights of the royal household gave their support, while vociferous partisans, concerned especially to disendow the church, emerged in the house of commons.

Lollard Beliefs.—The most complete statement of early Lollard teaching appears in the *Twelve Conclusions*, drawn up, originally in English, to be pressed upon the parliament of 1395. They began by stating that the church in England had become subservient to her "stepmother the great Church of Rome." The present priesthood was not the one ordained by Christ, while the Roman ritual of ordination had no warrant in Scripture. Clerical celibacy occasioned unnatural lust, while the "feigned miracle" of transubstantiation led men into idolatry. The hallowing of wine, bread, altars, vestments and so forth was related to necromancy. Prelates should not be temporal judges and rulers, for no man can serve two masters. The *Conclusions* also condemned special prayers for the dead, pilgrimages and offerings to images; they declared confession to a priest unnecessary to salvation. Warfare was "express contrarious to the New Testament, the which is a law of grace and full of mercy." Vows of chastity by nuns led to the horrors of abortion and child murder. Finally, the multitude of unnecessary arts and crafts pursued in the church encouraged "waste, curiosity and disguising."

Though no particular manifesto ever commanded general adherence, the *Twelve Conclusions* cover all the main Lollard doctrines except two: that the prime duty of priests is to preach, and that all men should enjoy free access to the vernacular Scriptures. The movement's obvious attraction lay in this last provision and in its argument that the wealth, pride, ritualism and coercive powers of the church stood at variance with the recorded practices of Christ and the apostles. Its weaknesses sprang from bibliolatry and the vagaries of uninstructed private judgment. Though modern knowledge of Lollard extremist fundamentalism derives largely from such hostile writers as Bishop Reginald Pecock and Thomas Netter, the movement inevitably acquired a fringe of cranks. From its early days it also tended to discard the scholastic subtleties of Wycliffe, who probably wrote few or none of the popular tracts in English formerly attributed to him.

Fluctuations During the 15th Century.—The personal opinions and political needs of the Lancastrian kings induced them from the first to support the bishops in a campaign to obliterate the heresy. In March 1401 Archbishop Thomas Arundel forced Purvey into submission and induced convocation to condemn William Sawtre (Sawtrey), who was in fact burned a few days before parliament passed the statute *De haeretico comburendo*. This measure stipulated that a heretic convicted by the spiritual court and refusing to recant, or relapsing after recantation, must be handed over to the civil power and suffer burning. The persecution, though reinforced in 1407 by Arundel's new purge at Oxford, failed to stifle Lollardy or to abash the boldness of its supporters in parliament. In 1410 these latter openly sought to modify the law of heresy, to dispossess the church and to endow the crown, together with many new earls, knights, esquires, universities and hospitals, from the spoils. Foremost among the lay converts was the distinguished soldier Sir John Oldcastle (*q.v.*), who was indicted in March 1413 for maintaining Lollard preachers and opinions. Arraigned before Arundel, he denied transubstantiation and the confessional. In October he escaped from the Tower of London and proceeded to organize a great march upon London by Lollards from many parts of the kingdom. On Jan. 9–10, 1414, Henry V assembled troops in St. Giles's fields and dispersed the rebels with little fighting. Though the elusive Oldcastle avoided arrest and execution until 1417, his rising resulted in a roundup of leaders and suspects so complete as to shatter the overt political influence of Lollardy. Driven underground, it operated henceforth chiefly among tradesmen and artisans, supported by a few clerical adherents. Between 1424 and 1430 over 100 Lollards were arraigned in the diocese of Norwich, while cases also proved common in Somerset and in parts of the diocese of Lincoln. Early in the century Scottish Lollards were being persecuted by the inquisitor Laurence of Lindores, yet the sect persisted there until the Reformation.

In the spring of 1431 a fresh Lollard plot came to light; its ramifications proved surprisingly extensive, and it aimed at no less than the overthrow of the government and the disendowment of the church. The subsequent decline in the number of prosecutions may indicate merely a slackening of official pressure. Despite a few martyrs, Lollardy was neither demonstrative nor heroic; it flourished upon quiet evasion, and most of its adherents submitted tamely when brought into the ecclesiastical courts. In 1455 Reginald Pecock issued his *Repressor of Overmuch Wijting [Blaming] of the Clergy*, a powerful attack upon Lollard beliefs and especially upon their misuse of biblical texts. His analysis indicates that the emphases of Lollardy had not substantially altered since the time of the *Twelve Conclusions*.

Lollardy and the Reformation.—There can be little doubt that a Lollard revival began about 1500. Much of the detailed evidence comes from John Foxe, *Acts and Monuments* (1563), yet it is highly circumstantial and finds support elsewhere. In the London diocese, especially in Essex, Bishop Richard Fitzjames prosecuted about 50 Lollards in 1510 and about as many again in 1518. In Dec. 1514 the murder of the Lollard merchant Richard Hunne in the episcopal prison at St. Paul's immensely intensified anticlerical feeling in the city. Between 1527 and 1532 the bishops Cuthbert Tunstal and John Stokesley caused at least 218 heretics to abjure in that diocese; with few exceptions these heresies remained purely Lollard. Another major focus lay in the Chilterns, especially around Amersham and Buckingham, where in 1506–07 about 45 cases were presented to Bishop William Smyth of Lincoln. In 1521 Bishop John Longland occasioned in that area 50 abjurations and 5 burnings, and he continued active for another decade. The region was connected through a number of scattered communities in the Thames valley with others in Berkshire, Wiltshire and the Cotswolds. At Newbury about 140 heretics are said to have abjured together sometime during the early years of the century. Yet another centre lay in the Kentish clothing towns of Tenterden, Cranbrook and Benenden, where in 1511 about 46 Lollards were denounced to Archbishop William Warham, 5 being burned, the rest abjuring. Between these various areas active liaison existed; for example, Thomas Man, burned at Smithfield in 1518, had moved about instructing communities in East Anglia, the Chilterns, the Thames valley and Newbury.

Before 1530 the old Lollard and the new Protestant forces had begun to merge. Early Lutheran missionaries, like Robert Barnes, sold William Tyndale's New Testament to Lollard communities. When the writings of Luther began to enter England, Bishop Tunstal wrote to Erasmus, "it is no question of pernicious novelty; it is only that new arms are being added to the great band of Wycliffite heretics." The list of proscribed doctrines compiled by convocation in 1536 still retained a high proportion of characteristically Lollard beliefs, and even the conservative north was affected by the revival. Research into the archives of the diocese of York revealed proceedings against about 32 heretics under Henry VIII and against 45 others during the reign of Mary I. The uneducated majority of these offenders evinced neither Lutheran nor Zwinglian beliefs. Both before and after the advent of continental Protestantism, they attacked, on a Lollard basis, saint worship, images, relics, holy bread, holy water, sacred buildings and objects, and, above all, the doctrines of confession and transubstantiation. Nearly all these cases fail to appear in the actual registers of the archbishops of York but emerge from day-to-day court books, which in most other dioceses have been lost for that period. Hence it is not possible to estimate accurately the scope of the movement or even the number of trials. Yet this resurgence of an inveterate Lollardy, however negative and confused, undoubtedly amplified those complex undercurrents of dissent and anticlericalism that disturbed English society under Henry VIII. Late Lollardy coloured proletarian criticism of the church outside as well as inside the small Lollard communities; it facilitated the spread of Lutheranism, predisposed opinion in favour of the king's anticlerical legislation and, since it persisted beyond mid-century, may have helped create the psychological bases of popular nonconformity.

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LOMAS DE ZAMORA, Argentine city and important suburb of greater Buenos Aires, located 10 mi. directly south of the federal district. Pop. (1960) 275,219. Its name and origin date from the end of the 16th century, when several of the low hills in the region were given in a grant to a Spaniard named Zamora who accompanied Juan de Garay in the second and permanent founding of Buenos Aires. The town developed as a residential area and with the growth of Buenos Aires merged into the suburban area of greater Buenos Aires. After 1940 it became a major industrial area with chemical, electrical and cement factories. (Js. R. S.)

LOMBARD, PETER (PETRUS LOMBARDUS) (*c.* 1100–1160), theologian and bishop, best known as "Master of the Sentences" (*Magister Sententiarum*), was born about 1100. Little is known of his life. After early schooling at Bologna he went to France to study first at Reims, then at Paris. From 1136 to 1150 he taught theology in the cathedral school of Notre Dame. He was present at the Council of Reims in 1148. In 1159 he was named bishop of Paris. He died in 1160. Besides the *Books of Sentences* (*sententiarum libri IV*), Peter Lombard wrote commentaries on Holy Scripture, sermons and letters. No special importance attaches to these writings. The *Sentences*, however, established his reputation and subsequent fame.

This work, written between 1148 and 1151, is a collection of teachings of the Church Fathers (*sententiae Patrum*), plus some opinions of medieval masters, arranged as a systematic treatise on sacred doctrine. Lombard takes due cognizance, throughout, of the role of reason in theology. His work marks the culminating point of a long tradition of theological pedagogy, and until the 16th century it was the official textbook of theology in the universities. Hundreds of scholars wrote commentaries on it (180 in England alone).

The contents of the *Books of Sentences* are as follows: book I deals with God, the Trinity, providence, predestination, evil; book II with angels, demons, the Fall, grace, sin; book III with the incarnation, the redemption, virtues, the Ten Commandments; book IV with the sacraments in general, the seven sacraments in particular, the four last things (death, judgment, hell, heaven).

The author shows originality in choosing and arranging his texts, in utilizing various currents of thought, in avoiding the extremes of both dialecticians and authoritarians, and above all in crystallizing the theology of the sacraments. He asserted that there are seven sacraments and that a sacrament is not merely a "visible sign of invisible grace" but also the "cause of the grace it signifies."

Peter Lombard's teachings encountered opposition during his lifetime and after his death. Later theologians rejected a number of his views. One opinion he held was officially censured, an opinion derived from Abelard's teaching that, in Christ, God *is* not man, but *has* humanity. This formula smacked of "christological nihilism" (a term applied to the heresy of adoptionism, according to which the Man, Christ, was not God's true Son, but his adopted son), and in 1177 Pope Alexander III condemned this error.

Notwithstanding, Peter Lombard was never regarded as unorthodox. Efforts to have his works condemned were unsuccessful. The fourth Lateran council (1215) even prefaced a profession of faith with the words "We believe with Peter Lombard. . ."

Peter Lombard's collected works may be found in J. P. Migne, *Patrologia Latina*, vol. 191 and 192. The best edition of the *Books of Sentences* (no English translation) is that by the Franciscans at Quaracchi, *Libri quattuor sententiarum*, 2 vol. (1916).

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LOMBARD, a village in Du Page county, northeast Illinois, U.S., 21 mi. W. of the Chicago "loop," is located on gently rolling terrain at an altitude of 700–750 ft. It was named for Joseph Lombard, a Chicagoan, who platted the site in 1868. Incorporated as a village in 1869, it is still classified as such, even though it has a population of about 23,000.

Known as the "lilac village," Lombard has six parks, covering more than 100 ac. Lilacia park, bequeathed by Col. William Plum who collected lilacs as a hobby, has notable varieties of these flowering trees and shrubs. Lombard was one of the first communities in Illinois to give women the right to vote.

Lombard is mainly a residential suburb of Chicago and has little local industry.

For comparative population figures *see* table in ILLINOIS: *Population.* (D. A. Pr.)

LOMBARD LEAGUE (12th–13th century), the league of towns in northern Italy formed to resist the attempts by the Holy Roman emperors to reduce the liberties and jurisdiction of the Lombard communes. In 1164 Venice took the initiative in allying with Verona, Padua and Vicenza against Frederick I Barbarossa's policy (Veronese league); and in March 1167 Cremona concluded a league with Mantua, Brescia and Bergamo, which was joined in the same year by Milan, Lodi, Piacenza and Parma. On Dec. 1, 1167, the two leagues combined for 20 years in a new league, which then included 16 towns. The new alliance, the Lombard league, was governed by *rectores* representing its members and usually chosen from among their consuls (*see* COMMUNE [MEDIEVAL]). Further adhesions followed—thus in 1168, Novara, Vercelli, Como and Asti joined—but the league never included all the Lombard cities. It was backed from the beginning by Pope Alexander III, who saw in it a welcome ally against Frederick; and the league gave the name Alessandria to the fortified town that it built near Asti in 1168. The negotiations between Frederick and the league, begun soon after his unsuccessful siege of Alessandria in 1174–75, led to the preliminary peace of Montebello, in which the emperor practically abandoned his former program. No final agreement was reached, however, and on May 29, 1176, the league defeated him at Legnano. The peace of Venice between Frederick and the papacy (July 1177) was combined with a six-year truce between the emperor and the league, and this was followed by the peace of Constance of June 25, 1183. While the cities of the league recognized the emperor's overlordship, which found expression in the imperial investiture of the consuls, they retained their liberties and most of their jurisdiction and had the right to preserve or renew their alliance.

After Frederick Barbarossa's death (1190) the Lombard league was renewed by Milan, Brescia, Mantua, Vercelli, Verona, Novara and Treviso in 1198 and by Milan, Brescia, Piacenza, Bologna, Vercelli and Alessandria in 1208; but it was not until 1226 that it again became a powerful factor in Italian politics for a long period. When the emperor Frederick II summoned a diet to Cremona for Easter 1226 with the purpose of restoring imperial authority in northern Italy, the Lombard league was renewed for 25 years by Milan, Bologna, Brescia, Mantua, Padua, Vicenza and Treviso. They were soon joined by Piacenza, Verona, Lodi and other towns, as well as by Boniface II of Montferrat and Goffredo of Biandrate. Tacitly or openly supported by the papacy, the new Lombard league effectively opposed Frederick II and his reorganization of northern Italy. The crushing defeat that it suffered at his hands at Cortenuova on Nov. 27, 1237, proved no more than a temporary setback for the league. After Frederick's death (1250) it was dissolved. Renewed on the arrival in Lombardy of his son Conrad IV in 1252, it is last recorded in Jan. 1253.

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LOMBARDO (LOMBARDI), the name given to a family of Lombard origin who practised as sculptors and architects in Venice in the 15th and 16th centuries, and who were largely responsible for the formation of the Venetian Renaissance style. Its most notable members were Pietro Lombardo (*c.* 1435–1515) and his sons Tullio (*c.* 1455–1532) and Antonio (*c.* 1458–1516). The son of Tullio Lombardo, Sante (1504–1560), also practised as an architect.

PIETRO LOMBARDO was born at Carona about 1435, and is first heard of in Padua, where he was active in 1464–67. There he executed the Roselli monument in S. Antonio (1467) and the Casa Olzignani. About 1467 he transferred his studio to Venice, where he worked for the remainder of his life, producing a long succession of buildings and sepulchral monuments. The Roselli tomb derives from Florentine humanist monuments, and the earliest of his buildings in Venice, the church of S. Giobbe (after 1470) is also markedly Tuscan in character. Thereafter he developed a more individual architectural style, of which the first evidence is found in the church of Sta. Maria dei Miracoli (completed 1489). With its harmonious proportions and rich marble incrustation, this is one of the most distinguished Venetian churches of the early Renaissance.

In sculpture Pietro Lombardo also worked his way forward from the Niccolò Marcello (d. 1475) monument in SS. Giovanni e Paolo to the more complex and more typically Venetian Pietro Mocenigo monument in the same church (1476–81). In 1482 he executed the tomb of Dante for Ravenna and in 1485 began work on his most distinguished monument, the Zanetti tomb in the cathedral at Treviso, where the carving was in large part carried out by his sons. From 1498 until his death in June 1515 he served as *capomaestro* of the ducal palace in Venice.

TULLIO LOMBARDO, the elder of Pietro's sons, was born in Venice, probably about 1455. He is mentioned with his brother Antonio by the humanist Collaccio in 1475, and assisted his father in work on the Pietro Mocenigo monument in SS. Giovanni e Paolo. The figure sculpture in his most important work, the Vendramin monument from Sta. Maria dei Servi, now in SS. Giovanni e Paolo, is the peak of Venetian classicism; a beautiful figure of Adam from this tomb is now in the Metropolitan museum, New York. In 1525 he executed his best-known work, the recumbent figure of Guidarello Guidarelli at Ravenna. His last dated work is the Bellati monument in the cathedral at Feltre (1528). Tullio was also active as an architect, designing the Cappella dell'Argento for the cathedral at Ravenna (1515) and the cathedral at Belluno (1517) and working in this capacity at Mantua (1527). He died on Nov. 17, 1532.

ANTONIO LOMBARDO, the younger of Pietro's sons, seems to have been born about 1458 and was already active by 1475. He assisted his father and brother in Sta. Maria dei Miracoli, on the Zanetti and Vendramin monuments, and on the façade of the Scuola di S. Marco (for the reliefs on which he and Tullio were jointly responsible). In 1501 he received the commission for two reliefs for the chapel of St. Anthony in S. Antonio at Padua, only one of which was completed (1505). This reveals Antonio as a more restrained and in some respects more sensitive sculptor than his brother Tullio. Between 1504 and 1506 he worked on the tomb and chapel of Cardinal Zen (d. 1501) in St. Mark's, Venice. This was the first major work in bronze executed by a Venetian sculptor and was completed by Paolo Savin.

In 1506 Antonio Lombardo transferred his workshop to Ferrara, where he was employed by the Este and where he is last mentioned in 1516. There he was responsible for the carving of the celebrated Camerini d'Alabastro (alabaster chambers) in the Castello, which were decorated with mythological and other reliefs. An important group of carvings from this complex is in the Hermitage at Leningrad.

See P. Paoletti, *L'Architettura e la scultura del Rinascimento a Venezia* (1893); L. Planiscig, *Venezianische Bildhauer* (1921). (J. W. P.-H.)

LOMBARDS, a Germanic people who from 568 to 774 had a kingdom in northern Italy. They appear in classical writings of the 1st century A.D. as one of a number of tribes who formed the Suebi. Their home was then evidently in northwestern Germany, on the left bank of the lower Elbe river. If distinctive types of late Iron Age pottery and brooches are rightly associated with them, their settlements extended both west and east of the medieval Bardengau, which, with its principal community Bardowiek (near Lüneburg), preserves the second element of their tribal name (Langobardas; classical Lat. Langobardi, medieval Lat. Longobardi). According to a tradition written down in the 7th century they arrived there from a more northerly home. The same source asserts that they got their name from their long, uncut beards; but a different explanation is possible.

Before A.D. 6, Roman soldiers had fought against them; in A.D. 17 they supported the Cherusci against the Marcomanni; and shortly after A.D. 47 they helped re-establish a deposed ruler of the Cherusci. About A.D. 166 Lombards were among the barbarians who attacked the Danube frontier. The main body of the Lombards, however, is generally thought to have pursued a settled pastoral existence in northern Germany until the beginnings of the great migrations late in the 4th century, and even after this others remained to be absorbed by the expanding Saxons. The tradition written down in the 7th century that the migration southward was associated with a change from leadership by a duke to rule by a king, in the person of Agelmund, may be authentic. The same source's account of the stages by which the Lombards moved to the middle Danube is extremely obscure. There is some archaeological evidence, however, that they established themselves successively along the upper Elbe and in the later Moravia, where in the mid-5th century they were temporarily part of the Hunnish empire of Attila.

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

LOMBARD BROOCH (7TH CENTURY) FROM TUSCANY, ABOUT 6 IN. LONG. IN THE BRITISH MUSEUM

At the end of 487 the kingdom of the Rugii, which roughly coincided with Austria north of the Danube, was destroyed and the Lombards occupied the area. Contact with the Ostrogoths and Franks brought them into touch with late Roman culture. The earliest examples of elaborately decorated brooches in which the styles and techniques current in these societies have in turn been adapted to Lombard taste appear in their graves shortly after this. In the early 6th century the Lombards temporarily expanded toward the Tisa river, which may have been one reason for the war fought *c.* 508 under their king Tato against the Heruli and their king Rudolf, which ended in the almost complete destruction of the Heruli. The Lombards then, according to their 8th-century historian Paulus Diaconus, "began of their own accord to seek occasions of war." At this period also they probably received their first Christian missionaries. When, later, they entered Italy they were certainly Arians; but there is evidence that at one time they had favoured orthodoxy and subsequently changed, possibly under Gothic influence. Tato was killed *c.* 510 by his nephew Waccho, who ruled for 30 years, his kingdom extending across the Danube as far as Lake Balaton. Shortly after 536 the Byzantine emperor Justinian I made a treaty with him directed against the Gepidae who held the country east of the Danube. But for nearly a decade the Lombards gained little or no advantage from it, since Waccho's successor, from *c.* 540 to 546, was a minor. In 546 Audoin began a new royal dynasty; and at the beginning of his

reign he and his subjects were allowed to establish themselves in the formerly Ostrogothic lands as far as and even beyond the Save. At that time, it seems, they began to adapt their tribal organization and institutions to the imperial military system of the period, in which a hierarchy of dukes, counts and others commanded warrior bands formed from related families or kin groups. For two decades intermittent wars with the Gepidae alternated with truces and the attempts of both sides to gain imperial support for their own ends. About 565 Audoin died. In the same year the Avars appeared in the west; with them Audoin's son and successor Alboin made a compact to destroy the Gepidae. The decisive battle (*c.* 567), however, was fought between the Lombards and the Gepidae only. The latter were destroyed and their king killed, and Alboin married his daughter Rosamund.

Even before this the Lombards seem to have had their eyes on Italy, where the Byzantine armies had recently overthrown the Ostrogothic kingdom. In the spring of 568, having arranged with the Avars that they could return to and reclaim their lands in Pannonia if they did not like Italy, they crossed the Julian Alps.

The Lombards' invasion of northern Italy was almost unopposed, and by Sept. 569 they had conquered all the principal cities north of the Po except Pavia. Subsequently Alboin sent armies across the Apennines; in 571 he may have threatened Rome itself, though only western Emilia and part of Tuscany were permanently conquered at this time. Simultaneously two other armies respectively occupied Spoleto with the land eastward to the Adriatic and Benevento with adjacent areas of southern Italy. Pavia fell in 572. Shortly afterward Alboin was murdered in revenge for having forced his wife to drink from her dead father's skull. The 18-month rule of his successor, Cleph, was marked by the ruthless treatment of the Italian landowners.

On his death the Lombards chose no successor. Instead the dukes, who with their followings had been or were now associated with one of the cities in the occupied area, exercised authority in their particular city-territories. Place names and archaeological evidence indicate that the war bands that settled south of the Apennines were fewer than those that settled in the Po valley and the northeast. But everywhere the Lombards were outnumbered by the native population, and they seem to have established themselves in groups in easily defended positions on the outskirts of the cities or in similar "castles" in the countryside. For a time they may have lived largely on tribute, though quite early many of them must have acquired lands of their own.

The ten-year "rule of the dukes" was later viewed as one of violence and disorder, in which the church suffered at least as much as the native landowners. In 584, however, threatened by a Frankish invasion which the dukes had provoked, the Lombards made Cleph's son Authari king; and when he died in 590 he was succeeded by Agilulf, duke of Turin, who married his widow Theodelinda, a Bavarian and a Catholic. A Franco-Byzantine alliance, which this marriage was partly intended to counter, had inflicted serious defeats on the Lombards by 590, but Agilulf was subsequently able to recover most of what had been lost. In the next decade Rome itself was threatened, first by the duke of Spoleto and subsequently by Agilulf, being saved only by the efforts of Pope Gregory I. By 605 the Lombards were in complete control of the Po valley and Emilia east of the Panaro; the Byzantines retained only the Venetian coastal strip, the Ligurian coast, the Po basin and the Adriatic coast southward, Perugia and the adjacent Apennine crossings, Rome and its neighbourhood, Naples and small areas in the southeast and southwest. In 643 a Lombard army under King Rothari (reigned 636–652) occupied Liguria.

When Authari became king, the dukes surrendered half their estates for the maintenance of the king and his court, and royal officials known as gastaldi were appointed to administer them and (eventually) to act as a check on the power of the dukes. Border duchies such as Friuli and Trento were always difficult to control, and except for relatively brief periods the dukes of Spoleto and Benevento were usually able to act independently of the king; but the internal weaknesses of the Lombard kingdom must not be exaggerated. By the 620s Pavia was emerging as something like a capital. The royal palace (built by Theodoric the Ostrogoth) was the centre of an administrative organization whose officials and techniques, like the documents they wrote, owed much to Roman traditions as transmitted by the Byzantines. Rothari's "Edict" of 643, in which the laws of his people were recorded for the first time, illustrates many aspects of this "romanization"; but it also shows how tenaciously the Lombards maintained many of their Germanic customs—though some of these, such as vendetta, had been modified by Christian and royal influence.

The Lombards' Arianism helped to maintain their separateness from the king's Roman subjects. Theodelinda's Catholicism had little permanent influence except for her support of the foundation of the influential monastery of Bobbio. Arian bishops continued to exist in parts of northern Italy, and Rothari was actively anti-orthodox; it was only in King Perctarit's reign (671–688) and after the intervention of missionaries organized from Rome that the Lombards finally abandoned Arianism.

Theodelinda's line died out with the brutal Aripert II (reigned 700–712) and a new dynasty was raised to the throne. Its second representative, Liudprand, who reigned from 712 to 744, was probably the greatest of the Lombard kings. Until 726 he seems to have been concerned exclusively with the internal condition of his kingdom. Subsequently, helped by the internal dissensions resulting from imperial policies, he steadily reduced the area still under Byzantine rule; and he also made his authority effective in Spoleto and Benevento. The laws which he issued in 15 of the 31 years of his reign reveal an increase in royal power, a growing opposition to violent revenge and the greater importance of property transactions. Coins and documents from his court confirm the impression of a strong and effective monarch.

In 751 Ravenna and the remaining central Italian Byzantine territories were occupied by Aistulf (king 749–756), who then invaded the territory round Rome. On the appeal of Pope Stephen II (III), the Frankish king Pepin led two expeditions into Italy in 754 or 755 and 756, and compelled Aistulf to surrender to the papacy most of his conquests since 751. When in 772 Aistulf's successor Desiderius invaded these papal territories, Pope Adrian I sought the help of the Frankish king Charles (*see* CHARLEMAGNE). The latter entered Italy in 773 and after a year's siege Pavia finally fell to his armies. Desiderius was captured, the great men of the kingdom made their submission and Charles became king of the Lombards as well as king of the Franks.

The traditions and achievements of the Lombards were not forgotten with the disappearance of an independent kingdom. In the 780s Paulus Diaconus, himself of an old Lombard family, wrote their history from the beginning to the death of Liudprand; and in the 9th century the princes of Benevento, whom the Franks failed to subject, regarded themselves as maintaining the ancient traditions of the Lombard people. The Italian language includes a number of words of Lombard origin; and for at least two centuries the judicial institutions of northern Italy showed traces of Lombard influence. The Lombards also played a part in the development of later Germanic ornament (in the 7th century), though their contribution to the art of Italy was negligible. Finally many features of later Italian life which have Roman origins, such as the notariate, were transmitted via the Lombards.

See also references under "Lombards" in the Index.

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LOMBARDY (It. LOMBARDIA), a region of northern Italy, is composed of the provinces of Bergamo, Brescia, Como, Cremona, Mantova, Milano, Pavia, Sondrio and Varese. Area 23,804 sq.km. (9,191 sq.mi.). Pop. (1961) 7,406,152. It is the leading industrial and commercial region of Italy and one of the country's best farming areas.

Physically, Lombardy may be divided into three zones: a northern, mountainous zone; a median, hilly zone; and a southern, flat zone. The northern zone is divided into the Alpine and the pre-Alpine zones. The Alpine zone, where crystalline rocks prevail, comprises part of the Lepontine and Rhaetian Alps, the Orobie

Alps, the Ortles and the Adamello. In the Bernina it reaches a height of 13,304 ft. and has many glaciers. The pre-Alpine zone, mostly calcareous, though also dolomitic, attains less elevated heights but occasionally rises above the 8,000-ft. line. It is particularly beautiful at some of its massifs, such as the Grigne. The hilly zone, partly composed of a morainic material with some morainic amphitheatres, is gently undulating. The alluvial plain, sloping northwest-southeast, is divided into high and low areas; the former has a gravelly soil, poor in superficial water; the latter, with plentiful moisture content, is separated from the former by the spring line where the waters, hidden in the subsoil at the higher level, gush out.

Lombardy has many rivers, all tributaries of the Po. The principal ones are the Ticino; the Adda, with its affluents the Brembo and Serio; the Oglio, with its affluents the Mella and the Chiese; and the Mincio. The Valtellina and the Brembana, Seriaria, Camonica, Trompia and Sabbia valleys are among the most beautiful in Italy. The region also has many Alpine, pre-Alpine and inframorainic lakes, containing all or part of Lake Garda, the largest lake in Italy, Lake Maggiore, the Lake of Lugano, Lake Como, Lake Iseo, Lake Idro, Lake Varese and the lakes of the Brianza (Pusiano, Annone, Alserio and Segrino).

The climate, though in the main continental, is variable, because of the great differences of height and the presence of large water areas; it is most continental on the lower plain at Milan, Pavia and Cremona. The rainfall, not less than 24 in. annually in the area near the Po, reaches 80 in. in the mountainous regions.

Lombardy has a larger population than any other Italian region and contains about 14.6% of the total population of Italy although it covers only 7.9% of the country's area. The population density is greatest in the pre-Alpine zone and on the plains, the areas of intense economic, agricultural and industrial development. A table giving area and population for the various regions will be found in the article ITALY.

Agriculture, especially on the plains, is industrialized, and high productivity is achieved by scientific use of fertilizers and by irrigation. Grasslands, where grass is mowed up to eight times a year in the *marcite* ("flooded meadows"), cereal growing (rice, wheat and corn) and sugar-beet cultivation are characteristic of the low plains; the higher plains grow cereals, green vegetables, fruit trees and mulberries. The hilly zone has fruit and chestnut trees; the climate and soil around the lakes are especially suitable for olive trees and limes. In the pre-Alpine zone vines grow at altitudes as high as 2,400 ft. above sea level, and on the Alps there is excellent grazing. In the Alpine hamlets cattle breeding is scientifically practised; about half of the cattle are milk producing. Pigs are also raised and sheep are bred for both wool and meat. Honey is another important product. Lombardy ranks third, after Veneto and Friuli-Venezia Giulia, in the production of silk cocoons.

A national park, of about 350 sq.mi., for the preservation of the indigenous animal life, was set up at Stelvio in 1935.

Lombardy is part of the industrial triangle of northern Italy, marked by the cities of Genoa, Turin and Milan. The Milan metropolitan area is known for steel and iron, automobiles and trucks, machine tools and machines, chemicals and pharmaceuticals made in Milan, Monza, Sesto San Giovanni and other centres. Brescia, Pavia and Cremona manufacture trucks, engines and machinery; Como, Legnano and Gallarate, textiles; the Brianza district, furniture; Vigevano and Varese, leather. Food industries are located in many of the smaller towns. Milan is the leading industrial city of Italy, its principal banking centre and its leader in wholesale and retail trade. The region's railway network radiates from Milan, which has through rail communications with Switzerland, France and Germany through the Simplon and St. Gotthard passes; with Turin and Paris via the Mont Cenis rail line; with Venice, Trieste and Yugoslavia to the east; with Genoa, Bologna, Rome and Bari to the south and southeast. Automobile expressways connect Milan with Turin, Genoa, Venice and Florence, and there are excellent highways throughout Lombardy.

For the history of Lombardy, *see* LOMBARDS; ITALY; *see* also references under "Lombardy" in the Index. (A. C.; G. KH.)

LOMBOK, one of the Nusa Tenggara Islands, in West Nusa Tenggara province, Indonesia, lies due east of Java, with the island of Bali between it and the Javanese coast, the Lombok strait separating it from Bali. Lombok has an area of 1,826 sq.mi. Pop. (1961) 1,300,234.

Physical Geography.—The island is very mountainous, being divided for nearly its whole length by two mountain chains, separated by a valley, which is broken in the centre by a ridge of low hills. The southern chain, which runs from southeast to westnorthwest, does not exceed 1,000 ft., but the northern chain, beginning with Gunung Wangsit, 11½ mi. N. of Ampenan, rises eventually to 12,352 ft. in Gunung Rindjani (the Peak of Lombok), one of the highest volcanoes of the Malay archipelago. Lower peaks flank the mountain, united by a plateau 7,200 ft. in height and containing a fine lake, Segara Anak. None of the many small rivers is navigable. The coast is very bold in places, with cliffs rising precipitously from the sea, but there are good anchorages in bays on the west and east coasts.

The flora includes, among the palms usual to the tropics, a great palm, a species of *Corypha*, which is a striking feature of the plains, and several Australian forms. The fauna comprises monkeys (*Macacus cynomolgus*), deer and wild pigs and many beautiful birds, large green pigeons, eight kinds of kingfishers, a ground thrush (*Pitta concinna*), grass-green doves, little crimson and black flower peckers, large black cuckoos, king crows, golden orioles and fine jungle cocks; dragonflies abound.

Lombok strait, which has depths exceeding 600 fathoms, marks the edge of the Asian continental shelf. The British naturalist Alfred Wallace in the mid-19th century drew a line from the strait northward, between Celebes and Borneo, and then passing eastward, between the Sangihe Islands and Mindanao, into the Pacific ocean, to denote the frontier between the Asian and the Australian regions; it has been known since as the Wallace line. It is supported by the fact that there are marked differences between the flora and fauna of Bali and Lombok, the barbets, fruit thrushes and woodpeckers of the former being practically unknown in the latter, while the cockatoos, honeysuckers and mound builders (Megapodidae) of Lombok are equally foreign to Bali. Later observations, however, have established that some intermingling of species is taking place, and that Wallace's line cannot be applied strictly to all forms of life—to spiders, for instance, it cannot be applied at all. To be exact, Lombok, in a biological sense, denotes the beginning of a transitional area in which Asian forms of life are gradually supplanted completely by Australian forms.

People.—The population of Lombok is composed largely of Sasaks (Sassaks), the indigenous inhabitants of the island, of Malay origin and akin to the indigenous population of the neighbouring island of Sumbawa (*q.v.*); there are also some Balinese, mostly in the northwest, and a few Chinese traders. The Sasaks, who are Muslims, built villages and houses after the Balinese pattern and followed customs resembling those of the Balinese, under whose domination they came in the 17th century. Sasaks use the Balinese script for writing, and their literature consists of Javanese and Malay translations.

Industry is at a comparatively high level; clothes and mats are woven, and there are workers in gold, silver and iron. The people are also capable agriculturists, their rice and coffee cultivation having reached a fairly advanced stage.

Mataram, the chief town and trade centre, is a short distance inland from Ampenan, the main port of Lombok, on the western coast; landing there is difficult during the west monsoon. From Ampenan and the port of Labuanhadji, on the east coast, frequent steamer service is maintained with ports in Bali and Java, with Celebes (Makasar) and with Sumbawa, Sumba, Flores and Timor. There is good road communication, and the island has cable connection with Java by way of Bali.

History.—As early as 1640 Lombok was regarded by the sultan of Makasar as being under his rule. When his power was shattered by the Dutch in 1667, a Sumbawa chief endeavoured to impose his sovereignty on the island, with the peaceful assistance of the Dutch. Civil war in Sumbawa left Lombok the prey first of pirate adventurers from Makasar and later of the Balinese, who

planted colonies in north Lombok and set about establishing their rule. Balinese intervention began about 1692; Dutch endeavours to get the signatories to the Bongay treaty (*see* CELEBES: *History*) to take action to counteract it were unsuccessful, and eventually the Balinese succeeded in establishing four kingdoms in Lombok: Mataram, Korangasem, Pagasangen and Pagutan.

In 1843 Mataram entered into a contract with the Dutch. Friendly relations between them continued until 1872, when Mataram, looking upon itself as independent and not in suzerainty to the Dutch, refused to send its regular embassy to Batavia (Jakarta) and, in 1891, interfered in the domestic politics of Bali. At the same time it cruelly oppressed the Sasak population of Lombok, so that the latter made ineffectual attempts to throw off the Balinese yoke, finally invoking Dutch aid. This was given, and in 1894, after one expedition had met with disaster, a second was successful in overthrowing the government of Mataram. Lombok was made a division of the residency of Bali and Lombok, under an assistant resident at Ampenan, and was divided into two districts, East and West Lombok; a third district, Central Lombok, was created in 1898, the capitals of the three districts being at Mataram, Praja and Sisi.

During World War II Lombok was occupied by the Japanese. It became part of the republic of Indonesia after the war. *See* also SUNDA ISLANDS AND STRAIT; MALAY ARCHIPELAGO.

(E. E. L.; J. O. M. B.)

LOMBROSO, CESARE (1836–1909), Italian criminologist, whose interests centred on the relation between mental and physical disorders, was born on Nov. 18, 1836, at Verona. He studied at Padua, Vienna and Paris, and in 1862 became professor of psychiatry at Pavia, then director of the lunatic asylum at Pesaro and later professor of forensic medicine and of psychiatry at Turin, where he eventually filled the chair of criminal anthropology.

He held that the criminal population exhibits a higher percentage of physical and mental anomalies than noncriminals; and that these anomalies are due partly to degeneration, partly to atavism, or reversion to a primitive evolutionary stage. He contended that criminals can be identified by certain "stigmata" or physical characteristics. Although most of Lombroso's theories were discredited, he worked in a practical way for a more humane and constructive treatment of convicts. (*See* CRIMINOLOGY.)

His *Crime, Its Causes and Remedies* was translated by Henry P. Horton (1911). Lombroso died at Turin on Oct. 19, 1909.

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LOMÉNIE DE BRIENNE, ÉTIENNE CHARLES DE (1727–1794), French ecclesiastic who for 16 months held the all-important ministry of the finances under Louis XVI and subsequently created cardinal, was born in Paris on Oct. 9, 1727, of a Limousin family. After he entered the church his brilliant intellectual gifts and aristocratic connections secured him rapid advancement: he was appointed vicar-general to the archbishop of Rouen in 1752, bishop of Condom in 1760 and archbishop of Toulouse in 1763. He achieved prominence as a member of the *commission des réguliers*, which suppressed some of the minor monastic orders in France, and by his administrative ability at meetings of the estates of Languedoc. In 1770 he was elected to the Académie Française, but for a time his further advancement in the church was prevented by his attitude as a freethinker.

His rise to important ministerial office under Louis XVI was facilitated by the favour of the queen, Marie Antoinette, and by his role, in the first assembly of notables (Feb.–May 1787), as leader of the clerical opposition to the fiscal and administrative plans of Calonne. Early in May 1787 he was placed in control of finances in the former post of Calonne, but soon proved his incompetence. He modified Calonne's fiscal proposals only in detail and quickly forfeited the confidence of the assembly of notables, which he dismissed on May 25. As the financial crisis deepened, he encountered the vigorous opposition of the *parlement* of Paris to his modified plans for the imposition of a land tax on the privileged orders. His attempt in May 1788 to deprive the *parlements* of their political powers failed and soon provoked the widespread revolt of the provincial *parlements* and the provincial estates. In June 1788 his demand for an enlarged *don gratuit* from the assembly of the clergy was only partially granted, and this final repulse compelled him, on July 5, 1788, to submit to demands for the summons of the estates-general. His appeal for guidance on the organization of this assembly let loose a war of pamphlets between the supporters of the claims of the third estate for double representation and the representatives of the privileged orders (*see* FRANCE: *History*). On Aug. 16, 1788, Loménie de Brienne was compelled to suspend payment from the treasury. Having thus virtually declared national bankruptcy, he was persuaded by the queen to resign in favour of Necker. He was then made archbishop of Sens and finally, in Dec. 1788, cardinal.

After the outbreak of the Revolution, he was one of the few French prelates who took the oath to the Civil Constitution of the Clergy in 1790. His former position as a court favourite, however, made him a suspect during the Reign of Terror, and he died in prison at Sens on Feb. 19, 1794. His journal of the assembly of notables of 1787 was edited by P. Chevallier in 1960.

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LOMOND, LOCH, the largest and perhaps the most beautiful of Scottish lakes, lies in the north of Stirlingshire and Dunbartonshire, and crosses the Highland edge, so that its scenery is varied from dramatically glaciated mountains in the north to softer, well-wooded hills and islands in the south. Its shape is a long narrow triangle, about 24 mi. north-south and varying in width from 5 mi. at its base in the south to $\frac{1}{2}$ mi. in the north. It lies 23 ft. above mean sea level, and its greatest depth near Inversnaid is 623 ft., a glacial excavation. In the north the loch occupies a narrow glaciated trench among the Dalradian schists (Ben Vorlich 3,092 ft.) and the grits of Ben Lomond (3,192 ft.). It begins to broaden while still north of the Highland boundary fault line, and the more northerly islands of Inchlonaig, Inchtavannach and Inchconnachan are also of grit, while Inchcailloch and Inchmurrin farther south, actually on the Highland boundary fault, are part of the softer Old Red Sandstone country, though with a core of resistant serpentine. Apart from the catchment area of the Endrick Water-Blane in lowland Stirlingshire, the 160 sq.mi. drained by Loch Lomond seem an anomalously small catchment, and the origin of the loch has long aroused controversy. It appears that parts of three major preglacial river systems draining east or southeast across this area had their watersheds breached, to form Loch Lomond and its present catchment area, by powerful Quaternary glaciers from the ice cap of the high-precipitation area of the southwest highlands, giving the very narrow, deep, steep- and straight-sided glacial trough of the upper loch. The loch drains by the short river Leven to enter the Firth of Clyde at Dumbarton. A good road follows the western shore of the loch; parts of the eastern side are accessible by minor roads.

Inchcailloch and Balmaha are mentioned in Sir Walter Scott's *The Lady of the Lake*, Inversnaid in his novel *Rob Roy*. Loch Lomond and the surrounding hills, so near to Glasgow, are naturally a major recreational lung for the city. The loch is used for angling and by various pleasure craft. There are tourist facilities including hotels, camp sites and a youth hostel. The chief lakeside resort villages are Balloch, Ardlui, Inversnaid, Balmaha, Luss, Rowardennan and Tarbet. At Inveruglas is a hydroelectric power station where the penstocks from the Loch Sloy project discharge into Loch Lomond; but the beauty of the countryside remains.

See D. L. Linton and H. A. Moisley, "The Origin of Loch Lomond," *Scot. Geog. Mag.*, 76:26–37 (April 1960). (A. T. A. L.)

LOMONOSOV, MIKHAIL VASILEVICH (1711–1765), Russian poet, grammarian and scientist, the first great Russian linguistic reformer, was born in the village of Mishaninskaya in the Archangel province, on Nov. 19 (new style; 8, old style), 1711, the son of a poor fisherman. He studied in Moscow and St. Petersburg, and spent the years 1736–41 abroad, studying at Marburg university in Germany. In 1741 he became a member of the

Academy of Sciences in St. Petersburg, and in 1745 was appointed professor of chemistry there. His scientific work includes research on the expansion of metals and gases, astronomy, geology, economics and polar exploration. In 1755 he helped to found Moscow university, which is now named after him, and of him Pushkin remarked, "Lomonosov is himself a university." Embittered by his quarrels with fellow academicians, most of them Germans, he took to drink in his last years and died at St. Petersburg on April 15 (N.S.; 4, O.S.), 1765.

Lomonosov's main achievement was literary and his theoretical works on linguistics include the *Kratkoe rukovodstvo k ritorike* (1743; "Short Guide to Rhetoric") and *Rossiskaya grammatika* (1755; "Russian Grammar"). He propounded the theory of three literary styles (high, medium and low) and confirmed the theory of tonic verse, which had already been practised by V. K. Tretyakovski, and has been the basis of Russian verse ever since.

His creative literary work belongs to the Russian classical movement. It consists mainly of odes, written in a solemn and majestic style to commemorate current events, and also in honour of the reforms of Peter the Great. The odes include *Na vzyatie Khotina* (1739; "On the Capture of Khotin") and *Utrennee razmyshlenie o bozhiem velichestve* (1751; "Morning Reflection on God's Majesty"). In his *Pismo o polze stekla* (1752; "Letter on the Use of Glass") he combines his poetic and scientific interests. His work also includes historical studies, among which is *Drevnyaya rossiskaya istoriya* (1766; "Ancient Russian History") and, in the sphere of art, the revival of mosaics in Russia.

See B. N. Menshutkin, *Russia's Lomonosov, Chemist, Courtier, Physicist, Poet*, trans. by J. E. Thal and E. J. Webster (1952). (R. F. Hi.)

LOMONOSOV (formerly ORANIENBAUM), a town and summer resort of Leningrad *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the southern shore of the Gulf of Finland opposite Kronshtadt and 40 km. (25 mi.) W. of Leningrad. Pop. (1959) 27,500. Founded in 1711, it was a favourite summer retreat of the Russian royal family, notably the tsaritsas Elizabeth and Catherine the Great. Notable buildings include the palace of Peter the Great (1714) and the Chinese palace, designed by A. Rinaldi and built in 1762–68. They suffered grave damage in World War II, during the siege of Leningrad, but have been restored. There is a fine park, with pavilions designed by Italian and Russian masters, such as the Katalnaya Gorka. The town was renamed in 1948 after the Russian scientist and man of letters, M. V. Lomonosov. (R. A. F.)

LONDON, JACK (JOHN GRIFFITH LONDON) (1876–1916), U.S. novelist, an enthusiast for social progress who reflected the hopes, conflicts, frustrations and romantic impulses of his period, was born at San Francisco, Calif., on Jan. 12, 1876. He soon moved to Oakland, Calif., where, as he recounts in his autobiographical *John Barleycorn* (1913), he quit school at 14 to escape poverty and gain adventure. In his sloop he explored San Francisco bay, alternately stealing oysters and working for the law, as told in *Tales of the Fish Patrol* (1905); he roamed as far as Japan as a sailor on a sealing cruise; and he saw much of the United States as a member of Kelly's Industrial army (a protest group, born of the panic of 1893, that originated in California and staged a march on Washington) and later as a railroad tramp, riding the rods as described in *The Road* (1907). Observation of depression conditions, fortified by a prison term for vagrancy, turned him in 1894 to Marxian socialism, a doctrine he supported for most of the rest of his life. Rebelling against becoming "a work beast," he crammed high school into one year, took a semester's work at the University of California, and energetically set out to write, supporting himself with odd jobs as narrated in *Martin Eden* (1909).

A winter in the Klondike during the gold rush of 1897 gave London his real start as a writer and supplied him with material for much of his best fiction. Combining his experience with ideas concerning evolution absorbed from Darwin and Spencer, and narrative techniques learned principally from Kipling, he gained a wide audience with his first book, *The Son of the Wolf* (1900). During the remainder of his short life he produced steadily, completing 50 books in 17 years. As his writing rested partly on reportorial elements, he constantly sought new scenes and experiences; thus, he lived in the London slums to get material for *The People of the Abyss* (1903); he served as a correspondent in the Russo-Japanese War; and he sailed a ketch to the South Pacific, telling of his adventures in *The Cruise of the Snark* (1911) and using the locale in many stories. In 1910 he settled on a large ranch near Glen Ellen, Calif., where he experimented with farming techniques and built his grandiose "Wolf House," which burned before completion. He died at his ranch on Nov. 22, 1916.

Though his writing was uneven, London produced a number of forceful novels and short stories. Besides those mentioned above, the following are outstanding: *The Call of the Wild* (1903), *White Fang* (1906) and *Burning Daylight* (1910), in which he dramatized in turn atavism, adaptability and the appeal of the wilderness; and *The Sea-Wolf* (1904), *The Iron Heel* (1907) and *The Valley of the Moon* (1913), in which he combined adventure with theories about the Nietzschean superman, the future of socialism and the plight of the city worker, respectively.

BIBLIOGRAPHY.—Charmian London, *The Book of Jack London* (1921); Irving Stone, *Sailor on Horseback* (1938); Joan London, *Jack London and His Times* (1939). (F. W.)

LONDON, a city of Ontario, Can., the seat of Middlesex county, is 115 mi. S.W. of Toronto, at the forks of the Thames river, 21 mi. N. of Lake Erie and midway between Lakes Ontario and St. Clair. Pop. (1961) 169,569; metropolitan area 181,283. London is a financial, ecclesiastical, medical, educational, military and manufacturing centre; its coat of arms incorporates a locomotive, attesting the continuing importance of transportation in the economy of the city. It is served by all major Canadian railroads and has rail service to Chicago, Ill., and to Detroit, Mich.; there are also excellent highways and a municipal airport.

The name London was first applied to the site when it was chosen, in 1792, for the capital of Upper Canada, but the plan was not acted upon, and there were no buildings until 1826, when the first settlement was made. London was incorporated as a village in 1840, as a town in 1848 and as a city in 1855. This rapid growth was due to its interlake position, its early development as a transportation centre and the excellence of the surrounding land. In 1840 Dundas street, a plank and gravel road, from near Hamilton, was extended to London, and in 1853 the first railroad, the Great Western (now the Canadian National Railways main line), arrived. Thereafter the city grew steadily as a manufacturing, distributing and financial centre. In the 1960s there were over 500 diversified manufacturing industries producing a wide range of goods, including breakfast cereals, biscuits, beer, wine, flour, brass and steel goods, abrasives, diesel locomotives, refrigerators, textiles, hosiery and boxes. There were also printing and lithographing industries.

London is the seat of the Anglican diocese of Huron and the Roman Catholic diocese of London. The University of Western Ontario, with its affiliated medical school, is located there. (G. FN.)

LONDON, the capital city of the United Kingdom and the centre of the Commonwealth of Nations. In population it is one of the world's three biggest cities (with Tokyo and New York), and it is the largest port and industrial complex in the kingdom and is also the nation's principal financial, commercial and cultural centre. It lies on both banks of the Thames, 50 mi. W. of the North sea. Its ancient heart is the City of London, which is situated on the north bank of the Thames at the narrowest crossing and is a county corporate with an area of 677 ac. and a resident population (1961) of 4,767. The City of London and the County of London (which consists of 28 metropolitan boroughs) make up the Administrative County of London, with an area of 117 sq.mi. and a population (1961) of 3,200,484. However, on July 31, 1963, the London Government Act 1963 became law; the act provided for a new administrative area called Greater London to absorb the Administrative County of London and almost all Middlesex (the remainder going to Surrey and Hertfordshire) and parts of Surrey, Kent, Essex and Hertfordshire. It would cover about 616 sq.mi., with a population of about 7,997,000.

The act would come into effect on April 1, 1965, and from that

date Greater London would comprise the City (with the Temples) and 32 London boroughs, of which 12 would be inner London boroughs and 20 would be outer London boroughs. The inner London boroughs would cover the same area as the 28 metropolitan boroughs (except that the parts of Woolwich metropolitan borough north of the Thames would go to Newham, an outer London borough). Greater London would be administered by the Greater London council, the City by the Common council and each London borough by its borough council. The new London boroughs (with their names given before the colon) would be made up as follows (the first 12 being the inner London boroughs): (1) City of Westminster: City of Westminster, Paddington, St. Marylebone; (2) Camden: Hampstead, Holborn, St. Pancras; (3) Islington: Islington, Finsbury; (4) Hackney: Hackney, Shoreditch, Stoke Newington; (5) Tower Hamlets: Bethnal Green, Poplar, Stepney; (6) Greenwich: Greenwich, Woolwich apart from the two areas north of the Thames; (7) Lewisham: Lewisham, Deptford; (8) Southwark: Southwark, Camberwell, Bermondsey; (9) Lambeth: Lambeth, a strip of eastern Wandsworth; (10) Wandsworth: Wandsworth (excluding the eastern strip), Battersea; (11) Hammersmith: Hammersmith, Fulham; (12) Royal Borough of Kensington and Chelsea: Royal Borough of Kensington, Chelsea; (13) Waltham Forest: boroughs of Chingford, Walthamstow, Leyton; (14) Redbridge: boroughs of Wanstead and Woodford, Ilford, the northern part of Dagenham borough, a small part in the south of Chigwell urban district; (15) Havering: Romford borough, Hornchurch urban district; (16) Barking: Barking borough except the southwest corner, Dagenham borough except the northern tongue; (17) Newham: county boroughs of East Ham and West Ham, the southwest corner of Barking borough, the northwest corner of Woolwich metropolitan borough; (18) Bexley: Bexley and Erith boroughs, Crayford urban district, the northern half of Chislehurst and Sidcup urban district; (19) Bromley: Bromley and Beckenham boroughs, Orpington and Penge urban districts, the southern half of Chislehurst and Sidcup urban district; (20) Croydon: Croydon county borough, Coulsdon and Purley urban district; (21) Sutton: Sutton and Cheam, Beddington and Wallington boroughs, Carshalton urban district; (22) Merton: Mitcham and Wimbledon boroughs, Merton and Morden urban district; (23) Royal Borough of Kingston upon Thames: Royal Borough of Kingston-upon-Thames, boroughs of Malden and Coombe, Surbiton; (24) Richmond upon Thames: Richmond, Twickenham, Barnes boroughs; (25) Hounslow: Brentford and Chiswick borough, Heston and Isleworth borough, Feltham urban district; (26) Hillingdon: Uxbridge borough, urban districts of Ruislip-Northwood, Hayes and Harlington, Yiewsley and West Drayton; (27) Ealing: Ealing, Acton, Southall boroughs; (28) Brent: Wembley, Willesden boroughs; (29) Harrow: Harrow borough; (30) Barnet: Finchley, Hendon boroughs, Barnet, East Barnet, Friern Barnet urban districts; (31) Haringey: Hornsey, Tottenham, Wood Green boroughs; (32) Enfield: Edmonton, Enfield, Southgate boroughs.

This article relates to London as it was administered before the London Government Act 1963, and there are separate articles on each metropolitan borough, borough and urban district in the above list.

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I. PHYSICAL CHARACTERISTICS

1. Geology.—London lies in latitude 51° 30′ N., and the prime meridian of longitude passes through the borough of Greenwich. The town developed outward from the centre of the London basin. This basin is a structural downfold (syncline) comparable to an oval plate disposed with its greater length west-east and slightly down-tilted with the east end submerged under the North sea. In the rim Chalk is exposed, rising away from the centre of the basin in gentle dip slopes to heights exceeding 800 ft. above sea level in the Chiltern hills to the northwest and the North Downs to the south, terminating in steep outward-facing scarp slopes. The Chalk forms a continuous floor to the basin, but is downfolded so that in central London at 86 ft. above sea level it is 157 ft. below the surface.

Above the Chalk the London basin is filled with great thicknesses of younger sediments. Their distribution is complex but in general the older formations are toward the edge and the new toward the centre of the basin. The solid rocks all belong to the Eocene division of the Tertiary period. The lowest occur directly above the partially eroded Chalk; they are called Lower London Tertiaries and consist of the Thanet Sands, the variable Woolwich Beds, the Reading Beds (sands and clays), and the Blackheath Beds (sands and pebbles). Collectively they are best developed in southeast London, running in a wide crescent from Croydon to Erith with a narrower extension from Erith west to Greenwich. There the Blackheath Beds form extensive sandy plateaus at 200–300 ft. terminating in marked south-facing scarps, as along the Cray valley southwest of Erith. The Reading Beds also outcrop in west Middlesex round Pinner and Harefield. Larger in surface outcrop is the mid-Eocene London Clay, a fairly uniform, stiff blue-gray clay, locally over 400 ft. thick. It outcrops widely in

Middlesex, occupying over four-fifths of that county north of a line Uxbridge–North Acton, and rising northward to plateaus capped with gravel at 450–500 ft. on the Hertfordshire border, which terminate in a north-facing escarpment overlooking the Vale of St. Albans. Except where capped by the gravels, it forms low, gently undulating ground. The soil is heavy when wet and hard when dry. At the top of the Eocene series in the London basin occur the predominantly fine Bagshot Sands, laid down probably under deltaic conditions. Their main mass lies in the southwest of the London basin between Aldershot in the west and Oxshott in the east, but an important outlier caps Hampstead heath. The soil is light, dry and infertile. The sands have been less eroded than the London Clay (because water sinks through them), and so now stand higher (in places over 400 ft. above sea level).

After the deposition of the Eocene rocks, the outer waves of the Alpine earth movements were felt in southeast England, reaching a maximum in the late Oligocene or early Miocene period and creating the present structural form of the London basin. Subsequently, important superficial deposits were laid down over the partly eroded Chalk and Eocene rocks. In the Pliocene period sands were deposited at 550–600 ft. above sea level on the Chalk dip slopes toward the edge of the basin, as between Sanderstead and Warlingham on the North Downs. At the beginning of the Pleistocene period Pebble Gravels were deposited on London Clay in the northern half of the basin. They form marked plateaus at 450–550 ft. above sea level. They contain chert pebbles (resembling flint) from Surrey, proving that when they were deposited the Thames flowed northward, along the line of the Vale of St. Albans.

During the Pleistocene period ice advancing from East Anglia deposited distinctive chalky boulder clay in hollows eroded by river action in the Pebble Gravel plateaus, notably in the Vale of St. Albans and in a north-south depression from Whetstone to Finchley and Hornsey. This latter represents the southern limit of the Pleistocene glaciation in the British Isles. The Thames and its tributaries were diverted by the ice southward into approximately their present courses, producing a series of flat gravel terraces which they subsequently eroded, so that only fragments remain. The northernmost and oldest are the so-called gravel trains at 200–370 ft. above sea level round Beaconsfield and Chalfont St. Giles, Buckinghamshire. Southward the most important terraces are: the Black Park terrace, at about 110 ft. above sea level on Wimbledon common; and the Boyn Hill terrace, about 100 ft., which appears north of the Thames at Farnham Royal, Stoke Poges, Hillingdon, Isleworth, Ealing, Islington, Highbury, Wanstead, Barkingside and Fairlop plain. South of the Thames it is seen at Virginia Water and Walton common, Richmond, Clapham common and Lewisham. The Taplow terrace, about 50 ft. above sea level, extends widely and almost continuously north of the river through Slough, Hayes, Southall, Hounslow, Acton, Shepherd's Bush, Hyde park, Holborn, the City, Stepney, Clapton, Tottenham, Edmonton, Enfield, Wanstead flats, Ilford and Becontree Heath; south of the river it is developed at Byfleet, New Malden, Merton, Mitcham, Beddington and Crayford. The Flood Plain terrace (about 25 ft.) is seen at Datchet, Egham, Molesey, Teddington, Kew, Fulham, Battersea, Chelsea, Southwark, Limehouse, West Ham, East Ham, Barking and Dagenham. The marked slope down from the Boyn Hill to the Taplow terrace is seen in Pentonville road east of King's Cross station; that from the Taplow to the Flood Plain terrace in Exhibition road (South Kensington) and St. James's street. Below the Flood Plain terrace is the alluvium (5–15 ft. above sea level) deposited by the Thames in slack water at high tides from Neolithic to early historic times, consisting of dark gray clay, sometimes weathered to brown at the top, containing impersistent bands of peat, shelly marl and sand. Finally, central London has up to 20 ft. of "made ground" accumulated in historic time.

The distribution of these deposits has had an important influence on human settlement and land use. The City of London was founded on twin hills of Taplow gravel, opposite a point on the south bank of the Thames where a tongue of flood-plain gravel approaches the river, reducing to a minimum the passage across the marshy alluvium. The river crossing thus created became the site of the first London bridge. The gravel provided a dry site and a water supply for the city. London grew as a trading centre partly because of the easy route along the south bank of the river below London bridge, via the belt of well-drained Lower London Tertiaries and Chalk, to the English channel ports. In Saxon times many agricultural villages, later to become suburbs of London, developed on the dry sites afforded by terrace gravels (Islington and Clapham on Boyn Hill gravels; Paddington, Hoxton and Dalston on Taplow gravels; Newington, Fulham and Stepney on Flood Plain gravels). The gravel soils, containing silt admixture, were fertile and easy to work. Below the terraces the damp alluvium was generally avoided for building until recent times. The London Clay also was damp, and drinking water was difficult to obtain before the advent of modern piping systems; so it remained relatively unsettled. It could be cultivated from dry-point sites for cereals, though its soils are badly drained and lack lime; grass growing is perhaps its logical use. For centuries the clay was made into bricks for London's houses. Since 1900 the tide of speculative building has almost completely covered it, though it is not good building land because of a tendency to crack in dry weather and to creep in wet weather. The coarse gravels and sands of the Pebble Gravels, Bagshot Sands and Blackheath Beds are dry, poor in plant foods and infertile. They were often used as common grazing land, and remained as commons after building had advanced round them (Blackheath, Bostall heath, Hayes common, Keston common, Chislehurst common on Blackheath Beds; Wimbledon common, Bushey heath, Epping forest on Pebble and Plateau Gravels; Esher common and Hampstead heath on Bagshot Sands).

2. The River.—The Thames flows west-east through the London basin, having entered it by the Goring gap, northwest of Reading, Berkshire. Its general line is slightly south of the centre of the syncline and throughout its recent history it has continued to shift southward; it bites at the foot of the Chalk dip slope below Dartford. It has well-developed meanders and an extensive alluvial flood plain. Embanking of the river took place mainly between the 12th and 14th centuries, reclaiming 42½ sq.mi. of marsh between London bridge and the sea. This area was mainly too damp for building but was used extensively in the 19th century for dock construction on the Rotherhithe and Deptford marshes and on the Isle of Dogs.

In early times the tidal limit of the Thames was probably London bridge, a fact doubtless critical in the choice of the site of the city; subsequent embanking has caused the tide to advance up to Teddington weir, about 19 mi. upriver. The mean tidal range reaches a maximum just below London bridge. The navigable channel below London bridge is the result of dredging in recent centuries. It is 14 ft. immediately below London bridge, 16 ft. below Wapping, 20 ft. below Greenland dock (Rotherhithe) and 27 ft. below King George V dock (North Woolwich).

Four northern tributaries of the Thames flowed through what is now central London, but have been lost in that none reaches the river above ground. The Walbrook flowed through the centre of Roman London and was used by shipping; today its valley is marked by a slight dip in Cannon street near the station. The Fleet rose in Hampstead and Highgate ponds and flowed by King's Cross to join the Thames at Blackfriars; it gave its name to Fleet street. The Tyburn rose near Swiss Cottage and flowed by Marylebone and Green park to join the Thames just west of Vauxhall bridge; its valley is marked by dips in Oxford street near Bond street tube station and in Piccadilly near Half Moon street. The Westbourne, Kilburn or Bayswater rose west of Hampstead and flowed southward to join the Thames near Ebury bridge; part of it now forms the Serpentine, a lake in Hyde park, and it is carried in an iron pipe over Sloane Square station; the name Knightsbridge recalls a former crossing point.

Outside central London the Thames tributaries still run mainly above ground. Most important on the north bank are the lower Colne, running southward from Rickmansworth to Staines in an alluvial valley about ¾ mi. wide; the Brent, flowing from Edgware

and Totteridge (where it is called Dollis brook) through Hendon and Brent reservoir (Welsh Harp) to Brentford; and the lower Lea which flows south from Ware in an alluvial valley about 1 mi. wide through Ponder's End and across Hackney marshes to join the Thames below Poplar. On the south bank the Wandle rises near Croydon and joins the Thames at Wandsworth. Where these streams have wide alluvial flood plains they have impeded communication and settlement; in some cases they have been developed in modern times for industry (the Lea and Wandle valleys) and arterial roads (the North Circular road in the Brent valley). (*See* also THAMES.)

3. Climate.—The climate of the London basin is typical of that of the eastern margin of the British Isles. Rainfall is basically cyclonic, influenced in its local distribution by relief; it ranges from over 32 in. annually on the crest of the North Downs to under 25 in. on Thames-side below Dagenham, which is part of the driest region in Britain. Summer rainfall is mainly convectional and in the form of a few heavy falls. Generally there is an April minimum and October maximum with a secondary minimum in September and a secondary maximum in August. The rainfall is irregular from year to year with extremes of 70%–130% of the average. Temperatures in the area vary little (on the average by 11.7° to 13.1° C. or 21.1° to 23.6° F.). Summer and winter averages are higher in London's built-up area because of heat retention by buildings, smoke cover and artificial heating. Thus the mean January temperature at St. James's park is 5.0° C. (41.1° F.) and the mean July temperature 18.2° C. (64.7° F.), while the corresponding figures for Kew observatory (Surrey) are 4.4° C. (40.1° F.) and 17.6° C. (63.8° F.). St. James's park has 23.44 in. of rain a year; Kew 23.95 in. Sunshine is reduced by fog in the central area, especially in mid-winter; but within living memory there has been a spectacular reduction in the incidence of "pea-souper" fogs ("London particulars") and even smog is now rare, though in the Decembers of 1952 and 1962 the London area was covered with dense smog for several days. This reduction is chiefly attributable to the replacement of coal fires by gas or electricity and the establishment of smokeless zones under the Clean Air act, 1956. (P. G. H.)

4. Flora and Fauna.—London is of special interest to naturalists for the plants and animals which thrive there in close association with man. More detailed records covering a longer period are available for London than for any other large city and these records are kept up to date by the 1,500 members of the London Natural History society.

In the centre wild plants are found in the parks, squares and private gardens, on building sites, railway banks, neglected gutters and broken walls. Many of the commonest have wind-borne fruits so that they quickly colonize any soil available. The most conspicuous of these are Oxford ragwort (*Senecio squalidus*), which is native to the central Mediterranean, and rosebay willow-herb (*Chamaenerion angustifolium*), which has spread rapidly since World War II. Bracken (*Pteridium aquilinum*) grows freely from wind-borne spores though this form of reproduction appears to be rare in the country. A shrub, *Buddleja davidii*, introduced as a garden plant from China, and Canadian fleabane (*Conyza canadensis*), a native of North America, are also common. These were the five most abundant plants growing on bombed sites during and after World War II when 269 species were found in the "square mile" of the City.

In the suburbs the number of species is much greater. Wimbledon, Mitcham and Barnes commons, Hampstead heath and Epping forest have a good representation of wild plants. Within 20 mi. of St. Paul's cathedral, a very wide range of habitats occurs, including chalk grassland, woods, heaths, Thames meadows and marshes, and London Clay fields and commons, and there 1,835 species of flowering plants and ferns, 221 mosses and 68 liverworts have been recorded since 1900.

London has given its name to several plants. London rocket (*Sisymbrium irio*) was first recorded in 1666, the year of the Great Fire, and after long absence reappeared in 1947. London ragwort (*Senecio* x *londinensis*), a hybrid between Oxford ragwort and viscid groundsel (*S. viscosus*), was frequent from 1943 to 1950 when the two parents grew together on bombed sites. London plane (*Platanus* x *hybrida*) thrives in London and is the tree most commonly planted in the streets. London Pride (*Saxifraga umbrosa*) was so-called because it was introduced by a nurseryman named London.

Four kinds of birds have learned to live in great numbers in close association with man. Feral domestic pigeons (*Columba livia*) have been a feature of London birdlife for at least 600 years and are familiar to visitors to Trafalgar square, St. Paul's cathedral, Victoria station, etc. They depend mainly on human food. House sparrows (*Passer domesticus*) abound in central London though their numbers seem to have decreased since automobiles replaced horse traffic, thereby removing the main source of food supply of the sparrows—oats spilled from the nose bags and near stables. Black-headed gulls (*Larus ridibundus*) have been regular winter visitors since 1895 and are seen in very large numbers by the Thames and elsewhere. Since about 1925 some nonbreeding gulls have remained throughout the summer, and a breeding colony was established near London airport in 1941–42. On winter evenings long flights of gulls returning to their roosts on reservoirs in the Thames and Lea valleys are a familiar sight, and the number roosting in midwinter has been estimated at 85,000–100,000. Immense numbers of starlings (*Sturnus vulgaris*) roost on buildings in central London, especially round Trafalgar square, and their spectacular massed flights at dusk from the suburbs, where they spend the day feeding, and their noisy arrival at the roosts, attract much attention; the numbers are increased by immigrants from Europe in the winter. A much rarer bird is the black redstart (*Phoenicurus ochruros*), a summer visitor which has bred in or near London in every year since 1926. In 1942 there was a sudden increase in numbers when large bombed areas provided exceptionally favourable temporary habitats. The mute swans (*Cygnus olor*) on the Thames are the property of the crown, and are marked by the Vintners' and Dyers' (Livery) companies who have a royalty. An ancient ceremony known as "swan-upping" takes place each July to mark the birds and then congregations of 100 or more may sometimes be seen on the Thames in central London. The ravens at the Tower of London are semidomesticated birds introduced from Wales.

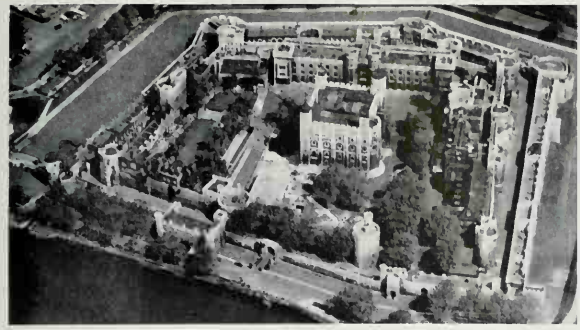
In inner London 160 species of birds are recorded and 37 have bred. The royal parks provide the best opportunities for their study. St. James's park and Kew gardens have good collections of waterfowl. Within 20 mi. of St. Paul's 245 species have been recorded since 1900 in a wide range of habitats that include reservoirs, gravel pits, sewage farms, woods, heaths, marshlands and agricultural land. Of these species 100 are believed to nest annually.

The brown rat (*Rattus norvegicus*) is a great pest, and the black rat (*Rattus rattus*) is found in the upper parts of buildings over a large area including the West End. London is one of the few British cities where it occurs away from the seaport area. The house mouse (*Mus musculus*) is common, hedgehogs (*Erinaceus europaeus*) are frequent in the suburbs, and several species of bat occur.

Butterflies are often seen and some species, such as the migrant red admiral (*Vanessa atalanta*), congregate round the flowers of buddleja and michaelmas daisies. Many moths occur in central London where the lime hawk (*Mimos tiliae*), eyed hawk (*Smerinthus ocellatus*) and poplar hawk (*Laothoë populi*) are among the larger species. The trend toward melanism (*q.v.*) is less general in moths in London than in other industrial cities, but is shown in a few species including the peppered moth (*Pachys betularia*) in which the black form is dominant. (J. E. Lo.)

II. POPULATION

Within the Greater London conurbation, the population of the City of London declined consistently after 1851, that of the county after 1901, and that of the suburban ring (and of the conurbation as a whole) after 1951. Between 1951 and 1961, however, the outer ring of the London region (a belt 20 to 30 mi. wide round the conurbation) increased its population by 975,105. The entire London region had in 1961 a population of 12,498,400, of whom



Aerial view of the Tower of London on the north bank of the river Thames. In the centre is the White tower, begun for William the Conqueror by Gundulf, bishop of Rochester, about 1078

The clock tower, at the north end of the Houses of Parliament, containing Big Ben. A light in the tower at night indicates that the House of Commons is sitting

Westminster abbey seen from the southwest. Altered many times since its founding in 1050 by Edward the Confessor, the church nonetheless remains one of the finest examples of medieval architecture in England. The west towers, shown here, were completed in 1745

New Zealand house, Haymarket, 1959–63. Postwar construction of tall buildings, such as this one, greatly altered the London skyline

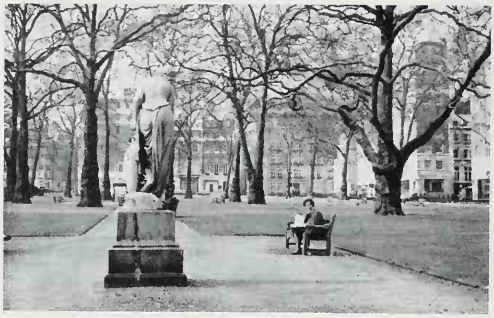
River Thames as seen from the Shell building on the South bank. Westminster bridge is to the right. In the right background is the Victoria tower of the Houses of Parliament. Lambeth bridge and the Vickers building, Millbank, are in the centre background

LANDMARKS OF LONDON

BY COURTESY OF (TOP RIGHT) BRITISH EUROPEAN AIRWAYS; PHOTOGRAPHS, (TOP LEFT) AEROFILMS AND AERO PICTORIAL LTD., (CENTRE LEFT) A. F. KERSTING, (BOTTOM LEFT) THE HIGH COMMISSIONER FOR NEW ZEALAND, (BOTTOM RIGHT) J. ALLAN CASH—RAPHO GUILLUMETTE

LONDON

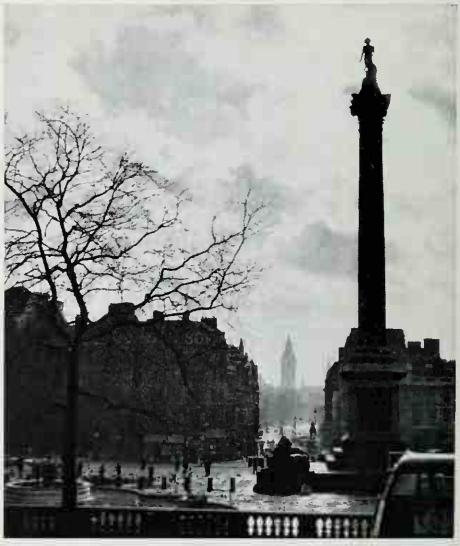
Great Windmill street, Soho. A congested district of narrow streets, Soho dates from the end of the 17th century and is well known for its cosmopolitan restaurants and for its night life



Berkeley square, laid out early in the 18th century on part of the gardens of Berkeley house. The plane trees, among the finest in London, were planted about 1789

Children playing at Brandon estate in Southwark, one of the large-scale urban renewal projects begun after World War II

The dome of St. Paul's cathedral, 1675–1710, seen from St. Paul's Churchyard. Designed by Sir Christopher Wren, St. Paul's long dominated the City skyline



Nelson's column in Trafalgar square. Built 1843, the column is a copy from the temple of Mars Ultor in Rome. The statue of Lord Nelson is by E. H. Baily, the lions at the base by Sir Edwin Landseer

LONDON SCENES

PHOTOGRAPHS (TOP LEFT) BRIAN BRAKE—MAGNUM FROM JOHN HILLELSON AGENCY LTD., (TOP RIGHT) CAMERA PRESS LTD.—PIX FROM PUBLIX, (CENTRE LEFT, BOTTOM RIGHT) CAMERA PRESS —PIX FROM PUBLIX (BOTTOM LEFT) LONDON COUNTY COUNCIL PHOTOGRAPH LIBRARY

Steeple and Corinthian portico of St. Martin-in-the-Fields seen through the columns of the National gallery, Trafalgar square. The church, by James Gibbs, was built 1722–26; the gallery was built 1832–38

Gallery in the British museum, Bloomsbury, housing the Greek sculptures known as the "Elgin Marbles." The museum's collection, dating from 1753, is one of the most famous in the world and includes antiquities of all cultures

Government buildings in Whitehall seen from across the lake in St. James's park. The 93-ac. park was landscaped during Charles II's reign; it was redesigned by John Nash in 1827–29

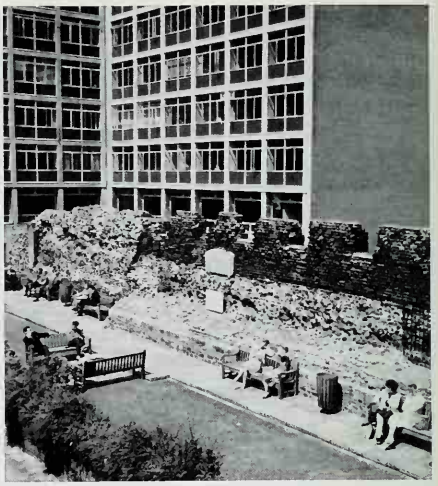
Two Guards officers in mufti watching the drill rehearsal at Horse Guards parade behind Whitehall, where the ceremony of "Trooping the Colour" is performed on the sovereign's official birthday early in June

VIEWS OF LONDON

PHOTOGRAPHS, (TOP LEFT, BOTTOM) CENTRAL PRESS PHOTOS LTD., (TOP RIGHT) "THE TIMES," LONDON—PICTORIAL PARADE (CENTRE RIGHT) AUTHENTICATED NEWS

LONDON

The Law courts at the junction of the Strand and Fleet street in the west central area between the City and Westminster. The buildings are Victorian Gothic designed by George E. Street in 1874–82



Part of the original Roman wall in the former churchyard of St. Alphege, now a small park, along the street known as London Wall. A modern building stands in marked contrast to the ancient rampart

The royal procession, with the monarch in the Irish state coach, passes St. Stephen's porch, Houses of Parliament, on the occasion of the State Opening of Parliament

Queen Anne's gate, a quiet, fashionable street in Westminster lined with houses in the Queen Anne style built by William Paterson about 1704

East front of Buckingham palace, facing the Mall. The Queen Victoria memorial stands in the foreground to the left. The palace is the London residence of the sovereign

TRADITIONAL LONDON

PHOTOGRAPHS, (TOP LEFT AND RIGHT) J. ALLAN CASH—RAPHO GUILLUMETTE, (CENTRE RIGHT) HELMUT GERNSHEIM, (BOTTOM LEFT) "THE TIMES," LONDON—PICTORIAL PARADE, (BOTTOM RIGHT) J. ALLAN CASH

TABLE I.—*Population of London*

Year	City of London	County of London	Suburbs	Greater London conurbation
1801	128,269	959,310	157,980	1,117,290
1851	127,869	2,363,341	321,707	2,685,048
1901	26,923	4,536,267	2,050,002	6,586,269
1951	5,324	3,347,956	5,000,041	8,348,023
1961	4,767	3,200,484	4,976,788	8,171,902

4,326,498 were outside the conurbation. (P. G. H.)

III. HISTORY

A. Roman Period

The history of London begins effectively with the Roman period, though finds of various pre-Roman dates are sufficient to indicate that as elsewhere along the Thames the area was probably occupied by a succession of small prehistoric communities. The Roman settlement (Londinium) no doubt came into existence with the first successes of the Claudian conquest in A.D. 43 and from the beginning a bridge over the Thames must have played an important part: it is generally accepted that its siting, rather to the east of the existing London bridge, was probably governed by tidal conditions which in their turn were affected by the fact that the river was at least 15 ft. lower in relation to the land in Roman times than it is today. The subsequent importance of London was based on the development of the port and on the control of the road system. As a bridgehead settlement the city seems to have originated on the eastern hill (Cornhill): there was the basilica, and the street that leads from the bridge is still preserved in the line of the modern Gracechurch street. The extent of the first open city can be determined by tracing the distribution of the fires set by Boudica's (Boadicea's) Icenian tribesmen during their revolt against the Romans (A.D. 60) when Londinium was sacked. The settlement had begun to spread beyond the Walbrook stream to the western hill (where St. Paul's was later built), and the locality seems to have been well occupied by the late 1st century.

Some replanning appears to have followed the Boudican episode: the rebuilt basilica, for instance, was much larger than the old one. The next outstanding event was the building of the Cripplegate fort on the northwestern fringe of the city. About 11 ac. in extent and built *c.* A.D. 100, the fort must have acted as a military depot attached to the port. But the city was still unwalled and remained so throughout the 2nd century A.D. In the meantime there is archaeological evidence for further widespread damage by fire in the 120s.

The city wall was built to enclose the occupied area at the earliest toward the end of the 2nd century. The fort was incorporated in the new defensive system and with its north and west walls then looking outward as part of the city wall, formed the Aldersgate re-entrant, thus giving the city two northwestern angles on that side. The later history of the fort and its relationship with the city are not known, though it seems probable that the fort continued in existence into late Roman times.

Throughout the late 1st and 2nd centuries the growth of the city seems to have continued, though in the absence of written record and limited opportunities of archaeological exploration detailed knowledge is restricted. The best-known building is the basilica, an aisled hall 500 ft. long with the forum attached to its south side. Stone buildings were widely distributed, but are represented only by fragments of walls and mosaic floors, with no complete plans. The exceptions to this are the temple of Mithras adjoining Walbrook, a bath building on the north side of Cheapside and the fragments of a second under the Coal exchange in Thames street. A large proportion of the Roman buildings were of timber or "cob," with thatched roofs, their materials reflecting the absence of building stone near London. The street plan is very inadequately known and post-World War II discoveries have done little to confirm earlier theories. Cheapside and Cannon street mark original east-west Roman streets and even apart from the clues provided by the known Roman gates it seems likely that the medieval street plan to some extent reflected that of the Roman city.

Though little evidence from the ground can be brought to bear on the later periods, London during the 3rd century evidently retained its prosperity and enhanced its importance. At about A.D. 286 the usurper Marcus Aurelius Carausius established a mint there. In 296 the struggle between Constantius I and Allectus involved the city: the famous gold medallion found at Arras, France, in 1922 celebrates its relief by Constantius from the threat of sacking by the defeated troops of Allectus. According to a 6th–7th century codex London sent a bishop to the synod of Arles in 314 and was then and later a centre of early Christianity. During the 4th century also it was accorded the title of Augusta when it figured in the troubles with the Picts and Scots and other barbarians who were defeated by Theodosius I. Archaeologically the disturbed conditions of the late 3rd and 4th centuries are reflected in some at any rate of the semicircular bastions which in London as elsewhere were late additions to the Roman wall. Throughout the 4th century London appears to have continued as the financial and administrative centre of the province, but little is known about its physical character of that time.

Some of the late bastions were built of materials derived from tombs and other monuments—a reminder that activity was not confined to the area of the walled city. Cemeteries existed in Whitechapel, Bishopsgate, Fleet street and elsewhere. There were Roman buildings beyond the river Fleet to the west and there were settlements also at Southwark and near the river crossing at Westminster, where burials also have been found. There must have been other minor habitation sites, farms and so on, in the surrounding country; their slight remains would escape recognition in the built-up area of modern London. (WI. F. G.)

B. Anglo-Saxon Period (5th–11th Centuries)

After the departure of the Roman legions in the early part of the 5th century A.D., little or nothing is known of what happened in London for the next 150 or 200 years. Some have suggested that it never fell to the Anglo-Saxon invaders but remained an independent city whose inhabitants preserved the Roman way of life throughout the centuries, while others have concluded that it crumbled to ruin, haunted only by a few refugees. Probably neither of these conjectures is exact. What does seem clear is that during the 4th and early 5th centuries, the importance of London was much diminished. The large Roman city of Londinium had owed its existence to trade and particularly to foreign trade; this was adversely affected by turbulent and unsettled conditions on the continent and so London grew less powerful.

By the end of the Roman occupation, however, many of London's buildings were of stone and the city was surrounded by a great stone wall. Such a wall protected the remnants of the population who could still make a living there and no doubt it afforded a refuge for those Britons who fled to London after their defeat by the Saxon Hengist at the battle of Crecgan ford, which may or may not have been Crayford, Kent, in A.D. 457. Moreover, the site of Londinium never became so overgrown and ruinous that the lines of its main roads and the position of its gates were lost. The east-west roads of Cheapside and Cannon street have been proved to be the medieval successors of Roman roads in their general alignment and the gateways at Aldgate, Bishopsgate, Cripplegate, Aldersgate, Newgate and Ludgate are demonstrably of Roman origin.

Just how London came into the possession of the Saxons is not known, for no chronicler mentions its capture. Few finds of 5th- and 6th-century date have been made in the London area, but it must be remembered that by comparison with their Roman predecessors, the Saxons had few personal possessions, so a mere numerical comparison between finds of late Roman and early Saxon date is not significant. What is notable, however, is that the nearest Saxon cemetery of this date, so far discovered, is at Greenwich, about 5 mi. away, while others at Hanwell, Mitcham, Beddington and Croydon are about 10 mi. away. While it is possible that an early Saxon cemetery nearer to the city may await discovery, the available evidence so far suggests that there was at first little contact between the Londoners and the new arrivals. A buckle plate of 5th-century date, now in the British museum, found at Smithfield, decorated in chip carving technique, and a cruciform brooch

from Tower street are the earliest finds of the Saxon period from London. In the London museum are about half a dozen objects which can be dated with some certainty to the late 5th or early 6th centuries, but beyond these few, if any, objects belonging to the first 150 years of the Anglo-Saxon period have been found in London.

After the arrival of St. Augustine's mission (597), the importance of London increased. Aethelberht (d. 616), king of Kent, founded St. Paul's cathedral and Mellitus was installed as bishop (604). Pope Gregory I, who had sent Augustine, appears to have intended that London rather than Canterbury should become the southern metropolitan see; but this aim was never realized. It would be possible to argue from Pope Gregory's plan that London had again become an important city by the beginning of the 7th century; but it is also possible that the pope was simply following the Roman administrative pattern which had long ceased to have any actual significance.

Though Mellitus was soon driven out of his bishopric by the pagan revival that followed the death of Aethelberht, London had come to life again and many objects have been found which date from the next century or so. The rising importance of the port of London is also clearly shown in various literary sources; Bede (d. 735) described London as the mart of many people coming by land and sea. London is not, however, mentioned again in Anglo-Saxon sources until the time of Alfred (d. 899) and the wars with the Danes. The Danish army wintered in the city in 871–872 and a garrison may have remained there for some years after that date, using London as a base rather than a capital. In 886 Alfred himself occupied London and his first biographer Asser tells that he made considerable repairs to the defenses. A bronze pendant with animal ornament, found in one of the bastions of the city wall, which some archaeologists would assign to the 9th century, may be associated with this work. London was entrusted by Alfred to his son-in-law Aethelred, ealdorman of Mercia, and it became an outpost of resistance against the Danes.

The archaeological evidence for the history of London in the later Anglo-Saxon period is again rather sparse. There is no lack of evidence to demonstrate the city's trading importance for it was obviously by then an important commercial centre with a large population. Imported pottery from the Rhineland has been found which dates from this period; such imports appear to have continued until after the Norman Conquest, showing that, far from causing a break, it stimulated trade. The stock-in-trade of a working jeweler, found in Cheapside, provides further evidence of contemporary prosperity. In 1962 evidence of a great Saxon hall of the 8th or 9th century was discovered beneath the remains of a Tudor palace under 10, Downing street. It contained domestic objects including some Ipswich ware and German pottery.

An indication of, at any rate, one of the types of domestic building of this period may be seen in the remains of an 11th-century hut of Saxo-Norman style excavated in 1956 by W. F. Grimes on the site of the Financial Times building, close to St. Paul's cathedral. This was a wooden hut about 10 ft. square the walls of which consisted of a number of uprights made of tree trunks split in halves longitudinally, to which was fastened horizontal planking. Two city churches have, so far, been proved to have Saxon foundations. At All Hallows' by the Tower, bomb damage during World War II revealed an early Saxon arch at the west end of the south wall of the nave which may have given access to the *porticus* of the early church. The style of masonry suggests that this could have been built in the late 7th century. From the ruins of the church came fragments of a late Saxon preaching cross and from the medieval blocking of the Saxon archway came a fragment of a Viking tombstone which must have been almost identical with that found in St. Paul's churchyard in 1852 and now in Guildhall museum. It bears a runic inscription which may be translated "Kona and Tuki set this stone up" and is generally recognized as the masterpiece of 11th-century art in Britain. It has been suggested that Tuki might be the Tuki (Tokig) who was a minister of Canute (d. 1035).

The other city church with proved Saxon origins is St. Bride's in Fleet street on the western edge of the City. There Grimes uncovered the foundations of the first church which, dating from the mid-11th century, had already replaced its original east end by an apse. These remains have been preserved and can be seen below the present St. Bride's church.

London was certainly the largest town in 11th-century England and it was developing in resources and in political consciousness. Some estimate of its trading importance can be gathered from the fact that more than 20 moneyers are known to have been minting simultaneously after 1042, more than are recorded for any other borough.

The growth of Westminster with its palace and monastery under Canute and Edward the Confessor fixed the pattern for London's future growth in the dual capacity of centre of commerce and seat of government, the City functioning for one, Westminster as the seat of the royal court for the other. But in the 11th century London was still far from having become the national capital, since the king's court, the centre of government, was still completely mobile; but the fact that the city had been the centre of organized resistance gave the citizens some sense of their importance and laid the foundations of their claim to the right to choose the king for England. The government of the borough itself was more complex than that of the provincial towns. Justice was administered through a series of courts meeting for three sessions a year. These folkmoots were responsible for order in the city and all citizens were expected to attend. In addition, the hustings met frequently for the transaction of civil business and probably originated as a court to settle pleas in which Danes and English were involved. By the time of the Norman Conquest dealings between English and foreign traders are known to have been transacted there.

After their defeat at the battle of Hastings (Oct. 1066), the English leaders seemed to think that London could be held while another army was raised. William the Conqueror sensed this and began an advance on the city. No resistance was offered to him by the defenders under Edgar (the Aetheling) until he came to the south end of London bridge, where he beat back their sortie. He then began a wide encircling movement, through Surrey, northern Hampshire and Berkshire; this obviously alarmed Edgar's party by its speed and menace, and at Wallingford on the Thames, William received an oath of fealty from Archbishop Stigand. His conclusive meeting with the English leaders took place at Berkhamsted where he received oaths of fealty from Edgar himself and the most prominent men in London. It is not clear whether further fighting occurred before the city itself was surrendered, but it is obvious that most Londoners were anxious for William to take control of the situation and to this end he was ordained king in Westminster abbey on Christmas day, 1066. Perhaps the most definite clue to the status of London and its citizens in late Saxon times is to be found in the charter which William granted to the city almost immediately. This simply promised that the citizens could enjoy the same laws as in King Edward's time, that every child should be his father's heir after his father's day and that the king would suffer no man to do them wrong.

C. Medieval London

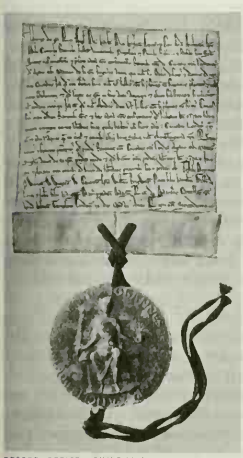
By about 1180 when William FitzStephen, the biographer of Thomas Becket, wrote a famous description of London, it had become a city of consequence and the effective capital; boasting 13 monasteries and 126 churches, it was dominated by William the Conqueror's White tower, and Montfichet and Baynard's castles. After the fire which in about 1136 destroyed many of the wooden thatched houses and St. Paul's itself, many richer citizens rebuilt their houses with stone and tiles. The streets were paved and at any rate partially cleansed by open sewers and conduits. London bridge was still a wooden structure: the stone replacement begun in 1176 took about 33 years to complete. The City was already spreading beyond its walls; William II's new palace at Westminster was completed by 1099 and the space between there and the City already contained a scattering of buildings. The mansions of the great were imposing, and well-to-do citizens had pleasantly laid out houses, backed by gardens and trees. The city boasted a public cookshop.

London had its share of amusements. At Smoothfield (Smithfield) where horse sales were held, races also took place. Bull- and bearbaiting were popular, also cockfighting; wrestling and archery were practised and the citizens had retained (from pre-Conquest times) the right of hunting in the Chilterns.

The administration of justice continued much as in late Anglo-Saxon times, the sheriff presiding thrice yearly at the folkmoot, the hustings meeting weekly at the Guildhall, while in Henry I's time the City was divided into wards for which various aldermen presided at the wardmoots, the London parallel of the provincial hundred courts. There also existed various private sokes or liberties, areas within which individuals or corporations, lay or religious, had been granted special rights and privileges. A charter of Henry I granted to the citizens important privileges, such as exemption from certain tolls and taxes and from the cumbersome procedure of trial by battle in civil disputes. They also had the right to account for the farm (rent) of Middlesex (assessed at £500), direct to the exchequer, and could appoint their own justiciar. Although the citizens formed a short-lived commune as early as 1141 to protect their rights, they were not able steadily to maintain them since Stephen and then Matilda appointed Geoffrey de Mandeville, earl of Essex and hereditary constable of the Tower, their "mortal foe," as sheriff and justiciar, and the farm, which had been reduced, was raised again by Henry II to £500.

London's trade was rapidly expanding and the wharves were always loaded with goods, some of which were brought from as far away as Constantinople. There had been in London a flourishing Norse colony, which accounts for the dedication to St. Olaf (Olave) of six City churches; but already the Germans, especially the merchants of Cologne, were supplanting the Danes as the largest foreign colony. The London weavers were particularly well-organized and guilds, such as that of the bakers, which existed in the reign of Henry II, were rapidly developing; but 18 "adulterine" guilds were swept away in 1180, including that of the goldsmiths.

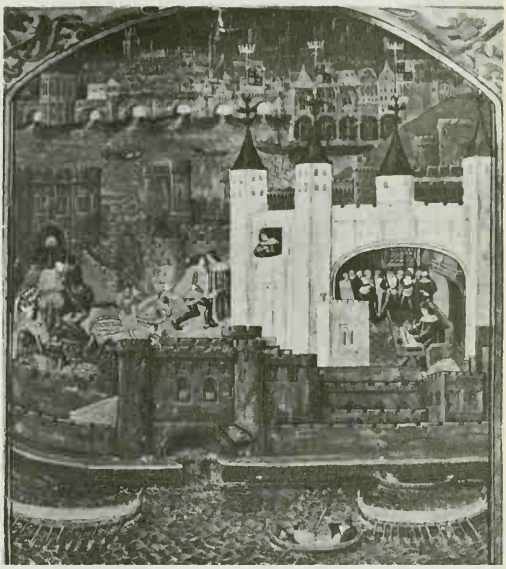
The disputed succession which had followed the death of Henry I in Dec. 1135 enabled the Londoners to exercise their claim to elect the king of England. They chose Stephen, who was crowned at Westminster within three weeks. After his capture at Lincoln (1141) they temporarily supported Matilda but, rapidly alienated by her temper and arbitrary demands for a tallage (or tax), they expelled her from the city after a very short sojourn there. When her army besieged Winchester soon afterward, London sent nearly 1,000 men-at-arms to its relief. (N. C. C.)



RECORD OFFICE, GUILDHALL

KING JOHN'S CHARTER ISSUED IN 1215, PROVIDING FOR THE ANNUAL ELECTION OF A MAYOR IN THE CITY OF LONDON

At the accession of Richard I in 1189 London emerged from a period of repression by Henry II. In 1191 the City obtained recognition of a commune, a sworn association of citizens claiming to rule as a sovereign body, with a chief officer called mayor. The mayor, elected annually after 1215, represented the community and was the king's executive officer; he was soon assisted by an advisory body of aldermen, who from late Saxon times had been the leaders of the wards (24 in number by 1206, 25 after 1394) into which the City was divided. In theory, the men of the wards elected the aldermen, and the whole community elected the mayor and sheriffs and approved legislation. In practice, the choice of officers and the direction of policy were increasingly performed by a closed oligarchy. By bargaining shares of its wealth with impecunious kings, primarily with John, London freed itself from royal officials; after 1215 it could again elect its sheriffs and account for royal revenues direct to the exchequer. Though kings sometimes withdrew its privileges, as did Henry III from 1265 to 1270 and Edward I from 1285 to 1298, they usually found coercion less expedient than compromise in their dealings with London, and they regularly sought advice from mayors or prominent citizens. The City thus continued to consolidate its autonomy, prestige and commercial advantages.



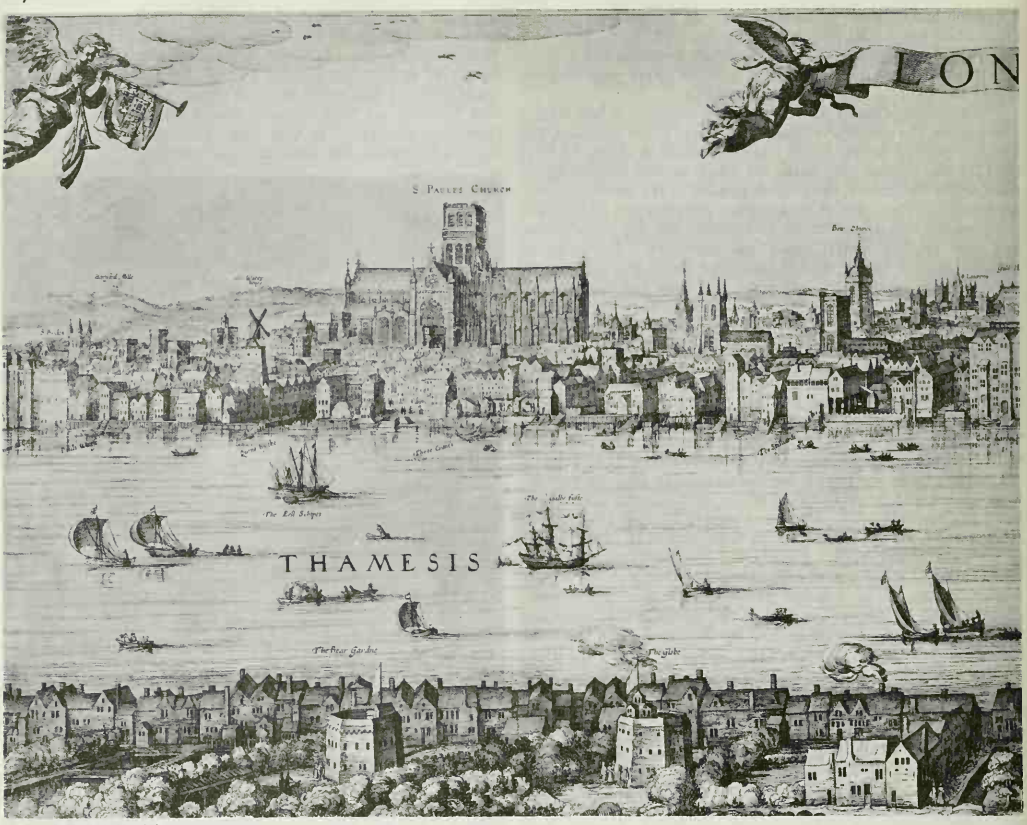
BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

MANUSCRIPT ILLUMINATION FROM THE "BOOK OF POEMS" OF CHARLES, DUKE OF ORLEANS (1391–1465), SHOWING A LATE MEDIEVAL VIEW OF LONDON

Preoccupied with trade, London had little wish to meddle in politics. Yet the gradual establishment of government departments, courts and colleges of law and meetings of parliament at Westminster had by the mid-14th century identified London as the political and administrative capital. The City was inevitably caught up in national affairs—in the deposition of Edward II in 1327 and of Richard II in 1399, for example, and in the Peasants' revolt of 1381 and Jack Cade's rebellion of 1450. Usually the citizens supported strong, orderly government. In the dynastic conflicts of the 15th century the City's chief concern was the maintenance of good order within the walls, for experience had shown that national unrest tended to provoke subversion in the City.

Mutual rivalries within the trading community and between the poorer craftsmen and traders and the governing clique led to conflicts in the 14th century. By 1377 London had at least 50 craft guilds, *i.e.*, the livery companies (*q.v.*), and 111 by 1400. The most powerful were associations of traders such as the mercers, grocers and drapers—wholesalers with far-reaching interests outside London. It was their influence that prevented the smaller, more radical guilds from breaking the civic oligarchy in 1319 and in the 1380s. Power thus remained in the hands of the richest merchant class in the 15th century, and with power, the heavy responsibility of supervising almost every aspect of urban and commercial life.

Despite its turbulence and suspicion of strangers, London attracted men from far and wide. Some, like Richard Whittington (d. 1423) from Gloucestershire, achieved both fame and fortune. Before his day much of London's trade had also been handled by resident merchants from Gascony, Flanders, north Italy and north Germany. The Steelyard, the headquarters of the German mer-



JOHN R. FREEMAN & CO., LTD.

PRINT OF LONDON, DATED 1616, BY CLAES JANSZ VISSCHER. IT SHOWS THE CITY FROM THE SURREY SIDE OF THE THAMES AS IT APPEARED PRIOR TO THE REMAINED LARGELY UNALTERED UNTIL 1757. THIS PARTICULAR PRINT IS NOW IN THE BRITISH MUSEUM.

chants until 1598, covered three acres beside the Thames.

Crowded with wharves, warehouses and about 50 steep lanes, the extensive water front proclaimed London's dependence on the river for its everyday needs and its domination of English commercial life. It captured a major share of the wool and then of the cloth trade, sapped the vitality of ports like Southampton and monopolized the activities of the Merchant Adventurers, who specialized in overseas trade. With its diversified markets and crafts, the city could survive occasional recessions. Archaeological and historical evidence attest the growing material comfort of the medieval Londoner. His timbered workshop dwelling was nonetheless cramped and squalid by modern standards. Only the richest merchants like the draper Sir John de Pulteney (d. 1349), with his house at Cold Harbour, Dowgate and Pountney's Inn in Candlewick (now Cannon) street, could emulate the mansions of noblemen.

Apart from such residences, the fantastic beauty of the bridge, Guildhall (built *c.* 1411–40), the City wall with its seven gates and the royal Tower, London's architectural splendour in the later middle ages was provided by its chief ornament, St. Paul's cathedral, whose choir had been greatly extended in the 13th century, and by the 23 important religious houses and many smaller establishments. Its parish churches were more numerous than splendid since they served a population of 35,000 (1377) or less. Most of the monasteries had been founded in the 12th century. Others followed, like the Benedictine nunnery of St. Helen, Bishopsgate (1205–15), the Carthusians' Charterhouse (1371) and the Cistercian abbey of St. Mary Graces (1350), but foundations of this period were usually small and dedicated to some specific purpose, like Bethlehem (Bedlam) hospital (1247) for the insane. In the 1220s the Dominican and Franciscan friars arrived at London; such was their popularity that they too, and to a lesser degree the Crutched, Austin and Carmelite friars who followed them, were able to build on a grand scale—the Franciscans off Newgate street and the Dominicans in the district still called Blackfriars. Since there were also many chantry priests in London, and bishops and abbots had more than 30 town houses in the city, the church impinged at every turn on London's life. A priory like Holy Trinity, sometimes called Christchurch, Aldgate, owned properties in 60 parishes; yet at least half the large monastic precincts were liberties, immune from civic interference and responsibilities.

D. Tudor and Early Stuart London

Henry VIII began the dissolution of the monasteries and the confiscation of their properties by the suppression (1532) of Holy Trinity, Aldgate. The civic authorities expressed no disapproval, except when the king also took over the liberties, and within ten years all the monasteries had fallen to the crown. Great changes in landownership resulted, many monasteries and episcopal palaces being granted or sold to courtiers whom the king wanted to reward or enrich. Others provided the materials for new buildings like Protector Somerset's palace in the Strand, begun in 1547. Some were used as storehouses, workshops or the halls of city companies. Ten churches, or parts of them, became parochial and

GREAT FIRE OF 1666. ON THE LEFT IS OLD ST. PAUL'S WHICH WAS DESTROYED IN THE FIRE; ON THE RIGHT IS THE ORIGINAL LONDON BRIDGE WHICH

thus survived. But most of the monastic sites were soon covered with new houses and tenements.

This intensive use of the newly available land was necessitated by a startling growth of population, resulting from immigration and an enormous expansion of trade. The Thames became more than ever the centre of the Londoners' world. Under Henry VII London's Merchant Adventurers gained a monopoly of the main outlet of English trade through Antwerp. Exports of cloth, the very basis of the economy, were doubled under Henry VIII, and after the Netherlands market collapsed London looked farther afield and supported the maritime adventures that led to the foundation of the Muscovy company (1555), the Turkey (afterward the Levant) company (1581) and the East India company (1600) and several others. The building of the first true business centre, Sir Thomas Gresham's Royal exchange (1566–67) in Cornhill, was a mark of the new prosperity and enterprise. Successful London businessmen were investing in country estates. New industries, among them silk weaving, majolica pottery and glass, were established, often beyond the city boundaries and the restrictive influence of its companies. Theatres also, despised by the City corporation, were set beyond its jurisdiction in Moorfields and on Bankside. A new spirit of materialism brought church building to a halt, turned the nave of St. Paul's into a fashionable resort and marketplace and its courtyard into London's book centre, and found eloquent and violent expression in the playhouse and in the bear garden on Bankside.

Alongside the luxury found in Elizabethan London, much poverty and distress also existed, no longer mitigated by monastic charity. By 1545 the Charterhouse (*q.v.*) had become the mansion of Sir Edward (afterward Baron) North; its conversion into a hospital and school by Thomas Sutton in 1611 was typical of many acts of private charity which endowed schools, hospitals and almshouses. The City authorities also tackled poverty and unemployment by introducing assessments for poor relief in 1547, instigating the foundation or reconstitution (1545–53) of the five royal hospitals (St. Bartholomew's, Christ's, Bethlehem, St. Thomas's and Bridewell) and providing grain in times of scarcity. The growth of London's population and of unregulated suburbs gave constant alarm to the government, who feared famine, disorder and the ruin of the provinces, for London controlled 80% of the country's trade while other towns languished. But repeated acts after 1580 entirely failed to stem the city's growth. In 1605, by filling up monastic sites and garden land and by subdividing tenements, 75,000 people had been housed within the walls and a further 150,000 lived in suburbs; the population had roughly trebled in size since 1530. Southwark was growing; it had become the 26th City ward, under the name of Bridge Without, in 1550.

But the main developments were taking place on the west, where houses began to appear in Lincoln's Inn fields and Covent garden, and on the east, where a straggling growth of slums around Whitechapel, Wapping and Henry VIII's dockyard at Deptford marked the beginning of the East End. The West End was also foreshadowed, not so much by the line of mansions of the new nobility along the Strand, but by the lodgings between London and Westminster of numbers of gentlemen of wealth and fashion

who then came to town for the season, *i.e.*, the legal terms or sittings. The occasional contact of the City and the court was also severed. Henry VII had rebuilt and sometimes used Baynard's castle in Blackfriars. Henry VIII built a palace at nearby Bridewell, but in 1529 he moved west and began his conversion of Cardinal Wolsey's York place into Whitehall palace and of a suppressed leper hospital into St. James's palace (the British court is still officially designated the court of St. James); in the reign of Elizabeth I the Tower ceased to be used as a royal residence. The Tudors, however, never lost London's allegiance. Even when its loyalty might have faltered under Mary I, for London was overwhelmingly Protestant, the city held firm against Sir Thomas Wyat's rebellion in 1554. Elizabeth, especially, based her strength on its enthusiastic loyalty, on its money and militia, for the city dominated England as never before or since. It provided a quarter of the men for service abroad in 1585 and 1589 and in 1588 formed its forces into "trainbands" against the threat of Spanish invasion. It was the presence of the trainbands at Turnham green that prevented Charles I from attacking London in 1642. The rift between the king and the City had long been widening. The king had flouted the City's privileges and trading interests; the City had disobeyed royal injunctions. When the Civil War began London, soon encompassed by forts, provided the core of parliamentary support and its allegiance was a major reason for parliament's success.

After their unhappy experiences during the Commonwealth, the citizens of London rejoiced at the restoration of Charles II in 1660. By then London was probably the most populous city in Europe with perhaps 500,000 inhabitants (the next largest English town, Bristol, had only 30,000) and in it was concentrated the bulk of English capital and talent. Building had continued on the east and west, and for the first time there was evidence of planning in some of the developments. Covent garden (*q.v.*) had been laid out as the first of London's squares in the 1630s and was soon followed by Southampton square and Lincoln's Inn fields. In these areas, London was becoming a city of brick. Elsewhere, however, timbered houses persisted, and the overcrowded and insanitary conditions of the City and its immediate suburbs, and the consequent threat of epidemics, were worse than ever before. Outbreaks of bubonic plague, beginning with the Black Death of 1348, had become increasingly frequent since the early 16th century; over 40,000 Londoners had died of it in 1625. The last and worst of the epidemics, the Great Plague, began in the spring of 1665. At its climax, about 7,000 plague deaths were recorded in a week. By December, the city was deserted; about 100,000 Londoners had died and many thousands more had fled.

(B. W. Sp.)

E. Later Stuart and Hanoverian London

Reconstruction After the Great Fire.—The Plague was followed in Sept. 1666 by the worst fire in London's history. Begun accidentally, in the house of the king's baker in Pudding lane near London bridge, in the four days Sept. 2–5, it burned all save the northeastern and the extreme western parts of the City. The Royal exchange, the Custom house, Guildhall and nearly all the civic buildings, the halls of 44 of the livery companies, St. Paul's itself and 87 of the parish churches, besides about 13,200 houses, were destroyed. Barely one-fifth of the City was left standing. In that fifth, the citizens began reconstruction. Gresham college was converted into a temporary Royal exchange, thus giving the merchant and trading community an adequate centre, and king and City each appointed three eminent "architects" to devise plans for a general rebuilding. The optimism of their initial decision that high streets should be 70 ft. wide and "alleys, if any, 16" faded as the difficulties appeared, especially those of financing the work. Parliament was apathetic. Fire insurance was a thing of the future, supplies and labour had to be assured and disputes resolved. Eventually two statutes of 1667 and regulations agreed between Charles and the City allowed building to start: by the end of 1671 almost all the houses had been built.

The new City showed many improvements. Well-designed brick houses replaced half-timbered. The streets were wider and straighter, the markets enlarged or re-sited, the Fleet river canalized, the quays below London bridge raised, and Guildhall given a direct link with the river via the new King and Queen streets. Work on the churches followed, as supplies of money and stone

BY COURTESY OF THE LONDON MUSEUM

"THE GREAT FIRE OF LONDON, 1666," A 17TH-CENTURY PAINTING ATTRIBUTED TO THE DUTCH SCHOOL SHOWING THE SCENE AS IT WOULD HAVE APPEARED ON THE EVENING OF THE THIRD DAY

became available. Many of the tiny parishes were combined: 49 churches and the great domed cathedral of St. Paul, all built by Sir Christopher Wren, set the stamp of his genius on the new city.

The end of the rebuilding did not mark the end of the City's troubles. For centuries the City and London had been synonymous, but expansion under the Tudors had carried the tide of building beyond its boundaries. From the days of Elizabeth I, successive governments had tried to limit this expansion, not altogether without success. The fashionable, well-built streets round Covent garden had been authorized under Charles I, and building had gone on all round the City's perimeter but it had been hampered by restrictions supported by both the central and the civic authorities. After the fire, with the enforced removal of perhaps 100,000 people, such limitation was impossible, and the subdivision and development of the great houses on both sides of the Strand was matched by new building in Westminster, in the fields which became St. James's square, in Soho, Clerkenwell, Whitechapel and on both banks of the river below the bridge. The City, despite its charters, was forced to accept new markets, such as Covent Garden and Spitalfields, for the food and the fodder required for these new areas and had to surrender, in fact, if not in name, much of the jurisdiction over them. Left to the control of the justices for Middlesex, the markets gradually drifted into the condition so sharply criticized by Henry Fielding and his half brother, Sir John (*qq.v.*).

Local Government and National Politics.—Within the City, the direct responsibilities of the individual householder dwindled and the courts of aldermen and common council gradually took over from ward and parish the supervision or the actual management of that whole range of urban economy, from paving and lighting to drainage and sewers, paid for nowadays by a consolidated local rate. The process was slow, beginning in 1667 with the appointment by the common council of a body of its own members as commissioners of sewers and pavements empowered to levy rates, but, in the main, it gradually produced in central London conditions which, if primitive by modern standards, were the envy of most visitors from Europe.

Politically the City remained as important as ever. The struggle between the sides soon to be known as Whigs and Tories was reflected in its elections and in the composition of its grand juries. Charles II's attempt to control parliament by controlling borough electorates reached its zenith when, after proceedings under a writ of quo warranto, the City's charters were declared forfeit (1683) and aldermen and officers unacceptable to the crown were replaced by royal nominees. The king's victory did not last long. James II, before his flight in 1688, made full restitution, but the City was not appeased. The lords spiritual and temporal met in Guildhall, within the protection of the City and its trainbands, to draw up the declaration of allegiance to William of Orange. The common council voted an address welcoming him. The value attached to the City's support was shown by the summons to the lord mayor, the aldermen and 50 representatives of the common council to attend the national assembly which met in London after William's arrival.

For the next 80 years, the City, whose electorate was the liverymen, men whose numbers and political education made them the most formidable urban constituency in the realm, usually supported the government. In matters of finance, the foundation of the Bank of England (1694), with members of the court of aldermen prominent on its court, marked the end of the Stuarts' enforced reliance on shifting syndicates and an unenthusiastic corporation. Henceforward, whether in peace or in war, the London money market was to be a prime factor in affairs of state. London's commercial and financial interests, growing with every expansion of the king's dominions, had much to gain from settled government. In the Jacobite rebellions of 1715 and 1745 London gave full loyalty to the throne, and during the Seven Years' War (1756–63) William Pitt (afterward earl of Chatham) gained much from its admiring support.

Under George III relations were more strained. Many Londoners ardently supported the turbulent John Wilkes (*q.v.*), and

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

"THE VIEW AND HUMOURS OF BILLINGSGATE," AN ENGRAVING BY ARNOLD VANHAECKEN DATING FROM 1762

"Wilkes and liberty" was a popular cry in the city. In 1771 a struggle over the reporting of debates in parliament saw Brass Crosby, the lord mayor, committed to the Tower. The advent to power (1783) of the Younger Pitt brought better relations, but the cause of parliamentary reform had strong support in the City, and Common Hall (the general meeting of the liverymen) was a source of much unwelcome advice to the king or the government of the day.

London by the Early 19th Century.—By 1820, when George IV succeeded to the throne, the whole character of London had changed. Its population, perhaps 500,000 in 1666, had increased to more than 1,100,000. The number of its houses had grown even more rapidly. Villages and hamlets—Marylebone, Islington, Bethnal Green and Newington are examples—which in 1666 had been the objects of Samuel Pepys's summer outings, had become part of the built-up area. Some of the building had been the planned, well laid-out work of great landowners whose suburban fields had become ripe for development: some was the sorry work of the small and greedy. Examples are still obvious today. The Bedford, Portman and Foundling estates produced streets and squares which embellished the town. Parts of Stepney and Bethnal Green were ill-built cottage terraces. Agar town, which lay near the modern King's Cross and St. Pancras, was a scandal.

The changes brought by these years 1689–1820 had followed no conscious plan. Inside the City its government was in full control and reasonably active. Beyond its boundaries, unchanged since the middle ages, government, services and communications for the new areas came piecemeal. The important developers obtained local acts of parliament enabling them to levy rates out of which to finance paving, lighting, cleansing and the watch. The popularity of their streets depended in part on such services and they were usually adequately administered. Lesser men left a legacy of rookeries (densely populated slum buildings) and neglect for later generations to clear. In communications generally, the City played a leading part. Once its opposition to a second Thames bridge had been overcome and Westminster bridge had been built (1739–50), it built Blackfriars (1756–69) and accepted without opposition the companies which built Waterloo (1811–17) and Southwark (1813–19). These all entailed approach roads and, between them, opened the marshy Surrey bank for building.

While turnpike roads were improving the entries into London, the New road (now the Marylebone, Euston and City roads) was started in 1756 as the first great bypass, and internal communications were eased by the covering over of the Fleet river (now Farringdon street), the removal after 1760 of the City gates, and the work done under the Westminster and City Paving acts. The congestion, delays and robberies of the port were at last eased by the opening in 1802 of the West India docks and later of the London (1805) and the St. Katharine (1828) docks.

Socially, commercially and financially, London was the hub of the kingdom and these improvements in communications were essential. As a corollary to its great wealth, fed by the profits of the East and West Indies' trade and by trade with most of the known world, it reigned supreme in England in matters of the theatre, literature and the arts. It was the London of David Garrick, Oliver Goldsmith, Samuel Johnson and Sir Joshua Reynolds, of the great furniture makers and silversmiths and of the world-famous foreign musicians. But its size brought increasing problems. The opening of a number of new waterworks, the modernization of the old, and the installation of steam pumping engines (1805–27) much improved the quantity if not the quality of water available.

F. The 19th and 20th Centuries

Although new dispensaries and new or enlarged hospitals were reducing mortality, the former riverside town required new forms of government, of communications and of sanitation if it was to continue to grow. These were slowly and painfully evolved in the London of 1820–1914. Against a background of statistics which showed the population of the built-up area rising from 1,225,694 (1821) to 6,581,402 (1901) the innovations came piecemeal. In 1829 a centralized Metropolitan Police force was provided, under the ultimate control of the home secretary, in place of the unco-ordinated watchmen and parish constables who had been helpless against most disturbances, let alone against the Gordon "No Popery" riots (1780) (*see* Gordon, Lord George). The lighting of streets by feeble oil lamps was revolutionized by the introduction of gas, and soon the Gas Light and Coke company (1810) was followed by similar companies scattered throughout London. George Shillibeer's omnibuses (1829) began a revolution in road transport, and carriage by rail came less than ten years later. The year 1845 brought a great inquiry into public health, with the exposure of London's worst deficiencies, 1852 legislation ensuring a purer water supply, and 1855 a statute (The Metropolis Management act) which combined a number of the smaller units of local government and replaced the medley of franchises with a straightforward system of votes by all ratepayers. Major works, such as main drainage, were put in the hands of a Metropolitan Board of Works operating for the whole of the then built-up area.

The momentum of these changes, established by such diverse reformers as Bishop C. J. Blomfield, Sir Robert Peel, Edwin (later Sir Edwin) Chadwick and the earl of Shaftesbury, continued throughout the century. New churches, new schools, better law and order, main drainage and care for the outcasts were some of the reformers' legacy; Trafalgar square, the Embankment, and roads driven like Shaftesbury avenue and Charing Cross road through the worst of the rookeries, are their most obvious monuments. The changes in government continued, if not so drastically. The London County council superseded the Metropolitan Board of Works in 1888, the vestries were transformed into Metropolitan boroughs by the London Government act (1899) and the various water companies combined in 1902 into a publicly owned Metropolitan Water board. Public and private works continued to transform the face of London. The opening of the Metropolitan railway (1863), and the making of Holborn viaduct (1869) were accompanied by the building of new Thames bridges and the rebuilding of Battersea, Westminster, Blackfriars and London bridges. After years of discussion and agitation, the road bridges outside the City passed into public ownership and the tollgates disappeared. All the main railways carried their lines into London and at Victoria, Charing Cross, Blackfriars and Cannon Street they crossed the river to the northern bank. It was an era in which an abundance of initiative and of capital was joined to abundant labour to make the widest use of new skills, cheap transport and copious raw materials. The Great Exhibition of 1851, opened in Hyde park by Queen Victoria, typified the age. London had become the shop window of the world, yet, in matters of daily life, much of it was brand new. A writer in *The Times* (London) of July 28, 1853, underlined this. "It does not take a very old man to remember when there was neither a gas lamp, nor a cab, nor an omnibus, nor a steam vessel, nor a plate glass window, in a city of which these things are now essential ingredients."

BY COURTESY OF THE LONDON TRANSPORT BOARD

VICTORIAN DIGNITARIES TAKING A TRIAL TRIP ON THE METROPOLITAN RAILWAY PRIOR TO ITS OPENING IN MAY 1863

Technical progress continued, gradually altering the lives of Londoners and the face of the town. Cheap suburban trains enabled the skilled artisan to live farther and farther from his work and the London School board, established under W. E. Forster's Education act (1870), set about the task of providing elementary education for all. Trams or streetcars (horse-drawn), after an unsuccessful beginning in 1861, become important in the 1870s and a major factor in metropolitan transport as their electrification developed in the first years of the 20th century. By then electricity was being used as the motive power for traffic below ground, the prince of Wales opening the world's first electric underground railway, from King William street to Stockwell, on Nov. 4, 1890. With the arrival, before 1914, of the petrol (gasoline)-driven omnibus, the outline of transport in modern London was complete and the way opened for still faster development of suburban lands.

Inevitably this was accompanied by rising land values in the central zone, by the construction of ever larger offices, factories and warehouses in place of small houses, and by a continuous outlay of public and private funds on better housing and street improvements. World War I, with air raids inflicting 2,632 casualties on London, brought only a temporary pause. Peace saw resumed development on a mounting scale. As a national and in some respects a world capital, London required institutions capable of meeting its needs. An era of amalgamation and expansion ensued. From banks to hospitals, and telephone exchanges to power stations almost all was expanded. Street congestion, well-known in the 1850s, was worse in the 1930s, despite the rationalization of traffic authorities. (For conditions after World War II see *Communications, Roads,* below.) By 1939 the population of greater London was around 8,000,000.

World War II, with evacuation planned and unplanned, and heavy damage by air raids, brought the greatest setback in the history of modern London. Air attack killed more than 30,000, injured more than 50,000, damaged most public buildings and, in such areas as the City and Stepney, obliterated whole sections of the street system. In Westminster, the abbey and the houses of parliament were damaged but saved, as were St. Paul's and Guildhall in the City. Ordinary houses and dockland probably suffered most of all.

The end of hostilities brought a gradual return of many evacuees and a housing shortage made worse by the ravages of dry rot. Reconstruction, hampered by the shortage of most materials, began at once—and with the advantage of plans and surveys already put forward. J. H. Forshaw and L. P. Abercrombie had produced in 1943 a plan for the county of London, supplemented in 1944 by Abercrombie's plan for greater London. C. H. Holden and W. G. Holford reported on the City (1947). The Town and Country Planning act (1944), followed by acts of 1947, 1954 and 1959, gave unprecedented powers of purchase, direction and control. The urgency of the Festival of Britain (1951) produced Lansbury (a redevelopment in Poplar) and the Royal Festival hall, but the

most significant features of 1946–60 were the vast investment in new houses, the restoration of the services and port of London, the general acceptance of a planned urban economy, and the sustained effort to divert industries to new or expanded towns outside London. Even so, 1961 began with a census return which showed the population of greater London as 8,171,902, while a royal commission of the previous October had reported unanimously that, following the precedent of 1855, the boundaries must be redrawn to include an even greater number. (T. F. R.)

IV. TOPOGRAPHY

1. Central London.—As officially defined, central London is an area of about 10 sq.mi., bounded roughly by (and including): the South Kensington museums; Paddington, Marylebone, Euston and King's Cross railway termini; the Angel, Islington; Shoreditch High street; Spitalfields market; the Royal mint; London Bridge station; the Elephant and Castle; Vauxhall and Chelsea bridges; and Sloane square. It thus includes the City of London. The central point is conventionally taken as Charing Cross. In 1961 this area had a resident population of 270,395. No exact employment statistics are available for central London, but the nearest equivalent had a total employment of 1,244,622 in 1951. Although the resident population of central London has declined for many decades, the working force, and consequently the commuting problem, have grown ever greater. Despite official efforts to limit the growth of employment in the centre, employment increased by about 15,000 annually in the 1950s.

Central London falls readily into two halves, with different histories and functions: the City of London; and west central London and the West End.

City of London.—The City's functions are commodity trading and finance (see *Economic Activities*, below). In 1950 it handled 26% of all wholesale trade in Great Britain. The financial institutions are remarkably concentrated within half a mile of the Bank of England. Lombard street, running southeast from the bank, is the traditional home of English banking; it is named after the Lombards from Italy, the chief financial power in 14th- and 15th-century England. The City has little manufacturing except the newspaper printing quarter along Fleet street.

The geography of the City has altered little over the centuries. The central institutions (the Bank of England, the Mansion house, the Royal exchange, the Stock exchange) stand on a triangular space where eight streets meet; thereabouts the main Roman streets also met. The medieval street pattern, in which names reflect the City's trading preoccupations (Cheapside, meaning the bargain quarter; Milk street; Bread street; Cornhill; Poultry), as well as the position of the gates in the old wall (Ludgate, Newgate, Aldersgate, Cripplegate, Moorgate, Bishopsgate, Aldgate), were retained as the basis for rebuilding after the Great Fire, despite improved plans drawn up by Wren and others. With certain exceptions it was again retained after the air-raid destruction of 1940–41. But the brick-built City merchants' houses, which arose after 1666, have all been replaced by offices and until 1939 these were of uniform but limited height. In postwar planning, however, opportunity was taken to vary building heights in order better to utilize the available daylight. The resulting tall blocks have revolutionized the traditional City skyline, in which the chief accents were St. Paul's cathedral and the spires of Wren's other churches. On Tower hill a garden containing the great Merchant Navy memorial, an extension of the 1914–18 Merchant Seamen's memorial, was opened in 1955. Two areas wholly rebuilt to segregate pedestrians from the road traffic are the area round St. Paul's cathedral and the 40-ac. Barbican site in the north of the City which includes a building 350 ft. high.

West Central Area and West End.—In the development of the area west of the City, at least five elements can be distinguished. First in point of time was the governmental function, which the late Saxon and Norman kings established round the palace and abbey church at Westminster. The existing government quarter stretches along the riverside, including the houses of parliament round the ancient palace; Westminster abbey; the seat of the prime minister and cabinet in Downing street; and the great blocks of government offices along Whitehall and adjacent streets. The seat of the crown was moved in Tudor times to St. James's palace, across the royal park, and in the 19th century to Buckingham palace nearby. Second was the legal quarter that grew up in the 14th century in the west central area between the City and Westminster, north and south of Fleet street. There are still found the four inns of court (Inner Temple, Middle Temple, Lincoln's Inn, Gray's Inn), together with the minor inns of chancery, solicitors' offices and the law courts. Most striking was the third element: the growth after 1600 of a residential area for the rich. At the Reformation monastic land was given to the nobility. In 1631 one of these, the duke of Bedford, used some of his ground to build Covent garden, a formal square modeled on the piazza at Leghorn, Italy, and on the Place des Vosges in Paris. It became the pattern for the development of the West End for more than 200 years. Houses round the new squares, or on the formal streets between them, found a ready market among those enriched by agriculture or trade. The late 17th century saw the building up of the areas known as St. James's and Mayfair, to the north of the royal parks of St. James's, Green and Hyde parks, which were fashionable resorts. In the 18th century Mayfair was completed and building spread north of Oxford street into Marylebone (the Cavendish-Harley and Portman estates) and to the northeast in Bloomsbury, where the formal layout reached its apogee. In the early 19th century Belgravia was laid out and by mid-century the marshes of Pimlico, to the south, had been reclaimed and the land built over. By 1850 the West End was the home of the rich. To serve it there developed the specialized luxury shops of Mayfair and St. James's: the bespoke tailors of Savile row, the gownmakers of South Molton street, the jewelers of Bond street, the wine merchants of St. James's, and the original West End theatres; while in the early 19th century St. James's became London's clubland.

From about 1870 onward a fourth element entered, and the character of the West End changed rapidly. Higher living standards changed luxuries into articles of popular consumption. Along Oxford street, popular department stores arose; one of the biggest, Selfridge's, was built in 1906–09. Theatres multiplied, a separate theatreland developing along Shaftesbury avenue. The cosmopolitan area of Soho (*q.v.*), and the Charlotte street area north of it, became the home of specialized restaurants. In the 1920s the Leicester square area became the main centre for luxury cinemas (motion-picture theatres). These new functions often brought with them new manufactures; thus a vast garment industry grew up round Oxford street, serving the popular dress shops. All these changes swelled the working population of the zone and diminished the resident population after 1900. Lastly, since 1920 but especially after 1950, the West End has become an office area. The character of Mayfair and St. James's has changed almost beyond recognition as big new blocks have replaced the former town houses. In Marylebone and Bloomsbury many of the houses, formally preserved, have ceased to have any residents beyond an occasional caretaker. But the character of the West End remains governmental, professional and cultural rather than commercial. Bloomsbury is dominated by the buildings of the University of London (*see* LONDON UNIVERSITY) which cluster round the British museum, and by the offices of publishers; Marylebone is the home of clinics and specialists' consulting rooms; Mayfair, Kensington and Belgravia house many embassies of foreign governments.

2. East End.—The quarter lying east of the rough line Shoreditch High street–Houndsditch–Aldgate–Tower bridge, and stretching east as far as the river Lea is called the East End and is largely a 19th-century creation. In the middle ages it was part of the great parish of Stepney, centred upon the Saxon village and church of St. Dunstan's. Ribbon building took place along the main roads (Whitechapel road and Wapping High street) by the early 17th century, when east London had already acquired its reputation as the home of the poor. But the great expansion came between 1820 and 1880, following the construction of the St. Katharine docks and the growth of manufacturing industries (clothing and furniture) needing quantities of cheap sweated labour. Overcrowding, casual employment and subsistence wages made the 19th-century East End an area of great poverty. In 1840

among the labouring classes of Bethnal Green 60% of all deaths were children under 5; the average age of death was 16. There was still no drainage in 1850. About 50 years later the great survey by the social reformer Charles Booth (*q.v.*) found 38% of the East End's population in poverty.

But after 1900—especially after 1940—the East End altered greatly. Its 1961 population was less than half the 1901 figure, the result of slum clearance, bombing and natural migration as living standards rose. The Stepney-Poplar Redevelopment area (470 ac.) was in the 1960s being rebuilt completely as a "New Town" within London for 100,000 persons, the largest urban renewal plan ever carried out in the United Kingdom. The old monotonous rows of two-story cottages are becoming a historical memory as they are replaced by four-story maisonettes and tall slab blocks of flats, set among gardens and parks. The old immigrant communities, once prominent in East End life, have been integrated and are much shrunken; Chinatown (Limehouse) has become a mere collection of restaurants along West India Dock road, and the Jewish community of Whitechapel largely migrated to other parts of London after 1930. There still survive, however, clearly marked industrial zones, each with its distinctive character: the furniture quarter of Shoreditch and Hackney road; the Jewish clothing quarter of Whitechapel round the historic Petticoat lane market (in Middlesex street); and dockland with its heavy industry.

3. Suburbs.—No enduring definition of the London suburbs is possible; what is suburb today could be town tomorrow. In the middle ages, Fleet street was *in surburbio* to the City; in the 18th century Bloomsbury and Marylebone were suburbs, in the 19th Islington, St. John's Wood and Camberwell. There is, however, an enduring suburban ideal: one of seclusion, of retreat from the bustle of the town. But as work usually remained in town this implied effective transport facilities once the suburbs had grown beyond walking range, *i.e.*, after about 1850. (See *Communications*, below.) Only after the extension of the underground railways into the country, and the electrification of the surface lines south of the river, did the suburbs proliferate. In 1914 the limits of built-up London were still Ealing, Cricklewood, Hornsey, East Ham, Lewisham, Wimbledon; places 5–8 mi. from the centre. By 1939 the limits were Watford, Edgware, Enfield, Loughton, Hornchurch, Orpington, Purley and Esher; the radius had doubled, the area had increased five times.

The need for seclusion dictated the form of the suburb. Until about 1850 the fashionable London house was one in a terrace, built in straight streets or formal squares. But the new suburbs after about 1820 had separate villas with their own gardens, grouped informally along irregular avenues. The models were John Nash's Park village (1818–25) near Regent's park, and the spontaneous extensions of Hampstead village in the same period. The forms were copied in villages as diverse as Camberwell, Dulwich and Highgate (*qq.v.*) and in Holland Park in the next 80 years. But until 1918 they were a luxury. Between 1918 and 1939, however, speculative builders took the form up and, following the electric railways, reproduced it for many miles across Middlesex, Essex, Surrey and Kent. The romantic cottages of Nash were standardized and debased into the detached and semi-detached mock Tudor patterns which line the avenues and arterial roads of these suburbs. They were built at low densities (about 12 houses per acre), for land was still cheap. Only rarely is the monotony broken by industry (mainly in well-defined pockets) or by the suburban shopping centres, many of which (Kingston-upon-Thames, Croydon, Harrow, Ilford, Bromley) developed out of the original village nuclei or the country market towns.

There are separate articles on the metropolitan boroughs of London (for list see *Government*, below) and on municipal boroughs and urban districts outside, and there are also articles on the following districts and areas: Billingsgate; Blackheath; Bridewell; Buckingham Palace; Charing Cross; Charterhouse; Clerkenwell; Covent Garden; Cremorne Gardens; Dogs, Isle of; Dulwich; Hampton Court; Highgate; Kennington; Limehouse; Ranelagh; Smithfield; Soho; Streatham; Tower of London; Vauxhall. (P. G. H.)

4. Thames Embankments and Crossings.—The Victoria embankment, commonly known as the embankment, runs from Blackfriars bridge to Westminster and was built in 1864–70. The river front at that time was disfigured by dilapidated buildings and offensive mudbanks. About 37½ ac. of mud were reclaimed for public gardens and a roadway 100 ft. wide beneath which runs the District railway. The engineer was Sir Joseph William Bazalgette. When the plan was first put forward, to meet the need for main drainage, it was found that an embankment with pipes buried behind it would cost no more than a pipeline along the foreshore. Accordingly the first alternative was adopted. The Chelsea embankment, 1 mi. long and providing for a roadway of 70 ft., also accommodates main drainage. It runs between Chelsea and Battersea bridges and was opened in 1874. Together the Victoria and Chelsea embankments (with Grosvenor road, constructed at the same time) provide a continuous riverside communication of about 4½ mi., interrupted only by the houses of parliament. On the south bank the Albert embankment, opposite the houses of parliament, was planned mainly for flood prevention and was opened in 1869. About 8½ ac. of foreshore were reclaimed and on this St. Thomas's hospital and a 70-ft. promenade were constructed. A fourth embankment providing a footway in front of County hall was opened in 1910. In 1951 it was extended to Waterloo bridge and gardens were laid out on land denuded of buildings during World War II. This site, known as the South bank, was the home of the Festival of Britain (1951) and has been set aside as a cultural centre to contain the Royal Festival hall and National Film theatre (both built in 1951), and the National theatre and an opera house, riverside memorial gardens, a hotel and the new Patent office.

Bridges.—From Roman times until the 18th century London bridge was the capital's only bridge. The first stone bridge begun in 1176 was removed in 1832; it stood about 100 ft. below (1) the present London bridge which was designed by John Rennie (1824–31), downstream of which is (2) Tower bridge (1886–94) designed by Sir Horace Jones and Sir John Wolfe-Barry. Upriver from London bridge are: (3) Cannon street railway bridge; (4) Southwark bridge, Rennie's old "Iron bridge" of 1813–19 having been replaced by one opened in 1921; (5) Blackfriars railway bridge and, close by, (6) Blackfriars bridge, opened in 1769, rebuilt 1865–69 and widened 1907–09; (7) Waterloo bridge by Sir Giles G. Scott, officially opened in 1945, replacing a celebrated bridge erected by Rennie in 1811–17; (8) Charing Cross railway bridge (1860–64), attached to which is the Hungerford footbridge; (9) Westminster bridge (completed 1862), replacing the 1739–50 bridge of William Wordsworth's sonnet; (10) Lambeth bridge (1929–32), replacing an 1862 suspension bridge built at the site of a ferry for transporting horses; (11) Vauxhall bridge (1906), replacing one built 1811–16; (12) Victoria railway bridge; (13) Chelsea bridge (rebuilt 1937 to replace one of 1858); (14) Albert bridge (1873); (15) Battersea bridge (1890), replacing a timber bridge of 1773 renowned as the subject of a James Whistler picture; (16) another railway bridge; (17) Wandsworth bridge, opened 1873 and reconstructed 1936–40; (18) a bridge carrying the District railway and a footway; (19) Putney bridge (1882–86), widened in 1933, replacing a wooden toll bridge of 1729; (20) Hammersmith bridge (1887), replacing a suspension bridge of 1827 which had been the first of its kind across the Thames.

Tunnels.—The Thames tunnel, constructed by Sir Marc and Isambard Kingdom Brunel, opened in 1843, between Shadwell and Rotherhithe, was an attraction to Victorian Londoners, with its shops and stalls, and was the starting point of a walk into Kent by east London pedestrians. The tunnel never paid its way and now carries the District railway between Whitechapel and New Cross. Four tunnels of the underground railway system go under the Thames between Charing Cross and London bridge. There are three ferries: the Limehouse Hole ferry, the Deptford ferry and the Woolwich Free ferry. The London County council maintains the latter (opened 1889) and also the following tunnels (west to east): Rotherhithe, opened 1908, 6,833 ft.; Greenwich (footway only); Blackwall, opened 1897, 6,200 ft. long; Woolwich (footway only), opened 1912, 1,655 ft. (X.)

V. ARCHITECTURE

Parts of the walls which include Roman work can still be seen at Tower hill, Monkwell street (east of Aldersgate street), St. Giles Cripplegate and the general post office. Beneath the Coal exchange (itself demolished in 1963) are the remains of a Roman hypocaust, and there are mosaic pavements inside the Bank of England. The Temple of Mithras, excavated on the site of Bucklersbury house in 1954, was moved to a nearby site in Queen Victoria street. A late Saxon rood panel remains at St. Dunstan's church, Stepney. Place names indicate considerable Danish influence in and around the City (*e.g.*, St. Clement Dane's church, Strand). Immediately before the Norman Conquest an impressive church was built at Westminster for Edward the Confessor, of which the Chapel of Pyx and the monks' dormitory undercroft remain within the abbey precincts.

1. Medieval and 16th-Century Buildings.—The Norman invasion resulted in major building activity in London, of which much is left. The Tower of London (*q.v.*) is outstanding. Many merchants' houses were built on vaulted stone crypts: houses surviving at Lincoln show the type. The wave of prosperity in the 12th century led to extensive rebuilding of churches in stone. Of these, the choir of St. Bartholomew the Great, Smithfield, founded in 1123 (nave completed in the 13th century) still stands. The rotunda of Temple church (consecrated 1185) remains, though much restored; and the crypts of St. John's church, Clerkenwell (1140–85), and St. Mary-le-Bow (*c.* 1090) can still be seen.

Life in medieval London revolved round the central market area of Cheapside. The City government is traditionally associated with this area, in which stood the halls of the city companies and where Guildhall remains with much important medieval work (new roof by Sir Giles G. Scott finished in 1954). As trade increased, much of the foreshore was reclaimed, the space within the walls was built over, and extramural building along the river bank began. The network of narrow streets which remains shows how overcrowded the City was; about one-quarter was occupied by religious houses and their holdings. There were 106 churches, serving so dense a population that the present Bank of England covers the sites of two parishes. Rebuilding in City churches continued in the late middle ages, but much was lost in the Great Fire. Surviving medieval churches are St. Etheldreda, Ely place, Holborn (the only pre-Reformation church in London occupied by the Roman Catholics), built about 1300 as the private chapel of the bishop of Ely; Lambeth palace chapel (*c.* 1230) with undercroft (*c.* 1200, restored after bombing); and, in the City, St. Helen's, Bishopsgate (with Perpendicular arcade), St. Ethelburga, Bishopsgate (with early 15th-century arcade), St. Giles Cripplegate (14th century, rebuilt 1545; damaged by bombing), St. Andrew Undershaft (rebuilt 1532) and the Savoy chapel, Strand (1505 *et seq.*).

Medieval Westminster, on the other hand, centred round the ceremonial of court and abbey. Until the late 18th century the river was the chief highway, and the chain of great houses of the nobility along the Strand linked the City with Westminster. In Westminster some of the finest medieval architecture of London can be seen. Westminster hall was completed in 1097, but modified in 1394–1402 when the magnificent hammerbeam roof was added—one of the finest in Europe. Damaged by incendiary bombs during World War II, the roof has been restored. Westminster abbey was rebuilt for Henry III between 1245 and 1269; the eastern part, the north and south transepts and five bays of the nave are of this period (*see* WESTMINSTER: *Westminster Abbey*).

Southwark cathedral, though much restored (nave wholly 19th century), contains interesting 13th-century work (retrochoir, chancel, etc.). Several other medieval churches outside the City still stand. The best preserved is St. Margaret's, Westminster, a fine Perpendicular parish church. St. Mary, Stratford-le-Bow (Poplar), retains much 14th-century work; good medieval west towers survive at the parish churches of Fulham, Lambeth and Putney. Two fine secular buildings are Crosby hall (1466–75), which was moved from the City and rebuilt in Chelsea in 1910, and Eltham palace, Woolwich, with its splendid great hall of the late 15th century. Staple Inn, Holborn, retains its fine half-timbered façade (1586) though extensively rebuilt behind.

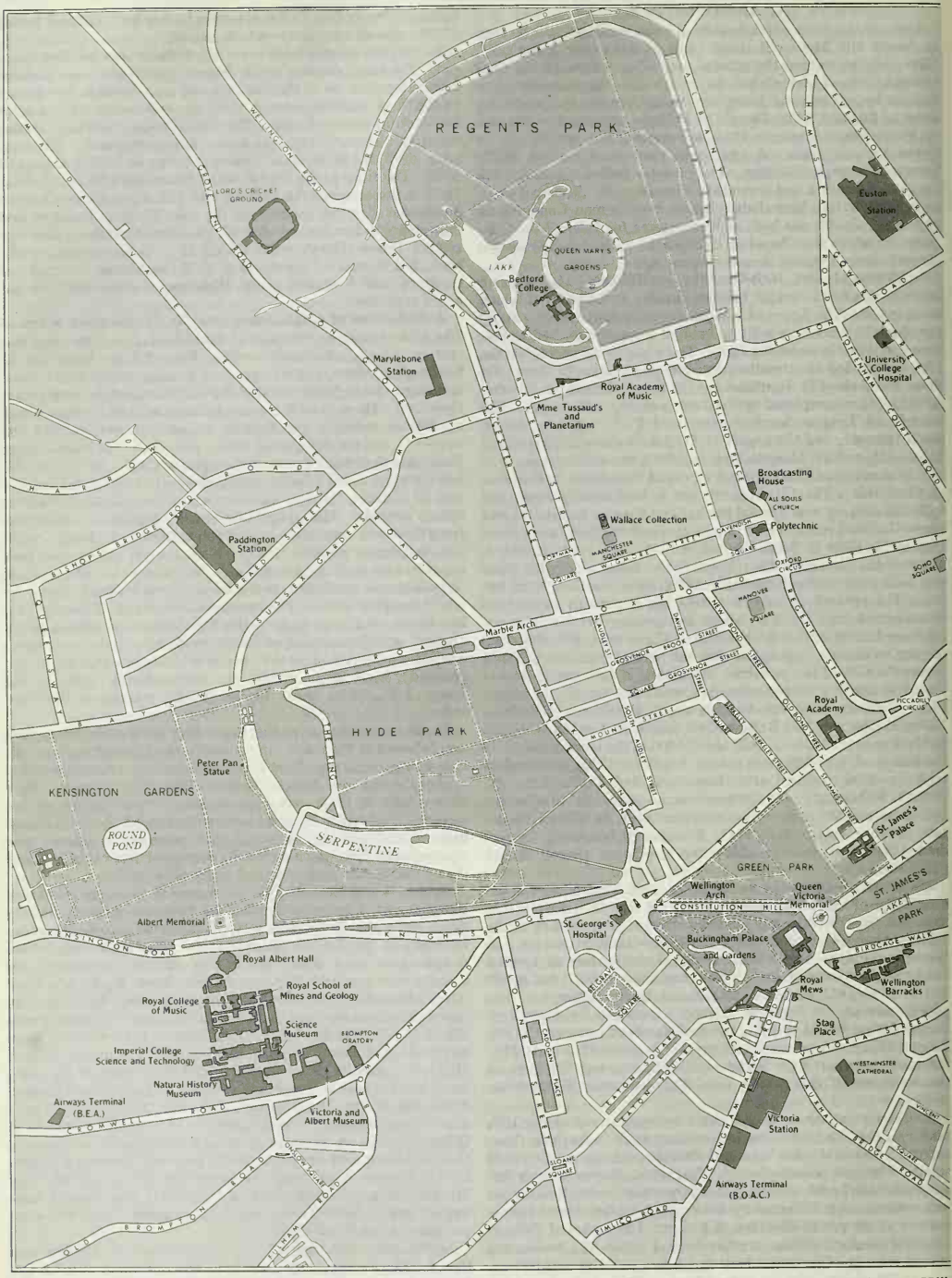
In the 16th century brick came into wide use as a building material. The brick gateway of St. James's palace and some parts of Lambeth palace are of the late 16th century. What is now known as the St. John's institute, at Hackney, is a well-preserved early 16th-century manor house. The Charterhouse, Finsbury, retains much 16th-century work and some earlier fragments. The remnants of Well hall, Eltham, contain a range of brick buildings of 1568. The front of Sir Paul Pindar's Bishopsgate house, of about 1624, is preserved in the Victoria and Albert museum. Charlton house near Greenwich (1607) is the only Jacobean house of first importance in London; number 17, Fleet street, retains a Jacobean room ("Prince Henry's room"; 1600–11); the George inn, Southwark, has a galleried courtyard of 1676, continuing the medieval tradition; and Cromwell house, Highgate, of about 1637–40, has a fine staircase.

2. Influence of Inigo Jones and Sir Christopher Wren.—The 17th century saw the rise of the individual architect and that century, which included the working lives of Inigo Jones and Sir Christopher Wren (*qq.v.*), gave to London some of its finest buildings. Inigo Jones initiated the use of a carefully worked out classicism. He worked in the court circle and built, in the manner of Andrea Palladio, the Queen's house, Greenwich (1617–19; 1629–37), and the Banqueting house, Whitehall (1619–23). Inigo Jones also designed Covent Garden piazza (begun 1630). Of the Lincoln's Inn fields scheme, begun about 1638 under the inspiration of Covent Garden, Lindsey house (possibly by Nicholas Stone) remains. The typical 18th-century London square derives from these two schemes. John Webb carried on in Jones's tradition and began work at Greenwich on a royal palace; his work comprises the eastern part of King Charles's block (1665–68) and the palace was continued, as the Royal Naval hospital, mainly by Sir Christopher Wren. The extramural expansion of London that had begun on a large scale in the Elizabethan age continued unchecked, and the speculative builder made his appearance. Noteworthy of the period is the chapel of Lincoln's Inn (1617–23; restored), built in an interesting revived Gothic style; a fine house, Ashburnham house (before 1662), remains in Westminster.

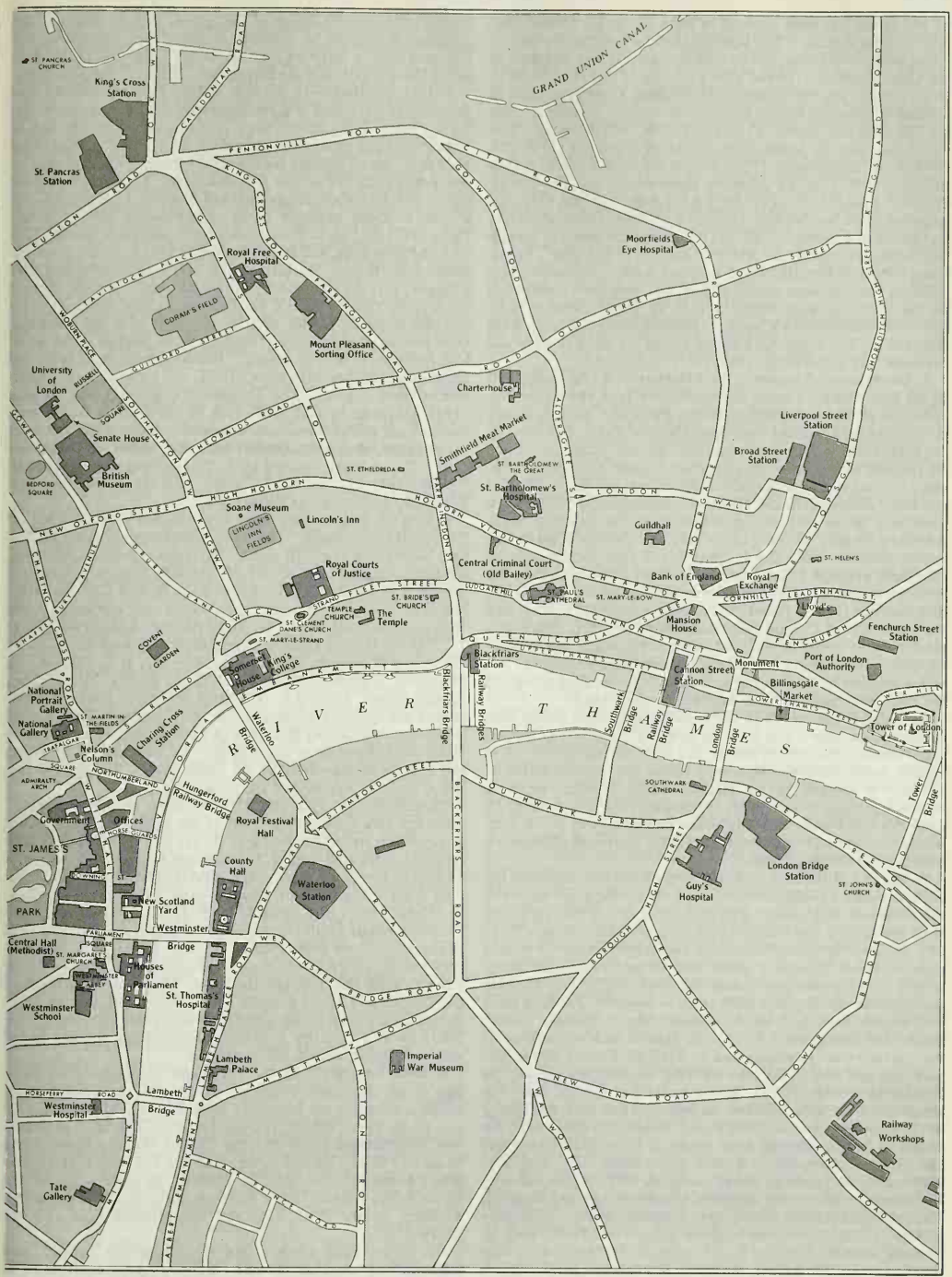
In the rebuilding after the Great Fire the earlier street plan was followed in the main. In the interests of fire prevention, private houses were then built in brick and stone. Among the lost medieval works were most of the halls of the city companies. They were rebuilt in brick and stone on similar lines to the private houses. World War II again destroyed most of them; Skinners' hall and Vintners' hall still stand, with interesting woodwork, and Apothecaries' hall, which retains its courtyard, is a valuable example of the former appearance of many City houses.

Before World War II, the 32 surviving examples of parish churches that were rebuilt, using the medieval ruins as foundations, under the supervision of Wren formed an unrivaled group of works in the English baroque style. The beautifully varied steeples gave great charm to the City skyline. In many cases steeples have survived, including the two finest, St. Bride's, Fleet street (1701–03), and St. Mary-le-Bow (1680). The only City churches to have survived the bombing intact are St. Benet, Paul's Wharf (1677–83); St. James, Garlickhithe (1676–83); St. Magnus the Martyr, London bridge (1671–1705); St. Margaret Pattens (1684–87); and St. Mary at Hill (1670–76); some of the damaged churches were restored in the 1950s. The major ecclesiastical monument of the City, St. Paul's cathedral (1675–1710), Wren's masterpiece, was almost undamaged and still dominates the City. Other buildings by Wren in London are Greenwich observatory (1675–76), parts of the Royal Naval hospital, Greenwich (1696–1705); Chelsea Royal hospital (1682–91); and almost certainly Morden college, Blackheath (founded 1695); also work at Kensington palace (1689–1702), and the Monument (1671–76) commemorating the Great Fire.

In the early 18th century, the rapid growth of London continued. Gray's Inn, Lincoln's Inn, Inner Temple and Middle Temple were almost entirely rebuilt and the distinctive character



CENTRAL LONDON AND THE CITY, SHOWING PRIN-



CIPAL STREETS, BUILDINGS AND RAILWAY STATIONS

of the period has been retained in spite of further modification and wartime damage. The squares, the most distinctive unit of Georgian town building, can be seen in the areas east and west of the City. Between 1710 and 1730 a number of fine churches built to serve these regions brought to prominence a new generation of architects following in the footsteps of Wren. Worthy of note are: St. Mary-le-Strand (1714–17) and St. Martin-in-the-Fields (1722–26), both by James Gibbs; St. Mary Woolnoth (1716–27), St. George, Bloomsbury (1720–30), and Christ Church, Spitalfields (1714–29), all by Nicholas Hawksmoor; and St. George, Hanover square (1712–25), by John James. In the City, the Mansion house was built in 1739–52 by George Dance the Elder on the site of a market. This was the first of the group of grandiose buildings marking the centre of activity in the City. Subsequent rebuilding there displayed the same spirit. The ancient hospitals of London were rebuilt and several new ones constructed on the outskirts; work begun in 1730 by James Gibbs is to be seen at St. Bartholomew's hospital (founded 1123). William Kent designed the Horse Guards building before his death in 1748 and the work was executed by John Vardy in 1751–58.

3. Georgian and Regency Architecture.—In the second half of the 18th century a move was made away from the earlier Palladianism of which Burlington house, Piccadilly, built originally in 1663–68 and refaced and remodeled by Colin Campbell in 1715–16, is one of the best examples. Robert Adam (*q.v.*) and his two brothers designed an important scheme, the Adelphi (begun 1768), of which the Royal Society of Arts building (1772–74) survives. Kenwood house, Highgate (reconstructed 1767–69), is a country house enlarged by Adam and later enlarged again. Adam's admiralty screen (1760) sets off Thomas Ripley's belatedly Wrenian Admiralty building (1722–26). Adam designed extremely graceful façades and delightfully varied interiors for his town houses, of which Chandos house, Chandos street, Cavendish square (1770–71), and 20 Portman square (1775–77), now the University of London Courtauld Institute of Art, remain in a good state of preservation. Adam's contemporary, Sir William Chambers, designed the first part of Somerset house (begun 1776), which survives in its riverside setting, with the arcaded terrace to the river front and the main entrance on the Strand.

Sir John Soane's work is far more personal and daring than earlier architecture. The Bank of England (1792–1833) was his major work. Part of the screen wall survives but almost all of Soane's work there was destroyed during the reconstruction of 1925–39 to designs by Sir Herbert Baker. Interesting work by Soane can also be seen in his own house (1812–14), number 13, Lincoln's Inn Fields (now the Soane museum), and in the Dulwich art gallery and mausoleum (1811–14; destroyed 1944 but rebuilt from the original plans).

At the end of the 18th and beginning of the 19th centuries important building projects were carried out on the great estates in the northwest of London. The most striking and best preserved is on crown land, the Regent's park-Regent street scheme (1811–23), designed by John Nash, with the curved sweep of Regent street between Piccadilly circus and Oxford circus, All Souls' church in Langham place, and the porticoed houses of Park crescent and the Regent's park terraces beyond. Portland place had already been laid out by Robert Adam's younger brother James, but little is left. In 1827 St. James's park was redesigned on "picturesque" principles and in 1827–33 Carlton House terrace was laid out. This plan included Buckingham palace; the Marble arch (1828, in 1851 moved to the top of Park lane) was designed for the park façade of the palace. Hyde park was altered at the same time, and Decimus Burton designed (1825 *et seq.*) the lodges to it, the excellent Ionic screen at Hyde Park corner and the Roman triumphal arch into Constitution hill, somewhat dwarfed by the Quadriga placed on top in 1912. Three buildings of the early 19th century dedicated to learning can be compared; all have flights of steps leading up to massive porticoes: University college (1827–29) and the National gallery (1832–38), both by William Wilkins; and the British museum (1823–47, with later additions) by Sir Robert Smirke. St. Pancras parish church (1819–22) by H. W. Inwood (with his father William Inwood) is typical of the church design of the period, with its caryatids and antiquarian copying of classical details. Two interesting late Georgian theatre exteriors survive: Drury Lane (1811), by Benjamin Dean Wyatt; and the Haymarket (1820–21), by John Nash.

4. 19th Century.—In the 19th century London increased considerably in area, and the administrative centre was largely rebuilt. Early 19th-century work is distinguished by the use of stucco, but brick returned to general use later. The railways called for a new type of building for the great termini. These display an interesting early use of cast iron and glass. The earliest, Euston (1836–49), by Robert Stephenson and P. and P. C. Hardwick, had a massive Doric entrance portico (demolished 1962). King's Cross (1851–52) by L. Cubitt has a forthright brick façade. The iron and glass train hall at Paddington (1854) is by the great engineer I. K. Brunel. Victoria station was built in 1862 and later enlarged; it is the station for continental trains. Finally, there is Sir George Gilbert Scott's St. Pancras station (1868–74); his complex romantic Gothic exterior contrasts with the admirable train shed in glass and iron (1868) by W. H. Barlow. The use of iron frameworks became general. Buildings were made taller and the exteriors became ever more varied. All types of earlier architecture were copied. The Travellers' (1829–32) and Reform (1838–41) clubs in Pall Mall, both by Sir Charles Barry, were modeled on Italian Renaissance palaces. Outstanding examples of Victorian Gothic in London are: the houses of parliament (1837–57) by Barry, assisted by A. W. N. Pugin; the Law courts, Strand (1874–82), by G. E. Street; and the Albert memorial (1863–72) by Sir George Gilbert Scott.

During the 19th century many new churches were provided for the growing metropolis. The most remarkable are those of William Butterfield (*e.g.*, All Saints', Margaret street, begun 1849), stridently original and wholly at variance with time-honoured standards of beauty. Pugin designed the Roman Catholic cathedral of St. George, Southwark (1841, rebuilt after damage in World War II), and Scott rebuilt St. Mary Abbots', Kensington (1869–79). Other leading London church architects were G. E. Street (St. Mary Magdalene, Paddington, 1868–78), J. L. Pearson (St. Augustine, Kilburn, 1870–80) and G. F. Bodley (St. Michael, Camden Town, 1876–81). The great revival of domestic architecture and design, beginning in the 1860s under William Morris' leadership, is also well displayed in London, mainly in houses in Hampstead, Kensington and Chelsea—by then centres of artists and artistic people—designed by Philip Webb, Richard Norman Shaw, C. F. A. Voysey and their followers.

Throughout the 19th and 20th centuries blocks of workers' dwellings were constructed. One of the earliest (1849) remains in Streatham street, Bloomsbury. In the late 19th and early 20th centuries a restated English baroque was evolved and used on a number of monumental buildings, several of which are still on the river front. Examples are New Scotland Yard (1891) by Shaw, and County hall (1912 onward) by R. Knott. Regent street and Piccadilly circus (with the statue of Eros as a memorial to Lord Shaftesbury) were redesigned in this style in the early 20th century and the Aldwych with Bush house and the buildings of Kingsway continued this trend into the 1920s. Sir Aston Webb designed the Victoria and Albert museum (built 1899–1909) and the Buckingham palace main façade (1913). Westminster cathedral (1895–1903) by J. F. Bentley is a fine neo-Byzantine building in red and white brick, with a tall campanile.

5. 20th Century.—In the 1920s and 1930s enormous buildings in an unadorned, massively simple style were built. Conspicuous examples are Imperial Chemical house, Millbank (1929–36), by Sir Frank Baines; London Transport Executive headquarters, Westminster (1928–29), by Charles Holden; Broadcasting house (1930–31) by Val Myer; and the University of London senate house (1933 *et seq.*) by Holden. In contrast are several of Sir Edwin Lutyens' finest buildings, including Britannic house, Finsbury square (1920–23), and the Midland bank, Poultry (1924–37).

But in the early 1930s a new trend appeared, derived from contemporary continental work. Buildings were constructed of reinforced concrete, with much use of cantilever construction to

permit larger unbroken window areas, and without the masking screens of decoration hitherto considered indispensable; for example, Simpson's store, Piccadilly (1936), by J. Emberton; Peter Jones' store, Sloane square (1936), by W. Crabtree and Sir Charles Reilly; and the two Highpoint blocks of flats, Highgate (1936 and 1938), by B. Lubetkin and Messrs. Tecton. Battersea power station (1933) by Sir Giles Gilbert Scott is a functional design in brick. Postwar building continued in this style. Among outstanding works are flats in Ranelagh road (1946), by P. Powell and H. Moya; and the Royal Festival hall, South Bank (opened 1951), by R. H. Matthew and J. L. Martin. In the 1950s much of the war-damaged area of the City was rebuilt, and there and elsewhere in London office buildings several hundred feet in height were erected. These include Castrol house, Marylebone road, by Gollins, Melvin Ward and partners (1958–59); New Zealand house, Haymarket, by R. H. Matthew and S. A. Johnson-Marshall (completed 1963); the 385-ft. Vickers house, Millbank, by Ronald Ward and partners (1959–62); and the Shell centre on the South bank, by Sir Howard Robertson and partners, with a 351-ft. tower (1957–62). Other notable buildings are Kensington Public library by Vincent Harris (1957–60) and the Royal College of Obstetricians and Gynaecologists, by Louis de Soissons (completed 1960) in Regent's park. (*See* also *Housing*, below.)

(K. Mn.; F. H. W. S.)

VI. CULTURAL AND RECREATIONAL FACILITIES

1. Museums, Art Galleries and Libraries.—The origins of the British museum in Bloomsbury go back to 1753 when the government purchased Sir Hans Sloane's collection and the Harleian manuscripts. The museum was opened in Montague house in 1759 and the present building was begun, immediately behind it, in 1823. The buildings, which now cover the site of Montague house, have undergone alterations and additions to the present day. The main collections are of prints, drawings and manuscripts (including oriental); coins and medals; ethnography; Egyptian, western Asiatic, oriental, Greek and Roman, British and medieval antiquities. The museum library receives a free copy of every book printed in the United Kingdom. The huge round-domed reading room, where Karl Marx and other famous men have worked, was planned by Sir Anthony Panizzi (*q.v.*) and opened in 1857. The newspaper library is at Colindale, near Hendon.

The British Museum (Natural History) in South Kensington was opened in 1881. It houses departments of zoology, entomology, paleontology, mineralogy and botany. The zoological museum at Tring in Hertfordshire is a branch of this museum. Also in South Kensington is the Victoria and Albert museum which had its origins in material collected after the Great exhibition in 1851. It houses a library and collections of sculpture, ceramics, engravings and illustration, paintings and drawings (including the Raphael cartoons and the John Constable collection), metalwork, textiles (including European costumes), and woodwork, of all countries and periods, and also a section for the arts of India and Pakistan. Its subsidiaries include the Bethnal Green museum (with a children's section) and the Wellington museum at Apsley house by Hyde Park corner. Near the Victoria and Albert museum are the Science museum, with collections showing the development of the physical sciences and their practical application (*e.g.*, transport by land, sea and air, mining, engineering, industrial machinery, tools and chemistry, astronomy and meteorology) and a large library; and the adjacent Geological museum. Also in Kensington (Holland park) is the new (1962) building of the Commonwealth institute (formerly the Imperial institute, founded in 1887) with a paraboloid copper-sheathed roof.

The London museum, temporarily housed in Kensington palace, and the Guildhall museum cover between them every aspect of the archaeology, history, daily life, trades and amusements of London. The London museum also contains a collection of royal robes and the Guildhall museum one of clocks and watches belonging to the Clockmakers' company. These two museums were designated for amalgamation in the 1960s. Notable museums in south London are the Imperial War museum in Lambeth road; the National Maritime museum at Greenwich; the Horniman museum and library, in Forest Hill, for the study of man and his environment and with a large collection of musical instruments. The Geffrye museum in Shoreditch contains mostly furniture, costume and domestic items arranged in period rooms from 1600 to the present day. The many smaller museums include the Public Record Office museum, four museums in the Royal Botanic gardens at Kew, the Jewish museum and the Wellcome Historical Medical museum.

Art galleries with permanent collections include the National gallery (1838), in Trafalgar square, which contains European paintings of all schools and was founded in 1824; the adjoining National Portrait gallery, founded in 1856; the Tate gallery (British painting, modern French painting and modern sculpture) at Millbank, opened in 1897 and built by the generosity of Sir Henry Tate, the sugar merchant; and the Dulwich College gallery. The Wallace collection in Hertford house (1776–78), Manchester square, has paintings, sculpture, furniture, armour, ceramics and other works of art bequeathed to the nation in 1897 by the widow of Sir Richard Wallace (*q.v.*). Sir John Soane's museum in Lincoln's Inn fields houses the founder's collection of paintings, drawings and works of art.

Of periodical art exhibition centres the most noteworthy is that of the Royal Academy of Arts in Burlington house, Piccadilly, which holds its main exhibition from the first Monday in May to the first Monday in August and a winter one of old masters or some particular nation's art. The Whitechapel art gallery was founded in 1900 for temporary exhibitions.

The boroughs of London all maintain public libraries, often with several branches; under a co-operation plan each borough specializes in one group of subjects in addition to building up its general stock. Considerable libraries, not all of them directly open to the public, are kept in certain ministries and government departments. The central library of the University of London supplements the libraries of the individual colleges. Most of the learned bodies and societies in London, *e.g.*, the Linnean society, the Royal Geographical society and many others house what is usually the best library for its subject in the country. Membership libraries include the London library in St. James's square and the Dr. William's library in Gordon square. The National Central library in Malet place is a national agency for interlibrary lending. (*See* also Library: *Modern Libraries.*) (X.)

2. Ceremonial Events.—The London calendar is distinguished by many picturesque events and ceremonies, some of ancient origin. Among the best known are: *Trooping the Colour* on the sovereign's official birthday (early June) by the Brigade of Guards on Horse Guards parade, behind Whitehall; the *State Opening of Parliament* by the sovereign, with a procession, generally in the second week of November; the *Lord Mayor's Show* on the second Saturday of November, a ceremony probably originating in a 13th-century custom that the new lord mayor of the City must be confirmed by the ruling monarch or his justices; this is followed by a *Banquet in the Guildhall* to which are invited more than 1,000 prominent guests; the annual *Opening of the Law Courts*, about Oct. 1, with a procession through the main Hall of the Courts, preceded by a special service at Westminster abbey; and the annual *Royal Academy Dinner*, held on the Saturday before the opening of the summer exhibition. During the summer two or three *Royal Garden Parties* are usually held at Buckingham palace.

Less distinguished, but extremely picturesque annual events include the *Van Horse Parade* on Easter Monday and the *Cart Horse Parade* on Whitmonday, both in Regent's park; the *Sheep-Dog Trials* in Hyde park at the Whitsun weekend; *Doggett's Coat and Badge*, and the *University Boat Race* between Oxford and Cambridge on the Thames; the *Fairs* on Easter Monday, Whitmonday and August bank holiday, on Hampstead heath and Blackheath; the *Soho Fair*, in July; and the *Chelsea Arts Ball* on New Year's eve. Daily ceremonies include the *Changing of the Guard* at Buckingham palace, which takes place every day the monarch is in residence; the *Mounting of the Guard of the Household Cavalry* in Whitehall; and the nightly locking up of the Tower of London, or *Ceremony of the Keys*, by the chief warder of the

yeomen warders ("Beefeaters"), a part of the Yeomen of the Guard attached to the royal palaces.

A telephone information (Teletourist) service provides details in English, French, Spanish and German of important events being held in and around London on the day of the call. (P. G. H.)

3. Places of Entertainment.—London has about 38 theatres presenting live entertainment in the West End and a further 6 in the outer ring. The number fluctuates as some theatres may be used for motion pictures for extended periods. There are also several music halls (revues, variety, etc.) and numerous regular motion-picture theatres.

The theatrical centre in the 18th century grew from the Theatres Royal, Drury Lane and Covent Garden (now the Royal Opera house), with the Queen's theatre (variously known as the King's and His or Her Majesty's) and the Little theatre, Haymarket (later the Theatre Royal) in the fashionable Pall Mall district. In the early 19th century theatres began to extend westward down the Strand and with the construction of Shaftesbury avenue in the 1880s this area became the principal theatrical artery. In 1962 a plan was announced for a National theatre (to replace the Old Vic) and an opera house (to replace Sadler's Wells) to be built on the South bank near the Royal Festival hall. The National Theatre company, formed in 1963, leased the Old Vic and an architect for its new theatre was appointed.

The outer ring theatres are within easy reach of the centre. They generally follow a definite policy: for example, the seasonal Open Air theatre in Regent's park specializes in Shakespeare and other poetic drama. There are two club theatres in the West End and numerous cabarets, theatre restaurants and night clubs. The exhibition halls of Olympia and Earls Court are also used for circuses, ice shows and tournaments.

Other popular places of resort are Madame Tussaud's waxworks in the Marylebone road, with an attached planetarium; and the zoological gardens in Regent's park. Concerts are held in the Royal Festival hall, South bank (capacity 3,266), and the Albert hall, Kensington Gore (capacity 7,000), and recitals at the Wigmore and other halls. The National Film theatre near the Royal Festival hall shows classic films from all countries.

Places of entertainment are licensed by the London County council (L.C.C.), whose supervision includes inspection in respect of fire precautions and structural safety. Under the Theatres act of 1843 the lord chamberlain grants licences for the performance of stage plays; his office is also responsible for censorship of plays and the British Board of Film Censors for that of films.

(Ra. Ma.; Jo. Mi.)

4. Parks and Open Spaces.—St. James's and Green parks, Hyde park and Kensington gardens stretch in an irregular belt for nearly 3 mi. between Whitehall and Kensington. Together with Regent's park and Primrose hill, Richmond park, Greenwich park and Hampton Court and Bushy parks, they form what are called the royal parks.

St. James's park was transformed from marshy land into a deer park, bowling green and tennis court by Henry VIII, extended and laid out as a pleasure garden by Charles II and rearranged by John Nash in 1827–29. Its lake, the broad Mall leading up to Buckingham palace and the proximity of the government buildings in Whitehall, combine to beautify it. St. James's park (93 ac.) is continued between the Mall and Piccadilly by Green park (49 ac.). Hyde park, to the west, belonged originally to the manor of Hyde, which was attached to Westminster abbey, but was taken by Henry VIII on the dissolution of the monasteries. James I opened it to the public after which Rotten row became a fashionable promenade for horse riders (and is still used for riding). In 1908 the northeast corner of Hyde park was cut to give additional accommodation for road traffic and the Marble arch was left isolated. Hyde park and Kensington gardens (together 615 ac.) between them contain a lake 1,500 yd. long known in its park portion as the Serpentine and in the gardens portion as the Long Water; from the bridge marking the division one of the finest prospects in London is seen, including the distant towers of Westminster and, on the north bank of the Serpentine, the bird sanctuary with Jacob Epstein's "Rima" memorial to William Henry Hudson. In the 17th and 18th centuries Hyde park was a favourite dueling ground, and for many years "Speakers' corner" by Marble arch has been the chief stamping ground of orators on social, religious and other topics. Trafalgar square is used for big organized political and other demonstrations. Kensington gardens, originally attached to Kensington palace, were subsequently much extended; they are specially favoured by children, for the famous Round pond is there, and in 1912 Sir George Frampton's statue of "Peter Pan" was placed near the west bank of the Long Water. Regent's park, mainly in Marylebone, owes its preservation to George IV, who, when regent, intended to build a palace there and had the park laid out by John Nash in 1812. With Primrose hill, adjoining it to the north, it covers 472 ac.

Other important open spaces are: in the northwest, the lofty Hampstead heath, which with adjoining open spaces forms an unbroken stretch of 800 ac. preserved to a great extent in its natural state; in the northeast, Victoria park (217.5 ac.) and Hackney marsh (343 ac.); in the southeast, Greenwich park (196.5 ac.) with a magnificent view over the river and adjoining Blackheath (270.5 ac.), Crystal Palace park (199 ac.) where motor racing and open-air concerts are held and where in 1964 the national recreation centre was completed, and more than 750 ac. of heath and woodland round Shooters hill and Abbey wood; in the southwest, Wimbledon common and Putney heath (together covering 1,200 ac.), Richmond park (2,469 ac.) whose higher parts command a wonderful view up the rich valley of the Thames, Bushy park (1,100 ac.) which is noted for its horse chestnut trees, and Battersea park (199.5 ac.) with its Festival gardens and fun fair designed for the Festival of Britain in 1951.

There is an extensive inner area where at most only small gardens and squares break the continuity of buildings, but about 521 ac. of new open space were completed between 1951 and 1960, including about 50 opened by the L.C.C. Many of these were in areas of great deficiency and represented first steps in the creation of new parks, *e.g.*, that at north Camberwell, planned by the L.C.C. to cover 133 ac. By the early 1960s the proportion of open space per 1,000 population in the administrative county was 2.69 ac. The L.C.C. also owns Hainault forest (1,108 ac.) in Essex.

The City of London administers small open spaces within its boundaries and also Highgate wood (70 ac.), Queen's park, Kilburn (30 ac.) and West Ham park (77 ac.). Notable outlying spaces administered by the City are Epping forest (6,000 ac.) in Essex, Coulsdon commons (423 ac.) in Surrey, and Burnham Beeches (504 ac.) in Buckinghamshire. There is a wide variety of sports facilities in the parks, while summer entertainments are held in many of them.

Sports Grounds.—Among many sports grounds, the two best-known cricket grounds are Lord's, near Regent's park (Marylebone Cricket club [M.C.C.]—and Middlesex county matches, Oxford *v.* Cambridge university matches, Eton *v.* Harrow school matches, etc.), and the Oval in Kennington (Surrey county matches, etc.). At these two grounds there also take place any "test" matches played in London by teams representing England against overseas, mainly commonwealth, sides. International Rugby football matches (among others) are played at Twickenham, and club Rugby is played at a number of grounds; and the final ties of the English association football cup at Wembley stadium. Several professional association football clubs are named after London districts, and have their grounds there. Athletic meetings take place at the White City (Hammersmith) and the lawn tennis championships at Wimbledon (Surrey). The Oxford *v.* Cambridge and men's international hockey matches are played at the Hurlingham park stadium (Fulham). In and around Greater London are several horse racing courses (including Epsom, the home of the Derby) and greyhound racing tracks (including White City and Harringay where horse shows are also held). Club golf is played regularly; there are also public courses.

(X.)

VII. GOVERNMENT

The Municipal Corporations act (1835) did not affect London, chiefly because the commissioners failed to reach a definite con-

clusion about the future of the metropolis. The City of London, unlike other large towns, did not expand, but remained, as it still remains, within its historic "square mile" with little change from the middle ages. The rest of London was generally governed by the inhabitants of each parish in vestry assembled, but the vestries had no powers of town management. To meet the needs of particular localities, commissioners or trustees having these powers had been created by local acts. In 1855 there were no fewer than 300 such bodies, in no degree responsible to the ratepayers. Two other bodies exercised jurisdiction over the whole metropolis except the City: the officers appointed under the Metropolitan Building act of 1844; and the metropolitan commissioners of sewers, appointed under the Commissioners of Sewers act, 1848. Neither was responsible to the ratepayers.

To remedy this chaotic state of affairs, the Metropolis Management act, 1855, was passed, whereby a vestry elected by the ratepayers was established for each parish outside the City. The vestries for larger parishes became the local authorities; smaller parishes were grouped under district boards. A central body, the Metropolitan Board of Works, having jurisdiction over the whole metropolis (including the City) was also established, with members elected by the common council of the City, the vestries and district boards and the previously established local board of Woolwich (*q.v.*). The board had a salaried chairman. The area of the metropolis for local government was then defined as the district used by the registrar general for bills of mortality. Until the formation of Greater London in 1965 the subsequent county of London was still virtually the same area. The Metropolitan Board of Works became the authority for main drainage and for the administration of the Building acts and subsequently acquired many additional powers and duties. It completed the main drainage scheme, made street improvements, constructed the Thames embankment, acquired 30 parks including Hampstead heath and established the London fire brigade. But, like some of the vestries, it acquired a reputation for corruption, which hastened its abolition at the general reform of county government in England.

1. London County Council.—By the Local Government act (1888) a directly elected London County council (L.C.C.) was established to administer the metropolitan area constituted in 1855. It took over the administrative powers of the justices of the peace, the functions of the Metropolitan Board of Works and (in 1903) the elementary education duties of the London School board. The Local Government act (1929) brought the transfer to it in 1930 of the poor law functions of the 25 boards of guardians, the Metropolitan Asylums board, the four boards of district school managers and the Central (Unemployed) body. Maternity and child welfare powers were transferred from the metropolitan boroughs under the National Health Service act (1946).

The act of 1888 left the vestries and the City unaffected. Over the next ten years controversy raged between the "unifiers," who wished to amalgamate the City with the L.C.C. and the "tenifiers," who wished to place local government in the hands of ten separate boroughs. The London Government act (1899) was passed which interfered with neither the L.C.C. nor the City; for the 40-odd vestries and district boards were substituted not 10 but 28 boroughs, each with a mayor and aldermen but with much the same powers as the bodies they succeeded.

In 1962 the L.C.C. had 126 councillors, each parliamentary constituency returning 3 representatives. These councillors elect a chairman and 21 aldermen. Councillors are elected every three years; aldermen hold office for six years, one-half being elected by each new council. By convention the vice-chairman is chosen from the majority party and the deputy chairman from the minority. The standing orders provide for a "leader of the council" and "leader of the opposition" who may attend and speak but not vote at the meeting of any committee or subcommittee of which they are not members.

The L.C.C. first met in 1889 at the City's Guildhall. It then moved into the premises of the Metropolitan Board of Works in Spring gardens, known as Old County hall. The present County hall on the south bank of the Thames was opened in 1922 and has since been enlarged.

2. Corporation of the City of London.—The aforementioned legislation did not apply to the City, so no other municipal body shares the traditions and peculiar dignity of the City corporation. This consists of a lord mayor, 25 aldermen and 206 (to be reduced to 159 by St. Thomas' day, 1965) common councilmen, forming the court of common council, which is the principal administrative body. The election of common councilmen, whose institution dates from the reign of Edward I, takes place annually, the electors being the ratepayers divided among the 25 wards of the City. An alderman (*q.v.*) of each ward (save that the wards of Cripplegate Within and Without share one) is elected for life. The lord mayor is elected annually by the court of aldermen from two aldermen nominated in the court of common hall by the livery, which is an electorate drawn from the members of the ancient trade guilds or livery companies (*q.v.*).

3. Metropolitan Borough Councils.—The metropolitan borough councils are elected every three years in May of the year after the county council elections. The councillors elect the aldermen, who hold office for six years and are in the proportion of one to every six councillors. Councils vary in size: in 1962, 10 of the 28 boroughs had 60 councillors and 10 aldermen; the 2 smallest had 30 councillors and 5 aldermen. Some wards return as many as nine councillors but the tendency is toward three councillors for each ward. Each borough has a mayor elected annually by the council. Most councils also elect a deputy mayor from among their members. Each borough has its town hall.

For negotiation with central government departments and with the county council, and for discussion of common problems, the borough councils established in 1912 a standing joint committee. This is made up of three representatives of the City and of each borough council, one of whom is usually the town clerk. It is assisted by advisory bodies of chief officers from the boroughs. The committee also manages a union catalogue for all the public libraries in the county and in 1951 it set up the first Organization and Methods service.

In the 20th century the most urgent problems have been the relation of the administrative county to the built-up areas beyond and the possibility of a unified local government for Greater London. The majority report of a royal commission (1921–23) was content to leave the structure as it was and proposed a London and home counties advisory committee to secure some common action.

The Local Government Boundary commission, which reported in 1947, excluded from consideration the Greater London area on the ground that it could not be treated independently of the future of the county itself. In 1949 a departmental committee set up to advise on implementing the Greater London plan pointed to the need for a regional authority and an "entirely new alignment of regional, county and local functions" and recommended reference to a Local Government commission.

TABLE II.—*Metropolitan Boroughs*

Borough	Population 1961	Area (in ac.)
Battersea	105,870	2,164
Bermondsey	51,860	1,505
Bethnal Green	47,078	759
Camberwell	175,304	4,481
Chelsea	47,256	660
Deptford	68,829	1,565
Finsbury	32,887	587
Fulham	111,791	1,708
Greenwich	85,546	3,863
Hackney	164,766	3,293
Hammersmith	110,333	2,287
Hampstead	98,844	2,266
Holborn	24,008	405
Islington	228,345	3,092
Kensington	171,272	2,292
Lambeth	223,763	4,090
Lewisham	221,753	7,017
Paddington	116,923	1,357
Poplar	66,604	2,346
St. Marylebone	60,045	1,472
St. Pancras	124,855	2,693
Shoreditch	40,455	658
Southwark	86,249	1,131
Stepney	92,000	1,770
Stoke Newington	52,301	864
Wandsworth	347,442	9,109
Westminster, City of	85,735	2,504
Woolwich	146,603	8,282

A royal commission on local government in Greater London reported in Oct. 1960. On July 31, 1963, the London Government Act 1963 became law and its provisions, outlined at the beginning of this article, were to come into force on April 1, 1965. The Greater London Council would consist of a chairman, aldermen and councillors (the first election of councillors took place in April 1964) and the councils of the London boroughs would each consist of a mayor, aldermen and councillors (the first election of councillors took place in May 1964). The City would continue to be administered by the court of common council as described above.

4. Administration of the Law.—*Police.*—The metropolitan police force, established by Sir Robert Peel in 1829, is under the direction of a commissioner who is appointed by the crown and acts under the authority of the home secretary. Half the cost of the force is met out of central government funds and the other half from precepts levied on the borough and district councils. In addition to the ordinary police, operating in 22 divisions, there is a body of Thames river police and specialist services at headquarters in New Scotland Yard, available for consultation by provincial forces. The City of London force was established in 1839 and is under the direction of a commissioner appointed by the Common council. (*See* also POLICE: *Great Britain.*)

Prisons.—The London prisons are local general prisons with additional special features. Brixton has accommodation for civil prisoners, Pentonville a small part reserved for recalcitrant prisoners. Wandsworth serves as an allocation centre for corrective trainees; Wormwood Scrubs as a corrective training and a young persons' prison as well as a reception centre for Borstal; it also has surgical and psychiatric centres. Holloway is a women's prison. Feltham in Middlesex is a closed Borstal for boys and Latchmere house near Richmond a reception centre.

Justice.—London has the judicial machinery of the rest of the country with certain peculiar features of its own. The principal courts for the trial of criminal cases are the central criminal court and the courts of quarter sessions. The central criminal court, taking the place of the provincial assizes, sits at the Old Bailey, under a high court judge and two full-time judges, the recorder of the City of London and the common serjeant. It serves the counties of London and Middlesex and parts of Essex, Kent, Surrey and Hertfordshire. The remaining parts of Greater London come within the southeastern circuit. London quarter sessions are held at Sessions house, Newington causeway.

In the administrative county, except for the northern part of Hampstead, the main courts of summary jurisdiction are the 12 metropolitan magistrates' courts, presided over by stipendiary magistrates. The chief magistrate's court is at Bow street. In the City the courts of summary jurisdiction are at the City of London justice rooms at the Mansion house, where the lord mayor or one of the aldermen sits, and at the Guildhall where the aldermen sit in rotation. In the remaining parts of London, summary jurisdiction is exercised by the petty sessional courts of justices of the peace, who have concurrent jurisdiction where there is a stipendiary magistrate. Lay justices also share with the stipendiaries some of the work of the criminal cases. The old petty sessional divisions were revised in 1953 and are now within the county of London. Juvenile courts within the metropolitan police court area are in an exceptional position in that they are controlled by the home office. The home secretary appoints from among the London justices a panel of magistrates who sit in eight courts. The London Probation service is also under the control of the home secretary, advised by a committee of metropolitan magistrates and juvenile court justices.

The county court districts in London bear no relation to any local government areas. The mayor's and City of London court covers the City. Some districts are wholly within the county, some within the remaining part of Greater London and some fall partly within and partly outside London. The coroners' districts include one for the City and two franchise districts for the Tower liberty and the queen's household. The other London coroners are appointed by the councils of the respective counties or county boroughs.

5. Parliamentary Representation.—The administrative county returns 42 members to parliament. The rest of Greater London is spread over about 50 constituencies. One metropolitan borough, Wandsworth, returns four members; 3 return three; 5, two; and 14, one each. The cities of London and Westminster together return one member, as do Shoreditch and Finsbury. Hackney returns one and one in conjunction with Stoke Newington; St. Pancras one and one with Holborn. Barons Court is shared by Fulham and Hammersmith.

6. Finance, Rating, etc.—The metropolitan borough councils each make one general rate (local tax) which includes the amount necessary to meet their own expenditure and also the demands of the L.C.C., the metropolitan police and the metropolitan water board. About one-third of the total amount from rates is retained locally by the City corporation and the metropolitan borough councils.

For certain services the central government makes a specific grant in aid, the principal grants being for housing, school milk and meals, and street improvements. In addition, London received before 1929 the revenue from certain assigned taxes. Between 1929 and 1948 block grants were paid to London and other local authorities, according to the needs of the different areas. After the Local Government act of 1948 the county of Essex and the county boroughs of East and West Ham were the only areas in Greater London to share in the new equalization grant. The Local Government act of 1958 abolished a number of specific grants and provided for a general block grant paid to county and county borough councils, including the L.C.C.

The main sources for grants to metropolitan borough councils are two: (1) the rate deficiency grant broadly designed to bring up to the national average the product of a penny rate to those councils which are below it; and (2) a grant resulting from the redistribution of the county's resources so as to bring the ratable value per head of the poorer boroughs up to the average for the county. The scheme, originally introduced in 1948, produced anomalies, and the 1958 act introduced a new scheme from April 1, 1959. This created an expenditure pool equal to 70% of the aggregate local rate-borne expenditure of all the boroughs and financed by ratable contributions from them. The pool is shared between the boroughs in proportion to their expenditure.

7. Ecclesiastical Areas and Denominations.—The Church of England diocese of London covers the cities of London and Westminster, the county of Middlesex and the boroughs of the county of London north of the Thames. In the diocese are the bishoprics suffragan of Fulham, Kensington, Stepney and Willesden. The diocese of Southwark contains the bishoprics suffragan of Woolwich and Kingston-upon-Thames. Parts of Greater London are in the dioceses of Chelmsford, Rochester, Canterbury, St. Albans and Guildford. The diocesan cathedrals in the county are St. Paul's and St. Saviour's, Southwark.

Westminster is the seat of the Roman Catholic primate of England; the cathedrals in Greater London are at Westminster, Brentwood and Southwark. Brompton Oratory is in Brompton road.

London is divided into six Methodist districts with the Central hall, Westminster, as the chief building. Other big Nonconformist churches are the City temple (Congregational) at Holborn circus; the Bloomsbury Central Baptist church in Shaftesbury avenue; St. Columba's Church of Scotland in Pont street, Chelsea; Friends' house (Quaker) in Euston road; the headquarters of the Salvation Army in Queen Victoria street, City. The Great Synagogue of the Jews is in Aldgate. Among the numerous foreign religious buildings are the French Protestant church in Soho square; the Greek cathedral of St. Sophia in Moscow road, Bayswater; the German Evangelical church in Montpelier place, Brompton road; the Dutch Protestant church in Austin Friars; the Islamic mosque near Regent's park.

8. Fire Prevention.—In 1833 the fire insurance companies united to form a small fire brigade, the London Fire Engine establishment. Previously fire protection had been given by separate insurance brigades and by engines provided by parishes. In 1866 after the great Tooley street fire of 1861 had shown its inadequacy, the establishment was taken over by the Metropolitan Board of

Works, which also took over the fire escape stations that had been maintained since 1836 by the Society for the Protection of Life from Fire. In 1888 the Metropolitan Board of Works was superseded by the L.C.C. The last manual engine was used in 1899, and from 1906 the internal combustion engine was standard on all new London fire brigade appliances. The brigade was built up by two famous firemen, James Braidwood, the chief of the establishment, killed at the Tooley street fire, and Eyre Massey Shaw, chief officer from 1861 to 1891. It gained a great reputation for efficiency and courage. A number of other brigades were maintained alongside it by the local authorities of the Greater London area.

Under the Fire Services act (1947) the National Fire service formed in World War II came to an end in 1948, and fire brigades became once again a local authority responsibility, but now of counties and county boroughs only. Greater London is therefore served by the brigades of the L.C.C., the county boroughs of Croydon, East Ham, West Ham, and the counties included in the area; all of these have arrangements for mutual assistance when needed.

The London Fire Engine establishment began with about 80 men; in 1888, when the L.C.C. took over, there were 581, and by the early 1960s there were more than 2,600.

The London fire brigade has about 60 stations each with a motor pump carrying a detachable, wheeled, 50-ft. escape. Most stations have another motor pump with a 30-ft. extending ladder. By the early 1960s the brigade had more than 130 motor pump escapes, mostly with water tanks and hose reels. The brigade's equipment also includes mechanical turntable ladders extending to 100 ft., several fireboats and a number of specialized vehicles. The brigade's cost is met from the county rates, after government grant and a contribution from the fire insurance companies have been credited. These companies also maintain a separate salvage corps. (For Civil Defense *see* GREAT BRITAIN AND NORTHERN IRELAND, UNITED KINGDOM OF: *Defense: Civil Defense.*) (J. E. ML.)

VIII. EDUCATION

The British and Foreign School society (1808), the National society (1811) and Ragged Schools union (1844) were the only special organizations for the education of the poor until 1870, but in that year, when the London School board was created, more than half the child population of London had no school to attend. Under the Education (London) act, 1903, which was passed to implement the intention of the Education act, 1902, of putting general education under municipal government, the board's activities were transferred (1904) to the L.C.C., which at the same time was given the responsibility of maintaining the voluntary schools.

Organized higher technical education did not get under way until the formation in 1893 of the Technical Education board under the L.C.C. During its 11 years' existence the board improved matters partly through grants to existing voluntary technical institutions and partly by conducting centres itself. There were also established the Central School of Arts and the London Day Training college (since 1932 the Institute of Education), besides many science lecture rooms, laboratories and workshops, while a scholarship plan to link elementary and secondary education was set up.

Provision for the foundation of polytechnics was made under the City of London Parochial Charities act, 1883, the model institution being that of Quintin Hogg in Regent street (1882). In 1880 the City and Guilds of London institute was formed for the advancement of technical education.

Under the Education act, 1944, the educational process was divided into primary, secondary and further education and the council was called upon to provide sufficient education throughout these stages. Free secondary education had to be available for all children of the appropriate age.

The development plan of 1947 provided for 103 comprehensive high school units, each catering for all the children in its area of the appropriate age group. Of these some would be county schools, the others would be voluntary schools and county complements. There would also be Church of England, Roman Catholic and Jewish secondary schools. Further places would be taken up in independent and direct grant schools. Nursery schools (ages 2–5) would require 1,350 units of 40 pupils. Primary schools (5–12) would average about 700 pupils. About one-fifth of the places would be in voluntary schools.

By 1962–63 approximate enrollments were 170,000 primary pupils in about 640 county schools and more than one-third of that number in about 270 voluntary schools; and 130,000 secondary pupils in about 160 county schools and about one-third as many in 100 voluntary schools. In both categories, the voluntary schools included large proportions conducted by the Church of England and the Roman Catholic Church, with a few Jewish schools. There were about 70 comprehensive schools.

The council was required by the 1944 act to consider the provision of boarding education in appropriate cases. Two methods were adopted: to pay for places in existing boarding schools; and to provide new schools. The council is therefore responsible for certain children in boarding schools not maintained by it. One selective county boarding school is provided at Woolverstone hall in Suffolk.

1. Special Services.—The educational system also makes provision for handicapped children. In 1963 there were 13 schools for the blind, partially sighted and deaf, 15 schools for the delicate, 13 schools for the physically handicapped, 32 for the educationally subnormal, 17 schools for children presenting behaviour problems through psychological maladjustment and 6 hospital schools. For other children there are speech clinics, child guidance clinics and other facilities providing specialist treatment.

2. Further Education.—Cultural and general recreational classes are offered at evening and literary institutes and a variety of educational and preliminary vocational courses for young people under 18 at colleges for further education.

Technical and professional courses are provided at more than 40 establishments, of which 14 were aided polytechnics and 28 maintained general and commercial colleges, technical colleges and colleges of commerce. The total number of full-time, part-time, day and evening students in these colleges and polytechnics in 1962–63 exceeded 160,000.

For the University of London *see* LONDON UNIVERSITY. There are three colleges of advanced technology and three national colleges of technology, which receive grants from the central government.

3. Teachers.—The L.C.C. maintains nine training colleges with places for 615 men and 1,423 women. These are not confined to London citizens, many of whom go outside the county for their training. There are also 13 voluntary training colleges in the London area. In the early 1960s London's primary and secondary schools had about 6,600 men and 11,000 women teachers. More than 1,300 full-time teachers and nearly 11,000 part-time were engaged in maintained institutions of further education.

4. Cost of the Education Service.—The gross expenditure of the L.C.C. education service in 1962–63 was £69,050,513. The cost per head in primary schools was £68 10*s.* 11*d.*, in secondary £119 8*s.* 1*d.* Of the gross expenditure 41.5% was absorbed by teachers' salaries and 5.7% by administration and inspection.

5. Independent Schools.—In early times the priories and other religious houses generally had grammar schools attached to them. Those at St. Peter's, Westminster, and St. Paul's attained a fame which has survived, while other similar foundations lapsed, such as St. Anthony's (Threadneedle street, City), at which Sir Thomas More, Archbishop Whitgift and many other men of eminence received education. Certain of the schools were re-endowed after the dissolution of the monasteries. St. Peter's college or Westminster school (*see* WESTMINSTER) is unique among English public schools of the highest rank in maintaining its original situation in London. But Charterhouse school, part of the foundation of Sir Thomas Sutton (1611), was moved (1872) from Finsbury to Godalming, Surrey; St. Paul's school (1509) has occupied modern buildings at Hammersmith since 1884, and Christ's hospital (1553) has been at Horsham, Sussex, since 1902.

Merchant Taylors' was founded by the company of that name in 1561, and occupied the premises vacated by Charterhouse school from 1875 to 1933, when it moved to Sandy Lodge, near Rick-

mansworth. The Mercers' school was transferred to Barnard's Inn in 1894 and closed in 1959. The City of London school (1442) occupies modern buildings on the Victoria embankment. Dulwich college originates in a licence granted in 1619 to Edward Alleyn. St. Olave's and St. Saviour's Grammar school received its charter in 1561 and since 1896 has been in Bermondsey. (X.)

IX. HEALTH AND WELFARE SERVICES

London has separate environmental health legislation from that of the rest of the country, the principal statute being the Public Health (London) act (1936). Public health bylaws for London are made by the L.C.C. although in many cases administered by the metropolitan boroughs.

1. Sanitation.—Drainage is shared between the county and the metropolitan borough councils. Various early works included the bridging over in 1637 of the Fleet river which as early as 1307 had become inaccessible to shipping through the accumulation of filth. A system of main drainage was inaugurated by the commissioners of sewers in 1849, but their work proceeded very slowly. It was carried on more effectively by the Metropolitan Board of Works (1856–88), and was transferred in 1889 to the L.C.C., which completed and improved the system. There are actually two distinct systems, north and south of the Thames, having separate outfall works on both banks of the river. The sludge is taken out to sea by boat and the remainder discharged into the river. The borough councils provide and maintain the local street sewers, which discharge into the county trunk sewers. The system takes both sewage and rain water, being supplemented by storm relief sewers which discharge into the Thames. Outside the London drainage area the borough and district councils are responsible, though several centralized disposal works are administered by joint boards and committees. The collection and disposal of house refuse is the responsibility of the borough councils. Disposal is usually by controlled dumping to reclaim waste land.

The City of London is the port health authority. The City and the metropolitan boroughs undertake sanitary inspection and the inspection of food, slaughterhouses, offensive trades and rodent destruction, and the provision of baths and washhouses.

2. Cemeteries.—The cemeteries of London have developed from the old parish burial grounds. There are between 300 and 400 disused grounds, some of which are now open spaces. Most of those now in use were opened after the passing of the Burial act (1852). As these are filled, new ones are opened outside the county boundaries. The Brompton cemetery is the property of the government. Several are privately owned, including the large Kensal Green cemetery. Of the 28 metropolitan boroughs, 21 have adopted the Burial act but only 17 provide municipal cemeteries. The first crematorium in Greater London was opened in 1902 at Golders Green. The City opened one at Ilford in 1904. Metropolitan boroughs followed suit in the 1930s.

3. Hospitals.—The present hospital service in London represents a confluence of two very diverse channels. Most of London's best-known teaching hospitals (of which there are 26) were not under public management before 1948, such as the Royal Hospital of St. Bartholomew, the oldest, founded by Rahere in 1123, St. Thomas' (1200), Guy's (1721), St. George's (1733), St. Mary's (1845) and the London hospital (1740). In April 1930, 77 hospitals as well as 5 mental hospitals were transferred to the L.C.C., which by 1948 maintained 100 hospitals with about 70,000 beds. On July 5 of that year, under the National Health Service act (1946) these were transferred to the regional hospital boards, which also took over the voluntary hospitals, except for the teaching institutions which were nationalized under separate management. After 1948 the county of London ceased to exist as a unit of hospital administration. There are four metropolitan hospital regions with regional boards, fanning radially from the Marble arch, but these stretch far beyond the boundaries of Greater London. In addition to these boards, there are governing bodies for the 26 London teaching hospitals.

Maternity and child welfare became the responsibility of the metropolitan boroughs in 1918, though some councils continued to use voluntary bodies. By the 1946 act the L.C.C. became responsible for these welfare services. The other branches of the national health service (dental, ophthalmic, etc.) are under the London Executive council, which covers the administrative county. The rest of Greater London comes under the executive councils of the appropriate counties and county boroughs.

4. Official Welfare Services.—After 1948 responsibility for helping those without resources or adequate means was placed on the National Assistance board (N.A.B.). Welfare (except financial assistance) remained with the county councils, who also received wider powers to care for children deprived of normal home life. The N.A.B. divides the standard London and southeastern region into an inner region (the counties of London and Middlesex with a small piece of Hertfordshire); and an outer region (western Essex, Surrey, Kent and Sussex). Within these regions there are areas of which 26 are within the administrative county. The county councils provide welfare homes and, on behalf of the N.A.B., manage reception centres in place of the old casual wards. A special problem is provided by those who, while not necessarily in financial difficulties, cannot obtain housing accommodation. For them, accommodation is provided by the L.C.C. in homeless family units and in rest centres. There are three reception centres in the administrative county, the biggest being in Camberwell.

5. Voluntary Welfare Agencies.—The special social problems of London have led to the development of voluntary work parallel with that of the official system. In addition to the big national bodies, London has had its own organizations, which grew out of the spasmodic religious and philanthropic work of the 18th and early 19th centuries. In 1869 the Charity Organization society was founded to provide systematic help for those in need. Octavia Hill (*q.v.*) began her pioneer work in housing management in 1867 by acquiring houses in St. Marylebone. Later in the century came the settlements, of which the best known are Toynbee hall (1884) in Stepney, Oxford house in Bethnal Green and Cambridge house in Camberwell. About 3,000 voluntary organizations exist for citizens of the metropolitan area.

After World War II and the growth of publicly provided welfare services, the work of voluntary organizations shifted to problems of personal adjustment, such as marital disharmony, and behaviour problems in children. In 1946 this shift was marked by renaming the Charity Organization society the Family Welfare association. There was also a growth in organizations for the care of the aged and the physically handicapped. The co-ordination of voluntary social work and the furtherance of community organizations are the special concern of the London Council of Social Service.

X. PUBLIC UTILITIES

1. Electricity.—Electric light was introduced in 1881 at the Royal Exchange and neighbourhood. Thereafter a large number of electric light companies came into existence, and some of the metropolitan borough councils and local authorities also undertook the supply.

Under the Electricity Supply act of 1926, the London and Home Counties Joint Electrical authority, composed of representatives of the county councils and the electrical undertakings, was formed and made responsible for the supply over an area of 1,841 sq.mi., stretching from Guildford to Gravesend and from Hertford to Reigate. Since 1948 the London Electricity board has served an area of 253 sq.mi. This is the smallest of the country's distribution areas but has the largest population.

2. Gas.—Gaslighting was introduced on one side of Pall Mall in 1809, though it is said that Golden Lane Brewery and portions of Beech and Whitecross streets were lit by gas in 1807. In 1810 the Gas Light and Coke company received a charter and developed gaslighting in Westminster. Since 1948 the gas industry, like electricity, has been nationalized and managed by area boards.

3. Water Supply.—In the middle ages London was supplied from local streams and from wells such as Clerk's well (Clerkenwell) and St. Clement's well near Clement's Inn. By the 13th century conduits and pipes were in use to convey the waters of the Tyburn from Paddington to the City. Subsequent conduits are recalled by Conduit street off Bond street and Lamb's Conduit street, Bloomsbury. In 1609 Sir Hugh Myddelton undertook to

supply reservoirs at Clerkenwell through the New river from springs near Ware, Hertfordshire; and these were opened in 1613. In 1630 a scheme to bring water from Hoddesdon on the Lea was promoted. The Chelsea Water company opened its supply from the Thames in 1721; the Lambeth waterworks were erected in 1783; the Vauxhall company was established in 1805, the West Middlesex, near Hammersmith, and the East London on the river Lea in 1806, the Kent on the Ravensbourne (Deptford) in 1810, the Grand Junction in 1811, and the Southwark (which amalgamated with the Vauxhall) in 1822.

In 1902 the Metropolis Water act constituted the Metropolitan Water board to purchase and carry on the undertakings of the existing companies and of certain local authorities. It consists of 88 members, appointed by the London county council, the City of London, the City of Westminster, the other metropolitan boroughs, the county councils of Middlesex, Hertfordshire, Essex, Kent and Surrey, the borough of West Ham, various groups of other boroughs and urban districts, and the Thames and the Lea Conservancies. Control passed to the board in 1904 and by 1943 it was one of the largest water companies in the world. It supplies an area of about 540 sq.mi. (42 mi. from north to south and 34 mi. from east to west). Roughly 65% of the water supplied by the board is taken from the Thames, next in importance being the Lea and New rivers. Water is taken regularly from the Laleham intake, 15 mi. above Teddington weir, and intermittently from the Staines intake 4 mi. farther upstream. (J. E. Mt.)

XI. HOUSING

The provision of municipal housing in the County of London is the responsibility of the metropolitan boroughs and the L.C.C. The boroughs have power only to build inside their own boundaries, but the county council can provide housing anywhere within the county and outside it; it is the only county council in the country with general housing powers.

Housing by the L.C.C. began at the turn of the century, but it was not until the introduction of a central government housing subsidy in 1919 that the program fully developed. The period between World Wars I and II saw a new effort to provide new homes to meet the housing shortages and to replace slum dwellings. Among these interwar in-county cottage estates is the old Roehampton estate in Wandsworth (1,212 dwellings), while Lilestone estate in St. Marylebone (391 flats) illustrates the typical high-density slum clearance developments of that period. Extensive housing estates were built in areas outside London: Becontree (Essex) and St. Helier (Surrey) were examples of such interwar out-county development.

During World War II house building stopped; by 1945 London was suffering not only from the loss of five years of housing production, but from the extensive bombing which destroyed or damaged many thousands of homes. This period, however, had not been entirely wasted. An over-all plan for the county was prepared in 1943 by Sir Patrick Abercrombie and J. H. Forshaw, and in 1945 a plan for Greater London, which covered the county and region round it, was prepared also by Sir Patrick Abercrombie.

These two plans, advisory only, have had great influence on London and the London region. The open-space proposals and the housing densities that were recommended have been very largely incorporated in the statutory Development Plan for London, prepared under the Town and Country Planning acts, 1947–62. The proposals in the Abercrombie Plan for Greater London for the establishment of a firm green belt round the built-up areas of the London area and the supplementing of out-county L.C.C. housing estates by New Towns (*q.v.*) were broadly accepted by the government and served as a basis for the policy of the statutory Development Plans for the Home Counties.

The postwar house building operations by the L.C.C. can be divided into three main sections: the building of homes within the county; the completion of a restricted number of out-county estates already proposed before World War II started; and later the building of homes under the Town Development act of 1952 which provides for the expansion of existing towns.

The L.C.C. started its first major housing project in 1894 under the Housing of Working Classes act, 1890, and by the early 1960s the council had completed more than 200,000 homes. The major effort immediately after World War II was in the building of homes in extensive out-county estates, where land acquisition had started or was proposed before the war, such as Debden (Essex) and Harold Hill. This out-county building program produced over 31,000 dwellings in seven years. Since 1950 the Architect's department of the council has set a standard of design and layout which has achieved international recognition. Before World War II, municipal housing was in general built either in cottage estates or estates of flats. The postwar trend in housing design has been for schemes of mixed development of flats and houses, using tall blocks of flats or maisonettes up to 27 stories, 4-story maisonettes and 2-story houses. What is probably the most outstanding example of municipal housing in the world is designed with this approach and is at Alton estate, Roehampton, in southwest London. There more than 2,600 dwellings are provided in 11-story maisonette and flat blocks, 4-story maisonettes, 2-story family houses and single-story old persons' houses which are set in nearly 130 ac. of a beautifully landscaped site on the edge of Richmond park. A population of approximately 9,600, with its own shops, schools, library, etc., has been housed on land which formerly comprised the extensive gardens of 18th-century country houses. Some of these fine houses have been retained and are being used for educational and social purposes.

On the other hand the L.C.C. has embarked on an ambitious program of urban redevelopment, particularly in the East End, where war damage, slum properties and obsolete layout provided an opportunity of getting rid of a sordid 19th-century environment. This was still proceeding in the early 1960s, and new houses, schools, factories and roads and, most important, an extensive system of open spaces, were being developed in the Stepney-Poplar area. There at the Lansbury estate and the Stifford estate tall blocks of maisonettes rise from grassed open spaces to give panoramic views of the docks and the Thames. Quadrant estate in Islington, Brandon estate in Southwark, Silwood estate in Rotherhithe and Warwick estate in Paddington are other examples of large-scale urban renewal projects.

The housing work done by the metropolitan boroughs has also provided some fine architecture. Examples are Churchill Gardens Housing estate, built for Westminster City council, the Golden Lane estate, built by the City of London, and certain developments by Camberwell Borough council. Outside the L.C.C. area the redevelopment carried out by the West Ham County Borough council in rebuilding one of the worst bombed areas in the Greater London area is noteworthy for its comprehensive approach.

London is a congested county, and the demand on land and the need to replace obsolete and slum areas with housing which offers greater space standards and improved living conditions means that many families have to be accommodated outside the area of the county. It has been estimated that a total of 380,000 additional dwellings would be required to meet the needs of London families between 1956 and 1972. Some, but by no means all, of these families would be settled in the eight New Towns round London; many would have to be found homes by the county council. To this end the L.C.C. initiated many plans for the expansion of existing towns under the Town Development act of 1952. Examples are at Haverhill (Suffolk), Thetford (Norfolk), Andover (Hampshire), Huntingdon (Huntingdonshire), Basingstoke (Hampshire). The county council has also proposed the building of its own New Town in Hook in Hampshire.

In general, between 1945 and the early 1960s the L.C.C. had provided more than 60,000 new dwellings inside the county and 45,000 out-county. Metropolitan boroughs had provided together about 70,000 new homes, and private builders 20,000. Over the Greater London area, which includes Middlesex and certain other authorities, local authorities had built more than 310,000 homes between 1945 and 1962, and private builders 139,000. Private building was restricted by licensing until 1952 since when it has greatly increased. Examples of outstanding privately built estates are those at Ham common, Blackheath and Dulwich.

(Ja. We.)

XII. ECONOMIC ACTIVITIES

1. Industry.—London has always been the leading centre of manufacturing in Britain. In the early 1960s Greater London had a working population of more than 5,000,000 of whom nearly half were in the manufacturing industries. The main types of industry, and of industrial area, are: (1) the old-established West End luxury industry (*e.g.*, the bespoke tailors of Savile row and the women's clothing area round Oxford street); (2) the mass-production industry of the East End, producing mainly clothing (as in Whitechapel) and furniture (as in Shoreditch and Bethnal Green). A feature of both (1) and (2) is the prevalence of small workshops concentrated in industrial quarters with the advantages of ancillary services, labour supplies and rapid dissemination of market trends. (3) Riverside heavy industry, dependent on imported materials (sugar refining, power stations, automobiles, shipyards); (4) the newer industries of the suburban ring (as in Park Royal, along the Great West road and on the west side of the Lea valley), which developed in 1918–39 for producing light, high-value goods, especially engineering, vehicles (including aircraft) and electrical products. Most of this last group represents outgrowths of (1) or (2) and since 1945 it has continued to expand rapidly both in the suburbs and in the outer ring. London is also the centre of the British printing industry and motion-picture production.

2. Trade.—With New York and Rotterdam, Neth., London is one of the three big ports of the world. Situated at the head of ocean navigation on the Thames estuary it is the chief exporting and importing centre of the United Kingdom, its exports valuing more than one-third of the national total. The imports, mainly consumption goods for the London region, are, in order of value: tea, petroleum, wool, raw sugar, timber, butter, metals and meat. Exports are mainly manufactured products.

The Port of London.—This comprises 69 miles of waterway, more than 2,000 ac. of dock real estate and 43 miles of deep-water quays. There are five main groups of docks: (1) the London and St. Katharine docks, nearest the City; they are warehousing docks (tea, wool, wines and spirits); (2) India and Millwall docks, on the Isle of Dogs (sugar, fruit, grain, hardwood); (3) Surrey Commercial docks, on the south bank (timber); (4) the Royal docks opposite Woolwich (Royal Victoria, Royal Albert with vast refrigerated meat stores, King George V); large capacity import docks (tobacco and meat); (5) Tilbury, 26 mi. downstream from London bridge, bulk docks for transit upstream, without warehouses; the passenger terminal with floating passenger landing stage and great dry dock. Since 1909 the docks have been managed by the Port of London authority (P.L.A.), comprising representatives of government departments, the City corporation, the L.C.C., Trinity house, traders and workers. Outside P.L.A. management are the private wharves lining the river downstream from London bridge.

3. Commerce.—London's commercial activities are concentrated in the City, and stem directly from the importance of the port in international trade. The London Chamber of Commerce is there. With New York, London is one of the two great financial centres of the world. Its financial institutions, which mostly date from the late 17th and early 18th centuries, include the Bank of England; the English clearing banks, 8 out of 11 of which have their headquarters in the City; the London offices of foreign and Commonwealth banks; the merchant banks for international borrowing; specialized financial institutions including discount houses, stockbrokers, insurance companies, including Lloyd's, the great marine underwriters; and the Stock exchange. The City also contains great commodity exchanges: the Baltic exchange (grain, seeds, vegetable oils, shipping) and the London Commodity exchange (cocoa, coffee, sugar, rubber, etc.), as well as specialized exchanges for wool and metals. (*See* Baltic, The; Bank of England; Lloyd's; Stock Exchange; *Great Britain.*)

Markets.—Much of the fresh food consumed by Londoners comes through wholesale markets situated mainly on or just beyond the edge of the City: Billingsgate (fish), on the waterfront; Smithfield (meat), at the northern edge of the City; Covent Garden, the great fruit, vegetable and flower market, on the west (this market was scheduled in the 1960s to be moved to a Nine Elms site in southwest London); Spitalfields, a subsidiary fruit, vegetable and flower market, on the east; and Leadenhall (poultry) on the southeast. The metropolitan cattle market and abattoir are at Islington. (*See* also Billingsgate; Covent Garden; Smithfield; Spitalfields.)

XIII. COMMUNICATIONS

1. River.—The primary importance of the river as a highway is to the port; although upstream of London bridge it is used by barge traffic (chiefly fuels and timber) to Teddington, where the lowest Thames lock is, and to Kingston-upon-Thames. Summer launch services run from Westminster upstream to Kew, Richmond and Hampton Court and downstream to Tower bridge, Greenwich and the docks; steamers from Tower pier take excursionists to Southend, Essex; but otherwise the river is chiefly important as a barrier.

2. Roads.—Main roads in London are of five kinds: (1) Roman roads, many of which are followed by modern highways; including Watling street (*q.v.*), northwest by Edgware road; Ermine street (*q.v.*), north by Kingsland road; Stane street, to Chichester (Sussex) by Clapham road; the Silchester road, by Bayswater road; (2) old field ways linked up to make modern high roads, *e.g.*, Harrow road; these, narrow and twisting, cause some of London's worst traffic problems; (3) former turnpikes of the 18th or 19th century, then just outside the built-up area; these included some new roads, *e.g.*, Finchley road, built 1826–30 as a direct road from the West End to the north, bypassing Islington and Highgate; (4) streets cut through central London in the 19th century as part of slum clearance schemes. The model was John Nash's Regent street (begun 1813). Later roads of this kind include New Oxford street, Clerkenwell road, Farringdon road, Charing Cross road, Shaftesbury avenue, the Thames embankments and Victoria street; (5) arterial roads built 1918–39 in the outer parts of the conurbation; they include such major works as the Great West road, North Circular road and Kingston bypass. After 1950 the Cromwell road was extended through Hammersmith to Chiswick, with new flyovers (overpasses) at both these places; the improvement was completed in 1962. Traffic congestion in inner London, already serious enough in 1905 to merit study by a royal commission, increased enormously with the growth of private motoring.

During 1960 the government announced an accelerated program of urban road construction, under which an average of £10,000,000 a year would be allocated to improvements in the County of London. The most important schemes expected to be completed in the decade 1960–70 include: the Park lane improvement (completed 1962), including the construction of an east-west underpass at Hyde Park corner and the conversion of Park lane and the East Carriage drive to complementary dual carriageways (four lane highways); the underpass between Kingsway and Waterloo bridge north approach, under the Strand (completed 1964); the underpass between Victoria embankment and Upper Thames street, under Blackfriars bridge; the underpass for Euston road under Tottenham Court road; new junctions on roundabout principles at Holborn near Kingsway, St. Giles' circus and Elephant and Castle; duplication of Blackwall tunnel to provide one-way flow in each tunnel; extension of Western avenue on motorway (M) principles to Paddington, with flyover across Edgware road to Marylebone road; a new north-south link on motorway principles across west London from Western avenue extension to a new Thames bridge near Wandsworth; comprehensive improvement of the Dover road, on motorway principles, with a spur to the duplicated Blackwall tunnel.

Outside the county, plans were made for radial motorways from Chiswick to London airport and the west (M4, completed 1965); from Hendon to the Birmingham motorway (M1, first stages to be completed 1967); from Leyton to Bishop's Stortford; from south London to Crawley, for Brighton; and from Sunbury-on-Thames to Basingstoke (M3).

Public road transport is provided exclusively by the central (red) diesel buses of the London Transport board (L.T.B.) and by taxicabs. The London General Omnibus company, founded in 1855, became the principal operator. It replaced horse buses by

motor buses between 1905 and 1911, amalgamated with the underground railways in 1915, and in 1933 passed under control of a public authority, the London Passenger Transport board, which in 1948, on the nationalization of the main line railways, became the London Transport executive of the British Transport commission. In 1962, on the abolition of the commission, the executive became the London Transport board. Buses replaced the remaining tramcars in 1952 and the remaining trolley buses in 1962. The L.T.B. operates all scheduled passenger services within a 2,000-sq.mi. region of average radius 25 mi. from Charing Cross. In the outer parts of this region the L.T.B. operates "country" buses (green), and right across the region run the express long-distance Green line coach services, introduced in 1930. About 6,000 diesel taxicabs are licensed by the Metropolitan police and are operated by companies or owner-drivers. Smaller taxicabs (minicabs) introduced in 1961 must be pre-booked and may not ply for hire.

3. Railways.—London's first railway was the London and Greenwich (1836). Most early lines (London and Birmingham 1837; Great Western 1838) were trunk lines, and suburban traffic developed tardily. When it did, it focused primarily on City termini: *e.g.*, the London, Brighton and South coast to London bridge; the North London, to Broad street. From the 1860s certain lines were compelled to run cheap workmen's trains at very low fares; this brought about the development of workers' suburbs in Tottenham and Walthamstow by 1900. After nationalization of the railways in 1948 King's Cross, Liverpool street, Marylebone (since 1959 wholly a London Midland region station) and Fenchurch street stations had headquarters offices for the Eastern region; Waterloo, Charing Cross, London bridge and Victoria for the Southern region; Euston for the London Midland region, with departments at St. Pancras, Broad street and Marylebone; and Paddington for the Western region.

Parliament did not allow the main lines to enter central London, stipulating that the termini should be connected by underground lines. The first such railway, the Metropolitan, opened under steam operation in 1863 between Paddington, Euston, King's Cross and Farringdon street; it was extended progressively to form an inner circle in 1884, the system being electrified in 1905. A separate underground network peculiar to London is the system of deep-level "tube" railways whose construction was facilitated by the underlying London clay; it runs at a depth of about 50–100 ft. (181 ft. at Hampstead). The first tube railway, the City and South London between King William street and Stockwell, was opened in 1890; by 1907 the network of lines under central London was complete. These early tubes were almost wholly within the built-up area, but between 1924 and 1939 they were extended above ground into the open country, thus encouraging suburban expansion on an enormous scale. By 1939 the tube system extended to Uxbridge on the west, to Stanmore and Edgware on the north and to Morden on the south, a radial distance of 10–15 mi. In 1962 a new tube was approved between Victoria and Walthamstow, to be completed 1968. (*See* also SUBWAY [UNDERGROUND RAILWAY]: *The London Transport System.*) South of the river the suburban services of the main line railways were increasingly electrified from 1909; most of those of the Southern railway were electrified between 1925 and 1930, and in 1933–38 express lines to the coast (Brighton, Portsmouth) were electrified, encouraging long-distance commuting. Suburban electrification north and east of London followed World War II.

4. Commuting.—In 1961, about 1,300,000 persons entered central London each workday morning between 7 and 10 A.M. Whereas in 1905 three-quarters of the commuters were bound for the City, by the 1960s about half went to the West End. About 505,000 came by underground railways, 453,000 by surface railways (mainly electric), 215,000 by bus, and 120,000 by private transport, including 90,000 people in 65,000 automobiles. Thus over 90% came by public transport. A major problem was the great congestion in the peak hour and even in very short periods within it. Attempts to meet the problem by the staggering of working hours met with only limited success.

5. Air Transport.—London airport, at Heathrow, 15 mi. W. of central London, is one of the largest and busiest in Europe, with a traffic that increased from 1,830,000 passengers in 1946 to 5,400,000 in 1960. As a result an increasing amount of traffic was diverted to Gatwick airport, 27 mi. S. of London. In 1964 a plan was approved to supplement these airports by one at Stansted, 34 mi. N. of London. A privately owned helicopter terminal (Heliport) was opened in 1959 on the south bank of the Thames.

6. Post and Telecommunications.—The post office dates from an act of 1657; it still occupies its traditional headquarters in St. Martin's-le-Grand on the northwestern edge of the City. For rapid distribution of mail, a post office underground railway crosses central London from Paddington to Whitechapel, with intermediate stops at the main sorting offices. The headquarters of the general post office telecommunication system are in London. The overseas telegraph, telephone and telex services are operated from London where there are international centres.

7. Radio, Television and the Press.—Broadcasting house, close to All Souls' church, Langham place, is the headquarters of the British Broadcasting corporation which has its television centre at Shepherds Bush. The national newspaper offices are in and around Fleet street, *The Times* having its offices in Printing House square.

See also references under "London" in the Index. (P. G. H.)

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LONDON, CONFERENCES OF. Many important international conferences have been held in London during the 19th and 20th centuries. The first, in June 1814, was the outcome of the visit of the Allied sovereigns to the prince regent after the downfall of Napoleon, the opportunity being used to effect some of the settlements agreed upon in the first treaty of Paris, notably the conditions attached to the erection of the kingdom of the United Netherlands. From 1815 onward, too, diplomatists of the Allies accredited to Great Britain formed a conference in London for the purpose of discussing measures for the suppression of the slave trade and of the Barbary pirates.

Greece.—In 1827 a conference met in London to attempt to settle the affairs of Greece. This conference (the first international gathering to be usually thus described) met on July 12, 1827, and sat till 1832. It was attended only by the representatives of the three powers which had signed the treaty of London (July 6, 1827); *i.e.*, France, Great Britain and Russia. The treaty of London of May 7, 1832, however, which established the kingdom of Greece, with Prince Otto of Bavaria as king, was signed also by Baron de Cetto on behalf of the king of Bavaria.

Belgium.—In 1830, while this conference was still in session, the insurrection of the Belgians against the king of the Netherlands led to the summoning of another conference in London, which first met on Nov. 4, 1830, there being in all 70 sessions. After the independence of Belgium had been recognized and Leopold of Coburg had been elected king (June 4, 1831) a Belgian plenipotentiary was also admitted. On Oct. 1, 1832, Austria, Prussia and Russia having refused to agree to the French proposal to coerce the Dutch king into accepting the 24 articles embodied in the treaty of Nov. 15, 1831, the conference virtually broke up, the further proceedings being conducted by the representatives of France and Great Britain. These ended on May 21, 1833, with the signature of a convention between the two powers and the Netherlands, providing for the nonrenewal of hostilities and freedom of navigation on the Scheldt and Meuse. Thus matters remained till 1839 when, the king of the Netherlands having at last consented to recognize the inevitable, the plenipotentiaries of all the five powers met in London to sign with those of the Netherlands, on April 7–19, a treaty to which the 24 articles of Nov. 15, 1831, were annexed (*see* BELGIUM).

Schleswig-Holstein and Luxembourg.—In 1848 the war between Prussia and Denmark over the Schleswig-Holstein question (*q.v.*) led to the assembling of an international conference in London. It met after the pressure of the powers had forced Prussia to conclude the truce of Malmö (Aug. 26) and resulted in the peace signed at Berlin on July 2, 1850, which left the main problems unsolved. By the protocol signed on May 8, 1852, the conference settled the succession to the Danish throne and the duchies of Schleswig and Holstein on Christian of Glücksburg.

In 1864, during the war between the two great German powers and Denmark, Great Britain invited the signatories of the protocol of 1852 to a conference in London, with a view to a settlement. The conference met on April 25, immediately after the storming of the Düppel lines; but, as a result of Bismarck's diplomacy, it broke up on June 25 without having effected anything.

In 1867 an important international conference met in London, at the instance of the king of the Netherlands, to deal with the situation in regard to Luxembourg created by the war of 1866 and the consequent dissolution of the old German confederation. The conference consisted primarily of the representatives of the states signatory of the treaty of 1839, by which the status of the grand duchy of Luxembourg had been determined (*i.e.*, Austria, Belgium, France, Great Britain, Holland-Luxembourg, Prussia and Russia), but on the motion of Lord Stanley, who presided, the Italian ambassador was also invited to assist. The conference resulted in the treaty of London of May 11, 1867, by the terms of which the Prussian troops, which had garrisoned the city of Luxembourg since 1815, were to be withdrawn and the fortress demolished. On the motion of the Prussian plenipotentiary, Count Bernstorff, the signatories guaranteed Luxembourg's neutrality.

Russia.—In 1871, during the Franco-German War, the denunciation by Russia of the Black Sea clauses of the treaty of Paris of 1856 led to the assembling of a conference in London, in order to regularize the situation thus created by a revision of the treaty of 1856, so far as regarded the neutralization of the Black sea, the straits of the Dardanelles and Bosporus, and the navigation of the Danube. The conference, which sat from January to March and was attended by the representatives of North Germany, Austria-Hungary, Great Britain, Italy, Russia and Turkey while revising the treaty in accordance with Russia's wishes, asserted the principle of the inviolability of treaties (*see* TREATY).

Treaty of Berlin.—In 1883 a conference sat in London (Feb. 8–March 10) to consider the execution of articles 54 and 55 of the treaty of Berlin of July 13, 1878, concerning the navigation of the Danube (*q.v.*). It was attended by representatives of all the powers which had signed the Berlin treaty and those of the other riverain states (*i.e.*, Serbia and Rumania) which had not signed the treaty were invited to attend but without a deliberative voice. Bulgaria, as a vassal state, was represented by the Turkish delegate. Rumania refused to accept these conditions, but the Serbian plenipotentiary attended the sessions.

Egypt.—In 1885 a conference between the great powers and Turkey was held in London to deal with the situation arising out of the financial crisis in Egypt. The result was the signature in March of what is known as the London convention, the terms of which were embodied in a khedivial decree and, with some modifications, remained for 20 years the organic law governing the administration of the finances of Egypt (*see* EGYPT: *History: Modern Period*).

Naval Conference.—In 1908, at the invitation of the British government an international naval conference met in London to attempt a settlement of those questions regarding contraband, blockade, etc., which had been raised at the second Hague conference. The conference met on Dec. 4, 1908 and continued in session until Feb. 26, 1909, the outcome of its labours being the Declaration of London. This declaration was never ratified.

The Balkans.—In 1912 and 1913 conferences were held in London to arrange terms of peace between Turkey and the allied Balkan states, Bulgaria, Greece, Montenegro and Serbia. The conference, which was attended by representatives of the belligerent states, was opened on Dec. 16, 1912, by the British foreign secretary but was suspended without result on Jan. 6. It met again on May 30, 1913, the outcome being the treaty of London signed on the same day. The conference was dissolved on June 9, and its work was rendered abortive by the outbreak, immediately afterward, of the Second Balkan War (*see* BALKAN WARS).

Conferences After World War I.—In 1921–22 four conferences of Allied statesmen were held in London, to adjust matters arising out of the peace treaties which ended World War I. The first met from Feb. 21 to March 14, 1921, and carried on alternately two sets of negotiations, one with the Athens, Constantinople and Ankara governments on the near eastern question (*see* TURKEY), the other with Germany on the subject of reparations. The result in both cases was failure. The conference was hardly over before the Greeks launched a new offensive against the Turkish Nationalists, while the unacceptable German counterproposals led, early in March, to fresh sanctions being taken against Germany (occupation of Düsseldorf, etc.).

On April 29 the Allied leaders met again in London, having before them the Reparations commission's estimate of Germany's total liability. They made this the basis of a schedule of payments which was sent to Berlin on May 5, with an ultimatum, and on the 11th the German government accepted the Allies' terms.

In 1922 as a result of the failure of Germany to carry out this agreement, similar conferences of Allied leaders met in London, in August and in December. At each of these R. Poincaré put forward his claim for "productive guarantees" from Germany as a precondition of any moratorium. The British could not agree to such sweeping measures and the conference adjourned on Dec. 11 without agreement being reached (*see* REPARATIONS).

In Jan. 1930 the United States, France, Italy and Japan, accepting a British invitation, met in London to discuss naval disarmament. By the end of three months general agreement had been secured on the regulation of submarine warfare and a five years' holiday for capital ship construction. The United States, Great Britain and Japan signed, on April 22, a treaty limiting battleship tonnage in the ratios of 10:10:7. France and Italy, opposed respectively to the concept of ratios and the acceptance of any inequality, declined to sign (*see* DISARMAMENT).

On June 12, 1933, the World Economic conference met in London, with representatives of the U.S. and all the League of Nations states in attendance. Soon after it opened, the announcement by Pres. Franklin D. Roosevelt of his opposition to currency stabilization rendered its proceedings nugatory, and on July 27 it adjourned with nothing accomplished.

Conferences After World War II.—On Jan. 10, 1946, the first part of the first session of the United Nations assembly met in London at the Central hall, Westminster. It was principally notable for the election of Trygve Lie as secretary-general and the bringing into operation of the Security council and the Economic and Social council.

After the failure of the French assembly to accept the European Defense community plan a nine-power conference was hurriedly summoned to meet in London on Sept. 28, 1954. The foreign ministers of Great Britain, the United States, Italy, Belgium, the Netherlands and Canada and the prime ministers of France, the Federal Republic of Germany and Luxembourg were present. The agreements which they signed on Oct. 3 provided for the termination of the occupation regime in western Germany, the establishment of an agency to control continental armaments, and the admission of Germany and Italy to the Brussels Treaty organization and of Germany to the North Atlantic Treaty organization (*q.v.*). Britain undertook to maintain four divisions on the continent for 44 years and the Federal Republic of Germany pledged itself not to seek German reunification by force.

In 1956 the nationalization of the Suez canal by the Egyptian government created an urgent problem for all the canal users. At the invitation of Britain, France and the United States a conference of 22 countries met in London during Aug. 16–23. Eighteen countries agreed on a plan to guarantee free use of the canal. This was rejected by Egypt, and a second London conference (Sept. 19–21) proposed the establishment of a canal users association. The association, imperfectly conceived and inadequately directed, failed to materialize and in October the Israeli attack on Egypt and the Anglo-French armed intervention in Suez gave events an entirely different turn.

See also references under "London, Conferences of" in the Index. (W. A. P.; H. G. N.)

LONDONDERRY, EARLS AND MARQUESSES OF. The title of earl of Londonderry was first created for THOMAS RIDGEWAY (*c.* 1565–1631), a Devon man, who was treasurer in Ireland from 1606 to 1616 and was engaged in the settlement of Ulster. Ridgeway was knighted in 1600, made a baronet in 1611, Baron Ridgeway in 1616 and earl of Londonderry in 1622. His great-grandson ROBERT, 4th earl, died without male issue in March 1714, when the earldom became extinct. Robert's son-in-law, THOMAS PITT (*c.* 1688–1729), son of Thomas "Diamond" Pitt (1653–1726) and uncle of the great earl of Chatham, was created earl of Londonderry in 1726, but the earldom again became extinct when his younger son RIDGEWAY, 3rd earl of this line, died unmarried in Jan. 1765.

In 1796 ROBERT STEWART (1739–1821), of Mount Stewart, County Down, was made earl of Londonderry in the Irish peerage. He had been created Baron Londonderry in 1789 and Viscount Castlereagh in 1795; in 1816 he was advanced to the rank of marquess of Londonderry. His son by his first marriage, ROBERT (1769–1822), 2nd marquess, is best known as Viscount Castlereagh, foreign secretary from 1812 to 1822 (*see* LONDONDERRY, ROBERT STEWART, 2nd Marquess of). He was succeeded by his half brother (*see* LONDONDERRY, CHARLES WILLIAM STEWART [VANE], 3rd Marquess of) who in 1819 married as his second wife the daughter and heiress of Sir Henry Vane-Tempest and changed his surname to Vane. The 5th and 6th marquesses made further changes to the family name, which became in 1885 Vane-Tempest-Stewart.

CHARLES STEWART HENRY VANE-TEMPEST-STEWART (1878–1949), 7th marquess, was member of parliament for Maidstone from 1906 to 1915, undersecretary for air (1920–21) and minister of education for Northern Ireland (1921–26). As secretary of state for air (1931–35), he was criticized first because of the extent to which his caution obstructed progress at the Geneva disarmament conference toward the abolition of bomber aircraft, and later, after Hitler's extravagant claims (1935) for the German air force, because of British weakness. He defended his policy in *Wings of Destiny* (1943). He died in Northern Ireland on Feb. 11, 1949. His grandson, ALEXANDER (1937–), 9th marquess, succeeded to the title in 1955.

LONDONDERRY, CHARLES WILLIAM STEWART (VANE), 3RD MARQUESS OF (1778–1854), British soldier and diplomatist who served in the peninsular war and took part in the diplomatic affairs of the Napoleonic and post-Napoleonic period. He was the son of the 1st marquess by his second marriage, with the daughter of the 1st Earl Camden, and was born in Dublin on May 18, 1778. He was thus half brother to Lord Castlereagh, the 2nd marquess of Londonderry (*see* LONDONDERRY, ROBERT STEWART). He entered the army and served in the Netherlands (1794), on the Rhine and Danube (1795), in the Irish rebellion (1798) and in the Netherlands (1799), rising to be colonel. He was elected M.P. for Derry and became undersecretary for war under his half brother Lord Castlereagh in 1807. In 1808 he was given a cavalry command in the peninsula, where, in 1809, and in the campaigns of 1810–11 as major general, he served under the duke of Wellington as his adjutant general.

He was at the capture of Ciudad Rodrigo, but at the beginning of 1812 he was invalided home and Wellington refused his request of a cavalry command. Castlereagh then sent him as ambassador and military representative to Prussia, now engaged in the struggle against Napoleon. He was no great diplomatist but his energy and courage were sometimes most useful. In 1814 he was made a peer as Baron Stewart, and later in the year was appointed ambassador at Vienna, and was a member of the important congresses which followed, where he sometimes shocked high society by his undiplomatic behaviour. In 1822 Castlereagh's death made him 3rd marquess of Londonderry, and after attending the conference of Verona he resigned, being created Earl Vane (1823). In 1835 he was appointed by Sir Robert Peel at the suggestion of the duke of Wellington as ambassador to St. Petersburg but criticism in the house of commons forced him to resign at once. After the death of Wellington in 1852, he received the Order of the Garter.

He was twice married, first in 1808 to the daughter of the earl of Darnley, and secondly in 1819 to the rich heiress of Sir Henry Vane-Tempest, when he assumed the name of Vane. He was devoted to his half brother, defended his reputation and published 12 volumes of his correspondence as well as books on his own military career and travels. He died in London on March 6, 1854. (C. K. W.)

LONDONDERRY, ROBERT STEWART, 2ND MARQUESS OF (1769–1822), better known as VISCOUNT CASTLEREAGH, statesman and diplomatist responsible for British policy in the peace settlement at the close of the Napoleonic Wars, was born in Dublin on June 18, 1769. His father, Robert Stewart (d. 1821), was a landowner of Donegal and County Down who, largely through successive marriages with daughters of Lord Hertford and Lord Camden, was elevated to the peerage in 1789, promoted earl (1796) and finally marquess of Londonderry in 1816. Robert, his eldest surviving son by his first wife (Lady Sarah Frances Seymour-Conway), known from 1796 to 1821 by the courtesy title of Viscount Castlereagh, was educated at Armagh and St. John's college,

Cambridge. He was elected to the Irish parliament of 1790 as an independent member. In 1794 he married Amelia Anne Hobart (d. 1829), daughter of the earl of Buckinghamshire, a beautiful if slightly eccentric woman to whom he remained devotedly attached throughout their long and childless marriage. In 1797 he was appointed keeper of the privy seal (Ireland) by his relative, Earl Camden, then lord lieutenant of Ireland, and from March 1798 served him as acting chief secretary. He was formally appointed to that office in Nov. 1798 by the next lord lieutenant, the marquess Cornwallis.

Castlereagh's tenure of office in Ireland coincided with the two most important events of Irish history in the late 18th century: the 1798 rebellion and the union with Great Britain. While taking active and successful measures to quell the revolt in 1798, Castlereagh shared the view of Cornwallis that a policy of clemency was essential to end the disturbances. At the same time the rebellion showed the need for drastic changes in the Irish constitution. The threat of French invasion and the 1798 rebellion convinced Castlereagh of the need for a union with Britain; and it was to assist Cornwallis in promoting this measure that he was appointed chief secretary. The operation was difficult and sordid; it was only by tact and persistence, backed by systematic bribery, that the executive finally carried the Union act through the Dublin parliament in June 1800. Its passage provided the first great demonstration of Castlereagh's qualities; and his singlehanded leadership of the Irish commons against the massed oratorical talent of the Irish Protestant opposition was the start of his political reputation. The bitter resistance confirmed his view that the issues of union and Catholic emancipation must be separated if either was to be achieved; but as soon as the union was accomplished, he urged the early settlement of the Catholic question. In Feb. 1801, when Pitt left office on his failure to obtain George III's consent to emancipation, Cornwallis and Castlereagh at once sent in their resignations, consenting to serve, however, until their successors could take over.

Secretary for War (1805–09).—Though out of office after May 1801 Castlereagh continued to advise Henry Addington's ministry on Irish questions, and in July 1802 he was appointed president of the board of control responsible for Indian affairs. His energy and intellectual powers gained him an immediate influence in the cabinet and after Pitt's return as prime minister (May 1804) he also took over in July 1805 the duties of secretary for war. His first important task, the dispatch of a British expeditionary force to Hanover, was rendered ineffectual by Napoleon's victory at Austerlitz (Dec. 1805); but it convinced Castlereagh of the strategic value of the British army in continental warfare, and he urged the organization of a permanent force of 60,000 men to serve in any suitable theatre of war. On Pitt's death in Jan. 1806 he left office and became the chief opposition spokesman on foreign and military affairs. He returned to the war department in the duke of Portland's ministry in April 1807, and successive projects for an expedition to the Baltic (partly frustrated by Russia's alliance with France in the treaty of Tilsit of July 1807) and to South America (to detach the Spanish colonies from French-occupied Spain) showed his determination to engage in major warfare against a continent now completely dominated by Napoleon. The adoption in 1808 of his plan for reorganizing the regular, reserve and militia forces provided the country with adequate home defenses and a larger and more efficient army for overseas operations. When the Spanish revolt broke out the same year, the decision was at once taken to send a major expedition to the peninsula. Castlereagh failed, because of the claims of seniority, to get Sir Arthur Wellesley (later duke of Wellington) as supreme commander, but after the death of Sir John Moore at Corunna in Jan. 1809, he secured the cabinet's consent to the continued defense of Portugal under Wellesley.

Castlereagh now planned an operation against Napoleon's central naval base at Antwerp, which would also influence north Germany in favour of the allies fighting in central Europe. Cabinet procrastination delayed the expedition until the battle of Wagram (July 1809) forced Austria to make peace, and the cautious tactics followed by the commander, the earl of Chatham, contrary to Castlereagh's instructions, allowed the force to waste away of disease on the island of Walcheren. The disaster brought to a head the long-standing divisions and intrigues in the cabinet. Since March 1809, George Canning, the foreign secretary, had been pressing for a change of policy and even before the Walcheren expedition he had secured secret agreement to the replacement of Castlereagh by the marquess Wellesley. When, in September, Castlereagh eventually learned of the ignominious position in which he had been left, he attributed the whole blame to Canning. The two men fought a duel (Sept. 21) and subsequently resigned office. Portland also retired, and though Spencer Perceval patched up the weakened cabinet, Castlereagh remained out of office for the next two and a half years.

Foreign Secretary (1812–22).—In March 1812 he rejoined the government as secretary for foreign affairs. After Perceval's assassination in May 1812 he offered to transfer to the exchequer to facilitate the adhesion of Canning, but negotiations broke down on Canning's refusal to accept the superior status of Castlereagh who had succeeded Perceval as leader of the house of commons. British foreign policy now passed for a decade under unified control. Castlereagh's first task was to hold together the shaky and distrustful elements in the general European opposition to Napoleon; but as the end of the war drew near he worked increasingly to obtain preliminary concert among the allies for the resettlement of Europe. For this purpose he went to the continent at the end of 1813 as British plenipotentiary. In talks at Châtillon he secured acceptance in principle of his plans for a peace settlement under the control of the great powers, and the treaty of Chaumont (March 1814), though in form a military alliance, contained provision for allied co-operation for 20 years after the war. On the fall of Napoleon the treaty of Paris (May 1814) secured immediate British requirements (the restoration of the Bourbon monarchy and the separation of the Low Countries as an independent kingdom), and set Castlereagh free to play a commanding and mediatory role at the peace conference at Vienna (*see* VIENNA, CONGRESS OF). His main European objectives were to obtain safeguards against Russia (the chief military threat, after France, to European stability) and to strengthen the weak central European areas of Germany and Italy. He and Metternich, the Austrian minister for foreign affairs, dominated the inner negotiations for the definitive treaty of Vienna, though it was Castlereagh who took the lead in resisting the inordinate territorial demands of Russia and Prussia. The final settlement, with some compromises, notably on Poland, was a practical embodiment of his principle of the "just equilibrium."

The other issue to which Castlereagh attached fundamental importance was the regular consultation by the great powers as a body on matters of common concern; and the peace treaty contained specific provision for periodic meetings of the contracting parties. Though the practice of holding such meetings became known as the "congress system," Castlereagh's aim was to make possible diplomacy by conference rather than to establish any system of international regulation by the great powers. The distinction became increasingly apparent in the remaining seven years of his career. The congress of Aix-la-Chapelle (*see* AIX-LA-CHAPELLE, CONGRESSES OF) in 1818 readmitted France to the concert of powers. Castlereagh firmly resisted, however, a Russian attempt to institute a league of European powers to guarantee the existing order under sanction of military force. When the liberal movement in Germany after 1818 and the revolutions in Spain and in the kingdom of the Two Sicilies in 1820 brought Austria and Russia closer together, he refused to treat their meeting at Troppau in Oct. 1820 as a full European congress; and after the congress of Laibach (1821) he openly repudiated the Troppau principle of intervention and coercion. His classic state paper of May 1820 emphasized the difference between the despotic states of eastern Europe and the constitutional structures of Britain and France, and made it clear that the British government could only act on the expediency of any given issue and within the limits of its parliamentary system. With the emergence in 1821 of the questions of Greek independence and the fate of the Spanish colonies, however, British political and commercial interests became directly

affected and Castlereagh decided to attend in person the congress of Verona in Oct. 1822. The instructions he drew up for himself showed plainly that he would not sanction forcible interference in either Greece or Spain, and that Britain would ultimately be prepared to recognize *de facto* governments resulting from successful revolutions. Though the cabinet, which now included Canning, may have had some influence in shaping the emphasis of these state papers, it is clear that Castlereagh was preparing for that detachment of Britain from the reactionary policy of the continental powers which was accomplished after his death.

This development was largely hidden from the British public by the personal nature of Castlereagh's diplomacy and his aloofness from public opinion. His apparent involvement with the eastern autocracies was disliked at home, and his role as spokesman for the government in the violent domestic politics of the postwar era kept him in a position of unpopular prominence. As leader of the house of commons he was identified with the repressive policies of the years 1815–19, which saw the Peterloo "massacre" and the six acts, and with the cabinet's unsuccessful introduction in 1820 of a bill to dissolve George IV's marriage with Queen Caroline. He was savagely attacked by Liberal romantics such as Lord Byron, Thomas Moore and Shelley, and his stock characterization in radical cartoons was "Derry Down Triangle," a reference to a baseless charge of flogging prisoners in the 1798 rebellion revived by Henry Brougham (afterward Baron Brougham and Vaux) in 1817. After the abortive Thistlewood plot in 1820 he always carried pistols in self-defense, and during the trial of Queen Caroline he was obliged to take up his residence in the foreign office for greater safety. Yet in his own aristocratic political world he was always a distinguished and commanding figure. Though he was a curiously bad debater and orator, except when replying to attacks, the house of commons trusted him as they never trusted Canning. From 1812 to 1822 he was a leading figure in the government and would certainly have succeeded Liverpool as prime minister had he survived. He was one of the few ministers who had influence with George IV, and the burden of work and anxiety imposed on him by the royal divorce affair of 1820, in addition to his duties at the foreign office and in the house of commons, probably hastened his final collapse. In 1821 there were premonitory symptoms of abnormal suspiciousness, and by the end of the parliamentary session of 1822 he was showing alarming signs of persecution mania. He was, or thought he was, being blackmailed on charges of homosexual acts, and on Aug. 12, 1822, he committed suicide shortly before he was due to set out for Verona.

Character and Achievements.—Castlereagh was a tall and dignified man, inheriting much of the beauty of his mother, with perhaps a hidden strain of the instability attributed to the Hertford family. His physical and moral courage, his patience and outward imperturbability covered a sensitivity of temperament shown in his love of flowers and natural scenery; while his stately appearance and exquisite courtesy made him the idol of women. With an aristocratic disdain for popular approval, an indifference to nationalist passions, and a scorn of abstract theories, he had a serene and unimpassioned intelligence and a civilized conception of the value of freedom, peace and order in international life. His character and achievements were violently misrepresented in his own day; and after his death his work was long overshadowed by the flamboyance of Canning, who gave greater emphasis and publicity to the policy which Castlereagh had been developing in the final phase of his career. The task of reconciling the divergent aims of the allies led him in later years into some ambiguities, and his cardinal aim of maintaining understanding among the great powers was subjected to increasing strain. Yet he remains one of the greatest and most creative of British foreign secretaries. The restraint and realism of the peace settlement after the Napoleonic Wars was more his achievement than that of any other man; and as long as he was in office the idea of the concert of Europe, which was his original contribution to international diplomacy, never broke down.

See also ENGLISH HISTORY: *Revolution and Reform, 1789–1837.*

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LONDONDERRY, a county of Northern Ireland, comprises the land between Lough Neagh and the river Bann and the Foyle basin, with small areas east of the Bann near Coleraine and west of the Foyle at Londonderry city. The Atlantic ocean and the county of Tyrone, respectively, mark the northern and southern limits of the county. The area is 804 sq.mi. and the population (1961), exclusive of Londonderry county borough, 111,565.

Roughly triangular in shape, Londonderry has as its main physical girder the Sperrin mountains formed by ancient mica schists and rising to more than 2,000 ft. To the north the glacially scarred Sperrins which sweep across the southern boundary give way to extensive plateaus of basaltic lava, covered with peat bog, which overlie chalk and igneous formations. The lava escarpments are flanked by drift-covered hills and river valleys with wide deltaic terraces. To the south and east Old Red Sandstone and Lower Carboniferous Sandstone cap older rocks and meet igneous rock and intrusive granite of north Tyrone at Slieve Gallion (1,735 ft.). West of the northern limits of the basalt and narrowing the outlet of the Foyle is the long sandy spit of Magilligan point, a raised shingle beach which in 1827 provided the base line for the primary triangulation of the British Isles.

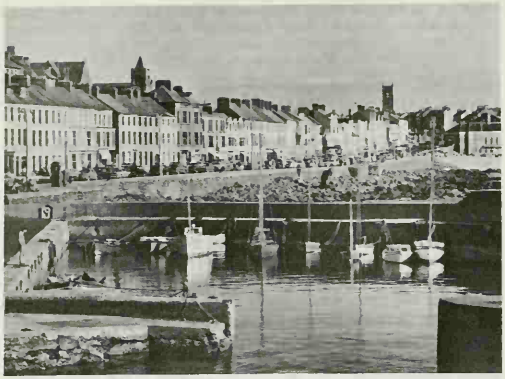
The climate, tempered by prevailing southwesterly winds, is equable and mild; rainfall is plentiful (40–50 in. a year); snow falls on the average on 15 to 20 days, and ground frost occurs frequently during winter and early spring.

About four-fifths of the county is cultivated land and mountain grazing, and there are 14,000 ac. of woodland, reafforestation having vested the hills with a mantle of conifers.

The earliest inhabitants were probably fishermen and hunters from across the North channel but there are few visible legacies of their existence. Archaeologists have, however, uncovered a Mesolithic site (*c.* 6000 B.C.) at Toome bay on Lough Neagh. Neolithic culture is represented by the massive burial chambers scattered over the county—the giants' graves of folklore; the later raths (circular earthworks) of the early Celt are also numerous. Marauding Vikings of the 9th to 11th centuries frequented the Foyle and the Bann but left few marks of their sojourns; neither did the Normans, who crossed the Bann in the 12th century, make a lasting impression.

The shiring of Ulster was carried out in 1585 and the county, then smaller than at present, was described as the county of Coleraine. Following the defeat of the Irish earls and the confiscation of their land, a plan for the exploitation of the escheated land was promulgated in 1609. Colonization of the land between the Foyle and the Bann was undertaken by the livery companies of the City of London and the Honourable The Irish society (founded in 1610). A charter of 1613 established the county of Londonderry comprising the old county, O'Neill lands of Loughinshollin and small portions of Donegal and Antrim. New towns for the territory were established and these, populated with Scots and English "planters," were developed in much the same way as in the tidewater colonies of the new world. The original buildings of the settlement towns were largely destroyed during the 1641 rebellions and in the wars of the late 17th century. The early 18th century saw the mass migration of dissenting Presbyterians from the county to New England where Ulster frontiersmen contributed in full measure to the advance of the frontier settlement and subsequently the creation of the United States. During World War II Lough Foyle assumed strategic importance as a naval base.

In 1961 the population of the county, including the county borough, was 165,309; that of the county borough and assize town of Londonderry was 53,744. Coleraine (11,912) is the only municipal borough and there are two urban districts, Limavady (4,324) and Portstewart (3,950), and four rural districts. The county comprises one United Kingdom parliamentary constituency (Lon-



BRITISH TRAVEL AND HOLIDAYS ASSOCIATION

QUAYSIDE AT PORTSTEWART

donderry) and part of another (Mid-Ulster); five members are returned to the Northern Ireland parliament.

An expansion of linen manufacturing in the 19th century followed by the introduction of shirtmaking, shipbuilding and spirit distillation marked the first impact on the county of organized industry. Factories are largely centred round Londonderry and Coleraine (chiefly shirtmaking, the processing of milk products and the manufacture of fertilizers, neoprene rubber and acrylic fibre). Linen manufacturing and shirtmaking are the industries of the small towns, and the rural areas are devoted to agriculture. Farms are generally small (25–30 ac.) and independently owned. The principal crops are oats, potatoes and grass seed; stock rearing predominates on the larger lowland farms. There are salmon and eel fisheries in the Foyle and Bann. Portstewart and Castlerock are tourist centres. The county has an excellent road system and is linked by two railway lines with Belfast. There is regular sea traffic between Coleraine and Scottish and northern ports.

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LONDONDERRY, a city, parliamentary and county borough, the second city of Northern Ireland, situated on the Foyle, a broad estuary into which flow the rivers Finn, Mourne, Strule, Derg and Deele. The city is 75 mi. W.N.W. of Belfast by road. Pop. (1961) 53,744.

Derry, the older name of Londonderry, comes from the Gaelic word *doire* meaning "oak grove." At that site St. Columba established a monastery in the middle of the 6th century. The fortunes of Derry as an ecclesiastical and monastic centre were varied. It was plundered by Norsemen and is said to have been burned down at least seven times before the year 1200. As a strategic site, Derry was of interest to Anglo-Norman adventurers, being sacked by John de Courci and finally granted by Richard II to Richard de Burgh, well-known as the Red Earl. It served as a strategic point in the Tudor wars against the native Irish, and was destroyed in 1568 by the blowing up of a munition dump. Sir Henry Docwra established a fort at Derry in 1600 as part of a successful plan to enclose Hugh O'Neill, earl of Tyrone. The little town at Docwra's fort was burned down by Sir Cahir O'Dogherty of Inishowen in his short-lived insurrection in 1608. Londonderry received its first charter in 1604, and was granted in 1613 to the City of London as part of the area to be colonized by the City. The town then received the name of Londonderry and was given a municipal corporation. The representatives of the Londoners planned a new town and built the present city walls. The governing charter granted by Charles II in 1662 confirmed an earlier charter of 1614. The district suffered much in the rising of 1641 and subsequent fighting, the city being besieged in 1649. It again experienced siege in 1688–89 when it held out for 105 days against the forces of James II, being defended with great heroism largely inspired by the Rev. George Walker, rector of Donaghmore, and relieved just before further resistance became impossible. In World Wars I and II it served as a naval base and still functions as such.

The city stands on a hill. It is surrounded by the city walls, about one mile in circumference, having seven gates and several bastions, but modern buildings extend beyond the walls and across the Foyle which is spanned by Craigavon bridge. St. Columb's Protestant cathedral, completed in 1633 and enlarged in 1886–87, contains many relics of the siege. Other important buildings are the Gothic St. Eugene's Roman Catholic cathedral (1873), the guildhall (rebuilt 1908), Magee University college (1865) and Foyle college, a school for boys, founded in 1617.

The staple industry of Londonderry is the manufacture of shirts and collars, and there are many smaller industries including the making of furniture, small ships, sound recorders, tire fabrics and various foods. The city returns one member to the parliament of Northern Ireland and is merged in the Londonderry county constituency for the purpose of returning one member to the United Kingdom parliament. (HU. S.)

LONDON UNIVERSITY. Plans for a university in London, Eng., were put forward as early as the 16th and 17th centuries, but it was not until after 1825 that a start was made. By then a rapidly growing urban middle class, in which dissent was strongly represented, was making demands for higher education that the older universities, which confined their degrees to members of the Church of England and paid little attention to physics, chemistry and other new branches of learning, could no longer meet in full. At the same time, the state of English medical teaching was arousing public concern.

In 1825 a group of influential dissenters, Whigs and Radicals led by Thomas Campbell, the poet, and Henry Brougham set to work to raise funds for founding a college in London on Scottish and German models to give a broad and wholly nonsectarian education in arts, science and medicine. This college was opened in 1828 as "the London university" in fine classical buildings in Gower street designed by William Wilkins. Church and Tory interests at once responded by founding in 1829 on Church of England principles a rival institution, King's college, which was opened in 1831 in a building adjacent to Somerset house, Strand, designed by Sir Robert Smirke. King's college did not seek university status; but the promoters of "the London university" petitioned the crown for powers to grant both general and medical degrees. This claim aroused widespread opposition, and a compromise was adopted. On Nov. 27, 1836, King William IV granted a charter which established the University of London in the form of a chancellor, and a senate of 36 fellows appointed for life by the crown, to hold examinations and grant degrees in arts, laws and medicine, but without teaching functions. On the same day the Gower street college accepted a charter of incorporation as "London University college." Candidates for examinations were to present certificates of attendance at University college or King's college, but other educational institutions, not necessarily situated in London, could be admitted by the government into connection with the university. But, with no organic link to unite them, the university and the London colleges soon drifted apart, the university developing its examination system primarily for national purposes through a free use of the power to admit provincial and even colonial colleges, while University college and King's college struggled to reach high academic standards unaided by the prestige of full university rank. In 1858 the senate acknowledged the realities of the position by throwing all examinations, except those for medical degrees, open to all candidates irrespective of their place of education. The university thus became, and remained until the end of the century, a general examining body. As such, it was the first body in England to institute degrees in science (1859) and the first to open its degrees to women (1878). Toward the end of the century a strong agitation developed in favour of a teaching university and two royal commissions reported on the question in 1889 and 1894. The existing system had staunch supporters, who feared the results of placing

it under the control of an academic body dominated by local college interests, and a long and at times bitter controversy was ended only in 1898, when the first University of London act became law.

The statutes made under this act, which came into force in 1900, reconstituted the university as a dual-purpose institution. Its governing body, the senate, was composed on its "internal" side of representatives elected by the teachers of certain established London colleges and other educational institutions, grouped in faculties of theology, music, arts, laws, medicine, science, engineering and economics; and on its "external" side of a like number of representatives of the convocation of graduates; a third group of representatives was appointed by the crown in council, the London county council and some other public bodies. The principal colleges received the academic status of "schools of the university" but only University college and King's college had statutory representation in the senate. They and the other schools admitted in 1900 carried on the bulk of the teaching work, and remained legally and financially independent of the senate, whose powers of intervention in their affairs were limited to instituting and appointing the holders of professorships and readerships, recognizing the more junior teachers, regulating the courses of instruction for degrees and periodical inspection. A peculiar feature of the constitution was the recognition of individual teachers, under whom students could follow courses of instruction leading to internal degrees, in a number of educational institutions in London not otherwise connected with the university. The former examining system of the university was placed under an external council controlled by the convocation members of the senate, and statutory precautions were adopted to ensure that the standard and prestige of the external degrees should not suffer.

London University Institutes and Schools (With Dates of Admission)

Institutes and schools	Admission date
University institutes	
Courtauld Institute of Art†	1932
Institute of Advanced Legal Studies	1947
Institute of Archaeology	1937
Institute of Classical Studies	1953
Institute of Commonwealth Studies	1949
Institute of Computer Science	1964
Institute of Education	1909‡
Institute of Germanic Studies	1950
Institute of Historical Research	1920
School of Slavonic and East European Studies	1932
Warburg Institute§	1944
Schools of the university	
Nonmedical	
*Bedford College	1900
Birkbeck College¶	1920
Imperial College of Science and Technology♀	1908
*King's College	1900
*London School of Economics and Political Science	1900
Queen Elizabeth College ♂	1928
Queen Mary College◇	1907
*Royal Holloway College	1900
Royal Veterinary College	1949
School of Oriental and African Studies	1918
School of Pharmacy	1925
*University College	1900
Westfield College	1902
*Wye College	1900◇
Medical	
British Postgraduate Medical Federation▲	1947
*Charing Cross Hospital Medical School	1900
*Guy's Hospital Medical School	1900
King's College Hospital Medical School	1909+
Lister Institute of Preventive Medicine	1905
*London Hospital Medical College	1900
London School of Hygiene and Tropical Medicine	1905
*Middlesex Hospital Medical School	1900
Royal Dental Hospital of London School of Dental Surgery	1911
*Royal Free Hospital School of Medicine●	1900
*St. Bartholomew's Hospital Medical College	1900
*St. George's Hospital Medical School	1900
*St. Mary's Hospital Medical School	1900
*St. Thomas's Hospital Medical School	1900
University College Hospital Medical School	1907+
*Westminster Medical School	1900
Theological**	
King's College Theological Department (Anglican)	1910+
*New College†† (Congregational)	1900
*Richmond College‡‡ (Methodist)	1900

*Original colleges of the university as reconstituted in 1900. †*i.e.*, art history. ‡As London Day Training college; became university institute under present name 1932. §Formerly Bibliothek Warburg, Hamburg, Ger.; for study of classical tradition in art, literature, science, etc. ¶Formerly London Mechanic's institution and Birkbeck institution; mainly for evening and part-time studies. ♀Federation of *Central Technical college (1900; now City and Guilds engineering college), *Royal College of Science (1900) and Royal School of Mines. ♂Formerly King's College of Household and Social Science. ◇Formerly East London college. +Formerly South-Eastern Agricultural college. ▲Comprising Institutes of Basic Medical Sciences, Cancer Research, Cardiology, Child Health, Dental Surgery, Dermatology, Diseases of the Chest, Laryngology and Otology, Neurology, Obstetrics and Gynecology, Ophthalmology, Orthopedics, Psychiatry (1924, as Maudsley hospital medical school), Urology; and Postgraduate Medical School of London (1934). +On separation from parent college. ●Formerly London School of Medicine for Women. **This group also included from 1900 to 1958 the London College of Divinity (formerly St. John's hall). ††Formerly Hackney and New college. ‡‡Formerly Wesleyan college.

Progress was at first delayed by mutual distrust between the internal and external parties, and by lack of additional resources for the new responsibilities which public opinion expected the university to undertake. With a view to strengthening it at its centre, University college in 1905 and King's college in 1908 surrendered their legal independence and in 1907 and 1910 respectively became incorporated in the university, but this example was not followed by other schools. The admission of Imperial College of Science and Technology to the University in 1907 led to the appointment in 1909 of yet another royal commission to review the whole position of the reconstituted university. Its drastic recommendations for replacing the loose federation by a closely articulated unitary organization were suspended by the outbreak of World War I. When in 1924 a governmental committee at length reconsidered the royal commission's report, a much more limited plan of reform was adopted. The principal changes effected in 1926 in the revised statutes which came into force in 1929 were first, the creation of a new body, the court, with supreme authority in matters of finance which extended over the independent schools in respect to all public grants or benefactions; and secondly, the closer association of the schools with the central body, mainly through statutory representation on the senate, which remained the supreme governing body of the university in all academic matters. The court, with 15 (now 16) members, was composed of those representatives of the crown and the local authorities who had hitherto sat in the senate, together with 6 members appointed by the senate and 2 *ex officio* members, the vice-chancellor and the chairman of convocation. The representation of other public bodies ceased. The essential features of the reconstitution of 1900—the federal principle and the dual system of internal and external degrees—were preserved. During the first half of the 20th century a great expansion of the teaching university took place. In 1900 there were 18 schools of the university and in 1902–03 it had 2,000 internal students. By 1963 the university comprised 33 schools (of which 17 were nonmedical and 16 medical) and 11 university institutes (*see* table), with about 1,050 professors and readers; there were also about 1,450 other recognized teachers. In 1962–63 the internal students numbered 28,603, of whom 5,230 were in "institutions having recognized teachers" not organically connected with the university. All schools of the university engaged in undergraduate teaching also promote advanced study and research. A significant feature of the modern growth of the university has been the development, in supplementation of the main teaching work carried on in the schools, of central institutes directly administered through committees or councils responsible to the senate.

The external work of the university continued to expand after 1900. While the university still registered many technical college and private students, it was increasingly concerned on its external side with fostering the growth of university colleges (*q.v.*) both in the United Kingdom and in the territories of the Commonwealth of Nations, providing them with advisory services and an examination and degree system during the period of their growth toward full and independent university status. The number of students registered for external degree and diploma examinations of the university in the 1960s was about 27,000.

The colleges and other institutions of the university are dispersed over a wide area, two (Royal Holloway college, near Staines, and Wye college, near Canterbury) being indeed outside London altogether. From 1836 to 1936 the university headquarters were housed by the government, from 1871 to 1900 in Burlington gardens, and later in part of the Imperial institute building at South Kensington. After 1910 the provision of a new headquarters on a central site became a major issue of policy. It was not, however, until 1927 that the university was able to acquire, with the aid of a munificent gift of £400,000 from the Rockefeller foundation, a site of 11½ ac. in Bloomsbury close to University college, on which it erected between 1931 and 1937 a monumental senate house and library to the designs of Charles Holden, the cost

being met by gifts of more than £1,300,000 from local authorities, City companies, business firms, banks and private donors. The Institutes of Education and Historical Research and the school of Slavonic and east European studies are in the same building. Space also has been found on the site for the school of oriental studies, Birkbeck college, the university students' union and the Warburg institute and Courtauld galleries.

In 1949–51 the university acquired, with the aid of the treasury and the London county council, a further 13½ ac. adjoining the original site. It was thus able to realize its long-cherished hope of establishing a "university precinct" in or near which a substantial proportion of its activities could find a focus. In 1959 a comprehensive outline plan for the future development of the whole precinct, prepared by Sir Leslie Martin, was approved in principle. (W. D. H.)

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LONG, CRAWFORD WILLIAMSON (1815–1878), U.S. physician, who first used ether as an anesthetic in surgery, was born in Danielsville, Ga., on Nov. 1, 1815. He received an A.M. degree from Franklin college, Athens, Ga., in 1835 and then read medicine under George R. Grant at Jefferson, Ga. He matriculated at the medical department of Transylvania university, Lexington, Ky., and later transferred to the University of Pennsylvania, Philadelphia. After his graduation in 1839, he went to New York city to walk the hospitals, then returned to Jefferson, where he soon acquired an extensive practice.

Long's imagination was stirred by the observation that injuries were sustained without pain during "ether frolics." On March 30, 1842, Long painlessly removed a tumour from the neck of James Venable, to whom he administered ether. At first, credit was denied to Long, who, as a rural physician, had no opportunities to test his discovery during major operations and cautiously accumulated data to justify publication in 1849 in the *Southern Medical and Surgical Journal*. In the famous ether controversy Charles T. Jackson, Horace Wells and William T. G. Morton (*q.v.*) each claimed the discovery for himself and applied for a national reward from congress. Long claimed no money; he wanted only recognition of the fact that he discovered and used the anesthetic effect of ether in surgery for the first time. Wells, a Hartford, Conn., dentist, conceived the idea, independently of Long, of anesthesia during "laughing gas parties"; he introduced anesthesia for tooth extractions, using nitrous oxide gas, in 1844. Morton, Wells's friend and onetime partner, in 1846 gave the first public demonstration of ether anesthesia in surgery; but he borrowed the idea from Jackson, a chemist and geologist, whose own claim to priority rests on accidental self-observations without witnesses. Long emerges from all the evidence as the discoverer of ether anesthesia in surgery and as a figure justly aloof from the ethically questionable implications of this chapter of medical history. He died at Athens on June 16, 1878.

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LONG, HUEY PIERCE (1893–1935), demagogic and flamboyant governor of Louisiana and U.S. senator, was born Aug. 30, 1893, near Winnfield, in an impoverished part of Louisiana, the son of a farmer. After public school education and brief legal training at Tulane University in New Orleans, he became a lawyer in 1915. Politically ambitious, he was elected to the Louisiana Railroad commission at the age of 25. In 1928, after an earlier unsuccessful candidacy, he won election as governor of Louisiana because of heavy support from rural districts. His picturesque speech and unconventional ways soon made him nationally famous, and he was widely known as "Kingfish." His real importance lay in his ambitious and successful program of public works and public welfare in a state that had been politically static for two generations, and in his concentration of political power into an executive dictatorship unprecedented in U.S. history. In 1930 he was elected to the U.S. senate and then sought to gain national power with a Share-the-Wealth program ("every man a king"), which was tempting to a depression-shocked public. By 1935, in open opposition to Pres. F. D. Roosevelt and in absolute control of Louisiana, he was at the height of his power when Carl Austin Weiss, the son of a man whom he had vilified, assassinated him in the capitol building at Baton Rouge.

Long apparently felt genuine sympathy for the underprivileged, and his regime brought tangible material progress and welfare to rural Louisiana. His vindictive and domineering temperament, however, led him to destroy the process of self-government in Louisiana, and his folksy, democratic manner diverted attention from the reality that he was ruthlessly autocratic in his rule.

His brother, Earl K. Long (1895–1960), served as governor of the state, 1939–40, 1948–52, and 1956–60. Huey Long's son, Russell B. (1918–), was elected U.S. senator from Louisiana in 1948 and re-elected in 1950, 1956 and 1962.

See Allen P. Sindler, *Huey Long's Louisiana* (1956) and Stan Opotowsky, *The Longs of Louisiana* (1960). (D. PR.)

LONG BEACH, a city of Los Angeles county, Calif., U.S., 20 mi. S. of Los Angeles, on San Pedro bay, is a tourist resort and an important industrial and commercial centre. Catalina Island is 23 mi. off the coast and the Palos Verdes hills lie to the west. The elevation ranges from 14.5 ft. below sea level to 170 ft. above sea level. Long Beach completely surrounds the cities of Signal Hill and Lakewood, and the three cities, along with Catalina, form a unified school district. The site was once a portion of a Spanish land grant given to Manuel Nieto in 1784 which was divided among his five children as ranchos. Two of the latter, Los Alamitos and Los Cerritos, which included most of modern Long Beach, passed into the hands of Abel Stearns and John Temple in the early 1840s. By 1882 both ranchos had been purchased by the Bixby family. William E. Willmore made the first attempt to found a town in 1882; after securing an option from Jotham Bixby on 4,000 ac., he organized the American colony, but the plan collapsed in 1884. The Long Beach Land and Water company continued with the project and gave the seven miles of wide strand the name Long Beach. It was first incorporated in 1897.

Until 1921 Long Beach was a seaside resort with a largely transient population. Harbour development was made possible by the acts of 1911 and 1925 by which the state granted to the city the bordering tidelands and submerged lands. Bond issues and revenue from oil and gas provided funds to develop an excellent man-made harbour. The discovery of oil in 1921 at Signal Hill resulted in increased industrial activity and a spectacular leap in population. After 1947 the city was plagued with litigation and legislation over the revenue accruing from the tideland reserves where the removal of oil and gas also produced the serious problem of subsidence.

In March 1933, Long Beach suffered a destructive earthquake, after which a widespread building program was inaugurated. During World War II a naval base (now a shipyard) was established there. Douglas Aircraft corporation built and progressively expanded a plant, which at peak production employed 30,000 workers. In nearby Seal Beach and Los Alamitos, a naval ammunition and net depot and air station were opened and continue to operate. A naval hospital was also erected, which became a veterans administration hospital. A modified council-manager form of government, with some aspects of the commission type, was adopted in 1921. Gas and water utilities are municipally owned.

The port of Long Beach has modern facilities, used by about 1,700 ships annually, and can berth 30 vessels at one time. After World War II most of the commerce was with Japan, and the principal export was petroleum. Long Beach and Los Angeles harbours are connected by Cerritos channel. Fisheries are important, and thousands of tons of fish are processed in local canneries. Freeways serve the port and the city. Diversified industries include automobile assembling and the manufacture of oil-drilling equipment, aircraft, soap and toiletries, chemicals, paints, furniture, clothing, furnaces and heaters, ceramics and glass, paper, plastics, and building and insulation products.

The great inundation of population after World War II produced grave educational problems, and it became necessary to double the capacity of the public schools. Long Beach City college (established 1927) is one of the largest two-year colleges in the nation; Long Beach State college (1949) has an enrollment of about 10,000. The city supports an art centre, an extensive library system, a symphony orchestra, a municipal band, a light opera association and community playhouses. It also maintains parks, municipal golf courses, a stadium, a marine stadium and a modern marina (1,250 ac.) for private ocean-going craft. Pop. (1960) 344,168; for the Los Angeles–Long Beach standard metropolitan statistical area *see* Los Angeles. For comparative population figures *see* table in California: *Population*. (H. P. Jo.)

LONG BEACH, a resort and residential city in Nassau county on Long Island, N.Y., U.S. Henry Hudson's log from the "Half Moon" reported in 1609 a "long glistening bar of exceptionally white sand" off the westerly, southern shore of the island. More than 200 years later the name Long Beach was given to this 7-mi. sand bar approximately 6 mi. from the New York city line. The white sandy beach, one of the few on the east coast which faces directly south off the Atlantic ocean, was ideally situated for New York vacationists. In 1880 the Long Beach hotel was constructed. In the early 20th century the city was developed into a thriving resort where many prominent citizens maintained summer residences. However, after the 1930s Long Beach attracted an increasing number of permanent residents, so that its character as a community became more suburban. For comparative population figures *see* table in New York: *Population*. (Wi. M. D.)

LONGBENTON, an urban district in the Wallsend parliamentary division of Northumberland, Eng., adjoining the north-eastern boundary of Newcastle upon Tyne for which it is a residential area. Pop. (1961) 44,633. The church of St. Bartholomew, originally built in the 12th century, stands between Longbenton and Killingworth. Thomas Addison, the physician, was born at Longbenton in 1793 and George Stephenson (*q.v.*), the inventor of the locomotive, was at one time the engineer at Killingworth colliery and his house is still preserved. In the 17th century the Newcastle races were run on Killingworth moor, later known as the district of Forest Hall and West Moor. The knights hospitallers also held land in Killingworth that was granted to them after 1308. Weetslade urban district was merged with Longbenton in 1935 to form the present district. Other than agriculture, the principal industry for about 200 years has been coal mining.

LONG BRANCH, a city of Monmouth county, N.J., U.S., is located on the Atlantic coast, 45 mi. S. of New York. For years it was known as one of the oldest summer resorts, but with the growth of the garment and electrical industries in the 20th century, it gradually became an all-year residential community. Fishing and truck farming are also significant. Its name stems from the fact that it borders on the eastern or long branch of the South Shrewsbury river.

The first village was established at West Long Branch, one mile from the shore. The section nearer the beach developed later, when there was a regular line of stages from Philadelphia and a steamboat service from New York. In 1860 the first railroad arrived. In the late 19th and early 20th centuries visitors to the resort included the presidents U. S. Grant, Rutherford B. Hayes, Benjamin Harrison and Woodrow Wilson. Pres. James A. Garfield, after he was shot in Washington, D.C., was brought to his summer cottage at Elberon, where he died in 1881. Long Branch was chartered in 1904 and includes the communities of Elberon, North Long Branch and West End. For comparative population figures *see* table in New Jersey: *Population*. (H. F. Wi.)

LONGCHAMP, WILLIAM (d. 1197), chancellor and justiciar to Richard I of England, was of Norman origin. He received a legal training and his first known employment was as official for the archdeaconry of Rouen. Later he became chancellor to Richard, then count of Poitou, and when Richard became king (1189) Longchamp continued as his chancellor. Consecrated as bishop of Ely (Dec. 31, 1189), he was, after Richard's departure on crusade, appointed joint justiciar (March 1190) with Hugh du Puiset, bishop of Durham. He was appointed papal legate by Clement III in June 1190, in which month he also became sole justiciar, although a council was nominated by the king to assist him. His rule was unpopular and many therefore supported the king's brother John when he returned to England early in 1191, obviously scheming to obtain not only the succession but possibly the crown. A series of disputes ensued over the custody of various castles, and Longchamp's position was weakened when his legateship lapsed on the death of Pope Clement in March 1191. Meanwhile Richard sent Walter of Coutances, archbishop of Rouen, to intervene (June 1191), with a commission fully empowering him to make changes in the administration. A settlement was reached in July between John and Longchamp, but in September Henry II's illegitimate son Geoffrey, now consecrated as archbishop of York, returned to England, like John violating an oath he had taken to stay away. Longchamp tried to prevent his landing and had him removed from a church at Dover in which he had taken refuge. This incident aroused the indignation of the clergy. Longchamp now had few friends, and in October he was superseded as justiciar by Walter of Coutances and retired to France. He visited Richard I in captivity early in 1193. Richard was convinced of his loyalty and retained him in the office of chancellor until his death at Poitiers on Jan. 31, 1197.

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LONG EATON, an urban district (1895) of Derbyshire, Eng., lies 10 mi. E.S.E. of Derby and 7½ mi. S.W. of Nottingham by road on the Erewash canal. Pop. (1961) 30,476. The church of St. Laurence, with a Norman aisle, stands in the market place where open markets are held twice weekly. Trent college, a boys' boarding school, was founded in 1866. West park, between the college and the Erewash canal, provides facilities for sport. Formerly an important centre of the lace trade, the town's manufactures include light textiles, pressed stainless steel domestic products, furniture, upholstery, hosiery, elastic and elastic braiding. Adjoining the urban district are the large railway marshaling yards at Toton. (R. Bt.)

LONGFELLOW, HENRY WADSWORTH (1807–1882), the most popular of U.S. poets in the 19th century, was born in Portland, Me., on Feb. 27, 1807. On both sides of the family he came from Yorkshire stock. His mother, Zilpah Wadsworth, was the daughter of a general in the American Revolution, who traced his ancestry back to the Plymouth Pilgrims. His paternal ancestor, a blacksmith, settled in Byfield, Mass., in 1680. His early education was in private schools and in the Portland academy. He entered Bowdoin college as a sophomore and graduated in the class of 1825 with Nathaniel Hawthorne. At college he studied unremittingly to fit himself for a literary career. He was attracted especially to Sir Walter Scott's romances and Washington Irving's *The Sketch Book*. While an undergraduate he published verses in national magazines. His father wanted him to enter his law office, but the future poet wrote, "I most eagerly aspire after future eminence in literature." During his junior year he had so deeply impressed a college trustee by the fluency with which he translated an ode of Horace that on graduation he was offered a professorship in modern languages provided that he would first study in Europe.

On the continent he learned French, Spanish and Italian, but refused to settle down to a regimen of scholarship at any univer-

sity. In 1829 he returned to the U.S. to be a professor and librarian at Bowdoin. There he proved himself an excellent teacher. He wrote and edited textbooks, translated poetry and prose, and wrote essays on French, Spanish and Italian literature.

He felt himself somewhat too isolated at Bowdoin, so when he was offered a professorship at Harvard, with the hint of another opportunity to go abroad, he gladly accepted and set forth for Germany in 1835. Before settling down he visited England, Sweden and the Low Countries. Saddened by the death of his wife in 1835 he ceased his wandering and settled at Heidelberg where he fell under the influence of German romanticism. The transcendental quality of such poetry as in Novalis' "Hymns to the Night" induced in him an introspective mood.

In Oct. 1836 he sailed for home and returned to Harvard. Meanwhile he had published a book of travel sketches, *Outre-Mer*, vignettes of life in France, Spain and Italy, written under the influence of Irving's *Sketch Book*. He lacked Irving's sense of humour and capacity for creating character and the book did not succeed. In 1839 he published *Voices of the Night*, a volume containing "The Psalm of Life" and "The Light of the Stars"—poems that became immediately popular. Early in the same year he brought out *Hyperion*, a romantic novel idealizing his European travels.

For 18 years he presided successfully over Harvard's modern language program, but his "poetic dreams were shaded by French irregular verbs," and he longed for freedom. The poet in him was kept alive by his work as a translator. In 1841 his *Ballads and Other Poems*, containing "The Wreck of the Hesperus," came out and swept the nation. In 1854 he left teaching and entered upon his long-cherished dream of building "some tower of song with lofty parapet." While this major ambition was maturing he wrote a few *Poems on Slavery* (1842), finished productions which lacked, however, the power of John Greenleaf Whittier's Hebraic denunciations. He was more at home in *Evangeline*, an idyll of Acadia skilfully written in dactylic hexameters, which reached almost every literate home in the U.S.

The Song of Hiawatha, published in 1855, proved another popular success. With Henry Rowe Schoolcraft's two books on the Indian tribes of North America as the base, and the trochaic metrics of the Finnish epic *Kalevala* as his medium, he fashioned one of his most artistic productions. Its appeal was immediate. In 1858 he wrote *The Courtship of Miles Standish* in the Evangeline" measure. The material is less idyllic than that of the earlier story, but the metrics are enriched by a more varied accent.

The death in 1861 of his second wife, who died of burns after she had accidentally set her dress on fire while sealing packages, deepened his melancholy (cf. "Cross of Snow," 1879). Her death drove him for spiritual relief into translating that "Mediæval Miracle of Song," the *Divine Comedy of Dante Alighieri*, one of the most notable translations of the Florentine to that time. While engaged in this work he wrote six sonnets on Dante which are among his finest productions.

The *Tales of a Wayside Inn*, modelled roughly on the plan of Geoffrey Chaucer's *Canterbury Tales* and published in 1863, reveals his marked narrative gift. The first poem, "Paul Revere's Ride," became a national favourite. He published in 1871 what was intended to be his masterpiece, the *Christus: a Mystery*, a trilogy dealing with the subject of Christianity from its beginning, and followed this trilogy with two supplementary dramatic poems: "Judas Maccabæus" and "Michael Angelo." But his genius was not dramatic, as he had demonstrated earlier in *The Spanish Student* (1843), although it should be noted that these neglected later works contain some of his most effective writing.

In the 19th century Longfellow was loved and honoured at home and abroad. Oxford conferred upon him a D.C.L. and Cambridge an LL.D. in 1868. After his death March 24, 1882, a memorial to him was unveiled in Westminster abbey. Some years after his death a violent reaction against his poetry set in. Critics who had put the romantic movement behind them and who deplored his sometimes heavy-handed didacticism appeared to take pleasure in reducing him to the status of a hearthside rhymer. This harsh dismissal was somewhat unfair. His poetry is still loved by the unpretentious, and such poems as "My Lost Youth" transcend the metrical scaffolding on which they are erected. His poetry rarely touches greatness; he does not produce the "martial music" of John Milton or Homer, but good singing poetry can be found throughout his work.

BIBLIOGRAPHY.—*See* the Riverside edition of Longfellow's *Works* (1886). Still of importance although outdated is the biography of the poet by his brother Samuel Longfellow, *Life of Henry Wadsworth Longfellow With Extracts From His Journals and Correspondence* (1886) supplemented by his *Final Memorials of Henry Wadsworth Longfellow* (1887). E. C. Wagenknecht's *Longfellow: a Full-Length Portrait* (1955) incorporates much new material hitherto scattered or unpublished. The most thorough account of the formative years is L. E. Thompson's *Young Longfellow (1807–1843)* (1938). H. S. Gorman's *A Victorian American, Henry Wadsworth Longfellow* (1926) has interest as an adversely critical biography. *See* also *Mrs. Longfellow, Selected Letters and Journals*, ed. by E. C. Wagenknecht (1956).

No comprehensive bibliography of Longfellow exists. Of limited value is L. S. Livingston's *Bibliography of the First Editions in Book Form of the Writings of Henry Wadsworth Longfellow* (1908).

Among special studies may be noted: Iris L. Whitman, *Longfellow and Spain* (1927); J. T. Hatfield, *New Light on Longfellow, With Special Reference to His Relations to Germany* (1925); A. F. Ellen, *Longfellow and Scandinavia* (1947); and C. L. Johnson, *Professor Longfellow of Harvard* (1944). P. Morin's *Les Sources de l'Œuvre de Henry Wadsworth Longfellow* (1918) is useful but must be supplemented with many subsequent articles. The Introduction to Odell Shepard's edition of *Representative Selections* in the "American Writers Series" (1934) is valuable, and William Dean Howell's description of his friend in *Literary Friends and Acquaintance* (1901) is of historical interest. Examples of early 20th-century opinion may be found in Paul Elmer More's *Shelburne Essays*, vol. v (1908) and Bliss Perry's *Park-Street Papers* (1908). (WM. S. K. X.)

LONGFORD (LONGFORT), a county of the Republic of Ireland in the extreme northwest of the Leinster province, bordering Cavan in Ulster to the northeast, and two Connaught counties, Leitrim and Roscommon, to the west. Longford does not possess the rich large farms characteristic of the best areas of Leinster, but rather shares the small farms so characteristic of Connaught and Ulster. It covers 405 sq.mi. Pop. (1961) 50,642.

On the west the boundary is the Shannon, with part of Lough Ree inside the county. At the northern end of this lake there is a crossing place, Lanesborough, with another at Termonbarry, 7 mi. farther north. From the Shannon, just south of Roosky, the boundary with Leitrim and Cavan runs through farmed lowlands to Lough Gowna, an intricate lake with many ramifications in the Erne valley. The eastern boundary crosses a water parting to the Inny river, a Shannon tributary, leaves it after a few miles to wander across the lowland, joins it again and finally sweeps across to Lough Ree. Effectively therefore the county is merely a part of lowland Ireland of no great size, but even so, this lowland has considerable structural variety. The general surface, floored by Carboniferous Limestone, rises from the Shannon to an altitude of 200–400 ft., but there are exposures of pre-Carboniferous rocks in the isolated hill at Ardagh (659 ft.) and in the hills to the west of Lough Gowna, which rise to 916 ft. in Corn hill. Much of the country between the heart of the Irish central lowland and the north is of this type, mainly a lowland varied by several ridges of higher land, but it is thickly plastered with glacial drifts, which in the north of County Longford grade into drumlins; few areas of solid rock are exposed. The disorganization of drainage by the glaciation has produced large areas of fens on which bogs have grown. One-fifth of County Longford is rough pasture, chiefly peat bog, but also including some meadows, known as callows, by the Shannon, which are flooded in wet seasons but valuable in drier periods.

The early name of Longford was Annaly or Analé, a principality of the O'Farrells. Then in Meath, it was granted by Henry II to Hugh de Lacy, who started an English colony. On the division of Meath into two counties in 1543 Annaly was included in Westmeath, but in 1569 it was made shire ground under the name of Longford.

Oliver Goldsmith lived during childhood at Pallas, near Ballymahon in the county, and the family of Maria Edgeworth, the novelist, lived at the demesne town of Edgeworthstown, sometimes known as Mostrim.

The county is administered by a county council, which meets at Longford, and shares a county manager with Westmeath. It is also united with Westmeath for electoral purposes, and the two counties return five members to *dáil éireann*. Granard and Longford are urban districts.

In County Longford hardly one-tenth of the farmland is given to crops, chiefly oats and potatoes. Most farms are of less than 30 ac. and their main concern is to pasture cattle, chiefly for export eastward to the richer and larger farms of County Meath. Some dairying is carried on, especially in the north. Only one-quarter of the county's population live in towns, of which the largest is Longford (3,558 in 1961), which has the Roman Catholic cathedral of the Ardagh diocese (with Clonmacnoise). The other towns include Granard (1,086), Ballymahon (835) and Edgeworthstown (635).

See James P. Farrell, *History of the County of Longford* (1891).
(T. W. Fr.; Hu. S.)

LONGFORD (Longphort), the county town of County Longford, Republic of Ireland, is on the Camlin river, 76 mi. W.N.W. of Dublin. Pop. (1961) 3,558. The principal building is the 19th-century St. Mel's Roman Catholic cathedral for the diocese of Ardagh and Clonmacnoise, which includes nearly all of Longford, most of Leitrim and parts of Offaly, Westmeath, Roscommon, Sligo and Cavan. Longford, anciently a fortress of the O'Farrells whose stronghold no longer exists, has a castle dating from the 17th century. It is also associated with the Clinton family, including Adm. George Clinton (*c.* 1686–1761), governor of Newfoundland and later of New York. Trade is in grain, butter and bacon. There are corn mills, a spool factory and tanneries.

The ancient name of the town was Athfada, and there a monastery is said to have been founded by St. Idus, a disciple of St. Patrick.

LONGHI, ALESSANDRO (1733–1813), Italian painter, etcher and biographer of Venetian artists, the most important Venetian portrait painter of his day, son of Pietro Longhi (*q.v.*), was born and died at Venice. His father gave him his first training but quite soon put him to study under the Rembrandtesque painter of portraits and fancy subjects, Giuseppe Nogari. In 1759 he was elected a member of the Venetian academy, for which he painted one of his rare subject pictures, the allegorical "Painting and Merit." In 1762 Longhi issued his book *Compendio delle Vite de' Pittori Venezioni Istorici piu rinomati del presente secolo con sui ritratti dal naturale delineati ed indisi*, one of the most important source books for the history of Venetian 18th-century painting. Both portraits and text were printed from plates he etched. In addition, he etched some of his own and some of his father's works. His work is best seen at Venice. (F. J. B. W.)

LONGHI, PIETRO (Pietro Falca) (1702–1785), Italian painter of small scenes of Venetian social and domestic life, was the son of a silversmith in whose workshop he received his first training. Later he worked under the Veronese history painter Antonio Balestra, but his one important work of this sort, the monumental ceiling of the "Fall of the Giants," executed in 1734 for the Palazzo Sagredo, was a complete failure. It is likely that it was because of this that he left Venice for a time and studied at Bologna under Giuseppe Maria Crespi. After his return to Venice he devoted himself to painting somewhat in the manner of Nicolas Lancret but more satirical. He also painted occasional portraits. Longhi was also undoubtedly influenced by Dutch genre painting, of which there was at least one important collection in Venice at that date. His paintings, like those of Antoine Watteau, were based on carefully observed figure drawings, a large number of which survive. Many of his paintings were engraved. He was elected to the Venetian academy at its foundation in 1756 and died in Venice on May 8, 1785. His works are best seen at Venice, though there are a few in London. (F. J. B. W.; X.)

LONGHORN (Texas Longhorn), the breed of cattle that formed the basis of the ranching industry of the American west during the 19th century. Texas longhorns made up the bulk of the great herds that were driven by cowboys from southern Texas to Kansas for shipment east by rail, and later to the northern plains states, to the Pacific coast and even into Canada.

The foundation stock of the Texas longhorns were the Mexican breeds of predominantly Spanish blood brought by the settlers from New Spain, who established missions and colonies in North America. In the territory that is now within the limits of the United States, California and Texas became the chief breeding grounds. In 1690, 200 head of cattle were brought up from far south of the Rio Grande to be released at a mission settlement in eastern Texas near the Louisiana line. By the time a party of 15 families from the Canary Islands reached San Antonio in 1731 mission ranches of the region already had numerous cattle. Yet each family came provided with a yoke of oxen, ten nanny goats and a buck, ten ewes and a ram, five sows and a boar, five mares and a stallion, five cows and a bull. All down the San Antonio river to the Gulf of Mexico stock raising became almost the only civilian occupation.

Anglo-American colonists who began entering Texas in 1821 introduced milk cows and a few bulls derived from English breeds. They found wild, ownerless Spanish cattle of various shades and colours, which they called "mustang" cattle, scattered over vast areas east of the plains. They had become heavier and more rangy than the standard Mexican breeds. Long-legged and long-walking as well as long-horned, they could endure thirst and fight off wolves or even grizzly bears. They were more hardy than meaty. The curves of the horns, often beautiful, were more striking than the space from tip to tip, and the shapes of horns were as various as colours of hair. Many cows wore long horns but the climax of horn growth was on "aged" steers, six years old and up, some with horns spreading as much as six feet. Cattle from Mexico—and during trail-driving days many came north across the Rio Grande—were generally smaller than the Texas longhorns, and seldom were their horns so heavy. Spanish rancheros had ignored selective breeding, and the American colonists found it difficult to control breeding on unfenced ranges. They hunted down and shot many wild cattle for meat. By the time Texas became a republic (1836) herds of cattle were being driven to New Orleans to be sold as beef. In the 1840s and 1850s small herds were driven to Missouri and even as far north as Chicago.

People flocking to California as a result of the discovery of gold consumed, for a time, more meat than the native stock could supply. High prices led to the importation of herds of Texas longhorns. While in time a good many California cattle were driven to Oregon and thence east, it was mainly Texas longhorns that occupied the vast territories left vacant by the wholesale slaughter of buffaloes and the confinement of Indians to reservations.

When the American Civil War ended in 1865 Texas had between 3,000,000 and 4,000,000 cattle, hundreds of thousands of them unbranded and feral because the men to manage them had been away as soldiers for four years. The great drives began in 1867 when Abilene, Kan., the first "cow town" of the west, became a buying, selling and shipping centre on the Union Pacific railroad. The Chisholm trail, which originally terminated at Abilene, was a corridor opening out of a vast breeding ground to vacant, virgin ranges. Herds of big steers were driven north from Texas to mature and stock cattle to breed. The Western trail made Dodge City famous.

For a time the westward expansion of population merely passed over the Great Plains and the fringing deserts and mountains. These spaces were occupied by the ranching industry, projected from the south. Some longhorns were driven as far north as the plains of Alberta, Can., but most came to graze the grasses of the Indian Territory (later Oklahoma), western Kansas, Nebraska, the Dakotas, Wyoming, Montana and Idaho. Tens of thousands were driven into New Mexico and Arizona. Before the trails were plowed under and fenced across, by 1890, 10,000,000 longhorns had been driven out of Texas. With them came the Texas cowboy, the most picturesque representative of the cattle industry (*see* Cowboy).

Longhorns were eventually nearly bred out of existence in favour of meatier types. In the late 1920s the U.S. forest service, after looking over many thousands of cattle in lower Texas, selected 27 head of longhorns to place in the Wichita Mountains Wildlife refuge, near Cache, Okla. A few outstanding bulls were acquired

later. A herd of about 300 longhorns is maintained in a fenced pasture of 30,000 ac. Partly because of the very nutritious grasses in the refuge area these longhorns are heavier than their south Texas progenitors, and they are magnificent representatives of the breed. *See* also CATTLE: *Breeds*.

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LONGINUS, the name assigned to the author of the treatise *On the Sublime,* a Greek work of literary criticism once mistakenly attributed to the Neoplatonist Cassius Longinus.

On the Sublime.—The earliest surviving manuscript of the treatise (*Parisiensis graecus* no. 2036; belonging to the 10th century A.D.) ascribes it to "Dionysius Longinus" in its heading; and the first printed editions (from 1554) followed this ascription. It was long unnoticed that the index to the manuscript read "Dionysius or Longinus," implying a guess that the author might be either Dionysius (*q.v.*) of Halicarnassus or Cassius Longinus. David Ruhnken in the 18th century tried to equate Dionysius Longinus with Cassius; but later studies discredited this equation. Identifications with Plutarch and with Dionysius of Halicarnassus were also shown to be untenable, and scholars mostly agreed that the author was someone otherwise unknown—to be designated by them as Pseudo-Longinus. In 1938, however, G. C. Richards (*Classical Quarterly,* xxxii, 3) tried to ascribe the treatise to Pompeius Geminus, the correspondent of Dionysius. Since the treatise is designed to remedy the faults of a work on the same subject by Caecilius of Calacte and since Manilius (as Richards argues) seems to quote from it, it is thought to have been written early in the 1st century A.D. About one-third is lost.

By sublimity (Gr. *hypsos*) the author means "excellence in language," the "expression of a great spirit," the power to provoke "ecstasy" and to move any reader however often he reads the passage. The work is thus a guide to an effective style. Sublimity is opposed alike to bombast, to silly conceits, to sentimentality and to frigidity. Quotations illustrate the sublime and its opposite throughout the treatise, some of them preserving work that would otherwise be lost (one of Sappho's odes is an example); Homer, Demosthenes and Plato are the author's chief models. The sources of sublimity are: greatness of thought (which may be inborn but can be acquired by trying to emulate great writers of the past); strong handling of the passions; skilful use of figures of thought and of speech; proper choice of language and metaphor; and composition (including musical or metrical effects in prose). Finally the author asks whether the contemporary dearth of sublime writers is due to the disappearance of democracy and answers no, it is due to the obsessive pursuit of wealth and cheap popularity.

Nicolas Boileau-Despréaux (*q.v.*) made the treatise the bible of European classicism. There are editions of the Greek text by A. O. Prickard in the Oxford series (1906; 2nd ed. 1947); and by W. Rhys Roberts, with English translation and appendices (2nd ed. 1909). There is also a separate translation by A. O. Prickard (1906).

Cassius Longinus.—Cassius Longinus (*c.* 213–273) was a nephew of the rhetorician Phronto of Emesa (Homs in Syria). Having been a pupil of the Neoplatonist Ammonius Saccas at Alexandria, he taught philosophy, philology and rhetoric at Athens; and Porphyry was a pupil of his before going to Rome to join Plotinus. The doctrine of Longinus that ideas exist outside the mind was rejected by Plotinus, and his work *On First Principles* drew from Plotinus the comment that Longinus was "a philologist but no philosopher"; but even so the two had a considerable respect for one another. Having gone to Palmyra to teach Greek literature to Queen Zenobia, Longinus became one of her closest advisers and inspired her anti-Roman policy. When this ended in disaster, Longinus was handed over to the emperor Aurelian, who put him to death.

Fragments survive of Longinus' works. A substantial part of his *Art of Rhetoric* is extant, but his celebrated *Philological Discourses* are lost. He also wrote several works of Homeric studies and composed a number of specialized word lists. Eunapius calls him "a living library and a walking university."

LONG ISLAND, a fragment of the North American continent extending 118 mi. E.N.E. from the mouth of the Hudson river on the northeastern shore of the United States. It roughly parallels the south shore of Connecticut from which it is separated by Long Island sound (90 mi. long) and lies southeast of the mainland of New York state, of which it is a part.

The island is from 12 to 23 mi. wide and has an area of 1,723 sq.mi. The east end is divided into two narrow peninsulas by three bays, Great Peconic, Little Peconic (in which lies Shelter Island) and Gardiners (in which lies Gardiners Island). The northern peninsula, about 25 mi. long, culminates in Orient point; the southern peninsula, about 40 mi. long, ends in Montauk point, the eastern extremity of the island. The north shore of the island is broken in its western half by Flushing bay, Little Neck bay, Manhasset bay, Cold Spring harbour, Huntington bay, Smithtown bay and Port Jefferson. The south shore has Jamaica bay, with many low islands and is nearly cut off from the ocean by the narrow spit of Rockaway beach; and the ill-defined Great South bay, which is separated from the Atlantic by the narrow Long beach, Jones beach and Oak Island beach and by the long peninsula called Fire Island or Great South beach. Still farther east is Shinnecock bay, about 10 mi. long and cut off from the ocean by a narrow beach.

Physiography, climate and location have combined to make Long Island one of the richest and most important garden spots in the United States. The hills of glacial moraine and much of the outwash plains of the southern half of the island, covered for centuries with forest mold, offer a rich soil to the husbandman. A mild maritime climate brings the spring earlier and holds the autumn later than in the continental interior at the same latitude.

History.—When the Europeans first settled on Long Island, they found the area occupied by Indians who were generally of Delaware stock and who, according to early accounts, were divided into a number of small groups, loosely called tribes. There were supposedly at least 13 of these major groups and there may have been more. As part of the Atlantic coast line claimed by England, the island was part of the territory originally included under the jurisdiction of the Plymouth company in the early 1600s and later in 1635 its title was presumably conveyed to the earl of Stirling (Sir William Alexander) by Charles I. The earl's agent, James Farret, was sent to the area and conveyed land titles to groups of individuals between 1635 and 1640.

Dutch interest in this part of the new world had been aroused by the voyage of Henry Hudson in 1609 and resulted in the Dutch West India company setting up a trading post on Manhattan Island in 1624. Long Island was part of the territory claimed by the company even though it conflicted with English claims to the same area. There is some evidence of settlement in the extreme western part as early as 1625; certainly Dutch settlers crossed the East river in the mid-1630s and located in what is now Kings county. Breuckelen (Brooklyn), Amersfort (Flatlands), Midwout (Flatbush) and Nieuw Utrecht (New Utrecht) were Dutch communities established under the authority of the company from 1636 to 1660.

In 1640 Englishmen from Lynn, Mass., under a Stirling patent, attempted to settle near Manhasset bay but were warned away by Gov. William Kieft of New Netherland, who would not admit the validity of the English claim. Later that year these people settled at Southampton, toward the eastern end of the island; at about the same time a group from New Haven located at Southold, a little to the north. These two settlements together with the Gardiner family on Gardiners Island (1639) were the first English groups on the Long Island scene. Another band of English settlers obtained a patent from Governor Kieft in 1644 to found Hempstead under the Charter of Freedoms and Exemptions. Other English towns, Gravesend (1645), Flushing (1645), Newtown (1655) and Jamaica (1656), were set up in similar fashion with the inhabitants swearing allegiance to the Dutch authorities. By the treaty of Hartford of 1650 between New Netherland and the United Colonies of New England, a demarcation line was drawn from Oyster bay to the ocean, recognizing the island as Dutch to the west and English to the east.

In March 1664 Long Island was part of the area given to the duke of York by Charles II and in August the conquest of New Amsterdam and the Dutch territory was effected. By this time the English settlements in the eastern part of the island had associated themselves generally with either New Haven or Connecticut, the latter making some claim to the Long Island area by its charter of 1662. Besides Southampton and Southold, the eastern towns included East Hampton (1648), Shelter Island (1652), Huntington (1653), Oyster Bay (1653), Brookhaven (1655) and Smithtown (1663).

Long Island, together with Westchester and Staten Island, became known as Yorkshire and was governed by the Duke's Laws promulgated at Hempstead in March 1665. In 1683 Yorkshire was abolished and the county system introduced in the province with Long Island receiving three of the original counties—Suffolk, Queens and Kings. The period of the American Revolution saw Long Island a hotbed of activity on the part of both Loyalist and Patriot, and its coastal area was the scene of raids by privateers and organized military units. For the entire period of the British occupation of New York city, Long Island was the major source of supplies of wood and food, and its western area was continuously occupied by detachments of British troops. A major political change occurred in 1898–99, when the three eastern towns of Queens county—Hempstead, North Hempstead and Oyster Bay—formed the new Nassau county and the other towns in Queens became part of New York city.

Industries.—During the 19th century Long Island was chiefly known for its agriculture and its fishing industry. Manufacturing was present in the metropolitan area of Kings county and to a certain extent in some other regions. Long Island agriculture of the 17th and 18th centuries was characterized by the self-sufficient farm. Toward the end of the 18th century some farmers began selling their surplus crops in New York. Connection with this market was made by wagons from the farms at the western end of the island and by small coasting boats from the homesteads of the north shore. Two events in the first half of the 19th century established Long Island agriculture on its modern basis. In 1825 the completion of the Erie canal gave New York city a connection with the continental interior and allowed a swift development which made it the metropolis of North America. In 1844 the Long Island railroad was completed to Greenport. The growth of New York and the completion of the railroad caused the general farms to be turned into market gardens, cultivated intensively.

Whaling was the most important maritime industry. So far as Long Island was concerned, the fishery had its origin in the 17th century at East Hampton and Southampton. Early in the 19th century Sag Harbor became the chief Long Island whaling port. The village, dependent almost solely upon whaling, prospered in the golden age of the industry and suffered heavily when whaling swiftly declined after the middle of the century. Throughout most of the 19th century the menhaden fishery flourished along the southern shore and in Peconic bay. Before the end of the 18th century, the blue point oyster bed in Great South bay had been discovered and was being worked, and in 1855 New York permitted the leasing of sea bottom, which was not part of a natural bed, for the purpose of establishing oyster farms. Oystering under the new conditions became one of the most important industries, not only of Great South bay, but of Peconic bay and some of the north shore harbours. Throughout the history of the island, deep-sea fishing—for cod, mackerel, bluefish, sea bass, weakfish, etc.—has been the major support of many Long Island families. Fishing for recreation has always been of importance and Long Islanders for many decades have provided services for sport fishermen.

In the colonial period milling of various kinds was carried on in the scattered settlements and some types of primitive manufacturing were engaged in to a limited degree. The chief manufacturing enterprises of the first half of the 19th century were those supplying the needs of the maritime industries. Cooperages and ropewalks characterized Sag Harbor in the whaling days. The building of ships and boats became an important industry at Port Jefferson and other north shore towns located near good timber. The development of oystering on a large scale made a new demand for boats and for repair work. More important was the growth of summer colonies on the shores. The making, repairing and storing of pleasure craft during the winter became an important industry. Here and there, as at Patchogue and Sag Harbor, other manufacturing industries sprang up, and, as the years passed, Brooklyn and Queens became two of the most important industrial centres in the United States.

Recreation.—In the first decade of the 19th century Far Rockaway became a watering place for New York's elite. After the Civil War, with the increase of railroad facilities, Long Island took on an added attraction for the wealthy. Southampton became a second Newport and great estates were built along the north shore. For some distance along the south shore eastward from the city of New York, summer hotels were constructed which by the turn of the century were attracting thousands of summer vacationists. Coney Island, pioneer of U.S. amusement parks, has always flourished, while a major recreational achievement has been the continued development of Jones beach by the Long Island State Park commission; it attracts millions of visitors each summer.

Population.—An outstanding phenomenon after 1950 was the tremendous upward surge of Long Island's population.

The four counties of the island expanded from 5,237,918 in 1950 to 6,403,852 in 1960. Between 1950 and 1960 Nassau county grew from 672,765 to 1,300,171 while Suffolk showed an increase from 276,129 to 666,784. One reason for this expansion in population was the construction of low-priced, one-family housing units in both Nassau and western Suffolk; a prime example is Levittown (pop. [1960] 65,276), developed after World War II as a private investment.

Transportation.—Long Island is served on both shores and through the central part of the island by the Long Island Rail Road, which is reputed to carry more commuters than any other railroad in the country. A highly developed and efficient system of parkways is in operation, while Manhattan is connected with Brooklyn and Queens by the Interborough Rapid Transit and Independent subway lines. Bridges connect the western part of the island with Manhattan and the Bronx; there is direct ferry service from north shore points to Connecticut and from the south shore to Staten Island.

With the advent of the airplane in the early decades of the 20th century, Long Island attracted attention because its flat plains presented ideal conditions for the manipulation of aircraft. By the 1920s Roosevelt field (closed in 1951) and Mitchel air force base (deactivated in 1961) had become internationally known. Both LaGuardia field and John F. Kennedy (formerly New York International, or Idlewild) airport are on the island and the airplane industry there is regarded as the single most important manufacturing enterprise outside the New York metropolitan limits.

(M. H. Le.)

Battle of Long Island, 1776.—The interest of this battle lies in the fact that it was the first engagement in the campaign of 1776 (*see* American Revolution) and was expected in England to be decisive of the contest in the colonies. After the evacuation of Boston (March 1776), Lord Howe moved against New York city, which he thought would afford a better base of operations for the future. The Americans undertook its defense although recognizing the difficulties in the case, as the bay and rivers adjoining would enable the British fleet to co-operate effectively with the army. To protect his left flank George Washington was forced to throw a portion of his troops over to the Long Island side of the East river; they fortified themselves there on the site of the present borough of Brooklyn. Lord Howe, who had encamped on Staten Island at the entrance to the harbour, determined to attack this isolated left wing, and on Aug. 22 landed at Gravesend bay, Long Island, with about 20,000 men. The Americans maintained strong outposts in the wooded hills in advance of their fortified lines. On the morning of Aug. 27 Howe, after four days' reconnaissance, attacked these posts with three columns, the left and centre delivering the holding attack, and the right and strongest column turning the enemy's left by a detour. Howe himself, accompanied by Generals (Sir H.) Clinton and Lord Cornwallis, led the turning movement, which came upon the rear

of the enemy at the moment when they were engaged with the two other columns. By noon the Americans had been driven back into the Brooklyn lines in considerable confusion, and with the loss of about half their number. This constituted the battle. The completeness of the British victory resulted from the neglect of the Americans in guarding the left of their outposts. Howe has been criticized for not immediately assaulting the American works, which he might have carried on the evening of the battle. In view of the fact that he had only defeated a small portion of the American forces, and that the works were of considerable strength, he decided to make a formal siege, and Washington took advantage of the delay in operations to retreat across the river to New York on the night of the 29th. This successful movement repaired to some extent the bad moral effect of the defeat of the 27th in the American camp. In the engagement of Long Island Washington lost 1,200 prisoners, 30 guns, and 400 killed and wounded; of the latter the British lost nearly the same number. (C. F. A.)

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LONG ISLAND SOUND, a semienclosed arm of the Atlantic ocean, lies between Connecticut and the island whose name it bears. Its easterly limits are defined by Long Island's Orient Point, and by Plum Island, Great Gull Island, and Fishers Island. The narrow western gateway is at Throgs Neck, where the waters of the sound meet the swift cross currents of the East river. The sound has a length of 90 mi. (78 nautical mi.), a width of 20 mi. (15 nautical mi.) and an area of 1,180 sq.mi. In Pleistocene time, the sound was deepened by two advances of the great Labrador ice sheet which scoured its crystalline bedrock and left two terminal moraines as a dominant feature of Long Island's topography. There is a maximum depth of 330 ft. near the sound's eastern limits, but elsewhere the water is little more than 100 ft. in depth. The mean tidal range is from less than 3 ft. in the east to more than 6 ft. in the west. The drainage basin of the sound is approximately 13 times its area and the annual volume of fresh water is about 35% of its total. Most of this runoff, chiefly from the Housatonic, Connecticut and Thames rivers, enters the sound's relatively open eastern end and is flushed out rapidly to Block Island sound; its effect on the salinity of the sound as a whole is minimal. As this freshened surface layer moves eastward it is replaced by a more saline inflow along the bottom. The relatively shallow waters of the sound are rich in plankton and bottom organisms, which make them favourable for young fish but deter most commercially valuable fish. Except for menhaden, processed for fish meal, the sound does not support an important commercial fishery. The major sports fishing is for weakfish and bluefish. Lobsters, crabs, and clams are caught along the Connecticut shores, and oyster farms are found from Bridgeport eastward. Long Island sound is an important coastal shipping route. Its shores have many residential communities and yachting centres. (W. Wr.)

LONGITUDE: *see* Latitude and Longitude.

LONGOMONTANUS (Christian Severin) (1562–1647), Danish astronomer and astrologer, who is best known for his association with Tycho Brahe and for his published expositions of the Tychonic system of the world, was born at Longberg, in Jutland, Den., on Oct. 4, 1562. He is usually known as Christian Longomontanus, from the latinized form of his birthplace. Educated at Longberg and at Viborg, he was employed for eight years (1589–97) by Tycho Brahe at Copenhagen, as an assistant. He was appointed rector of the *Gymnasium* at Viborg in 1603, elected professor in the University of Copenhagen in 1605 and promoted to the chair of mathematics in 1607. Longomontanus began the construction of the Copenhagen observatory in 1632, but he died on Oct. 8, 1647, before its completion. (O. J. E.)

LONGSTREET, JAMES (1821–1904), lieutenant general in the Confederate army during the American Civil War, was born on Jan. 8, 1821, in Edgefield district, S.C., and graduated from the U.S. Military academy at West Point, N.Y., in 1842. He was severely wounded in the Mexican War and was twice brevetted for gallant and meritorious conduct. In 1861, having attained the rank of major, he resigned from the U.S. army when his state seceded, and was named brigadier general in the Confederate army. As a brigade commander, Longstreet won distinction at Blackburn's ford in the first battle of Bull Run. He fought well as a division commander in the Peninsula campaign at Williamsburg, Fair Oaks, and in the Seven Days' battle. At Antietam and Fredericksburg he commanded what was soon called the I corps in Lee's army of northern Virginia. Most of the corps was in southeastern Virginia and in North Carolina when the battle of Chancellorsville took place; but Longstreet, now a lieutenant general, returned in time to participate in the battle of Gettysburg as Lee's second in command. Believing that Lee had agreed to make the campaign offensive in strategy and defensive in tactics, Longstreet strenuously disagreed with Lee's orders to attack at Gettysburg on July 2 and 3, 1863. After a somewhat slow deployment, he assaulted vigorously but with only limited success (*see* Gettysburg). In Sept. 1863 he took part in the battle of Chickamauga, directing the attack that broke the Union lines. In May 1864, back with Lee's army, Longstreet delivered a crushing attack on Grant's left flank at the Wilderness, but a severe wound prevented him from following it up decisively. In Oct. 1864, although paralyzed in the right arm, he resumed command of his corps and handled it ably until the surrender at Appomattox.

During the period of postwar Reconstruction, Longstreet's attitude toward political problems, and the discussion of certain military incidents—notably the responsibility for the Gettysburg failure—made him extremely unpopular. His admiration for Grant and his loyalty to the Republican party accentuated the ill feeling of the Southern people. But in time his services in former days were recalled, and he became once more "General Lee's war horse" to his old soldiers and the people of the south.

Longstreet held several civil offices, among them that of U.S. minister to Turkey under Grant, and later commissioner of Pacific railways. In 1896 he published his reminiscences *From Manassas to Appomattox*. While painfully defensive in tone, the book is useful for historians. Longstreet died on Jan. 2, 1904.

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LONGUEVILLE, ANNE GENEVIÈVE DE BOURBON-CONDÉ, Duchesse de (1619–1679), French princess, an extremist successively in social and literary fashion, in politics and in religion, was born on Aug. 29, 1619, at Vincennes, where her imprisoned father, Henry II de Bourbon, prince de Condé, had been joined by his wife, Charlotte de Montmorency. Anne's brothers, Louis, later the Great Condé (*q.v.*), and Armand, prince de Conti, were born in freedom. When her uncle Henry de Montmorency was beheaded in 1632, she wanted to become a Carmelite, but was dissuaded. Angelically beautiful, she was married in June 1642 to Henry d'Orléans, duc de Longueville (1595–1663). Enthusiastic for preciosity, she became a star visitor of the marquise de Rambouillet. Her husband's mistress, the duchesse de Montbazon (Marie d'Avaugour), had to apologize publicly for alleging misconduct between her and Maurice de Coligny; but Coligny provoked a duel with Mme de Montbazon's friend Henry de Guise in Dec. 1643 and was mortally wounded. From July 1646 to March 1647 Mme de Longueville was abroad with her husband (plenipotentiary at Münster in Westphalia). On her return she resumed a fatal liaison with François, prince de Marcillac and later duc de La Rochefoucauld (*q.v.*). Marcillac drew her into political intrigue, but was absent when she and others at Noisy in the autumn of 1648 made the plans that matured in the first war of the Fronde (*q.v.*). When the royal court left seditious Paris in Jan. 1649, she stayed behind; and when Marcillac brought Conti

and Longueville to Paris, she went to lodge in the Hôtel de Ville as a surety for their good faith. There she bore the "child of the Fronde," Charles Paris d'Orléans (1649–72), almost certainly Marcillac's.

After the first war Mme de Longueville amused herself in the "Quarrel of the Sonnets," championing Voiture's "Uranie" against Benserade's "Job." In the second war she tried to hold Normandy for her arrested husband's cause, then took refuge in Stenay, treating with the Spaniards. Back in Paris by March 1651, afraid to rejoin her disgruntled husband, she prompted Condé to rebellion; and her relations with the duc de Nemours (C. A. de Savoie) turned La Rochefoucauld's love to hatred. During the third war Condé in March 1652 left her with Conti in Bordeaux. Having abetted the democratic faction there, she had to retire into provincial exile in July 1653. Amnestied by the government and reconciled with Longueville (late 1654), she spent the rest of her life in penitence as the pupil and patroness of the Jansenists. She died at the Carmelite convent of St. Jacques in Paris on April 15, 1679. (J. G. R.-S.)

LONGUS (2nd or 6th century A.D.), Greek writer, was the creator of the pastoral romance and author of *Daphnis and Chloe*. Nothing is known about his life: even his name is suspect, and the only evidence for dating him is the hazardous criterion of stylistic comparison with other authors. His romance, a bucolic idyll in prose, narrates how Daphnis and Chloe, two foundlings brought up by shepherds in Lesbos, gradually fall in love and finally marry. The difficulties, such as abductions, traditionally hindering lovers in this literary genre are severely limited in number and bearing: what interests the author is to describe how the passion of love developed from the first naïve and confused feelings of childhood to full sexual maturity. Longus' psychological analysis, which is penetrating and felicitous, contrasts strongly with the poor characterization in other Greek romances. His descriptions of gardens, landscapes and the alternating of the seasons show a notable feeling for nature, and the atmosphere of pastoral naïveté, which perspicacious critics recognize as artificial, is so dexterously created as to appear natural and convincing to most readers. His short sentences neatly arranged in symmetrical structures aim perhaps at reflecting the style of Alexandrian poetry; in his diction he is a pure Atticist. The general tone of his romance is dictated by the quality prescribed by ancient critics for the bucolic genre—*glykytes*, a "sweetening" of the pastoral life which appealed to the critics of the 18th and early 19th centuries. Bernardin de Saint-Pierre and Salomon Gessner are the best-known imitators of Longus.

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LONGVIEW, a city of eastern Texas, U.S., is the centre of a rapidly growing urban area, 126 mi. E. of Dallas, and the seat of Gregg county. It has a large municipal airport and is the principal city of the east Texas oil field, a region with 20,000 producing wells. There are also numerous gas wells and iron-ore deposits in the vicinity, with a fully integrated steel plant located 30 mi. to the north.

Longview has petroleum refineries, and plants manufacturing oil-field machinery and equipment, chemicals, paper, plastics, agricultural implements, feedstuff, building materials and photographic supplies. The city's industrial growth has reduced the number of farms in the area, but agriculture is still significant, with many small landowners working part time in the industrial plants. It adopted a commission-manager form of municipal government in 1923. For comparative population figures *see* table in TEXAS: *Population*. (N. McG.)

LONGVIEW, a seaport city at the confluence of the Cowlitz and Columbia rivers, in Cowlitz county, Wash., U.S., is about 50 mi. N. of Portland, Ore. Founded in 1922 by R. A. Long, of the Long-Bell Lumber company, on the site of old Monticello, it is one of the world's greatest lumber centres and was the first city of the Pacific northwest to be completely planned with streets, parks and zoned areas. Longview was dedicated in 1923. A large timber company maintains its largest lumber, paper and pulp mills there, drawing raw material from a 500,000-ac. tree farm.

In addition to Longview's lumber and pulp industries, aluminum, paint, concrete pipes, canned goods, dairy products and fisheries are significant. Nearly 600 ships a year call at the city's public port docks. The Longview bridge, which spans the Columbia and connects Washington and Oregon, is one of the longest cantilever bridges (1,200 ft.) in the U.S. Adjoining Longview to the northeast is the older city of Kelso.

On Nov. 25, 1852, a group of residents of northern Oregon territory held a convention at Monticello to petition congress for division of the territory. This led to the creation of Washington territory in 1853.

For comparative population figures *see* table in WASHINGTON: *Population*. (J. M. McC.)

LONICERA: *see* HONEYSUCKLE.

LÖNNROT, ELIAS (1802–1884), Finnish folklorist and philologist, and the compiler of the Finnish national epic *Kalevala* (*q.v.*). He was born at Sammatti in the province of Uusimaa, on April 9, 1802, the son of a poor country tailor. By perseverance he achieved his doctorate in medicine at Helsinki university (1832). In 1833 he became district medical officer at Kajaani, in a remote part of eastern Finland, near Russian Karelia, where he remained for 20 years. During this time he made 11 expeditions and wrote down extensive collections of traditional folk poetry; and among the Lapps, the Finnish tribes living in the northwest areas of Russia, and the Estonians, he collected material illustrating the mutual relationships of the Baltic branches of the Finno-Ugric languages.

Inspired by Homer, Lönnrot compiled the *Kalevala* on the basis of folklore (1835; 2nd enlarged ed. 1849). He also published a collection of lyrical folksongs, *Kanteletar* (3 vol., 1840–41), and collections of proverbs, riddles and incantations. He was professor of Finnish language and literature at Helsinki university, 1853–62. As a leader of the national revival movement he helped by his extensive publications to make Finnish an official language beside Swedish, which had previously been predominant, and this led to the birth of modern Finnish literature (*q.v.*). An outstanding achievement was the establishment of a standard Finnish, which took into consideration the different dialects, and its development into a language capable of expressing modern cultural ideas. His Finnish-Swedish dictionary, (2 vol., 1874, 1880), was long one of the most important sources for research into the Finnish language. The prolonged reform of the Finnish hymnbook (1883) also owed much to him.

Lönnrot was a quiet, modest man. In his last decades he became an honoured patriarch, rising above all differences of opinion. He was honorary member of several foreign scientific organizations; *e.g.*, the Paris Ethnological and Philological society and the Academy of Sciences of St. Petersburg. He died at Sammatti on March 19, 1884.

See Aarne Anttila, *Elias Lönnrot*, vol. i (1931), vol. ii (1935); introduction to Eng. trans. of *Kalevala* by F. P. Magoun (1963).

(V. KN.)

LONSDALE, EARLS OF. This English earldom has been held since 1784 by members of the Lowther family (of Lowther in Westmorland), which traces its descent from Sir Hugh Lowther, attorney general in the reign of Edward I. Sir Hugh's descendants included Sir Richard Lowther (1529–1607), who was a supporter of Mary Stuart and was involved in schemes for her rescue from imprisonment in England, and Sir John Lowther, bart. (d. 1706), who developed the port of Whitehaven and the exploitation of the mineral resources of the surrounding area. Sir John's cousin, another Sir John (1655–1700), was created Viscount Lonsdale in 1696.

The 1st viscount's great-grandson JAMES LOWTHER (1736–1802) was created earl of Lonsdale in 1784. Between 1751 and 1756 he succeeded to the estates of three separate branches of the family; in 1751 he inherited the family baronetcy. He married in 1761 a daughter of Lord Bute. Sir James sat in the house of commons almost continuously from 1757 to 1784. Because of his great

wealth, he exercised an enormous influence on elections in the north of England and controlled nine seats in the house of commons, where his nominees were known as "Sir James's ninepins." He died without issue on May 24, 1802, when the earldom became extinct. It was revived in 1807 for his cousin WILLIAM LOWTHER (1757–1844).

William's eldest son WILLIAM (1787–1872), 2nd earl, was postmaster general (1841–45) and lord president of the council (1852). His great-nephew HUGH CECIL LOWTHER (1857–1944), 5th earl (in the second creation), was a flamboyant and well-known sporting personality. Born in London on Jan. 25, 1857, the second son of the future 3rd earl, he succeeded his elder brother in the title in 1882. An expert judge of horses and dogs, Lonsdale was especially interested in hunting, the turf, yacht racing and boxing. It is in connection with the latter sport, through his institution in 1911 (when president of the National Sporting club) of the Lonsdale belts for boxing champions, that his name is chiefly remembered. He died on April 13, 1944. His great-nephew JAMES (1922–), 7th earl, succeeded to the title in 1953.

LONSDALE, DAME KATHLEEN (née YARDLEY) (1903–), English crystallographer, one of the first two women to be elected (1945) to the fellowship of the Royal society, was born on Jan. 28, 1903. She was educated at the University of London, where she earned a D.Sc. in physics. From 1922 to 1927 and from 1937 to 1942 she was research assistant to Sir William Henry Bragg at University college and the Royal institution, London. Between these two periods, she was Amy Lady Tate scholar in the University of Leeds and then Leverhulme research fellow, and afterward, during 1944–46, Dewar fellow at the Royal institution. In 1947 she was special research fellow, United States public health service. She became professor of chemistry at University college, London, in 1949. In 1956 she was created Dame of the British empire and in 1957 was awarded the Royal society's Davy medal in recognition of her distinguished studies. She served as vice-president of the society in 1960–61.

Dame Kathleen Lonsdale's publications include *Structure Factor Tables* (1936), *Crystals and X-Rays* (1949) and many papers in scientific journals. She was also editor of *International Tables for X-Ray Crystallography* (3 vol., 1952–62). Her other interests are reflected in *Quakers Visit Russia* (1952), *Removing the Causes of War* (1953) and *Is Peace Possible?* (1957).

(D. MCK.)

LONSDALE, WILLIAM (1794–1871), English geologist and paleontologist, whose studies of fossil corals suggested the existence of an intermediate system of rocks, the Devonian, between the Silurian and Carboniferous systems, was born at Bath on Sept. 9, 1794. He was educated for the army, served in the Peninsular War at the battles of Salamanca and Waterloo, and retired as lieutenant. At his home at Batheaston he collected a series of rocks and fossils which he presented to the Literary and Scientific Institution of Bath. He became the first honorary curator of the natural history department of the museum, serving until 1829 when he became assistant secretary and curator of the Geological Society of London at Somerset House (1829–42). In 1829 Lonsdale read before the society an important paper on the oölitic district of Bath, the results of a survey begun in 1827; later he was engaged in a survey of the oölitic strata of Gloucestershire (1832), and he mapped the boundaries of the various geological formations.

He became the highest authority in England on corals, and he described fossil forms from the Tertiary and Cretaceous strata of North America and from the older strata of Great Britain and Russia. In 1837 he suggested from a study of the fossils of the South Devon limestones that they would prove to be of an age intermediate between the Carboniferous and Silurian systems. This suggestion was adopted by Adam Sedgwick and Roderick (later Sir Roderick) Impey Murchison in 1839, and may be regarded as the basis on which they founded the Devonian system.

Lonsdale's paper, "Notes on the Age of the Limestones of South Devonshire" (read 1840), was published in the same volume of the *Transactions of the Geological Society* (ser. 2, vol. v) with Sedgwick and Murchison's famous paper "On the Physical Structure of Devonshire." Lonsdale died at Bristol on Nov. 11, 1871.

LONS-LE-SAUNIER, a spa of eastern France, capital of the *département* of Jura, lies on the Vallière river 86 km. (53 mi.) S.S.E. of Dijon by road. Pop. (1962) 15,570. The town is surrounded by the vine-clad hills of the western Jura. It owes its name to the salt mines of Montmorot, its western suburb, which have been used from early times. The church of St. Désiré (12th and 15th centuries) has a huge Romanesque crypt. The thermal springs are situated to the southeast, the waters contain salt. Lons-le-Saunier is on the main railway from Basel and Besançon to Bourg and Lyons. Another line runs to Dijon. The principal industry is the manufacture of sparkling wines.

Lons-le-Saunier, known as Ledo in the time of the Gauls, was fortified by the Romans, who added the surname Salinarius to the Gallic name. An object of contention because of the value of its salt, it belonged for a long time during the medieval period to the house of Chalon. It was burned in 1364 by the English, and again in 1637, when it was seized by the duke of Longueville for Louis XIII. It became definitely French in 1674. There the meeting between Marshal Ney and Napoleon took place, on the latter's return from Elba in 1815.

LOO (formerly called LANTERLOO; Fr. *lanturlu,* the refrain of a popular 17th-century song), a game of cards, invariably played for a stake. The players may number from five to about nine, each for himself. The pack of 52 cards is used.

In the simplest form of the game, three cards are dealt to each player, and the next is turned for trump. Eldest hand leads, and one-third of the pool goes to the winner of each trick. The pool is formed by antes before each deal, and may be increased by payments for loo (failure to win a trick) and fines for irregularities.

Among the features added to this base are found:

1. Turn of a card for trump is deferred until the first time any hand fails to follow suit. The trump then fixed affects the winning of the current and any subsequent tricks.

2. The first pool is a single, three counters put in by dealer alone. The players who are looed pay three counters each to the next pool, making it a double.

3. A player dealt a flush (three trumps) wins the pool without play.

4. The penalty for loo is to double the current pool. This variant, unlimited loo, has caused some considerable fortunes to change hands.

5. The hand may be five cards instead of three: pam, the knave of clubs, is always the highest trump. It may be used as a "wild card" to complete a flush (five cards of one suit) or a blaze (five court cards). The holder of either wins the pool without play.

(G. MH.)

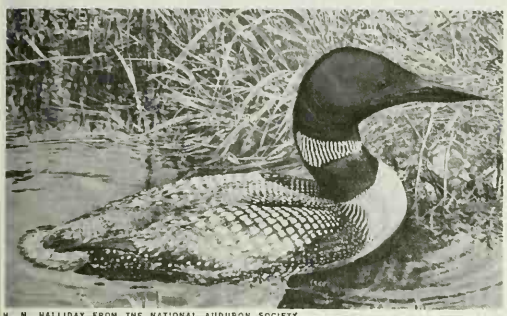
LOOE, a seaport and urban district of Cornwall, Eng., lies 18 mi. W. of Plymouth by road. Pop. (1961) 3,878. It is divided into East and West Looe by the Looe river, which forms the harbour and is crossed by a seven-arched stone bridge. Above the bridge the river also divides into the East and West Looe rivers. Its streets are narrow, steep and winding, with many ancient thick-walled houses. The East Looe beach is sandy while the Hannafore beach, on the other side of the river, is largely rocky. The parish church of St. Mary adjoins the sea front at East Looe. Remains of a Benedictine priory and of a Celtic chapel have been found. The harbourage was probably the original cause of settlement at Looe. At the time of the Domesday survey East Looe was assessed under Pendrym, which was of the king's demesne, and West Looe under Hamelin's manor of Trelowia. In the 14th century the former manor was held by the family of Bodrugan, the latter by that of Dauney. In 1237 Henry Bodrugan received the grant of a market on Fridays and a fair at Michaelmas. A charter of incorporation was granted in 1587, and in 1685 James II provided that there should be a mayor and 11 aldermen, 36 free burgesses, four fairs and a court of piepowder (to administer justice at the fairs). East Looe was governed under this charter until 1885. West Looe (known also as Porpighan or Porbuan) was constituted a free borough by a charter ratified in 1325. Upon the attainder of the earl of Devon in 1539 the borough fell to the crown and in 1574 a charter of incorporation was granted providing for a mayor and 11 burgesses, also for a market on Wednesdays and

two fairs. West Looe continued to be administered under this charter until 1869.

Looe was second only to Fowey as a port in the 15th century. It furnished 20 ships for the siege of Calais. A considerable export trade in copper, tin and granite was formerly carried on; the harbour is used by sailing dinghies and other small craft, and by fishing boats. Shark angling has become a major tourist attraction. Looe is also the headquarters of the Spearfishing club of Great Britain. Up the West Looe river is a pilchard canning establishment. Looe Island, ½ mi. from the beach and 1 mi. in circumference, has many legends and is presumed to have been connected with the abbey of Glastonbury.

LOOM: *see* WEAVING.

LOON (DIVER), name properly restricted to birds of the family Gaviidae, containing four species of the genus *Gavia* and constituting the order Gaviiformes. Measuring about two to three feet in length, they have thick plumage, which in summer is mainly black or gray above and white below, with spots, streaks or bars of white on the upper parts. With the exception of the red-throated loon, *G. stellata*, distinguished by its rich chestnut throat



H. M. HALLIDAY FROM THE NATIONAL AUDUBON SOCIETY

COMMON LOON OR GREAT NORTHERN DIVER (GAVIA IMMER) IN SUMMER PLUMAGE

and foreneck (summer plumage), they lose the bold dorsal pattern in winter. They all have a strong, tapering bill; rather small, pointed wings; and legs placed so far back on the body that walking is virtually impossible. The tarsal bones of the ankles are laterally compressed and the first three toes webbed.

Almost wholly aquatic, divers or loons are capable of swimming long distances beneath water and have been known to dive to depths approaching 200 ft. Usually they are found singly or in pairs but may winter in small flocks. The voice is distinctive, consisting of various guttural notes and very loud quavering calls. They feed mainly on fish, crustaceans and insects. The nest usually is a heap of vegetable matter at the edge of water. The eggs, one to three in number, are olive-brown spotted with darker brown.

The loons are wide ranging: the common loon or great northern diver, *G. immer*, of the northern hemisphere, is the most abundant loon in North America; the arctic loon or black-throated diver, *G. arctica*, is circumpolar in distribution, being commonest in the old world; the yellow-billed loon, *G. adamsii*, is found on arctic coasts from Siberia to northwestern Canada. (E. R. BE.)

LOOS, BATTLE OF, the name given to the British share in the Anglo-French offensive in Artois in Sept. 1915, during World War I. This operation, carried out at the request of the French, was conducted by the 1st British army under Gen. Sir Douglas Haig. The attack began early on Sept. 25, 1915, after a four-day artillery bombardment, and was preceded by the release of chlorine gas. Six divisions (47th, 15th, 1st, 7th, 9th and 2nd), forming the I and IV corps, took part. In addition the XI corps (guards, 21st and 24th divisions) was available, but under G.H.Q. and not directly at Haig's disposal.

The attack had some initial success; but exploitation was slow because of the delay in bringing the reserves forward, and subsequent attempts to advance had little success. On Sept. 27, when the attack had reached a depth of about 8,000 yd., the order to halt was given. Preparations were made to renew the offensive, but these were upset when the Germans counterattacked, with only meagre success, on Oct. 8. Failure was due mainly to the misplacing of the reserves, to shortage of artillery ammunition and to the changing wind's interference with the gas attack. British casualties were 48,200; those of the Germans were estimated at 65,000.

See the British official *History of the Great War—France and Belgium, 1915*, vol. ii (1928). (C. N. B.)

LOOSESTRIFE, the common name for plants of the family Lythraceae, especially the genera *Lythrum* and *Decodon*, and for two genera of the primrose family (Primulaceae; *q.v.*), *Lysimachia* and *Steironema*, certain species of which are used as ornamentals. Purple loosestrife (*Lythrum salicaria*), native to Eurasia and naturalized in eastern North America, is a handsome plant growing two to six feet high. It grows on river banks and ditches, and has a branched stem bearing whorls of narrow pointed stalkless leaves and ending in tall tapering spikes of beautiful rose-purple flowers. The flowers exist in three forms, which differ in the relative length of the styles and stamens and are known as long-styled, mid-styled and short-styled forms; the size and colour of the pollen also differ. These differences are important in the pollination of the flower, making self-fertilization next to impossible. (*See* POLLINATION.) Swamp loosestrife, water willow or wild oleander (*Decodon verticillatus*), a perennial herb native to swamps and ponds of eastern North America, finds some use in the bog garden.

JOHN MARKHAM

WOOD LOOSESTRIFE, ALSO CALLED YELLOW PIMPERNEL (LYSIMACHIA NEMORUM)

The Eurasian yellow loosestrife (*Lysimachia vulgaris*), an erect plant, two to four feet high, is common on river banks in England and is introduced in eastern North America; the branched stem bears tapering leaves in pairs or whorls, and terminal panicles of rather large deep yellow flowers. Yellow pimpernel or wood loosestrife (*L. nemorum*), a low-growing plant with slender spreading stem and yellow flowers standing singly in the leaf axils, is frequent in England. *L. nummularia* is the well-known creeping jenny or moneywort, a larger plant with widely creeping stem, pairs of shining leaves and large solitary yellow flowers; it is found on banks of rivers and damp woods, and is a common rockery plant. Fringed loosestrife (*Steironema ciliatum*), a yellow-flowered perennial, native to moist parts of North America and naturalized in Europe, is little cultivated but can be used in moist, shady places in the garden.

LOOY, JACOBUS VAN (1855–1930), Dutch author and artist, who most clearly and successfully embodies the naturalist ideal of some of the *Nieuwe Gids* writers and the impressionism of the Hague school of painters, was born at Haarlem on Sept. 12, 1855. In his life he emerged from the insecurity of an upbringing in an orphanage to gain the Prix de Rome in 1883, and in his work this search for self-assurance is marked by the transition from the wistful realism and vivid fantasy of his first short stories in *Proza* (1889) to the neoromantic exuberance of *Feesten* (1902) and the detached humour of his autobiographical stories about the child *Jaapje* (1917), continued in *Jaap* (1923) and *Jacob* (1930). He died at Haarlem on Feb. 24, 1930. (P. K. K.)

LOPBURI, located in the southern part of the central plain of Thailand east of the Chao Phraya river, is watered during the rainy and flood season by the Lopburi river. This river branches off from the Chao Phraya to the east about 20 mi. below Chainat and, after flowing past the cities of Lopburi and Ayutthaya (Phranakhornsri-ayuthya), rejoins the Chao Phraya at Bang Sai. The *changwad* of Lopburi (area 2,544 sq.mi.) had a population of 335,661 in 1960 (density 132 persons per square mile). Soils ill-

suited for irrigation and rough terrain have helped limit agricultural development. Lopburi (21,244), the capital, is on the Northern railway 75 mi. N. of Bangkok. As an ancient city called Lavo, it was ruled by the Mons during the 7th–8th centuries and by the Khmers during the 10th–13th centuries. After 1665, the Ayutthaya period of Thailand's history, Lopburi became the alternate capital and there the king lived in a royal residence during the rainy season. Lopburi declined after Ayutthaya was sacked by the Burmese and the capital moved to Bangkok. (T. F. B.)

LOPE DE VEGA: *see* VEGA CARPIO, LOPE FÉLIX DE.

LOPES, FERNÃO (*c.* 1380–*c.* 1460), Portuguese historian, was the first and greatest of the Portuguese royal chroniclers and the most accomplished writer of 15th-century Portuguese prose. He occupies a special place in medieval European historiography because he held that the surest way of arriving at historical truth was through the evidence of historical documents. Nothing certain is known of his early life and his name is first mentioned in 1418, when he was already keeper of the royal archives—a post he long held. In 1434 King Duarte appointed Lopes to write the chronicles of Portugal from the monarchy's origins to the time of John I. The new chronicler prepared himself for his task by studying the contents of the royal archives and by traveling round the kingdom examining monastic and other records, looking at epitaphs and familiarizing himself with the topography of towns and battlefields. When he retired (1454) his history had been completed up to 1411. The last reference to him in contemporary records is dated 1459.

All his chronicles up to the death of Alfonso IV (1357) disappeared from sight early in the 16th century after they had been utilized by Rui de Pina, though what may be an incomplete transcription of them has since been found. There remain intact the short *Crónica de D. Pedro I*, the much more elaborate *Crónica de D. Fernando* and the massive *Crónica de D. João I*, which, though unfinished, runs to nearly 400 chapters. This last was the first of Lopes' works to be printed (1644). Lopes uses documents systematically, sometimes quoting them *in extenso* in his text but, more often, building up a continuous narrative from what he read, particularly in the chancery registers. Since much of this documentary material has now disappeared, the value of Lopes' work as a primary source for Portuguese medieval history can hardly be exaggerated. He also incorporated—particularly in his accounts of the reigns of Ferdinand and John I—material taken from a number of contemporary Portuguese chronicles, most of which have also disappeared. This loss makes a definitive appraisal of Lopes' own work difficult. He is, however, critical of the veracity of some of his predecessors and often corrects them by reference to documents; he acts in a similar way when using the Castilian chronicles of Pedro López de Ayala (*q.v.*) who is, nevertheless, one of Lopes' major sources.

Fernão Lopes writes in a rich, slightly archaic, easy flowing language with a distinct popular flavour, eschewing the displays of erudition and rhetorical device characteristic of other contemporary prose writers. He has a notable ability to handle dialogue realistically and to rise to dramatic moments in his country's history. The main feature of his writing is his desire to leave his readers with a strong visual impression of historical events, though analysis of motive and character is also undertaken. He was of plebeian origin and his approach to history shows marked sympathy with the point of view of the lower orders, whose collective reactions to events are described in masterly fashion. His attitude to the great is notably objective and devoid of flattery. Even his portrait of John I himself—his royal patron's father—is by no means uncritical. He was aware, too, of the importance of economic factors in history: these are given a special place in his account of Ferdinand's reign. Lopes is least convincing when dealing with battles, since he had little, if any, military experience. His intense nationalism caused him, too, to underrate the value of English diplomatic and military support for Portuguese independence in the time of John I. But, in general, he succeeded in his often expressed intention to purvey the whole truth, even when this was not flattering to the Portuguese.

BIBLIOGRAPHY.—The most easily available editions of *Crónica de D. Pedro I* and *Crónica de D. Fernando* are by D. Peres (1932 and 2 vol., 1933–35 respectively): the best are in *Colecção de livros inéditos de história portuguesa*, vol. iv (1816); *Crónica de D. João I*, ed. by M. Lopes de Almeida and A. de Magalhães Basto, 2 vol. (1945–49); an incomplete transcript of the chronicles up to the death of Alfonso IV which may be by Lopes is to be found in *Crónicas dos sete primeiros reis de Portugal* (1952–53). *See* also A. F. G. Bell's useful if somewhat out-of-date study, *Fernam Lopez* (1921); P. E. Russell, *Fontes de Fernão Lopes* (1941); A. J. Saraiva, *Fernão Lopes* (1953).

(P. E. R.)

LÓPEZ, CARLOS ANTONIO (1792–1862), second dictator of Paraguay, ended his country's isolation, sought to modernize its economy and society, and became deeply involved in international disputes. Born in Asunción on Nov. 4, 1792, López attended the San Carlos seminary, taught there until it was closed by the dictator José Gaspar Rodríguez Francia (*q.v.*), and then became a lawyer. Exiled to his *estancia* in 1837, López returned to his suburban home when Francia died in 1840. The next year he became the principal of two consuls and in 1844 was elected president with dictatorial powers, an office he held until his death on Sept. 10, 1862.

López amassed a large personal fortune and bestowed favours liberally on his family. Imported foreign technicians built a railway, highways, foundries and modern fortifications. López founded Paraguay's first newspaper, encouraged education and relaxed some of Francia's stern laws. Commerce, agriculture and foreign trade, largely monopolized by the state, improved moderately. At first conciliatory, Pres. Juan Manuel de Rosas of Argentina refused to recognize Paraguay's independence and a brief war occurred (1845–46); relations improved when Rosas was overthrown in 1852. Recognition by several countries followed in 1853, but Paraguay's foreign relations were never smooth. Difficulties with the United States almost resulted in war and neighbouring countries remained unfriendly during most of the López regime.

(H. G. WN.)

LÓPEZ, FRANCISCO SOLANO (1827?–1870), dictator of Paraguay and eldest son of Carlos Antonio López (*q.v.*), seized power upon his father's death in 1862. Born near Asunción on July 24, 1826 or 1827, he received an indifferent education but fancied himself without a peer in military science. A brigadier general at 18, he commanded Paraguay's army in the abortive war with Argentina (1845–46). A few years later he headed a diplomatic mission to Europe during which he purchased munitions, engaged foreign artisans and acquired an Irish mistress, Eliza Lynch. When he became dictator López continued the construction of public buildings and roads and installed the first telegraph system in South America. He devoted most of his time and resources to military preparations until Paraguay had a standing army of more than 60,000, a force López was ready to use to settle boundary and navigation disputes with Brazil and to prevent disruption of the delicate political balance in the La Plata basin. He believed that maintenance of Paraguay's independence and territorial integrity required that he champion nonintervention in Uruguay. On Nov. 12, 1864, less than a month after Brazil intervened in the Uruguayan civil war, López seized a Brazilian merchant vessel and started what became the War of the Triple Alliance. Instead of marching to the aid of his favoured Uruguayan faction, López in December sent an army northward which overran the disputed region of Mato Grosso north of the Río Apa and captured Corumbá. Reinforced with supplies taken in this campaign, López prepared to attack southern Brazil. When Pres. Bartolomé Mitre refused permission to cross Argentine territory, López seized Argentine ships and attacked Corrientes in April 1865. This move brought Brazil, Argentina and Uruguay together in alliance on May 1. López launched a combined river and land attack in July which resulted in disaster. While the allies prepared to invade Paraguay, López concentrated his forces around the famed fortress of Humaitá which finally fell in July 1867. Thereafter López fought a war of movement, gradually falling back to the north of Paraguay where he was killed on March 1, 1870, at the Aquidabán river. López in 1868 executed several hundred prominent Paraguayans whom he accused of conspiring against him. The war, which exterminated more than 300,000 Paraguayans, caused significant changes in demographic and cultural characteristics. Long

considered a cruel tyrant. López later was elevated to the pantheon of Paraguayan heroes. (H. G. Wx.)

LÓPEZ DE AYALA, PEDRO (1332–1407), Spanish historian, poet and chancellor of Castile from 1398 until his death (in Calahorra), was born at Vitoria. His most impressive works are the chronicles of the four kings under whom he served. After transferring his allegiance in youth from Peter the Cruel to Henry of Trastámara, he held high office under the latter and his successors John I and Henry III, seeing action against the Black Prince at Nájera (1367) and the Portuguese at the disaster of Aljubarrota (1385), where he was taken prisoner. Ayala has been called the first Castilian humanist because of his translations from Boccaccio and Guido da Colonna. As a poet, he is the last representative of the medieval "clerkly craft," and his *Rimado de Palacio*, written largely in the old *cuaderna vía*, is notable for its blistering satire on contemporary society, sparing the mighty of neither church nor state. The chronicles (of which the standard edition is that of 1779–80) display the same powers of implacable observation and vivid expression as the *Rimado*, but substitute for the *saeva indignatio* of the poem an icily impassive surface objectivity even more effective, thanks to Ayala's shrewd choice of significant detail and incident, in conveying his moral judgments.

Ayala's *Poesías* were edited by A. F. Kuersteiner (1920) for the Hispanic Society of America. (F. S. R.)

LÓPEZ DE GÓMARA, FRANCISCO (1512–1557?), Spanish historian, who recorded the deeds of Hernán Cortés, was born in Soria, studied the humanities at Alcalá university and became chaplain in Cortés' household. There he acquired much of the material for his greatest work, the *Historia de las Indias y conquista de Mexico* (1552), the first part of which relates to the discovery and conquest of the Indies and the second part to the triumphs of Cortés. He made Cortés the central figure, giving him all the credit, and his biased account provoked a fellow soldier, Bernal Díaz (*q.v.*), into producing a rival version. His clear, individual style made his work popular, but its partiality caused it to be banned.

LÓPEZ DE MENDOZA, ÍÑIGO, Marqués de Santillana; *see* Santillana, Íñigo López de Mendoza, Marqués de.

LOP NOR (Lob Nor, Chinese Lo-pu-no-erh), a lake in Sinkiang Uigur Autonomous Region of China. It lies in the eastern Tarim basin, between the Astin Tagh on the south and the Kuruk Tagh on the north. Ancient Chinese and Greek accounts and maps placed the lake south and east of the great Silk Road station of Lou-lan, at a point about 42° 30′ N. lat. About A.D. 330 the lower Tarim river broke out of its old course, turning southeastward, to establish a new terminal water body rather close to the base of the Astin Tagh, causing the abandonment of Lou-lan as a Silk Road station. No medieval European travelers mentioned this change, and European cartographers continued to place Lop Nor in the classical location. In 1876 the Russian explorer N. Prjevalsky discovered two closely connected lake basins 1° S. of the classical site of Lop Nor, which he regarded as being identical with the classical lake.

Several decades of exploratory search for the lake followed. Explorers and geographers engaged in heated debate over the physical history of the Tarim river and Lop Nor. In 1928 Sven Hedin, who had repeatedly sought to solve the puzzle, found both the lower Tarim river and Lop Nor back in their classical positions, the river having returned to its ancient channel in 1921. Hedin's studies made clear that the precise location of the terminal lake had steadily shifted over the centuries, and that the lake varied both in area (about 946 sq.mi.) and in depth.

See Sven Hedin, *The Wandering Lake* (1940). (J. E. Sr.)

LOQUAT (*Eriobotrya japonica*), a subtropical tree of the family Rosaceae, related to the apple and other well-known fruit trees of the temperate zone. It is occasionally called, misleadingly, Japanese plum and Japanese medlar, but these names are gradually disappearing. The latter name refers to its resemblance to the closely related medlar (*q.v.*).

Though its native home is probably central-eastern China, the loquat tree was introduced very early into Japan, where it was much developed horticulturally and is still highly valued. Some superior Japanese varieties eventually reached Europe, the Mediterranean basin and a few other regions. The loquat is grown commercially (usually on a rather small scale) in many subtropical regions. It is not adapted to the tropics, except at elevations where the climate is cool. In Mexico the tree is known as *nispero del Japón*.

JOHN H. GERARD

LOQUAT LEAVES (ERIOBOTRYA JAPONICA)

Ornamental in appearance and rarely more than 30 ft. in height, the evergreen loquat is frequently planted in parks and gardens. The leaves, which are clustered toward the ends of the branches, are thick and stiff, elliptic to lanceolate in form, eight to ten inches long, with coarsely serrate margins. The small fragrant white flowers are arranged in dense terminal panicles. The fruits are borne in large loose clusters; individually they are round, obovoid or pear-shaped, one to three inches in length, with a tough, yellow to bronze plumlike skin enclosing juicy, whitish to orange-coloured flesh surrounding three or four large seeds. The flavour is agreeably tart, suggesting that of several other fruits of the same family.

While the loquat is commonly grown from seeds, commercial plantings are usually based on grafted trees of superior varieties, such as Tanaka of Japanese origin, Gold Nugget, Champagne and Early Red of California. Propagation is by shield budding and cleft grafting; loquat seedlings or quince rootstocks grown from cuttings can be used, the latter if a dwarf tree is desired.

When planted in orchard form, the trees are spaced 20 to 25 ft. apart. They grow well on various soils, from sandy loams to clays, and come into bearing at an early age, three or four years.

See Wilson Popenoe, *Manual of Tropical and Subtropical Fruits* (1920); W. H. Chandler, *Evergreen Orchards*, 2nd ed. (1958). (W. Po.)

LORAIN, a city of Ohio, U.S., in Lorain county, is a port on the Great Lakes. Its harbour, the lower 3 mi. of the Black river, is on the south shore of Lake Erie, 25 mi. W. of Cleveland and 70 mi. E. of Toledo. The city occupies the level terrain on both sides of the river to and beyond the head of navigation.

In the early 19th century the area was occupied by Indians. Title to the Connecticut Western Reserve district passed to the Connecticut Land company with the signing of the treaty of Fort Industry in 1805. The territory was then surveyed and opened for settlement under the name of Mouth of Black River. The village was first incorporated as Charleston in 1836. It declined in importance and lost its charter after Cleveland was selected as the terminus of the Ohio and Erie canal and when the westward extension of the railroad was routed through Elyria, leaving Charleston's port without rail connections with the interior. When the Poe lock at Sault Sainte Marie, Mich., was opened in 1896 and the Cleveland, Lorain and Wheeling railroad (later part of the Baltimore and Ohio) to the coal fields of southeastern Ohio was completed in 1872, the coal and iron ore trade was established. The town was rechartered in 1874 as Lorain because the U.S. post office had approved another Ohio town as Charleston.

In 1890 the Johnstown Steel company was located on 3,000 ac. of land at the head of navigation on the Black river. This company was chiefly responsible for the city's growth. Other manufacturing industries include shipbuilding, power shovels, cranes, bearings, steel stampings, car and truck assembly, railroad shops, gypsum lath and wallboard, and clothing. Coal averages 98% of all water-borne shipments, and iron ore and limestone constitute 95% of total receipts of the port of Lorain. About 50% of the iron ore and limestone are used locally.

Lorain is a cosmopolitan city with large population segments of Puerto Ricans, Hungarians, Poles, Germans, Italians, Czechoslovaks and Slovenians. Five public parks comprising 171 ac. provide recreational facilities. Population (1960) 68,932; Lorain-

Elyria standard metropolitan statistical area (Lorain county), 217,500. For comparative population figures *see* table in OHIO: *Population*. (R. B. FR.)

LORANTHACEAE, the mistletoe family, containing 25–30 genera and more than 600 species in tropical and temperate regions. All the members of this dicotyledonous family are partially parasitic plants; their greenish leaves are capable of making some food of their own. Most are evergreen herbs or shrubs found attached to the branches of trees. In the United States the family is represented by about six species of *Phoradendron* (American mistletoe) and about eight species of *Arceuthobium* (pine mistletoe). The only British species is *Viscum album*, the mistletoe of history. *Nuytsia floribunda*, the so-called parasitic Christmas tree or mistletoe tree of western Australia, is remarkable in being the only terrestrial and treelike (up to 35 ft. high) member of the family. *See* MISTLETOE; NUYTSIA.

LORCA, FEDERICO GARCÍA: *see* GARCÍA LORCA, FEDERICO.

LORCA, a town of the province and region of Murcia, southeastern Spain, is situated on the Guadalentín river 62 km. (38½ mi.) S.W. of Murcia by road. Pop. (1960) 58,641 (mun.). It is in a semiarid and steppelike area surrounded by rugged mountains. The town, which is divided in two by the Guadalentín, has many fine houses with coats of arms on the walls. The old part surrounds the castle; the modern part is centred on the Calle de la Corredera. The industrial area of San Cristóbal is on the other side of the river. The farming district is San Juan. Cattle fairs are held in the Santa Quiteria suburb. Lorca is on the railway from Granada to Murcia and Valencia. Cereals are the main crop. Irrigation has been practised since the time of the Muslim invasion. Water is bought and sold all the year round in the Casa del Alporchon. The pasture lands support cattle, sheep, mules and donkeys. There are factories manufacturing hemp sandals. The town was the Ilukro of the Romans and the Muslim Lurka. It was reconquered in 1234 and became a Christian stronghold. (M. B. F.)

LORD, in its primary sense, the head of a household, the master of those dependent on him for their daily bread; the word frequently occurs in this sense in the Bible. As a term implying the ownership of property, "lord" survives in "lord of the manor" and "landlord." It is not only a general word for a prince or sovereign but also a common word for a feudal superior, and particularly for a feudal tenant holding directly of the king, a baron (*q.v.*). Hence in Britain lord denotes a peer of the realm, a member of the house of lords, which includes the lords temporal and the lords spiritual; this is the chief modern usage. The prefix "lord" is ordinarily used as a less formal alternative to the full title, whether held by right or by courtesy, of marquess, earl or viscount, and is always so used in the case of a baron (particularly in the peerage of Scotland where it remains the only correct usage at all times.) Where the name is territorial the "of" is dropped, thus "the marquess of A.," but "Lord A." The younger sons of dukes and marquesses have, by courtesy, the title of lord prefixed to the Christian and surname, *e.g.*, Lord John Russell. In the case of a diocesan bishop his proper title is the Lord Bishop of A., whether he be a spiritual peer or not. Some high officials of the cabinet have the word "lord" prefixed to their titles, *e.g.*, first lord of the treasury (the prime minister), lord high chancellor, lord president of the council, lord privy seal, etc. In certain cases the members of a board which has taken the place of an office of state are known as lords commissioners, *e.g.*, lords of the treasury, civil or naval lords of the admiralty.

For lord lieutenant and lord mayor (the title given to the mayors of certain large cities in England) *see* LIEUTENANT and MAYOR. The form of address, "my lord," is properly used not only to those members of the nobility to whom the title "lord" is applicable and to bishops but also to all judges of the high court in England and lord provosts. (S. B.-R. P.)

LORD ADVOCATE, or queen's advocate, the principal law officer of the crown in Scotland. His business is to act as a public prosecutor, and to plead in all causes that concern the crown. He is the head of the administration of criminal justice, and thus his functions are much more extensive than those of the English law officers. He is aided by a solicitor general and four advocates-depute. The office seems to have been established about the beginning of the 16th century, but it was only in the year 1597 that the holder was empowered to prosecute without the concurrence of a private party. He has the privilege of pleading in court with his hat on. *See* also SCOTLAND: *Administration and Social Conditions: Justice*.

LORD CHAMBERLAIN, an important officer of the British royal household, to be distinguished from the lord great chamberlain (*q.v.*), whose office also evolved from that of the chamberlain (*q.v.*) at the Norman court. The office of lord chamberlain, unlike that of the lord great chamberlain, is not hereditary, but it is always held by a peer and a privy councilor. Formerly he was a member of the government, appointed by the prime minister, and before 1782 the office carried cabinet rank. In 1924, when the first Labour government was in power, it was decided the office should be nonpolitical and the holder should be appointed by agreement between the sovereign and the prime minister.

The lord chamberlain is the second dignitary of the court. On ceremonial occasions he carries a white staff and wears a golden or jeweled key representing the key of the palace, which is supposed to be in his care. He does, in fact, control the state apartments at Windsor castle and at St. James's palace. He is in charge of all court ceremonial and of the arrangements for all state ceremonies, such as the state visits of foreign dignitaries, royal marriages, christenings and funerals except that of the sovereign, which is the responsibility of the earl marshal (*q.v.*). He also organizes the royal garden parties, where he is in close personal attendance on the sovereign. He has an office in St. James's palace where he is assisted by a staff under a comptroller and an assistant comptroller.

At one time the lord chamberlain discharged important political duties, but these are now mainly confined to presenting addresses from the house of lords to the sovereign and conveying the reply to them. The same duty is performed for the house of commons by the vice chamberlain, whose office is still a political appointment. The vice chamberlain is a member of the government of the day, usually one of the junior whips. Like the lord chamberlain, he carries a white staff as a badge of office on ceremonial occasions.

The lord chamberlain is the head of the royal household and is responsible for the ecclesiastical and medical households, the honourable corps of gentlemen at arms and the sovereign's bodyguard of the yeomen of the guard. Under him, too, are such varied officials as the surveyors of the sovereign's pictures and works of art, the librarian of the royal library, the poet laureate, the master of music, the bargemaster and watermen, and the keeper of the royal swans. When any article of the regalia is required for a state ceremony, such as the opening of parliament or the distribution of the royal maundy, it is the lord chamberlain who issues the necessary instructions to the keeper of the jewel house at the Tower of London. On the more ceremonial side the marshal of the diplomatic corps, the officials of the central chancery of orders in knighthood whose province it is to regulate investitures, and the gentlemen ushers and serjeants at arms also come under the lord chamberlain's office. Of the gentlemen ushers the principal usher is the gentleman usher of black rod, who derives his title from the black rod which he carries as the badge of his office. Black rod is an officer of the Order of the Garter, and is in constant attendance at the house of lords, where it is part of his duty to carry messages and summonses to the house of commons. It is he, for instance, who is sent at the opening of parliament to summon the members of the house of commons to attend the upper house in order to hear the speech from the throne.

The lord chamberlain is also chairman of the committee that recommends for the sovereign's consideration applications for the grant of the royal warrants of appointment for the supply of goods. One curious but important part of his duties is the licensing of London theatres (which includes fire precautions, etc.) and the censorship of stage plays throughout the United Kingdom. This dates back to the reign of Queen Elizabeth I when the lord cham-

berlain was in charge of all court entertainments and took the players under his personal protection. To assist him in the censorship there are three examiners who advise on plays submitted to them.

When there is a queen consort or a queen mother, she has her own lord chamberlain, treasurer, mistress of the robes and ladies in waiting. *See* also HOUSEHOLD, THE ROYAL; CHAMBER, KING'S.

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(L. E. TA.)

LORD CHIEF JUSTICE OF ENGLAND is the head of the queen's bench division of the high court of justice and next in rank to the lord chancellor. He usually presides over the court of criminal appeal, is ex officio a member of the court of appeal, and is appointed by the crown on nomination of the prime minister. He is invariably raised to the peerage on appointment, and so is able to take part in the appellate work of the house of lords; and although, like all other judges except the lord chancellor, he must not form public associations with any political party, the lord chief justice may (as Lord Goddard did when he held the office) intervene in debates on legal and judicial problems. His title was conferred upon him by the Judicature act, 1873, by which the court of queen's bench became one of the divisions of the queen's bench division. *See* also JUDICIARY AND COURT OFFICERS.

LORD GREAT CHAMBERLAIN, who must be distinguished from the lord chamberlain (*q.v.*), is one of the great English officers of state. His office dates from Norman times, when, as his name implies, he was specially connected by his duties with the king's chamber (*see* CHAMBER, KING'S), and he was originally the financial officer of the household. As he was always a great baron, deputies performed his financial work (*see* CHAMBERLAIN: *England*), and his functions became, as they are now, mainly ceremonial though the emblem of his office is still a key.

From its creation in the 12th century until 1779 the office was held by the De Veres, earls of Oxford. It then passed to coheiresses. In 1962 the holder was the marquess of Cholmondeley, in whom the office was vested jointly with the earl Ancaster and the heirs of the late marquess of Lincolnshire.

The lord great chamberlain has charge of the palace of Westminster, especially of the house of lords, and when the sovereign opens parliament in person he is responsible for the arrangements. He assists at the introduction of peers into the house of lords on their creation. At coronations he emerges into special importance, and takes an active part in investing the sovereign with the royal insignia.

See G. E. C., *The Complete Peerage,* vol. x, appendix F, "The Office of Lord Great Chamberlain of England," pp. 46–90 (1945).

(L. E. TA.)

LORD HIGH CHANCELLOR, a British officer of state with three main functions: he presides over the house of lords; he is the head of the judiciary; he is also a minister, a member of the government and of the cabinet, having under his control all the judicial appointments in the country except those reserved to the prime minister, and a great deal of ecclesiastical patronage.

This miscellany of duties and powers are united in one person for reasons that lie deep in history. In England the office of chancellor dates back to St. Edward, the Confessor, who, in making this appointment, followed the model of the Carolingian court. Until the 14th century the chancellor was invariably a priest; he was at once a royal chaplain, the king's secretary in secular matters and keeper of the royal seal. This combination of duties, characteristic of the primitive administrative systems of the early middle ages, has left its imprint on the chancellorship to the present day: as chaplain the chancellor was keeper of the king's conscience, as secretary he was the king's closest confidant in secular matters and as keeper of the seal he played a necessary part in all formal expressions of the king's will. By him and his staff of chaplains the whole secretarial work of the royal household was conducted, the accounts were kept under the justiciar and treasurer, writs were drawn up and sealed and the royal correspondence was carried on. The chancellor was, in fact, as the historian Bishop Stubbs put it, a sort of secretary of state for all departments.

From the 12th century until the early Tudor period the chancellor wielded immense power, especially during an interregnum or the king's absence abroad. Among notable chancellors were Roger (d. 1139), bishop of Salisbury, who organized the exchequer in the reign of Henry I, and Thomas Becket (d. 1170), who held the office before Henry II made him archbishop of Canterbury. In the reign of Richard I, Archbishop Hubert Walter (d. 1205) achieved particular prominence because of the king's prolonged absences. Robert Burnell (d. 1292) was Edward I's most trusted and influential minister, while tenure of the office contributed greatly to the power and self-importance of the cardinals Henry Beaufort (d. 1447) and Thomas Wolsey (d. 1530).

The chancellorship in England developed on different lines from the chancellorship in the Holy Roman empire and, later, the Austrian and the German empires; there the chancellors, as exemplified by Metternich and Bismarck, remained up to modern times the effective heads of government, as is the chancellor in the Federal Republic of Germany (*see* CHANCELLOR). The reason for the difference lies in the development in England of the judicial duties of the chancellor. These grew out of the fact that all petitions addressed to the king passed through the chancellor's hands. Already in the reign of Henry II the chancellor was largely employed in judicial work. The office acquired a more definitely judicial character when, in the reign of Edward III, the chancellor's court ceased to follow the king; and the time when, in the middle of this reign, all petitions that were matters of grace were definitely committed to the king may be taken as the start of the equitable jurisdiction of the chancellor (*see* EQUITY). The chancellor's court was the direct precursor of the court of chancery, which, by the Judicature act, 1873, was fused into the high court of justice, the chancery division of which is primarily responsible for that court's equitable jurisdiction. The lord chancellor is the president of the chancery division; he is a member of the court of appeal and, if present, presides over it.

The judicial work of contemporary chancellors is, however, almost exclusively confined to the house of lords and the judicial committee of the privy council (*q.v.*); when the chancellor is present, he presides over both tribunals, though, because of the weight of administrative business, modern chancellors seem to have less time for their judicial duties than had their predecessors before 1939.

The position of the chancellor as speaker or prolocutor of the house of lords dates from the time of the English Norman kings, when the ministers of the royal *curia* (the king's court) formed ex officio a part of the *commune concilium* (the great council) and parliament. The chancellor originally attended with the other officials, and he continued to attend ex officio after they had ceased to do so. The chancellor attends the house of lords by virtue of his office, but he has generally, and since the reign of Queen Anne invariably, been a peer. There have been times when the great seal has been put into commission and other times when its custody has been transferred from the chancellor to a minister with the title of lord keeper of the great seal (*q.v.*). By the Act of Union (1707) of England and Scotland one great seal was appointed to be kept for all public acts; the chancellor's authority thus extends to the whole of the United Kingdom, and the commissions of the peace for Scotland as well as for England issue from him. By the Roman Catholic Relief act, 1829, it was enacted that no Roman Catholic was to be appointed lord chancellor or keeper or commissioner of the great seal.

As speaker of the house of lords, the chancellor's powers and duties differ considerably from those of the speaker of the house of commons. He puts the question but has no power to rule upon points of order. Like the speaker of the house of commons, he may take part in debates, and, unlike modern speakers, chancellors frequently do so.

See also MINISTRY, GOVERNMENT. (W. T. Ws.)

LORD HIGH CONSTABLE: *see* CONSTABLE.

LORD HIGH STEWARD. In England the lord high stewardship of the later middle ages looks back to the grants of the stewardship of England and Normandy by the future Henry

II as duke of Normandy in 1153 to Robert earl of Leicester (d. 1168) and his son Robert (d. 1190). The death of the next earl without male heir in 1204 caused the office to fall into desuetude until it was revived for Simon de Montfort who served as steward at Queen Eleanor's coronation in 1236. The office was mainly honorific (*see* HOUSEHOLD, ROYAL). On Simon's death at the battle of Evesham in 1265 his forfeited lands were given to Henry III's younger son Edmund, earl of Lancaster, who held the stewardship for life. Soon after his coronation in 1308, Edward II conferred the office on Edmund's son Thomas, and his heirs.

Its annexation by the most acquisitive branch of the royal family accounts for the peculiar importance of the office in the hands of John of Gaunt, duke of Lancaster, who assumed control over the minor, Richard II. By the duke's order the minutes of proceedings held before him on the claims to take part in the coronation ceremonies were enrolled. The judgments became precedents for the court of coronation claims held before the steward. In the mid-20th century this court is still held before coronations, but is presided over by commissioners. In 1397 John of Gaunt established another notable tradition by presiding as lord high steward at the trial before parliament of the earl of Arundel and others. The lord high stewardship ceased to be a permanent post in 1421 with the death of Thomas of Lancaster, duke of Clarence. Thereafter a steward was appointed only to preside over the court of claims, to perform certain ceremonial duties at the following coronation and, in certain cases, to act as judge at the trial of a peer (*see* below). Nowadays the lord high steward fulfills only the second of these functions.

The general principle of judgment by peers embodied in Magna Carta strengthened the claim of the lords in parliament that they should not be tried by the ordinary courts for serious crimes. The history of the trial of lords for treason is obscure (*see* IMPEACHMENT), but it became established that if such a trial were held during a parliamentary session the lords sat in the ancient traditional manner of a court of justice under the presidency of the lord steward. The peers who were members of the court were the judges, and each, including the president, individually pronounced his judgment on the accused. The lord steward presided in the manner that a feudal lord's steward had presided over the court of his lord's vassals. If parliament were not in session, the trial was held before the lord high steward sitting as a true judge, the peers acting as a jury who must give a unanimous verdict. For each trial a special commission was issued appointing a lord high steward. In accounts of such trials he is described throughout as "His Grace," and at the end of the trial his rod or staff of office was handed to him by the gentleman usher of black rod to be broken by the steward as a sign that his office had ended. It was in the lord high steward's court that the suppositious duchess of Kingston was tried for bigamy in 1774, and that the earl of Cardigan was tried for attempted murder by shooting in 1841. The most recent examples are the trials of Lord Russell in 1901 and Lord de Clifford in 1935. The procedure was abolished by the Criminal Justice act of 1948.

See T. F. T. Plucknett, *A Concise History of the Common Law*, 5th ed. (1956); L. W. Vernon-Harcourt, *His Grace the Steward and the Trial of Peers* (1907). (D. M. S.)

LORD HIGH TREASURER. In England, the late Saxon kings had their treasury at Winchester and the first man known to bear the title of treasurer had a house in the city before the Norman Conquest. Winchester remained the royal treasury through the 12th century with subordinate treasuries in royal castles such as Salisbury for the king's convenience as he moved about the land. The offices of treasurer and chamberlain in Henry I's reign were sometimes held by the same man, but the establishment of the exchequer (*q.v.*) and the rapid increase of business meant that the offices could not long be combined. The treasurer became responsible for the working of the exchequer at Westminster and before the end of the 12th century was continually occupied there. He was represented in the treasury by his clerk. The continuous history of the office begins with the appointment early in Henry II's reign of Richard Fitzneale (*q.v.*), son of Bishop Nigel of Ely. Near the end of his long tenure of the treasurership he wrote the *Dialogus de Scaccario*, a description of the working of the exchequer with which the history of English financial organization effectively begins. In Henry III's reign the treasurer ranked with the justiciar (*q.v.*) and the chancellor (*q.v.*) as one of the three great officers of state. The titles "lord treasurer" and "lord high treasurer" came into general use in the 16th century and were used continuously from 1612 when the office was first put in commission (*i.e.*, the duties were relegated to a specially chosen board). The Restoration (1660) was followed by important changes, and the commissioners appointed in 1667 controlled a newly ordered treasury organization which was distinct from the exchequer and more independent of the privy council than previously. The office was in commission intermittently until 1714 and permanently thereafter. From 1690 to 1841 the first commissioner, or lord of the treasury, if not a peer of the realm, was also chancellor of the exchequer and finance minister; if he was a peer, the chancellorship was ordinarily held by a member of the house of commons. In the mid-20th century the prime minister is the first lord and the chancellor of the exchequer the second lord of the treasury. The five junior lords who make up the rest of the board are government whips. *See* also CHAMBER, KING'S; GOVERNMENT DEPARTMENTS.

See F. M. Powicke and E. B. Fryde, *Handbook of British Chronology*, 2nd ed. (1961), which gives a list of treasurers and a full list of sources for the history of the office. (D. M. S.)

LORD HOWE ISLAND, in the southern Pacific ocean, is 436 mi. N.E. of Sydney, Austr., in longitude 159° 5′ E. and latitude 31° 30′ S. Pop. (1961) 249. The island measures about 7 mi. by 1 mi., is well wooded and rises to 2,840 ft. in Mt. Gower at the southern end. It is of volcanic origin, and the coral reefs on its western shore are the most southerly known. Discovered in 1788 and now governed by a board in Sydney, the island is mainly a tourist resort. The atoll Ontong Java in the Solomon Islands was also formerly called Lord Howe Island. (O. H. K. S.)

LORD JUSTICE CLERK, in Scotland, the judge next in rank to the lord justice-general (*q.v.*). He presides in civil cases in the second division of the court of session, and in the absence of the lord justice-general, in criminal cases in the court of justiciary. Like the master of the rolls he was originally not a judge at all, but clerk and legal assessor of the justice court. In time he was raised from the clerk's table to the bench, and by custom presided over the court in the absence of the justice-general. Up to 1672 his position was somewhat anomalous, as it was doubtful whether he was a clerk or a judge, but an act of that year, which suppressed the office of justice-depute, confirmed his position as a judge, forming him, with the justice-general and lords commissioners of justiciary, into the court of justiciary. The lord justice clerk is also one of the officers of state for Scotland, and one of the commissioners for keeping the Scottish regalia.

LORD JUSTICE-GENERAL, the highest judge in Scotland, head of the court of justiciary (the highest criminal court), called also the lord president, and as such head of the court of session (the supreme civil court) and representative of the sovereign. The office of justice-general was for a considerable time a sinecure post held by one of the Scottish nobility, but by the Courts of Session act, 1830, the office was united with that of lord president of the court of session, who then became presiding judge of the court of justiciary. *See* also SCOTS LAW.

LORD KEEPER OF THE GREAT SEAL, in England, formerly a great officer of state. The great seal of England, which is affixed on all solemn occasions to documents expressing the pleasure of the sovereign, was first adopted by Edward the Confessor (*see* SEALS), and entrusted to a chancellor for keeping. The office of chancellor from the time of Becket onward varied much in importance; the holder being an ecclesiastic, he was not only engaged in the business of his diocese but sometimes was away from England. Consequently, it became not unusual to place the personal custody of the great seal in the hands of a keeper; this, too, was the practice followed during a temporary vacancy in the chancellorship. This office gradually developed into a permanent appointment, and the lord keeper acquired the

right of discharging all the duties connected with the great seal. He was usually, though not necessarily, a peer, and held office during the king's pleasure; he was appointed merely by delivery of the seal, and not, like the chancellor, by patent. His status was definitely fixed (in the case of lord keeper Sir Nicholas Bacon) by an act of Elizabeth I, which declared him entitled to the same powers and jurisdiction as the lord chancellor. Subsequently he was generally raised to the chancellorship, and retained the custody of the seal. The last lord keeper was Sir Robert Henley (afterward 1st earl of Northington), appointed in 1757 and made lord chancellor in 1761.

See also CHANCELLOR; LORD HIGH CHANCELLOR.

See F. M. Powicke and E. B. Fryde, *Handbook of British Chronology*, 2nd ed. (1961), which gives a list of keepers; H. C. Maxwell-Lyte, *Historical Notes on the Use of the Great Seal* (H.M.S.O., 1926).

(SN. G.)

LORD PRESIDENT OF THE COUNCIL, in England, one of the great officers of state and a member of the ministry who formally directs the privy council. It was only in 1679 that the office of lord president became permanent; previously either the lord chancellor, the lord keeper of the seal, or some particular court official carried out the duties.

The office was of greater direct importance when the powers of the privy council, exercised through various committees, were of wider extent than at the present time (*see* PRIVY COUNCIL). The duties of the office are to preside over the meetings of the privy council and to draw up the minutes of council upon subjects which do not belong to any other department of state. In modern times the lord president was, until the appointment of a minister for science, to a large extent a minister of science, since the department of scientific and industrial research and the departments responsible respectively for medical and industrial research came under his control. The office is very frequently held in conjunction with other ministerial offices. The lord president is generally a member of the house of lords, and is included in the cabinet.

LORD PRIVY SEAL, the officer in the British government who has custody of the privy seal. *See* SEALS.

LORDS JUSTICES OF APPEAL: *see* JUDICIARY AND COURT OFFICERS.

LORDS OF APPEAL IN ORDINARY: *see* JUDICIARY AND COURT OFFICERS.

LORD'S PRAYER (Lat. ORATIO DOMINICA or PATER NOSTER) perhaps from the beginning was meant as that unifying bond it has become in Christendom. The Jews had their daily prayers and "sectarians" had theirs. Luke xi, 1 gives the Lord's Prayer as such a prayer, and it resembles Jewish prayers with their three elements of praise, petition and yearning for God's Kingdom ("May his great name be . . . hallowed . . . May he establish his Kingdom in your days"). The Lord's Prayer, however, shows greater economy of words (*cf.* Matt. vi, 7). The Lucan form (Luke xi, 2–4), in the better manuscripts, is shorter and often considered more original; yet it shows signs of theological reflection, while the Matthean form (Matt. vi, 9–13), that universally used, has more liturgical features, not to be held against its originality.

Roman Catholics say the Lord's Prayer without the doxology ("for thine is the Kingdom . . .") used in the rest of Christendom. Roman Catholic usage agrees with the best manuscripts; but it is known from Jewish prayers that a prayer ended with a freely chosen doxology. One of these occurs in the version of the prayer given in the Didache (viii) and made its way into the later biblical texts. "Trespasses" (Tyndale's Bible and the Book of Common Prayer) and "debts" (King James version and Revised Standard version) are different translations of a word meaning "that which one owes" (probably to one's brother in the community; *cf.* Matt. xviii, 15).

Used three times daily by the 2nd century (Didache, viii, 3), the Lord's Prayer found its place at the centre of the Mass and all services. With the Apostles' Creed (*see* CREED) it formed the nucleus of medieval devotional practice and catechism, as retained, *e.g.*, by Luther. By the early 3rd century Origen and Tertullian had woven theological tractates around it, but the attempts to reach back to its original meaning began with the recognition of eschatology (*q.v.*) as the frame for the teaching of Jesus. In that light the prayer becomes a meaningful unity and its petitions take on precision. A radical eschatological interpretation would in paraphrase read somewhat like this:

> Hallowed by thy name among the nations [*cf.* Ezek. xxxvi, 23] by the coming of the Kingdom and by the manifestation of thy plan of salvation on earth as it is now realized in heaven.
>
> Give us today the foretaste of the heavenly banquet [daily bread; rather, the bread for the morrow; Matt. viii, 11].
>
> And forgive us what we have done against our bretbren as we have forgiven those who have wronged us.
>
> And cause us not to suffer the utmost trial [*cf.* Matt. xxiv, 22], but deliver us from evil [or, the Evil one].

While differing in details, most scholars agree that the original meaning of the Lord's Prayer is to be sought in such a direction; there lies the common denominator for later interpretations and the impetus for new insights in the life of Christian prayer.

See also PRAYER.

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LORD'S SUPPER, a title of the Eucharist, the central rite of Christian worship, instituted by Jesus at the Last Supper on the night before his crucifixion. St. Paul alone among the writers of the New Testament used the term "Lord's Supper" (I Cor. xi, 20), as he alone used the term "communion" or "participation" in this sense (I Cor. x, 16). From the 2nd century on, Christian writers generally preferred the title "Eucharist." *See* EUCHARIST.

LORD STEWARD, in England, an important official of the royal household who is not to be confused with the lord high steward (*q.v.*), one of the great officers of state. Both offices evolved from that of the early medieval steward, or seneschal, during the 13th century. The duties of the lord steward were originally domestic, and he was known as the "chief steward" of the household (first recorded in 1293). In the *Ordinances of Eltham* (1526) he is called "the lord great master," and in 1554, at the request of Queen Mary I, the name was changed by act of parliament to the present title "Lord Steward of the Queen's most honourable Household." The office was of considerable political importance under the Tudors and Stuarts, and up to 1782 it carried cabinet rank. Until 1924 it continued to be a political appointment which was bestowed on a member of the government. Since that date the office has been filled at the discretion of the sovereign. In theory the lord steward is responsible for the day-to-day management and the financial affairs of the royal household; in practice these duties were assumed by the master of the household when the prince consort reorganized the household in the 1840s. A further change took place in 1920 when the executive and some of the ceremonial duties of the lord steward were transferred to the lord chamberlain (*q.v.*). In consequence, the functions of the lord steward are now purely ceremonial and are mostly confined to state occasions, when he bears a white staff as the badge of his office. He is still the first dignitary of the court and is always a peer and a privy councilor. (*See* also HOUSEHOLD, ROYAL.)

In the past, the lord steward also had legal and judicial authority. He presided over the counting house, or Board of Green

Cloth (as it came to be called in Tudor times), a name derived from the green-covered table at which its transactions were originally conducted, where together with the cofferer and others he controlled the expenditure and made the necessary provisions for the royal household. The board also had "power to correct all offenders, and to maintain the peace of the immediate verge or jurisdiction of the court-royal, which extends every way two hundred yards from the gate of the palace" where the sovereign might happen to reside for the time being. The functions of the Board of Green Cloth are now largely nominal. It meets annually to license, on behalf of the sovereign, public houses within the verge (*i.e.*, 12 mi. radius) of the old Palace of Whitehall. The audit of household civil-list accounts is now conducted by the treasury.

From the turn of the 13th century the lord steward also presided over the lord steward's court, which had jurisdiction over offenses and felonies committed by the king's servants (this judisdiction was extended in 1541 to cover treasons, murders and manslaughters or offenses where blood was shed), and over the Marshalsea court, a court of record held before the lord steward and the knight marshal of the household, which had civil and criminal jurisdiction over any action within the verge where at least one of the parties was a member of the royal household. In 1630, King Charles I, by letters patent, established a new court of record, called the palace court, under the lord steward and the knight marshal. Its powers were renewed in 1665 with jurisdiction over all actions arising between parties within the verge, the jurisdiction of the Marshalsea court, the City of London and Westminster hall being excepted. In later days these courts lost much of their importance, and since defendants both in the Marshalsea and palace courts were empowered by statute to remove the cause by habeas corpus to a superior court if the damages were stated to be £5 or more, they became mainly courts for the recovery of small debts. Both the Marshalsea court and the palace court were abolished in 1849 by act of parliament.

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LOREBURN, ROBERT THRESHIE REID, 1ST EARL (1846–1923), British lawyer and politician, who as lord chancellor was largely responsible for the passage of the Court of Criminal Appeal act (1907), was born at Corfu on April 3, 1846. He was educated at Cheltenham and Balliol college, Oxford, where he won the Ireland scholarship in 1868. He was called to the bar in 1871, and in 1880 entered politics as Liberal M.P. for Hereford. In 1882 he became queen's counsel and represented Dumfries Burghs from 1886 to 1905. In 1894 he became solicitor general and during 1894–95 was attorney general. On the formation of Campbell-Bannerman's government in 1905, Sir Robert Reid, who had been knighted in 1894, became lord chancellor, and was created Baron Loreburn. In 1912 he resigned on grounds of health. Lord Loreburn, who was created an earl in July 1911, published *Capture at Sea* (1913) and *How the War Came* (1919). He died at Dover on Nov. 30, 1923.

LOREE, LEONOR FRESNEL (1858–1940), U.S. railroad president, was born in Fulton City, Ill., on April 23, 1858. After graduating from Rutgers college, New Brunswick, N.J., in 1877 he entered the service of the Pennsylvania railroad as a rodman. Later railroad experience included positions with the Mexican National railway and again with the Pennsylvania. He served in engineering positions of increasing importance with the Pennsylvania and in 1901 was elected to a vice-presidency. He resigned the same year to become president of the Baltimore and Ohio railroad, and in 1904 he was chosen president of the Rock Island company. In 1907 he was elected president of the Delaware and Hudson company, a position he held for more than 30 years. He invented the upper quadrant system of semaphore signaling, built the first high-pressure locomotive and established the first organized railway police force. He wrote *Railroad Freight Transportation* (1922). He died Sept. 6, 1940, at West Orange, N.J. (W. H. D.)

LORELEI, the name of a rock with a remarkable echo in the Rhine river near St. Goar. The word is derived from Old High German, *Lur,* connected with modern German *lauern,* "to lurk," "be on the watch for," and equivalent to *Elf* ("goblin") and *Lai* ("a rock"). In the commonest form of the story associated with it the Lorelei is a maiden who threw herself into the Rhine in despair over a faithless lover, and became a siren who lured fishermen to destruction. Clemens Brentano created the legend in its main essentials in his novel *Godwi* (1800–02). In the 19th century it formed the subject of a number of songs and dramatic sketches (listed in H. Seeliger, *Loreleysage in Dichtung und Musik;* 1898). The poem most often set to music was Heinrich Heine's "Ich weiss nicht was soll es bedeuten," of which the settings by Friedrich Silcher (from a folk song) and by Franz Liszt are the most famous.

See R. Elwenzeller-Favre, *Lorelei. Entstehung und Wandlung einer Sage* (1946).

LORENTZ, HENDRIK ANTOON (1853–1928), Dutch physicist, who shared the 1902 Nobel prize for physics with Pieter Zeeman for work on the influence of magnetism on radiation and helped lay the basis for Albert Einstein's special theory of relativity. He was born at Arnhem on July 18, 1853. He studied at Leiden, where he was appointed professor of mathematical physics in 1878. In 1912 he became director of research at the Teyler institute, Haarlem. He remained honorary professor at Leiden, where he gave a weekly lecture on modern physics, which was usually reported for publication by one of the audience.

Lorentz' work in physics was very wide in its scope, but its central aim, it appears, was to arrive at some consistent theory for electricity, magnetism and light. He tried to explain these phenomena by assuming an ether which was at rest and had electrons either at rest or moving in it. A number of phenomena were successfully explained on this electron theory, but it failed to give an explanation of the negative result of the Michelson-Morley experiment (*q.v.*). To overcome this difficulty Lorentz introduced the idea of local time in 1895. The connection between this and the Fitzgerald contraction was pointed out by Sir Joseph Larmor, and in 1904 Lorentz extended his work and arrived at the Lorentz transformation, which helps form the basis of Einstein's restricted theory of relativity (1905).

Lorentz' earlier investigations were originally published in the *Archives Néerlandaises* and consequently were not known to English physicists; Lord Rayleigh and Sir Oliver Lodge were largely responsible for the spread of his ideas in England. His first paper, published in 1875, dealt with the reflection and refraction of light by dielectrics and metals. In 1880 he published a memoir on the relation between the refractive index and the density of a medium. This was the first application of James Clerk Maxwell's theory to a medium consisting of discrete molecules. Lorentz dealt with optical dispersion and tried to give an explanation on the assumption that it was due to resonant vibrations. This work was continued in his two well-known memoirs, *La Théorie électromagnétique de Maxwell et son application aux corps mouvants* (1892) and *Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern* (1895). In the latter memoir he deals with the electrodynamic field of a system moving with uniform velocity. Lorentz gave an explanation of the Zeeman effect very soon after it was observed, and predicted polarization effects which were verified later by experiment. He was also the author of a number of papers on gravitation theory, thermodynamics, radiation and kinetic theory. He was chairman of the committee of intellectual co-operation set up by the League of Nations. He died at Haarlem on Feb. 4, 1928.

Lorentz' works include *Collected Papers* (1934–39); *Lectures on Theoretical Physics* (1927–31); *Problems of Modern Physics* (1927); *The Theory of Electrons* (2nd ed. 1953).

See G. L. de Haas-Lorentz, *H. A. Lorentz* (1957). (E. TR.; X.)

LORENZETTI, the name of two brothers, both Italian painters of the Sienese school, active in the first half of the 14th

century. Their style combined the harmonious colour and expressive design of Duccio di Buoninsegna with the monumental realism of Giotto and, in the case of the elder, the dramatic naturalism of Giovanni Pisano. Their art was much imitated in Siena during the third quarter of the 14th century, and many works by close followers are still commonly attributed to one or the other.

AMBROGIO LORENZETTI (*c.* 1290–1348), the younger brother, ranks in importance with the greatest Sienese painters, Duccio and Simone Martini. Since neither he nor his brother is mentioned in documents after 1348, it is assumed that both died of the plague that devastated Siena in that year. Only six documented works of Ambrogio, apparently covering a period of merely 13 years, have survived. They include four scenes from the legend of St. Nicholas of Bari in the Uffizi gallery, Florence, which are parts of an altarpiece painted about 1332 in Florence; the wall decorations of 1337–39 in the Sala della Pace in the Palazzo Pubblico, Siena, representing "Good Government," "Effects of Good Government," "Bad Government" and "Effects of Bad Government"; and the signed and dated panels of the "Presentation of Christ in the Temple" (1342) in the Uffizi, and of the "Annunciation" (1344) in the Pinacoteca, Siena. Ambrogio's most important undocumented works are panel paintings of the "Madonna and Child."

It is not known who Ambrogio's teacher was, but his early works indicate that the young painter received his main inspiration from the art of Duccio, his brother Pietro and Giotto. Already at this early period his representations reveal a realistic individualism and an intense occupation with significant composition and form. These characteristics are most evident in the "Allegories" in the Palazzo Pubblico, the most important Sienese fresco decoration. In it we see Ambrogio as an acute observer of the world around him, an empirical explorer of linear and aerial perspective, a student of classical works of art, and a political and moral philosopher. His desire to depict spatial depth convincingly led Ambrogio to an increasingly accurate rendering of space in his paintings and almost to one-point perspective in his last work, the "Annunciation." With his profound interest in perspective and in classical antiquity Ambrogio anticipated the Renaissance.

PIETRO LORENZETTI (*c.* 1280/90–1348), incorrectly called Pietro Laurati by Vasari, apparently was the elder brother of Ambrogio. His earliest certain work, the Madonna polyptych of 1320, an altarpiece in the Pieve at Arezzo, indicates that he studied under Duccio or a close pupil of this master, and that he was influenced by Giotto's solemn and Giovanni Pisano's dramatic representations. These influences are evident also in the somewhat later frescoes of the "Madonna and Child with Saints," and the "Crucifixion, Deposition, Entombment, Descent Into Limbo, and Resurrection of Christ" in the left transept of the lower church of S. Francesco, Assisi. In the Madonna painting at Arezzo and in that at Assisi the Virgin and Child are depicted intently gazing at each other, a motif directly derived from Giovanni Pisano's sculpture. In the important altarpiece of 1329 for the Carmine church, Siena, now in the Pinacoteca of that city, the artist chose a less intimate composition for the Virgin and Child, but he compensated for the formal main representation by adding very animated predella scenes, in which spatial depth is skilfully asserted.

During the 1330s Pietro became somewhat influenced by the art of his brother, with whom he produced in 1335 four scenes from the life of the Virgin (destroyed in the 18th century) on the façade of Sta. Maria della Scala, Siena. In Pietro's triptych of the "Nativity of the Virgin" in the Museo dell'Opera del Duomo, Siena (1335–42), the figures have a breadth and composure, and the space representation has an originality suggestive of Ambrogio.

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LORENZO, FIORENZO DI (*c.* 1445–*c.* 1525), Umbrian painter, a precursor of Pinturicchio, became a member of the guild of painters in Perugia between 1463 and 1469. In 1472 he was elected prior of the guild and his birth is for this reason generally assumed to have taken place about 1445. A signed altarpiece in the Galleria Nazionale dell'Umbria representing SS. Peter and Paul beside a niche with a lunette of the Virgin and Child was painted in 1487. Works conjecturally datable before this time are a triptych from the Confraternità della Giustizia at Perugia and an Adoration of the Shepherds from Monteluce, both in the Perugia gallery, and a triptych in the National gallery, London. The London triptych is related to paintings by Niccolò Alunno at Deruta and by Benozzo Gozzoli at Vienna, and both these artists seem to have exercised a significant, though not necessarily direct, influence on Fiorenzo's early style. The relationship of Fiorenzo di Lorenzo's early works to paintings by Verrocchio is also noteworthy and lends some force to the view that before 1470 he worked in Florence. Documents of 1490, 1491 and 1513 relate to the production of lost works, but the artist's mature development can be traced through frescoes in S. Francesco at Deruta (1478), Monteluce (1491), Monte l'Abate (1491–92) and in the Perugia gallery (from S. Giorgio, 1498). The last reference to Fiorenzo di Lorenzo's activity dates from Feb. 1522 and he was dead by Feb. 14, 1525. After about 1480 the Verrocchiesque elements in Fiorenzo's work become less pronounced and thereafter he develops a typically Umbrian style. An attractive but relatively weak artist, Fiorenzo di Lorenzo was a precursor of Pinturicchio, who was probably a member of his studio during the 1470s. His later work is a pallid reflection of that of Pinturicchio and Perugino.

See W. Bombe, *Geschichte der Peruginer Malerei* (1912); R. van Marle, *The Development of the Italian Schools of Painting*, vol. xiv (1933). (J. W. P.-H.)

LORENZO MONACO (DON LORENZO) (*c.* 1370–*c.* 1425), Italian painter whose work combined the rhythmic, graceful flow of line and decorative feeling of the Sienese school with the Florentine traditions of the followers of Giotto. Lorenzo was born at Siena. He took the vows of the Camaldolese order in 1391 and lived mostly at the monastery of Santa Maria degli Angeli, in Florence. His name as a layman was Piero di Giovanni del Popolo di San Michele de Bisdomini and a painter of that name was entered in the books of the guild of St. Luke at Florence in 1396. Lorenzo was in some respects an innovator in Florence; in his later work he appears to be influenced by the realistic tendency of the early Renaissance. The Uffizi in Florence contains a signed work by the master, "Coronation of the Virgin" with many figures, painted in 1413 for his convent. The National gallery in London has another smaller version of the same subject; one of his most graceful altarpieces is the "Annunciation" in the Bartolini chapel in the church of Sta. Trinita at Florence. His "Madonna and Child with Angels" was acquired by the Metropolitan Museum of Art, New York city. Another late work of the master is the "Adoration of the Magi" in the Uffizi. The master's feeling for decorative composition, his expressive line and his originality come out well in his small predella pieces, as in the three small fragments at the Florence academy, representing the "Nativity," the "Life of a Hermit" and a stormy seascape, and in the two remarkable illuminations in Berlin museums of the "Journey of the Three Kings" and the "Visitation."

LORETO, episcopal see and a noted pilgrimage resort of The Marches, Italy, in Ancona province, 15 mi. S.S.E. of Ancona by rail. It lies on the right bank of the Musone. Pop. (1957 est.) 8,663 (commune).

The town, surrounded by 16th-century walls and bastions, is virtually a long narrow street, lined with shops for the sale of religious objects. The principal buildings in the Piazza della Madonna are the Palazzo Apostolico (containing works of Lorenzo Lotto and Lodovico Carracci and a replica of the tapestries designed by Raphael for the Sistine chapel) and the Basilica of the Holy House or the Santuario della Santa Casa (a late Gothic structure begun in 1468 and continued by Giuliano da Maiano, Giuliano da Sangallo, Bramante and other architects, who altered the original plan, which was again revived in 1886 by Giuseppe Sacconi). The façade of the basilica was completed under Pope Sixtus V; his colossal statue stands in the middle of the entrance steps. Over the main door is a life-size bronze statue of the Virgin and Child

by Girolamo Lombardo; the three superb late-16th-century bronze doors are also by Lombardo, his sons and his pupils. The doors of the Santa Casa (*see* below) and the magnificent chandelier over the presbytery are by the same artists. The richly decorated campanile by L. Vanvitelli is 250 ft. high, and the principal bell, presented by Leo X in 1516, weighs eight tons. The interior of the church has mosaics of Domenichino, Guido Reni, Barrocci and C. Maratti. In the old sacristies are frescoes by Melozzo da Forlì and Luca Signorelli. The Treasure room, where precious gifts and a collection of 16th-century majolica are on view, is close by.

The Santa Casa itself is of plain stone, 28 by 12½ ft., and 13½ ft. in height, with a niche containing a small black image of the Virgin and Child, in Lebanon cedar, and richly adorned with jewels. It is enclosed by a lofty marble screen, designed by Bramante, which has four sides representing the Annunciation, the Nativity, the arrival of the Santa Casa at Loreto and the Virgin's Nativity. According to tradition, the Holy House of the Virgin, threatened with destruction by the Turks, was carried from Nazareth by the ministry of angels and deposited (1291), in the first instance, on a hill at Tersatto in Dalmatia, where an alleged appearance of the Virgin and miraculous cures attested its sanctity. Three years later it was similarly transported across the Adriatic to a laurel grove (*lauretum,* whence Loreto) near Recanati and from there removed (1295) to the present hill. Papal bulls in favour of the shrine were issued. Pope Innocent XII appointed a *missa cum officio proprio* for the feast of the Translation of the Holy House (Dec. 10). Benedict XV declared the Madonna di Loreto to be the patron of aviators (1920). The chief festival is held on Sept. 8, the Nativity of Our Lady.

The Fountain of the Madonna, by C. Maderno, in the piazza, and the Fountain of the Galli (cocks) are worthy of note. The Polish War cemetery is nearby. (Po. G.)

LORETO, the largest and most easterly department of Peru, bounded north and northeast by Colombia, northwest by Ecuador, east by Brazil, west by the departments of Amazonas, San Martín, Huánuco and Junín, and south by Cuzco. Area, 184,686 sq.mi. Pop. (1961) 331,177. This area at the time that Peru gained its independence in the early 19th century was a province of the intendencia of Trujillo, under the name of Maynas. Later it became a province of La Libertad, then of Amazonas in 1853, an independent "littoral province" and finally a department. In 1906 the western portion was attached to the new department of San Martín (*q.v.*).

The chief river in the east of the department, the Ucayali, joins the Marañón or upper Amazon at Nauta. Other significant affluents of the Marañón are the Tigre, Pastaza, Morona, Huallaga and Samiria. From Iquitos westwardly ocean steamers ascend to the confluence of the Ucayali with the Marañón. The Marañón is navigable at all seasons for steamers of four- to eight-feet draft as far as Puerto Limon, a distance of 484 mi. The Huallaga is navigable at all seasons for steamers of the same draft to beyond Yurimaguas, about 150 mi. The lower Ucayali is navigable to the confluence of the Pachitea for vessels of six-feet draft.

Iquitos (pop. [1961] 55,696) is the capital of the department and entrepôt for the upper Amazon. It is served by ocean steamers and can be reached from Lima in five days via the Pucallpa highway and the Ucayali river, two days by bus and three days by river steamer.

The department, largely made up of the Amazonian plains, is almost completely forested. The climate is hot and humid with heavy rainfall (103 in., annually at Iquitos). The average elevation is about 500 ft. above sea level and the greater part of the region is inundated part of the year. Important exports of the department are rubber (the leading export before the East Indian plantations came into production), Brazil nuts, skins and hides, products of oil, medicinal and wax-bearing plants, and hardwoods. Rice, sugar cane, bananas, manioc, tobacco and other tropical products are cultivated there. The population is chiefly Indian and mestizo. (J. L. Tr.)

LORIENT, a maritime town of western France on the Bay of Biscay, in the *département* of Morbihan, is situated on the right bank of the Scorff river at its confluence with the Blavet river. Pop. (1962) 58,504. It is important for naval construction and as a submarine base, and Kéroman to the south of the town is a thriving fishing port. The roadstead of Lorient is formed by the estuary of the Blavet and its entrance is about 3 mi. S. of Lorient. The naval port to the east of the town is formed by the channel of the Scorff, on the right bank of which the chief naval establishments are situated. A floating bridge connects the right bank with the peninsula of Caudan, which is formed by the junction of the Scorff and the Blavet. The shipbuilding yards are on this peninsula. The commercial port consists of a quay in deep water. Kéroman's port facilities include two tidal docks accessible to fishing boats at all times, a covered auction market, fishmongers' warehouses, an ice works and a slipway for the renovation and repair of trawlers. Employment is provided by the naval arsenal, the fishing and commercial ports, and factories that can sardines and tunnies. The town's principal imports are exotic and northern woods, coal, Algerian wine and hydrocarbons. It exports kaolin, kale, fish, oysters and tin plate. (G. Man.)

History.—At the entry to the roadstead of Lorient, which is well protected by the isles of Groix and Belle-Isle, a small hamlet named Blavet grew up in the late middle ages. A citadel was built there under Louis XIII and Blavet was renamed Port Louis. Companies of merchants established themselves there, and in 1664 Louis XIV sanctioned the creation of a new and more important Compagnie des Indes, which settled at the mouth of the Scorff. The company prospered and from its commercial and colonial expansion in the orient came the name "L'Orient" in 1666. France's war against the Grand Alliance was fatal to the company and the town. New life was given to Lorient in 1719 when John Law, the Scottish banker, formed a new company. In 1732 Lorient became the marketing centre of the company, and its annual fair was the most important in Europe. In 1738 it was made a free town. By the middle of the 18th century its prosperity made it the rival of London and Amsterdam. But the disasters of the Seven Years' War and the ruin of the company were serious blows to the city's progress. In 1770 the property of the company was ceded to the state, and in 1782 the king established a royal arsenal at Lorient. The French Revolution brought ruin to the city's trade, but its arsenal was later modernized and continued into the 20th century to be a major element in the economic life of the city. The town was virtually destroyed by Allied bombing during World War II because it was used by the Germans as a submarine base, but it was later rebuilt along modern lines. (G. Gx.)

LORIMER, GEORGE HORACE (1867–1937), U.S. editor, long associated with the *Saturday Evening Post,* was born at Louisville, Ky., Oct. 6, 1867. He attended Colby college and Yale university and, after a short time in business in Chicago, became a newspaper reporter and correspondent. In 1897 he was literary editor of the *Saturday Evening Post* and in 1899 became its editor in chief. The remarkable success of this periodical was largely caused by Lorimer's keen appreciation of the public taste, coupled with his ability to meet it. His *Letters From a Self-Made Merchant to His Son* (1902), which attained great popularity, and *Old Gorgon Graham* (1904) are effective expositions of the philosophy of getting on. He continued his editorship of the *Post* until Jan. 1, 1937, and died at Wyncote, Pa., Oct. 22, 1937.

See John Tebbel, *George Horace Lorimer and The Saturday Evening Post* (1948).

LORIMER, JAMES (1818–1890), Scottish jurist and authority on international law, was born at Aberdalgie, Perthshire, on Nov. 4, 1818, and was educated at Edinburgh university. After study abroad he was admitted to the Scottish bar and in 1862 became professor of public law in Edinburgh university, where he taught until his death on Feb. 13, 1890. Against the positivism of contemporary English jurisprudence Lorimer taught a doctrine of natural law founded on divine authority and revealed in conscience and in history; in particular he held that the science of international law should be concerned with the application of this natural law to the relations of nations with one another. Lorimer's system did not prove of permanent value but his writings are

memorable for their vigour and for flashes of prophetic insight, notably his draft scheme (1870) for a "permanent congress of nations" and an international court of justice.

His major writings are: *The Institutes of Law* (1872); *The Institutes of the Law of Nations*, 2 vol. (1883–84); *Studies National and International* (1890). (AR. H. C.)

LORIS, the common name for Indo-Malay lemurs (*see* PRIMATES). Their soft fur, huge staring eyes, rudimentary tails and imperfectly developed index fingers render lorises easy of recognition. The slender loris (*Loris tardigradus*), of the forests of Madras and Ceylon, is smaller than a squirrel. The slow loris (*Nycticebus coucang*) is a heavier built and larger animal, known for its deliberate and unhurried pace. It ranges from eastern Bengal to Indochina, the Malay peninsula, Java, Borneo and Mindanao.

W. SUSCHITZKY

SLOW LORIS (NYCTICEBUS COUCANG), FOUND IN SOUTHEASTERN ASIA

LORIS-MELIKOV, MIKHAIL TARIELOVICH, COUNT (1826–1888), Russian army officer whose military successes were followed by a brief career of enlightened statesmanship, was born at Tiflis on Jan. 1, 1826, the son of an Armenian merchant. Educated in St. Petersburg at the Lazarev school of oriental languages and at the Guards' cadet institute, he joined a hussar regiment in 1843. In 1847 he was sent to the Caucasus, where he spent 20 years. He was governor of the Terek area from 1863 to 1875. In the Russo-Turkish War of 1877–78, commanding an army corps, he took the fortress of Ardahan, was repulsed by Mukhtar Pasha at Zevin, but then won a victory at Aladja Dagh, took Kars by storm and laid siege to Erzurum. For these services he received the title of count.

In 1879 Loris-Melikov was appointed temporary governor-general of the region of the lower Volga, to combat an outbreak of the plague. He was then transferred to the provinces of central Russia to combat revolutionary terrorism. He advocated removing the causes of popular discontent, and for this purpose he recommended to the emperor a modest scheme of administrative and economic reforms. The emperor, Alexander II, thereupon in Nov. 1880 appointed Loris-Melikov minister of the interior with exceptional powers. The proposed scheme of reforms was never carried out. On the very day that he signed an *ukaz* creating the necessary commissions, Alexander was assassinated (March 13, 1881); and his successor, Alexander III, adopted a reactionary policy. Loris-Melikov resigned on May 19, 1881, and lived in retirement until his death at Nice, France, on Dec. 24, 1888.

LORME, MARION DE (1613–1650), the celebrated French courtesan whom Victor Hugo made the heroine of a drama and who figures also in Alfred de Vigny's novel *Cinq-Mars*, was born in Paris on Oct. 3, 1613, the daughter of Jean de Lon, sieur de Lorme, and Marie Chastelain, and was brought up at the château of Baye, near Champaubert. She was introduced to the life of pleasure by Jacques Vallée, sieur des Barreaux, a *libertin* or free-thinker, who expressed his sincere love for her in passionate verse. She soon left him, however, for the marquis de Cinq-Mars (*q.v.*), Louis XIII's elegant young favourite, whom at one moment she was on the point of marrying. She then set herself up in the fashionable Place Royale (now the Place des Vosges) in Paris, where her salon attracted the most brilliant company of the town. After the execution of Cinq-Mars (1642), she had many lovers: Saint-Évremond; the marquis de Rouville (Hercule Louis); the soldier and poet Isaac Arnauld de Corbeville; the comte de Miossens (César Phébus, later marshal d'Albret); the comte de Coligny (Gaspard de Chatillon), who was converted to Catholicism to please her; the duc d'Enghien (Louis de Bourbon Condé); the duc de Brissac (Louis de Cossé); the comte de Gramont (Philibert); the superintendent of the finances, Michel Particelli d'Emery; and even the cardinal de Richelieu himself. Paul Scarron and other poets were among her friends and wrote in praise of her. The marshal de La Meilleraye (Charles de La Porte), Emery's successor as superintendent during the Fronde, began a persecution of her, and she had to leave the Place Royale and go to her mother's house in the rue de Thorigny. Though most of her friends and lovers supported the opposition to Cardinal Mazarin, there is no proof of the story that she was about to be arrested when she died, in poverty, on July 2, 1650. Her body, in a white dress, was laid out as if in state, and the curé of the parish of St. Paul had to intervene to stop this scandal. The 18th-century story that she died a centenarian is without foundation.

See J. Péladan, *Histoire et légende de Marion de Lorme*, 2nd ed. (1927); G. Mongrédien, *Marion de Lorme et ses amours* (1940). (G. Mo.)

LÖRRACH, a town in the extreme southwestern part of Germany which after partition of the nation following World War II became part of the *Land* (state) of Baden-Württemberg, Federal Republic of Germany, is situated on the Wiese, 9 km. (5½ mi.) N.E. of Basel, Switz., by road. Pop. (1961) 30,536. The position of Lörrach, where the Wiese leaves the mountains, is agreeable. The castle of Markgrafenburg and the ruins of that of Rötteln are nearby. From Tüllinger Höhe there is a view of three countries, and by night the lights of Basel can be seen. Lörrach is connected with Basel by railway and (1960s) by trams (streetcars). There are a considerable textile industry and some light manufactures. There are extensive vineyards and also trade in wine, fruit and timber. Lörrach is a centre for the transmission of the electric power generated from the Rhine nearby. It received market rights in 1403 and municipal privileges in 1682.

LORRAIN, CLAUDE: *see* CLAUDE LORRAIN.

LORRAINE, CHARLES DE LORRAINE, CARDINAL DE (1525–1574), one of the foremost members of the house of Guise (*q.v.*) in French politics of the third quarter of the 16th century, was born at Joinville on Feb. 17, 1525, the second son of Claude, 1st duc de Guise, and Antoinette de Bourbon. He was from the first destined for the church, and studied theology at the Collège de Navarre in Paris. He attracted Francis I's notice by his oratorical gifts and in 1538 became archbishop of Reims. Soon after Henry II's accession, he received the red hat (1547): he was called cardinal de Guise until 1550, when his uncle, Jean, died and he took over his title of cardinal de Lorraine as well as his numerous benefices, which included the see of Metz and the abbeys of Cluny and Fécamp. Charles' income amounted to 300,000 *livres* annually and his ecclesiastical patronage was extensive. The cardinal was also very important politically: as a member of the king's council he actively supported the policy of French intervention in Italy; and in 1559 he helped to negotiate the peace of Câteau-Cambrésis. Although he was a grand inquisitor and did persecute Huguenots, Charles was by nature inclined to pliancy and leniency. Under Francis II, he and his brother François, 2nd duc de Guise, gained control of the government; their unpopularity provoked the conspiracy of Amboise. On the accession of Charles IX (1560), he became less influential in state affairs, but the regent, Catherine de Médicis, listened to his religious advice. In 1561 he defended the Catholic viewpoint against Theodore Beza at the colloquy of Poissy. In 1562–63 he championed the Gallican cause at the Council of Trent, but in 1564 he tried, unsuccessfully, to secure the promulgation of the council's decrees in France. After continuing to serve Catherine for a while, he retired from court in 1570. Charles de Lorraine combined a handsome physique with intellectual gifts, but he was avaricious and cowardly, and his versatility often made him appear hypocritical and ineffective. He died at Avignon on Dec. 26, 1574.

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LORRAINE (Ger. LOTHRINGEN), the name given first, in original form LOTHARINGIA, to a kingdom intermediate between the Western and Eastern kingdoms of the Carolingian empire; then to the two duchies into which Lotharingia was divided, Lower Lorraine and Upper Lorraine; then to a duchy based on Upper

Lorraine alone. Annexed to France in the 18th century, this last Lorraine was divided in 1790 among four *départements*, Meuse, Meurthe, Moselle and Vosges, corresponding to the later Meuse, Meurthe-et-Moselle, Moselle and Vosges (*qq.v.*). Geographically, Lorraine is the area bounded north by the Ardennes region and by the Hunsrück massif; east by the Vosges mountains; south by the Monts Faucilles and by the Langres plateau; and west by the Argonne plateau. The upper courses of the Meuse and Moselle rivers, separated by the Woëvre plateau, traverse the western part of Lorraine, the Sarre river the eastern. The soil contains the greatest iron-ore deposits in Europe.

Lotharingia.—By the treaty of Verdun (A.D. 843), the three sons of the Carolingian emperor Louis I the Pious divided the Frankish territory into three parts: Francia Occidentalis went to Charles II the Bald, Francia Orientalis to Louis the German, and Francia Media, the zone extending from the Low Countries to Italy, to the emperor Lothair I. This Francia Media was partitioned by Lothair I in 855 between his sons: the elder, Louis II, received Italy and the imperial title; the younger, Lothair (*q.v.*), received the northern area thenceforward known as Lothair's kingdom or Lotharingia.

This kingdom was bounded north by the North sea; east by a line from the mouth of the Ems river to Wesel and then by the Rhine southward to the confluence of the Aar (but with a westward recession of the frontier that left Mainz, Worms and Speyer to the Germans); south by the Aar and by the Jura mountains; and west by the Saône (from a point just south of the Doubs confluence), the Ornain, the Meuse and the Scheldt. Lotharingia thus comprised the dioceses of Utrecht, Cologne, Trier, Strasbourg, Basel, Besançon, Toul, Metz, Verdun, Cambrai and Liège.

When King Lothair died without heirs in 869, Charles the Bald and Louis the German dismembered Lotharingia: by the treaty of Mersen (Meerssen) in 870 Charles received Liège, Verdun, Toul and Besançon, while Frisia and the eastern territory went to Louis. By the treaties of Verdun and Ribémont, however, in 879–880, the West Frankish kings Louis III and Carloman ceded their part of Lotharingia to Louis the Younger, king of the East Franks or Germans. When the latter's brother, the emperor Charles III the Fat, was deposed (887), Rudolf I of Burgundy annexed Besançon to his own kingdom; but the main part of Lotharingia remained with the East Franks, whose king Arnulf gave it as a kingdom to his bastard Zwentibold in 895. When Zwentibold was killed in battle on the Meuse (Aug. 13, 900), his half brother, the East Frankish king Louis the Child, succeeded him in Lotharingia; but in 911 the Lotharingians refused to accept the German king Conrad I, of the new Franconian dynasty, as their ruler and acknowledged instead the West Frankish Carolingian, Charles III the Simple.

At this time one of the most powerful counts in Lotharingia was Rainier or Reginar I of Hainaut. His son Giselbert wanted to make himself king of Lotharingia and took part in the revolts that led to the deposition of Charles the Simple. Giselbert, however, could not maintain himself against France without help from the German king Henry I, who after a first campaign in 923 recovered Lotharingia for Germany in 925. Married to Henry's daughter Gerberga, Giselbert was duke of Lotharingia by 928.

Giselbert rebelled against Henry's successor Otto I but was defeated near Andernach and drowned in the Rhine (Oct. 2, 939). Otto I then invested a certain Count Otto, son of Ricuin, with the duchy of Lotharingia and, in 942, obtained recognition of his suzerainty over it from the French king Louis IV d'Outremer, who had supported Giselbert's rebellion and had married Giselbert's widow. When Otto, son of Ricuin, died (944), Otto I gave the duchy to his own son-in-law, Conrad the Red. Having deposed Conrad for rebellion in 953, Otto entrusted the administration of the duchy to his brother Bruno, archbishop of Cologne (d. 965).

Upper Lorraine and Lower Lorraine.—In 959 Bruno divided Lotharingia into two parts, Upper Lorraine the southern and Lower Lorraine the northern, with their boundary running from a point on the Rhine north of Andernach westward and southwestward to a point on the Meuse north of Mézières. Lower Lorraine thus included most of the historic Netherlands belonging to the German kingdom between the Rhine, middle Meuse and Scheldt rivers, while Upper Lorraine included the Ardennes, the Moselle valley and the upper Meuse valley. At least from Bruno's death, Upper Lorraine was held as a duchy by Frederick (d. 978 or 984), count of Bar, a descendant of the Carolingians through his mother and Bruno's nephew by marriage, who was succeeded as duke in turn by his son Dietrich (d. 1026) and by the latter's son Frederick II (d. 1033). Lower Lorraine was entrusted first, as a march or marquisate, to a certain Godfrey (d. 964); but in 977 the emperor Otto II invested the Carolingian prince Charles (*q.v.*) as duke of Lower Lorraine. Charles was succeeded by his son Otto, but after the latter's death Lower Lorraine was given in 1012 to a count of the house of Ardenne, who became duke as Godfrey I (d. 1023). Godfrey I was succeeded by his brother Gozelo or Gothelo I, who in 1033 obtained Upper Lorraine also.

On Gozelo I's death (1044) Lotharingia was divided again between two of his sons: Godfrey the Bearded (d. 1069) received Upper Lorraine, Gozelo II (d. 1046) received Lower Lorraine. Godfrey the Bearded, angry at the division, became a persistent rebel against his suzerain, the emperor Henry III. Finally deprived of Upper Lorraine he went to Italy and, in 1054, married Beatrice, mother of the great heiress Matilda of Tuscany. Reconciled at last with the German kingship, Godfrey the Bearded was invested with Lower Lorraine in 1065, on the death of Frederick of Luxembourg (Gozelo II's successor). Upper Lorraine meanwhile had been granted in 1047 to a certain Adalbert (d. 1048), of the house of the counts of Metz, and then to his nephew Gerard of Châtenois.

The duchy of Lower Lorraine passed in 1070 to Godfrey the Bearded's son, Godfrey III the Hunchback, on whose assassination in 1076 the German king Henry IV bestowed it on his own two-year-old son Conrad. In 1087, however, the ducal title was transferred to Godfrey (*q.v.*) of Bouillon, the Hunchback's nephew. After Godfrey's death on the first crusade (1100), Henry IV gave the duchy in 1101 to Henry I, count of Limburg (d. 1119?). By this time, however, ducal authority had already been weakened by the rise of other countships in the area besides Limburg, such as Hainaut, Louvain and Namur, and by the consolidation of the bishopric of Liège; and the troubles of the German kingdom led to further disorders. The German king Henry V in 1106 replaced Henry I of Limburg as duke by the count of Louvain, another Godfrey also called the Bearded; then Lothair II, Henry V's successor, in 1128 replaced Godfrey the Bearded in turn by Henry's son Walram II of Limburg. In 1139 both Godfrey the Bearded and Walram II died, and the Hohenstaufen German king Conrad III finally gave the ducal title to Godfrey's son Godfrey II of Louvain (d. 1142), with whose descendants, styled dukes of Lothier, it remained, though the house of Limburg contested it at least till 1155. Eventually the counts of Limburg became dukes of Limburg instead; and in 1190 Godfrey II's grandson dropped the title duke of Lothier and took that of duke of Brabant, as Henry I (d. 1235). (*See* BRABANT, DUCHY OF; LIMBURG, DUCHY OF.)

The Duchy of Lorraine.—With the dissolution of the Lower duchy, the Upper duchy alone conserved the name Lorraine. It remained with the male descendants of Gerard of Châtenois till 1431. The succession—from father to son unless otherwise indicated—was as follows: Gerard (d. 1070); Thierry (d. 1115); Simon I (d. 1139); Matthew (d. 1176); Simon II (till 1205; d. 1207); Ferry or Frederick I (Simon's brother; 1205–06; d. 1207); Ferry II (d. 1213); Thibaut or Theobald I (d. 1220); Matthew II (Thibaut's brother; d. 1251); Ferry III (d. 1303); Thibaut II (d. 1312); Ferry IV (d. 1328); Rudolph or Raoul (d. 1346); John I (d. 1391); and Charles II (d. 1431).

The authority of these dukes was offset not only by the temporal power of the three bishoprics within their frontiers, namely Metz, Toul and Verdun, but also by the rise of great feudal dynasties: the counts of Luxembourg challenged the dukes in the north; the counts of Bar (*q.v.*), heirs to the patrimony of Frederick II of Upper Lorraine from 1033, were dangerous vassals in the west; and from 1070 a junior branch of the ducal house held the countship of Vaudémont in the southwest. The dukes therefore, who

had their capital at Nancy (*q.v.*) from the middle of the 12th century, were reluctant to forfeit the protection of their suzerains, the German kings. In the Investiture conflict of the 11th–12th century they took the royal or imperial side, together with the bishops of Verdun, while Bar and Metz took the papal; and in the dispute for the German kingship after 1198 they supported the Hohenstaufen candidate till 1213, when Thibaut I changed to the Welf side (Bar thereupon made the converse change). After his victory in 1215 the Hohenstaufen king Frederick II intervened effectively in Lorraine, but from 1250 his successors were too weak to protect the area from French encroachment.

Louis IX of France mediated between Luxembourg and Bar in a territorial quarrel (1268); Philip IV of France took Toul under his protection (the cathedral chapter in 1289, the town in 1300) and received homage from Bar for lands west of the Meuse (1301); and Louis X obtained a protectorate over Verdun (1315), which however became ineffective in the early part of the Hundred Years' War. Having at first resented the French approach, the dukes, who were more interested in Metz than in the other bishoprics, for a time became open partisans of France (Raoul was killed fighting the English at Crécy). The German king Charles IV, himself a member of the house of Luxembourg and well-disposed toward France, was only concerned with stabilizing the area: Luxembourg and Bar were both erected into duchies, on a par with Lorraine, in 1354.

In the 15th century ducal policy was conditioned by Lorraine's position between the northern and southern halves of the great new Burgundian state (*see* BURGUNDY; FRANCHE-COMTÉ; NETHERLANDS, THE: *History*). Charles II (*q.v.*) of Lorraine long collaborated with Burgundy against France, but modified his attitude when his heiress Isabella was married in 1420 to René of Anjou (*see* RENÉ I), brother-in-law of the future king of France, Charles VII.

René became duke of Bar in 1430; but on Charles II's death in 1431 Antony of Vaudémont, son of Charles II's younger brother Ferry (d. 1415) by the heiress of Vaudémont, contested René's claim to succeed to Lorraine by right of Isabella. René was taken prisoner at Bulgnéville (July 1431) and released only in 1436 at the price of great concessions to Antony's Burgundian ally, who moreover proceeded to acquire Luxembourg in 1443. To counteract this Burgundian aggrandisement Charles VII of France led an expedition into Lorraine, reasserted the protectorate over Toul and Verdun and besieged Metz (1444–45). René had to resign Lorraine to his son John on Isabella's death (1453). John was succeeded by his brother Nicolas I (1470), Nicolas I by his sister Yolande's son René II (1473), who already in 1472 had succeeded his father Ferry (Antony's son) in Vaudémont.

Charles the Bold, duke of Burgundy, invaded Lorraine in 1475 and took Nancy, but his death in battle outside Nancy in Jan. 1477 saved René II's duchy. On the death of René I, who had retained Bar, René II succeeded him in that duchy (1480), thus reuniting it at last with Lorraine and Vaudémont. This consolidation, together with the ducal house's success in installing its members in the bishoprics, enabled Lorraine to confront the new situation caused by the passing of the Burgundian inheritance to the Habsburgs. The Habsburgs as Holy Roman emperors might have liked to strengthen Lorraine's theoretical attachment to the *Reich*, but they were soon preoccupied with the troubles of the Reformation in Germany; and France's struggle against the Habsburgs gave René II (d. 1508) and his son and successor Antony the opportunity to build Lorraine up as a neutral buffer state. By the treaty of Nürnberg (Aug. 26, 1542), the emperor Charles V recognized the duke's sovereign freedom from feudal obligation for all his territory save a few little fiefs, at the same time undertaking that the *Reich* would protect Lorraine.

Antony's death and the accession of his son Francis I (June 14, 1544) coincided with the crossing of Lorraine by an imperial army on its way to invade French Champagne. Within a year Francis was dead (June 12, 1545), leaving Lorraine and Bar to the two-year-old Charles III (*q.v.*). Henry II of France, having seen the frontier's weakness, concluded the treaty of Chambord (1552) with a number of German Protestant princes who, in return for support in their rebellion, consented to his occupying Metz, Toul and Verdun as vicar of the *Reich*. The French occupied the three bishoprics, and François de Lorraine, duc de Guise (Charles III's cousin; *see* GUISE [HOUSE OF]) held Metz heroically against siege by the emperor. Charles III was taken to the French court.

After the peace of Câteau-Cambrésis between France and Habsburg Spain (1559), Charles III returned to his duchies, which he raised to the zenith of their prosperity. While France, torn by the civil wars of religion, could not thrust the spearhead of occupation any further into Lorraine, Charles confirmed his links with Germany by acquiring places in the Saarland, developed the administration and economy and pushed the Counter-Reformation forward (University of Pont-à-Mousson, founded in 1572 and given over to the Jesuits). In 1584 he adhered openly to the Holy League sponsored by his Guise cousins in France, but by 1594 hostilities between him and the French king Henry IV were over.

Charles III's son Henry II, duke from 1608, did homage for Nomény to the emperor Matthias in 1613. For the strange transactions following Henry's death (1624) and the reigns of the duchess Nicole (1624–25) and of the dukes Francis II (1625), Charles IV (1625–34, 1641–44 and 1661–70) and Nicolas Francis (nominally and momentarily duke, 1634), with the chronology of the successive French occupations of Lorraine between 1633 and 1670, *see* CHARLES IV. Metz (where the French set up a *parlement* in 1633), Toul and Verdun were formally renounced to France by Germany under the peace of Westphalia in 1648. They were then organized as the *généralité* of Metz, under an intendant. The dispossessed Charles V, titular duke from 1675, rejected the terms procured by the emperor Leopold I for the restoration of Lorraine to him under the treaty of Nijmegen (1679), which required *inter alia* the surrender of Nancy to France in exchange for Toul. Subsequently Louis XIV of France set up a chamber in the *parlement* of Metz to arrange the "reunion" to France of further areas supposed to have been feudally dependent on the bishoprics. Only after the War of the Grand Alliance were Lorraine and Bar restored to Charles V's son Leopold, under the peace of Rijswijk (1697), with conditions, however, that kept him defenseless against France.

Leopold undertook the rehabilitation of his country. He codified the law, promoted glass, paper and textile industries as well as ironworking and attracted thousands of immigrants; but he had to submit to another French occupation (1702–14) during the War of the Spanish Succession. On his death in 1729 the duchies passed to his son Francis Stephen (Francis III of Lorraine; *see* FRANCIS I, Holy Roman emperor), whose betrothal to Maria Theresa, the emperor Charles VI's heiress, made a change of dynasty inevitable, since France could never admit the union of Lorraine and the Habsburg lands. In the War of the Polish Succession, therefore, under the peace preliminaries of Vienna (1735), it was agreed that Francis Stephen should eventually succeed to Tuscany and should meanwhile renounce Lorraine and Bar, which were to go to the dispossessed Polish king Stanislaw I (Stanislaw Leszczynski) and then to the latter's daughter Marie, already the consort of Louis XV of France. Stanislaw took possession of Lorraine in 1737, and the preliminaries were confirmed by the definitive peace of Vienna in 1738.

Maintaining a gay little court at Lunéville and indulging his taste for architecture (Nancy is his great monument), Stanislaw left the government of Lorraine to his chancellor, A. M. Chaumont de La Galaizière, who paved the way for Lorraine's incorporation into France. On Stanislaw's death (1766) Lorraine and Bar became French. A *généralité* was set up at Nancy. The *parlement* of Nancy was created in 1776.

Lorraine was dissolved into *départements* in 1790, during the French Revolution. For the later annexations of part of the old Lorraine to the German *Reich*, *see* ALSACE-LORRAINE. For Lorraine as a great industrial region *see* FRANCE: *The Economy*. *See* also references under "Lorraine" in the Index.

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LORRY: *see* MOTOR TRANSPORTATION.

LORTZING, (GUSTAV) ALBERT (1801–1851), German composer of light romantic operas. Born at Berlin on Oct. 23, 1801, he was largely self-taught. His first opera, the one-act vaudeville entitled *Ali Pascha von Janina*, was produced in 1828. He produced several other light works of this kind including a play with songs, *Der Pole und sein Kind* (1832), and *Szenen aus Mozarts Leben*, a play with music selected from Mozart's works, written in 1832 but not produced. From 1833 to 1844 he was employed as a tenor at Leipzig, where his *Die beiden Schützen* (1837) was well received. His most successful opera, *Zar* (originally *Czaar*) *und Zimmermann*, based on an episode in the life of Peter the Great, was given at Leipzig in 1837 and in Berlin two years later. Between 1840 and 1850 he produced nine operas, chiefly at Leipzig, on librettos devised by himself and based on French and German plays. Among them were *Undine* (1845), a romantic opera in the style of Weber and Marschner, and *Rolands Knappen* (1849), a lighter work in the comic style. During this period he was also well known as a conductor and wrote incidental music. He died at Berlin on Jan. 21, 1851.

Lortzing's style derives from that of the early 19th-century French *opéra-comique*, which enjoyed a great vogue in Germany during the composer's lifetime, and also from the German *Singspiel*. The style of light German opera that he established remained in favour until the middle of the 20th century.

LORY: *see* PARROT.

LOS ALAMOS (Spanish meaning "the cottonwoods"), a town of New Mexico, U.S., and seat of Los Alamos county, lies 24 air mi. N.W. of Santa Fe, at an elevation of 7,300 ft., on the summit of one of the innumerable mesas comprising the Pajarito plateau, a forested shelf on the eastern slope of the Jemez mountains.

Until 1942 the site was occupied solely by a group of log cabins and stone buildings comprising the Los Alamos Ranch School for Boys. The mesa was selected because of its comparative isolation and natural facilities as the site for the atomic research laboratory then known as the Manhattan project or Project Y which developed the first nuclear-fission or A-bomb. (*See* ATOMIC ENERGY: *The Atomic Bomb.*) After World War II, the Los Alamos Scientific laboratory, operated by the University of California for the Atomic Energy commission, developed the first thermonuclear-fusion or H-bomb. The town's sole reason for existence is the Scientific laboratory, which is one of the greatest atomic research institutions in the world. The laboratory has been expanded to neighbouring South Mesa where it utilizes about 300 buildings and 77 sq.mi. Research includes basic scientific development directed toward industrial uses of atomic energy, health, radiology, organic chemistry and industrial hygiene.

By the 1960s the small complex of makeshift residential quarters for scientists had grown into the modern town of Los Alamos. (For comparative population figures *see* table in NEW MEXICO: *Population.*) In 1949 it was named the seat of Los Alamos county, the state's newest and smallest county (area 108 sq.mi.), created from part of Sandoval county. In Feb. 1957 it was made an "open city" which anyone could visit, although only persons who are employed there can take up permanent residence. The commission-manager form of municipal government was adopted in 1955.

The Bandelier National park is 5 mi. S., and the Puye pre-Columbian ruins are a few miles north of the town. (FR. W.)

LOS ANGELES, a vast, sprawling metropolis, seat of Los Angeles county, located in southern California, U.S., was until 1961 the largest city in area (455 sq.mi. in 1960). It is about 350 mi. S.E. of San Francisco and 110 mi. N.N.W. of San Diego. It has an average altitude of about 275 ft., ranging from sea level to 1,692 ft. atop Mt. Hollywood. The geographical setting between the mountains and the sea is attractive; the central commercial district lies several miles from the Pacific ocean on a coastal shelf extending inland to the foothills of the San Gabriel mountain range.

The original Spanish town or pueblo, located close to a series of man-made water ditches or *zanjas* that drained water from these mountains, was built around a square, which is the historic plaza area of the modern city. Urban growth was to the south, east and west from this original nucleus, especially after the coming of the railroads in the 1870s. Separate municipalities, by the 1880s, sprang up nearby, of which Pasadena (*q.v.*) is the largest; others whose interests are closely bound with Los Angeles include Alhambra, Burbank, Compton, Culver City, Glendale, Huntington Park, Inglewood, Long Beach, Santa Ana, Santa Monica, South Gate and Torrance (*qq.v.*). A sizable spur of foothills toward the west, which for a time blocked expansion in that direction, was eventually pierced by tunnels and boulevards. The problem of access to the sea was solved by annexation of a strip of land, about 20 mi. long, and ¼ mi. wide, known as the "shoestring strip." This corridor connects the metropolis with Los Angeles harbour. The city touches the ocean at the annexed towns of San Pedro, Wilmington and Venice, and entirely surrounds such separate municipalities as Beverly Hills (*q.v.*), Vernon and San Fernando. There are about 45 relatively large municipalities within Los Angeles county (area 4,155 sq.mi.). Among them is Hollywood (*q.v.*), 8 mi. N.W. of the business district which by annexation is municipally a part of Los Angeles, but retains its name and business entity. A city ordinance, repealed in 1957, that limited the height of buildings to 150 ft., encouraged the decentralization of Los Angeles.

Climate.—Little variability is the chief characteristic of the climate at Los Angeles and in southern California generally. Winter is a season of moderate rainfall, 15.23 in. yearly being the average. There is relatively little rain from May to October. Winter days are sunny and warm and the nights are often cold, with occasional frost in December and January. A 50-year average of the records of the U.S. weather bureau shows the mean temperature to be 62.4°. There is a 72% possibility of daily sunshine, an average of 179 clear days each year, and only 37 days with more than .01 in. of rain. However, serious floods have occurred, notably in 1914 and in 1938; the greatest disaster was in 1928 when the St. Francis dam unit of the Los Angeles aqueduct collapsed resulting in violent floods of the Santa Clara river through Los Angeles and Ventura counties. Los Angeles experienced a moderate earth tremor about once every five years during the first half of the 20th century. The earliest recorded earthquake occurred in 1769 when the expedition led by Gaspar de Portolá (see *History*, below) reached the banks of the Santa Ana river, which was appropriately named *El Río del dulce nombre de Jesús de los temblores* ("the river of the sweet name of Jesus of the earthquakes").

The average wind velocity of only 6.1 mi. per hour, one of the lowest of any major U.S. city, has directly contributed to one of Los Angeles' most pressing modern problems, heavy air pollution leading to smog. Pollution of the atmosphere by choking, noxious fumes causes uncomfortable eye irritation and has led to the establishment of an air pollution control district, operated by the Los Angeles county board of supervisors. This agency has conducted studies which traced smog to three main sources: automobile exhausts, industry and home incinerators. In 1956–57 local regulations forbade the burning of trash, and home incineration was replaced by the city's first thorough municipal rubbish collection system. Surveillance of industrial air pollution failed to reduce the climatic discomfort of Los Angeles. Two warning systems (one anticipatory, the other remedial) had to be instituted for the protection of health by averting hazardous concentrations of contamination. Eye irritation is especially severe in the summer months.

Population Characteristics.—In the past, the relationship of good climate to spectacular growth marked the development of Los Angeles. Sunny skies and the attractions of outdoor life caused population within the city limits to soar from 576,673 in 1920 to 1,238,048 in 1930. Further increase in the 1930s occurred partially because of the immigration of job hunters from depressed areas, retired persons and Hollywood aspirants. According to the census bureau, the city's population grew from 1,504,277 in 1940 to 1,970,358 in 1950. By 1960 it ranked as the third largest city in the U.S. The population booms of the 1880s and 1920s were eclipsed during and after World War II when expansion was

General view of the centre of the city. Two large buildings in the foreground house government offices: Los Angeles city hall is at left (with tower); next to it is the Federal building and post office

Church of Jesus Christ of Latter-day Saints, dedicated in 1956, largest Mormon temple in the world

Rose garden, Exposition park. In background is the Los Angeles County museum, which has both art and science collections and exhibits

Some of the docks and shipping facilities of San Pedro harbour, the port of Los Angeles. An artificial harbour, created by dredging the flats of San Pedro bay, it is connected to the rest of metropolitan Los Angeles (on the north) by a narrow piece of land called the "shoestring strip"

METROPOLITAN LOS ANGELES

BY COURTESY OF (TOP) LOS ANGELES CHAMBER OF COMMERCE, (BOTTOM RIGHT) UNION PACIFIC RAILROAD COMPANY, PHOTOGRAPHS, (CENTRE LEFT) JOSEF MUENCH, (BOTTOM LEFT) DAVID MUENCH

LOS ANGELES

Oil-well derricks silhouetted against the sky at Signal Hill, one of the three highly productive petroleum fields discovered in the Los Angeles area in 1920–21

An Easter sunrise service at Hollywood Bowl, a 50-ac. natural amphitheatre in Beachwood canyon, Hollywood

Fisherman surf casting along the shore at Malibu Beach, an unincorporated community near Santa Monica

Fountain in the courtyard of the city hall of Pasadena, largest of the separate communities associated with Los Angeles

General view of Hollywood (foreground) and the Hollywood freeway, major motor traffic artery between Los Angeles and the northwest

SCENES IN LOS ANGELES COUNTY

BY COURTESY OF (TOP RIGHT, BOTTOM RIGHT) UNION PACIFIC RAILROAD COMPANY, PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT, BOTTOM LEFT) DAVID MUENCH

accelerated by an influx of workers for defense industries. The 1960 city population was 2,479,015. The Los Angeles-Long Beach standard metropolitan statistical area (Los Angeles and Orange counties) had a population of 6,742,696 in 1960. In 1963 the standard metropolitan statistical area was redefined as comprising Los Angeles county only, 1960 population 6,038,771, and Orange county was designated a separate standard metropolitan statistical area (Anaheim-Santa Ana-Garden Grove). Demographers forecast a population of 10,500,000 persons for the Los Angeles metropolitan area by 1975, when the city should (if annual population growth of about 240,000 should continue) become the largest in the U.S. The population, aside from groups that characterize other large U.S. cities, includes considerable numbers of Mexicans, Chinese, Japanese and Filipinos. (For comparative population figures *see* table in CALIFORNIA: *Population.*)

History.—On Aug. 1, 1769, a Spanish exploring expedition under Gaspar de Portolá (*q.v.*) and Father Juan Crespi, traveling northward from the peninsula of Lower California through San Diego, reached an Indian village called Yang-na near a stream, at the present site of Los Angeles. They named the place Our Lady Queen of the Angels (*Nuestra Señora la Reina de Los Angeles*). The Indian settlement remained relatively undisturbed for 12 more years. Then, on Aug. 18, 1781, as part of Spain's design to colonize California more thoroughly, the future city's first permanent residents arrived after a 100-day march northward from Mexico through the blistering heat of the deserts. These humble, mostly illiterate folk consisted of 12 families (46 persons in all), of mestizo (Spanish-Indian), Negro and Spanish blood. On Sept. 4, 1781, California's Spanish governor, Felipe de Neve, gave the community of Los Angeles official status as the territory's second (after San Jose, founded in 1777) pueblo.

The nearby Franciscan mission of San Gabriel—still in existence as an intact landmark—had been established ten years earlier a few miles from the centre of the new pueblo. Development of a better overland route from Sonora and Sinaloa to California (opened as early as 1775 by Juan Bautista de Anza) markedly increased the number of travelers that had come over the Lower California route. The new arrivals cleared the wild mustard and sagebrush and settled upon land grants given them by Spain's authority. They thereby began the great southern California ranchos of the future, some of which were to be larger than whole European countries.

After Mexico's independence from Spain (1822) frequent political disturbances and revolts hampered the social and economic stability of the little town. The few Americans who visited it during this period included the fur trapper Jedediah Strong Smith, the first white man to come overland, in 1826, via San Gabriel mission, from the Missouri river frontier settlements. In search of beaver and otter, Smith preceded the first organized overland pioneers (the William Workman-John Rowland party of 1841) into Los Angeles by 15 years. During the 1830s, however, other American fur trappers such as James Ohio Pattie and Ewing Young reached Los Angeles, pioneering the future western routes of the covered-wagon migrants.

In 1835 the Mexican congress declared Los Angeles the capital of California, an edict that was hardly enforced by governors who favoured the north. For a time, just prior to the U.S. conquest of 1846, Gov. Pío Pico, California's last Mexican governor, removed the capital to Los Angeles. The city was rent by north-south and local factional quarrels when war broke out between Mexico and the United States. With the appearance of U.S. troops under Commodore Robert Field Stockton and Capt. John Charles Frémont (*qq.v.*), the Mexican defenders of Los Angeles fled and the U.S. flag was raised over the city on Aug. 13, 1846. An insufficient garrison of 50 men, left in control, was compelled in October to withdraw because of a revolt of the inhabitants, and Los Angeles was not retaken until Gen. Stephen Watts Kearny and Commodore Stockton entered the city from San Diego in Jan. 1847.

After a short period as a military garrison Los Angeles reverted to civilian rule under U.S. control. On April 4, 1850, the city was incorporated and became the county seat, and in that year the first English-language school was opened and the first Protestant church established. Los Angeles thrived upon a big cattle trade with California's northern mines. At first a lawless frontier town, the files of the Los Angeles *Star*, southern California's first substantial newspaper, are filled with stories of almost routine daily violence during the 1850s and 1860s.

Until the building of the railroads, large-scale immigration remained limited by California's remoteness and isolation. Distance alone, not to speak of such natural barriers as deserts and almost impassable mountains, restricted communication with the rest of the world. Such travelers as ventured to the west in the two decades after the gold rush of 1848–49 tended to move toward San Francisco, then a larger, more cosmopolitan, better-known city. In 1869, however, the transcontinental railroad era dawned. Before that time (1866), Pres. Andrew Johnson confirmed the city's Spanish and Mexican pueblo land titles (consisting of 17,000 ac.). This action was particularly important as the claims of numerous residents under grants issued by the original pueblo rested on these titles.

Los Angeles finally attained a railroad connection with San Francisco in 1876, and with the eastern U.S., via the Santa Fe system, in 1885. An immense tide of immigration soon thereafter enveloped southern California, partly because of a vigorous rate war between the Southern Pacific and Santa Fe railroad companies. In the year 1887 railroad fares from Los Angeles to Chicago (and other Mississippi valley terminals) dropped to $1. The dawn of the railroad age held commercial implications for Los Angeles as well as increasing its population. As early as 1877 local growers sent a carload of oranges eastward by rail. Then began a new era of horticultural enterprise. The railroad rate war and a simultaneous land boom soon created thousands of new customers for southern California's farmers and merchants. A significant proportion of the travelers to Los Angeles in the 1880s became permanent settlers. It is from the real estate boom of 1887 that the tourist era also dates.

But Los Angeles, located 20 mi. from the ocean, could not expect to become a great metropolis without a harbour. San Pedro, an open roadstead, with scanty protection from the sea, had served as its only port facility. Before a harbour was finally built, a long political battle ensued with Collis P. Huntington and Southern Pacific railway interests. These wanted a $4,000,000 facility built, with government subsidy, at Santa Monica, rather than in the San Pedro-Wilmington area. The struggle over the site of the city's future harbour, with San Pedro favoured by a civic group known as the Free Harbour league, did not come to an end until 1896.

That year the U.S. congress voted an appropriation of $2,900,000 to build an artificial harbour for Los Angeles at San Pedro, thereby defeating the Huntington interests. Three years later the city celebrated the Free Harbour jubilee and 20,000 persons gathered at San Pedro to watch the dumping of the first barge of stone for a breakwater. Construction of the harbour was finally completed in 1914 and, aided by traffic through the new Panama canal, Los Angeles began almost immediately to benefit by this new world trade route. Thereafter the history of Los Angeles was marked by continued commercial and industrial expansion.

Administration.—The city of Los Angeles is governed under a charter in operation from July 1, 1925. It provides for the initiative, the referendum, the recall and an executive budget. Elected at large are the mayor (the chief executive, with wide powers of appointment), the city attorney, the controller and seven members of the board of education. The 15 members of the city council (the legislative body) are elected by districts for a term of two years. They handle budget and tax problems, public improvements and local civil service matters. The principal functions of government are entrusted to 16 commissions of 5 members each, appointed by the mayor, which appoint and fix the salary of general managers for their departments. There is also a municipal housing commission consisting of 12 members together with 4 judges and the president of the chamber of commerce. All the above groups work in co-operation with a powerful board of county supervisors, who govern both urban and rural areas and control the many special districts and agencies in Los Angeles county.

Financial, Commercial and Industrial Development.—In Southern California banking developed later and on a smaller scale than in the northern part of the state. Banks existed in San Francisco 15 years before they were established in Los Angeles. The first city bank was opened by Isaias W. Hellman in 1865. In 1868 Hellman bought out the rival bank of William Workman and his son-in-law Francisco P. F. Temple and in 1871 joined forces with California's Gov. John G. Downey to form the Farmers and Merchants bank, which became Los Angeles' first large bank. The development of the city as southern California's banking and financial centre was the natural outcome of population growth. Los Angeles has long been the home of numerous building and loan associations which have supplied much capital for real estate development. This capital is invested directly in land, buildings, oil and manufactures and there is also a large local investment in securities. The area is ranked as the third largest financial centre in the U.S. The economy of greater Los Angeles is exceedingly varied as well as dynamic. The reasons for its continuing prosperity are many and diverse.

Agriculture.—The city's first commerce was highly agricultural. Following the gold rush of 1848–49 the growth of population furnished an urgent market for cattle, grain and other foodstuffs. Prior to 1860 fully 60% of California's population was engaged in mining; the southern counties, of which Los Angeles was the centre, became the agricultural suppliers of this moneyed population. In 1850 cattle sold for as high as $500 per head and the great ranchos of the south flourished. Until drought conditions and falling prices in the 1860s damaged the sheep and cattle industries, Los Angeles was known as "queen of the cow counties." Grain, wheat and fruit production also made Los Angeles important agriculturally. Wine was made from the mission variety of grape from the early Spanish period. As early as 1831 there were about 100 ac. of vineyards at Los Angeles, containing about half of the state's 200,000 vines. The Camulos rancho at nearby Ventura was renowned for its fruit long before the gold rush occurred. William Wolfskill and Don Luis Vignes experimented on a small scale with the growing of grapes and oranges throughout the 1860s on the site of the modern downtown area.

It was the orange industry that first brought Los Angeles widespread agricultural acclaim. At nearby Riverside (*q.v.*) in 1873 Luther Calvin and Eliza Tibbets planted the first Washington navels, a new variety of seedless orange from Bahia, Braz. The climate and soil proved so well suited to this species of orange that it attained an agricultural perfection unmatched by any other fruit. The new industry added immeasurably to the commercial stability of Los Angeles. With the development of large-scale wine production at nearby Cucamonga, egg production in the San Fernando valley and a big dairy industry at Norwalk, Los Angeles achieved agricultural maturity well before the turn of the 20th century.

At mid-20th century Los Angeles county had led the nation in the value of its agricultural production each year since 1910. The city was a marketing centre for a wide diversity of crops, including oranges, lemons, apricots, peaches, almonds, walnuts, truck vegetables, figs, avocados, poultry, grain, alfalfa, livestock and dairying. The first outstanding success in co-operative farm marketing was made by the orange industry's local California Fruit Growers' exchange. This organization, as well as the California Walnut Grower's association, and the avocado and lemon exchanges, established headquarters in Los Angeles. However, agriculture steadily yielded large areas of fertile land formerly devoted to the raising of crops and livestock to real estate subdivisions, defense plants, new industrial establishments and space-consuming freeways. Los Angeles county's status as a leading county in agricultural production slipped markedly as the area became increasingly industrialized.

Manufactures.—Early manufacturing was chiefly for local needs and included such products as soap, confectioneries (utilizing locally grown sugar beets), beverages and brewing, as well as household goods. By 1925 Los Angeles, nevertheless, ranked first among California cities with a manufacturing output valued at more than $500,000,000, a payroll of 58,000 and an annual wage expenditure of $86,000,000. A significant feature of this development was the shifting of manufacturing leadership from San Francisco to Los Angeles. In 1900 San Francisco ranked first among California's manufacturing cities but by 1910 had shown little increase in output while Los Angeles had advanced 100% in the same period. The shortages created by World War I further encouraged industrial enterprise at Los Angeles. World War II, with its Pacific fronts craving supplies, further stimulated, indeed forced, rapid industrial progress. By mid-20th century Los Angeles was a leading manufacturer of military and commercial aircraft.

After the war, the city had about 10,000 factories in the metropolitan area and by the early 1960s the number had increased to more than 16,000. Production of transportation equipment, motion pictures, fabricated metal products, machinery, petroleum products and printing formed a large part of this activity. Los Angeles also ranks as a fashion centre for sportswear and women's apparel; glass, chemicals, cement, paints, food processing and fish canning are also leading products. Until Japan entered the world market, southern California for decades had what amounted to a monopoly on the packing of tuna and Los Angeles became the largest fish-packing (including sardines) and fish-distributing centre in the U.S. Production of fish meal and fish oil are important by-products of this industry. Branch plants of eastern U.S. concerns are engaged in automobile assembling and the manufacture of tires, furniture, glass, textiles, tin cans, paper, steel and metal articles. Before the Fontana steel mill was built in 1942, Los Angeles foundries relied upon scrap and pig iron from England, Belgium and Utah and upon coke from Colorado.

Motion Pictures.—Reliable constancy of sunshine and varied scenery brought the motion-picture industry to Los Angeles. As late as 1909 only 4,000 people were living in Hollywood. At the turn of the decade, with ample land for studios, it became with Universal City, Burbank and Culver City an international centre for this industry. By the 1960s, however, television had changed the nature of the industry as even the largest studios gave way to the production of films for TV. At the height of its success Hollywood employed more than 100,000 persons in the making of films. (*See* HOLLYWOOD; MOTION PICTURES.)

Natural Resources.—Petroleum and water power were the first resources developed on a large scale. Electricity was generated in the mountains and Los Angeles pioneered long-distance electric power transmission and the linking of large electric networks. Within a radius of 300 mi. are valuable deposits of metals and minerals: copper, petroleum, soda, salt, potash, silica, infusorial earth, talc, graphite, limestone, building stone, marble and onyx. Except for utilization of borax and iron (from nearby Eagle mountain) these resources have not been widely exploited.

Associated with Los Angeles as much as oranges or motion pictures, however, has been large-scale oil production. A natural bituminous pitch, oozing out of the earth and called *brea*, was used by the Indians and early Spaniards to coat the roofs of their dwellings. After crude experiments to distill this product, in the 1850s and 1860s, there followed the colourful era of Edward L. Doheny who began the first widespread development of the gas and oil fields surrounding the city in the 1890s. Several oil companies were founded within the first decades of the 20th century and vast quantities of oil were taken from newly discovered Signal Hill (1921), Santa Fe Springs (1921) and Huntington Beach (1920). The production of these three nearby fields was so great that they frequently upset the national oil price, storage and distribution structure throughout the 1920s and 1930s. Hundreds of millions of barrels were produced by these and other Los Angeles wells. Not only did the petroleum industry enrich many individuals; it also became a great source of revenue for the state and provided widespread employment. The oil industry also helped make Los Angeles a transportation hub for ships, the railroad and, later, the trucking industry.

Transportation.—The development of transportation for Los Angeles has a long and colourful history. After U.S. occupation (1847) regular sea trade was established between San Pedro harbour and San Francisco, and mail was carried fortnightly by land between the latter city and Los Angeles. The first freight wagon overland from the east arrived in 1851, the first overland stage

in 1858. In 1860, a ten-day pony express linked Los Angeles with the Missouri river. A local railway from Los Angeles to San Pedro harbour was opened in 1869. The Southern Pacific railway from San Francisco to Los Angeles was completed in 1876. Until the Santa Fe connected the city with the east in 1885 the Southern Pacific company, under Collis P. Huntington, enjoyed a virtual monopoly of railroad transportation throughout California and into Los Angeles. By the 20th century this monopoly had been broken and the city had three direct railways to the east.

A municipal transport system of buses links the city with its harbour, beaches and various airports. At one time the Pacific Electric railway, a subsidiary of the Southern Pacific, had 1,161 mi. of track radiating from downtown Los Angeles to points as far outside the city as Redlands and Balboa beach. These inter-urban rail lines gave way to bus routes. Los Angeles is a terminal for various national highways and, because of the heaviest per capita density of automobiles in the world (more than 3,000,000 registered autos), is a natural centre for California's widespread freeway system (part of a master plan of highways to solve the traffic problem) which carries a heavy truck and bus traffic.

Los Angeles is also a travel centre for the southwest and several thousand visitors arrive daily by train, bus, car, ship and airplane. Hotels, apartment houses, motels and trailer courts cater to the tourist traffic.

Air service is available for transportation northward and eastward and Los Angeles has also become a terminus for the polar air route to Europe. Its International airport ranks high in the nation in volume of commercial passengers and freight. Other nearby airports are located in Van Nuys and at the Lockheed air terminal in Burbank.

The Port of Los Angeles.—By sea the city also maintains shipping connections to all parts of the globe, as well as a coastal traffic to both Pacific and Atlantic ports of North and South America. In Spanish times San Pedro bay afforded an uncertain roadstead, chosen because of accessibility by level land route to the city. Despite a stage route (1852) to the harbour and later a railroad, San Francisco enjoyed most of the sea trade in the 19th century. The lengthy squabble over the future site of Los Angeles harbour ended with the annexation in 1906 of the "shoestring strip" to the ocean, giving Los Angeles municipal jurisdiction over its future harbour, the annexation of San Pedro and Wilmington (1909), the building of a breakwater by the U.S. government (1910) and of an inner harbour by the city itself (1912–14). Cargo shipments increased eight times in both tonnage and value, in the decade 1920–30. With more than 40 mi. of water front, and superior accommodations for large ocean-going vessels, facilities were enlarged in 1941 in co-operation with the separate harbour at Long Beach. After World War II Los Angeles became, in total volume, one of the largest export harbours in the U.S. Chief imports are bananas, newsprint, copra, rubber, coffee, sodium nitrate, jute, iron and steel scrap, vegetable oil and fibres. Chief exports include oil, cotton, borax, citrus fruits, asphalt, steel plates, industrial chemicals, pipes, tubes and fittings, canned fish, machinery, chemicals and automobile tires. Los Angeles harbour is an operating centre for the U.S. navy.

Water Supply.—Los Angeles required an unrelenting supply of water for industrial and domestic purposes. Located in a semi-desert region, water was crucial to its growth. In 1904 William Mulholland, chief engineer of the city's water department, suggested an aqueduct to the Sierra Nevada range through the Mojave desert. By 1908 city bonds were voted, and work begun upon a most controversial project which virtually depleted Owens lake and turned part of the southern Sierra into a desert wasteland. Los Angeles aqueduct, finished in 1913, was 233 mi. in length and the longest work of its kind in the world. The cost of construction was nearly $25,000,000, including 142 tunnels, 97 mi. of covered conduit, 12 mi. of siphons, 39 mi. of lined canal, and 24 mi. of unlined canal. Despite a daily capacity of 288,000,000 gal., and additional water supplies from the Los Angeles river, by the 1930s the city began to fall seriously behind in its water requirements. Construction in 1936 of the giant Colorado river (*q.v.*) aqueduct, part of a $220,000,000 project piercing six mountain ranges with 38 tunnels totaling 108 mi., afforded an additional allotment of 677,000,000 gal. daily and provided a new water supply to 13 cities in the metropolitan district. The major electrical energy comes over a transmission line of 266 mi. from Hoover (formerly Boulder) dam. By the 1950s the city was keenly aware that new sources of water supply would have to be developed. However, California's water problems became ensnarled in a bitter north-south sectional controversy over retention of water rights by northern "counties of origin" which were reluctant to release further water resources to a seemingly insatiable Los Angeles. The north needed flood control projects almost as much as the south needed water, but political factionalism stymied co-operation in launching such remedial programs as the controversial Feather river project, which finally was begun officially in 1960.

Cultural and Educational Activities.—In addition to its numerous well-known "motion-picture palaces," Los Angeles supports considerable legitimate theatre. Hollywood is the centre of energetic little-theatre activity. The Player's Ring, Huntington-Hartford theatre and Pasadena's Community playhouse are familiar sites. Extensive television and radio facilities have been built in Los Angeles, from which many national and regional network programs emanate.

Grand opera is usually presented in Shrine auditorium, seating 7,000 persons. Orchestra programs and other recitals are given in the Philharmonic auditorium. As the climate makes outdoor entertainment attractive, the city has a number of gathering places such as the Los Angeles coliseum seating 105,000 persons, a sports arena for athletic events and conventions (35,000), Hollywood Bowl (25,000), the adjoining Pilgrimage Play amphitheatre and outlying auditoriums, such as the Pasadena Rose Bowl (89,000). The *Symphony Under the Stars* is presented in Hollywood Bowl and ballet and outdoor drama are presented each summer at the municipal Greek theatre in Griffith park.

The Los Angeles County Museum of History, Science, and Art in Exposition park exhibits skeletons of prehistoric mammals from nearby La Brea pits. It also maintains an important art museum located near the state museum of science and industry. The Southwest museum at Highland Park specializes in the civilizations of the southwestern United States, Mexico and Central America and is particularly strong in materials concerning the American Indian. Its Casa de Adobe is a replica of an early Spanish colonial home, complete with furnishings. At Barnsdall park, in Hollyhock house, a structure of Mayan inspiration, built in 1913 by Frank Lloyd Wright, is located the Municipal Art gallery, the site also of cultural activities and small musicales. City zoos are located at Elysian and Griffith parks. At Griffith observatory are 12- and 6-in. refracting telescopes, a 3-in. solar telescope; a museum of the physical sciences; and a planetarium.

The Los Angeles public library with more than 60 branches has about 2,250,000 volumes. The Los Angeles county public library, also with more than 60 branches, has over 1,000,000 volumes. The city has special libraries belonging to colleges, professional associations and business concerns, devoted to law, medicine, architecture, mining, petroleum, minerals and industrial subjects. One of these is the William Andrews Clark library of the University of California (devoted to the collection of books on Anglo-American civilization); and the Henry E. Huntington library and art gallery (at nearby San Marino) is rich in rare books and manuscripts, mostly English and American, with collections of incunabula. There is also an outstanding collection of portraits and landscapes of the English painters of the "golden age"—Thomas Gainsborough, Sir Joshua Reynolds, Sir Thomas Lawrence and George Romney. The J. Paul Getty museum, near Santa Monica, includes collections in two major fields: French 18th-century art and Greek and Roman sculpture.

Enrollment in the Los Angeles public schools during the early 1960s totaled more than 600,000. In a 15-year period after World War II, enrollment in the city's high schools increased by 60% while elementary school growth during the same period was 75%.

Among the major institutions for higher education, in order of their founding, are: (1) the private coeducational University of Southern California (1880), in the central part of the city; (2)

Occidental college (1887), located on an attractive campus in the Eagle Rock section, at the northern border of Los Angeles, a private coeducational college devoted to the liberal arts and sciences; (3) California Institute of Technology (1891), at Pasadena, a private institution whose work is largely confined to scientific and engineering subjects; it is notable for pure science and research. At the Institute's Jet Propulsion laboratory the United States' first earth satellites were constructed in 1957; (4) Loyola University of Los Angeles (1911), Roman Catholic, with courses in engineering, commerce, premedical studies and law; (5) the public University of California at Los Angeles (1919), on a huge, sprawling campus at the western border of the city; it is increasingly graduate in character, but gives complete university training. Its facilities include schools of law, medicine and engineering. Other nearby public institutions are Los Angeles state college (1947) and San Fernando Valley state college (1956). Located in greater Los Angeles are Whittier college (1901); the Associated colleges, five institutions at Claremont, and Redlands university (1907). All except the state institutions were founded by religious denominations but, by agreement with their respective churches, many gave up all organic denominational connection early in the 20th century.

Parks and Recreation.—Los Angeles city and county maintain several hundred parks, playgrounds, swimming pools and youth centres. Among these are: Griffith park, 4,253 ac.; Exposition park, 114 ac., with Los Angeles museum; Elysian park, 599 ac., in a natural state; Sycamore grove, 15 ac.; Lincoln park, 46 ac.; and Pershing square, the only park in the business section besides the old Spanish plaza. At the latter is the old Plaza church, one of the plaza's many historic buildings dating from the period 1800–12 onward. Nearby are the Lugo house, the city's first multistory building, dating from 1840 when it was built by Don Vicente Lugo; it was later used for a time by St. Vincent's college (later Loyola university) as its first campus. Olvera street, called El Paseo by the Spaniards, is a brick walkway named for Don Agustin Olvera, and visited traditionally by tourists. Avila adobe, a private museum on this street, was built in 1818 by Don Francisco Ávila; surrounding it are several dozen shops, including several candlemaking establishments, that sell Mexican handicrafts. Also near the Plaza and Olvera street there stands the Pico house, a hotel on Main street built in 1869 by Gov. Pío Pico.

Another tourist attraction is La Brea pits. Located farther west on Wilshire boulevard, the "pitch springs," as they were known when utilized by the Indians, were discovered by the Portolá expedition of 1769. These fossil-bearing tar pits, containing prehistoric remains of extinct animals once caught in sticky seepage, came into the possession of G. Allan Hancock, who gave them to the city in 1915 for park development purposes. Hancock park now contains life-size restorations of such prehistoric animals as the sabre-toothed tiger, mastodon, giant ground sloth and prehistoric camels and bison.

Many tourists visit Mt. Wilson, site of the 100-in. Carnegie telescope located northeast of the city, Lake Arrowhead and Big Bear lake in the San Bernardino mountains and Santa Catalina Island, 23 mi. S.W. from San Pedro. Other attractions include Disneyland, Knott's berry farm, Pacific Ocean park and the Marineland of the Pacific, an oceanarium near Palos Verdes.

Since 1957 Los Angeles has been the home of the former Brooklyn Dodgers, a professional major (National) league baseball club. In 1961 the Los Angeles Angels, an American league club, began play. The Los Angeles (formerly Cleveland) Rams of the professional National Football league are also located there.

City Planning and Problems of Growth.—Once a sleepy pueblo of red-tiled, whitewashed adobe buildings and muddy streets, the town presented a distinctive impression upon travelers in former times. Its population at the turn of the 20th century was 102,489 inhabitants. Baedeker's *Guide* said in 1899 that within the preceding decade "its adobe houses have given place almost entirely to stone and brick business blocks and tasteful wooden houses." The typical "California house" of the early 20th century was frequently an adaptation of Spanish design and the bungalow from India. In fact, southern California's architecture is still highly eclectic. The Monterey-style house, with its balconies and terraces, became especially popular. Stucco or wood frame construction were alternately featured by builders who pioneered real estate tracts that mushroomed interminably in a horizontal construction boom that eventually obliterated the Los Angeles countryside.

Only after 1925 did the city develop a real civic centre, with its nearby Spanish-style union passenger railroad terminal and accompanying government buildings. By the 1960s these developments were giving way to massive redesigning of the city's entire civic centre. A central mall became the site of a series of city, county, state and federal buildings. Slum clearance and relocation developments were simultaneously transforming the Bunker Hill region into a new commercial and residential area. After the removal in 1957 of a 150-ft. height maximum on public buildings came the construction of many 20- to 40-story buildings that line 15 mi. of the city's central sector and its westward extension into the Wilshire boulevard district with an increasingly vertical skyline of apartment houses and office buildings.

Construction of freeways, parks, airfields, schools, fire stations, libraries, sewers and other facilities on the city's expanding periphery barely kept up with the population avalanche that came to Los Angeles after World War II. Statistics for the 1950s indicated that on the average one new person entered southern California every 55 seconds. A new school was needed for additional pupils every Monday morning into the 1960s. Each year Los Angeles added a city larger than Syracuse, N.Y. The costs of such expansion were great as municipal plans became obsolete even before they emerged from blueprints.

All this frenzied growth was not without concern to those residents who knew the city when it was a pleasanter place in which to live. The smog, increased traffic congestion, industrialization and other municipal problems decreased the charm of rural and suburban living. The traditionally colourful orange groves and vineyards made way for aircraft factories, steel mills, housing developments and large apartment construction. Nevertheless there was no evidence that migration to southern California in general, and Los Angeles in particular, would taper off. The pattern indicated the city would move outward to swallow up even more of its countryside. Population experts predicted a vast urban complex stretching almost solidly from Santa Barbara to San Diego, its centre—and controlling focus—Los Angeles.

See also references under "Los Angeles" in the Index.

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LOS ISLANDS (ÎLES DE LOOS), a group of islets just off Conakry, the capital of the Republic of Guinea, west Africa. There are five principal islands: Tamara, Kassa, Roume, Blanche and De Corail. The first two are the largest, Tamara being about 8 mi. long and 1–2 mi. broad. Tamara and Kassa lie parallel to one another, Tamara to the west; they form a sort of basin, in the centre of which is the islet of Roume. The other two islands are to the south. The highest point is a knoll of 499 ft. on Tamara. All the islands are richly clothed with palms and flowering underbrush. The inhabitants, about 1,500, are immigrants of the Baga (*q.v.*) tribe.

Tamara has a good harbour, but the wealth of the islands derives from the bauxite obtained from the volcanic rocks (nepheline syenite) of which they are composed. The deposits, first exploited in 1949, are worked by opencast mining and by the late 1950s yielded about 400,000 tons annually.

The Los Islands derive their name from the sacred idols (*los idolos*) found there by the early European navigators. In 1818 the governor of Sierra Leone obtained the cession of the islands from the Baga chiefs and in 1882 France recognized the group as

a British possession. However, because of their proximity to Conakry, they were ceded to France by the Anglo-French convention of April 8, 1904. In 1958 the islands became part of the independent Republic of Guinea. (J. D.)

LOS RÍOS, province in the coastal lowland of Ecuador, bounded west by Guayas, north by Pichincha and Cotopaxi, east by Bolívar and south by Guayas. Area, 2,292 sq.mi. Pop. (1960 est.) 219,800. Its capital is Babahoyo, pop. (1959 est.) 13,100. The province is mostly in the lowlands west of the mountains, along the middle courses of the Vinces and Babahoyo rivers, tributaries of the Guayas. The chief land use is for beef cattle, bananas, cacao, sugar cane and rice. From the forests come balsa wood, timber, tagua nuts and rubber. As the name suggests, transportation is almost entirely by river boat to Guayaquil. Steamers reach Babahoyo even during the dry season and in flood season can ascend to Zapotal. (P. E. J.)

LOS SANTOS, a small province in southern Panama occupying much of the hilly Azuero peninsula and facing the Gulf of Panama. Area, 1,494 sq.mi. Pop. (1960) 70,554, of which 70% was rural. The largest town and capital is Las Tablas, pop. (1960) 3,504; it is 8 mi. N.W. of the port of Mensabé. Los Santos is important agriculturally, ranking high in the production of corn, rice, sugar, swine, cattle and poultry. The province is a major supplier of eggs and chickens to the urban centres in and near the Canal Zone, to which it ships products by boat and truck. (C. F. J.)

LOSSIEMOUTH AND BRANDERBURGH, a seaport and small burgh of Moray, Scot., at the mouth of the Lossie on the Moray firth, 5¼ mi. N. of Elgin. Pop. of burgh (1961) 5,855. Lossiemouth, or the old town, dates from 1700; Seatown is somewhat later; Branderburgh, farther north, grew with the harbour and began about 1830; and Stotfield is now purely modern, although on the site of the oldest settlement. In the 15th century Lossiemouth succeeded Spynie as Elgin's port, when that town was silted up by sand and shingle, but it declined with the migration of the herring until its popularity as a seaside town brought back its prosperity. There are long sandy beaches and a fine golf course. Fishing is still the main industry (whitefish only) and the town has a fleet of 80 seine-net boats. J. Ramsay MacDonald (1866–1937), the first Labour prime minister, was born in Lossiemouth. The cliffs at Covesea, 2 mi. W., contain caves, in one of which prehistoric weapons were found and the roof of another is carved with early Celtic ornamentation. On the coast is Covesea lighthouse.

Nearly midway between Lossiemouth and Elgin stand the massive ruins of the palace of Spynie, formerly the castle of the bishops of Moray. The larger tower, with walls nine feet thick, was built about 1470.

LOSSKI, NIKOLAI ONUFRIEVICH (1870–), Russian philosopher, was born at Kreslavka near Vitebsk on Dec. 6, 1870. He was educated at Kreslavka and at the University of St. Petersburg, where he was professor, 1916–21. In 1922 he was compelled to leave the U.S.S.R. and went to live in Prague, Czech. He was a professor in Bratislava, 1942–45. After World War II he emigrated to the U.S. and became a professor in the Russian Orthodox seminary, New York (professor emeritus, 1950). According to Losski's views, knowledge is immediate contemplation (intuition). His intuitionalism differs from Bergson's insofar as he considers the ideal-rational forms to be elements of realities, intuitively cognizable. Losski assumes not only concrete real being, but concrete ideal being as well; *i.e.*, supratemporal and supraspatial substantial agents with creative force, which are the basis of spatiotemporal being. This doctrine leads Losski to his teaching of the freedom of the will. Among Losski's most important books are *Die Grundlehre der Psychologie vom Standpunkte des Voluntarismus,* published in Russian (1903), in German (1905); *The Intuitive Bases of Knowledge* (1904; Eng. trans., 1919); *Handbuch der Logik* (1922); *The World as an Organic Whole* (Eng. trans., 1928); *Freedom of Will* (Eng. trans., 1932); *Value and Existence* (Eng. trans., 1935); *Des conditions de la morale absolue* (French trans., from Russian manuscript, 1948); and *History of Russian Philosophy* (1951).

LOSTWITHIEL, a market town and municipal borough (1885) in the Bodmin parliamentary division of Cornwall, Eng., on the Fowey river, 6 mi. S.S.E. of Bodmin. Pop. (1961) 1,954. St. Bartholomew's church has a fine Early English tower and a Decorated spire. A bridge of the 14th or early 15th century crosses the river. The Shire hall or Duchy palace includes remains of the 13th-century Stannary prison. The Western Region railway route has workshops there. The boundaries of the borough were further extended in 1934 to include parts of the parishes of St. Winnow, Lanlivery and Lanhydrock.

Lostwithiel probably owed its existence to the neighbouring circular castle of Restormel, restored in 1930. The first charter dates back to about 1190. The Pipe Rolls (1194–1203) show that Robert de Cardinan, lord of Restormel, paid ten marks yearly for having a market at Lostwithiel. He surrendered to the burgesses all the liberties given them by his predecessors (*antecessores*) when they founded the town. Isolda, granddaughter of Robert de Cardinan, gave the town to Richard, king of the Romans, who granted to the burgesses a guild merchant and many privileges, as well as a yearly fair and a weekly market. His son Edmund decreed that the coinage of tin should be at Lostwithiel only. In 1609 a charter of incorporation provided for courts of record and piepowder. From 1305 to 1832 two members represented Lostwithiel in parliament, but under the Reform act (1832) the town became merged in the county.

For the victory gained by Charles I over the earl of Essex in 1644, *see* CIVIL WAR, ENGLISH.

LOT, in the Bible, the legendary ancestor of the two Palestinian peoples, Moab and Ammon (Gen. xix. 30–38; *cf.* Ps. lxxxiii. 8); he appears to have been represented as a Horite or Edomite. As the son of Haran and grandson of Terah, he was Abraham's nephew, and he accompanied his uncle in his migration from Haran (Harran) to Canaan. Near Bethel Lot separated from Abraham because of disputes between their shepherds and, being offered the first choice, chose the fertile and well-irrigated Jordan valley. It was in this district that the cities of Sodom and Gomorrah (*q.v.*) were situated. He was saved from their fate by two divine messengers who spent the night in his house, and next morning led Lot, his wife and his two unmarried daughters out of the city. His wife looked back and was changed to a pillar of salt, but Lot with his two daughters escaped first to Zoar and then to the mountains east of the Dead sea, where the daughters planned and executed an incest by which they became the mothers of Moab and Ben-Ammi (*i.e.*, Ammon). The account of Chedorlaomer's invasion and of Lot's rescue by Abraham, recounted in Gen. xiv, belongs to an independent source, the age and historical value of which have been much disputed. *See* ABRAHAM; AMMONITES; MOAB.

LOT, an inland *département* of southwestern France, was formed in 1790 from the district of Quercy in the old province of Guienne (*q.v.*). It is bounded north by Corrèze, east by Cantal and Aveyron, south by Tarn-et-Garonne and west by Lot-et-Garonne and Dordogne. Area 2,018 sq.mi. Pop. (1962) 149,929. In the east the *département* rises above 2,000 ft. on the rolling crystalline plateaus, known as Ségalas (rye lands), that form the western flanks of the Massif Central, but the greater part consists of dry limestone platforms, between 800 and 1,500 ft., called Causses. They are less elevated than the Grands Causses of the Tarn and Aveyron basins farther southeast and are sometimes known collectively as the Petits Causses. The Lot river, crossing the Causses from east to west in a deep, steep-sided valley that opens out about Cahors, separates the Causse de Cahors to the south from the Causse de Gramat, which stretches north to the parallel valley of the Dordogne river in the northern extremity of the *département*. Although less severe than the Grands Causses, the limestone plateaus show the characteristic feature of underground drainage, with numerous swallow holes and grottoes. Their stony surfaces are often suited only for sheep pasture, but there are some woodlands of stunted oak and juniper, and truffles are renowned as a local speciality. In hollows, where pockets of soil have accumulated, some cultivation is carried on. The agricultural wealth lies in the warm and sheltered valleys. There a variety of crops flourish, including grain, vine and fruits, often grown on

terraced slopes, while the flat valley floors are ribbons of irrigated meadows. There is little mineral wealth, but the limestone is quarried in places. Although the main railway from Paris to Toulouse traverses the *département* from north to south through Cahors, the area is a rural backwater. Another railway follows a more easterly route along the Lias marl groove at the contact of the crystalline and limestone plateaus, where the small market towns of Figeac and St. Céré are situated.

Cahors, the largest town (pop. [1962] 15,528), is also the capital of the *département* and centre of the bishopric that is co-extensive. Its cathedral is notable for its cupolas, and Souillac also has a famous Romanesque church with cupolas, as well as a remarkable sculptured portal. The village of Rocamadour is picturesquely situated in a gorge beneath a 400-ft. wall of rock, which carries the famous sanctuaries that make it a pilgrimage centre. The *département* is divided into three *arrondissements* centred upon Cahors, Figeac and Gourdon. It comes under the educational administration of Toulouse and is served by the court of appeal at Agen. (Ar. E. S.)

LOTA, major coal mining centre in southern Chile, located on the Gulf of Arauco. Although it was founded in 1662, sustained development of the city did not begin until 1852, when Matías Cousiño began a coal mining enterprise. The completion of a railway from Concepción in 1888 stimulated the growth of Lota by providing land transportation for the coal, which is taken from seams that lie below the gulf floor to about 3½ mi. offshore. Other industries in Lota include a brick and refractories plant and a copper smelter, and there are also extensive pine and eucalyptus plantations in the surrounding area. Operating and administrative facilities and a planned company town comprise Lota Alto; together with Lota Bajo, a commercial and residential community, Lota's population (1960) is 51,679 (mun.). Renowned in Chile for its beauty is the splendid Isidora Cousiño park. (J. T.)

LOT-ET-GARONNE, an inland *département* of southwestern France, was formed in 1790 from the Agenais and Bazadais portions of ancient Guyenne (Guienne) and the Condomois Lomagne, Brullois and Albret districts of Gascony. It is bounded north by Dordogne, east by Lot and Tarn-et-Garonne, south by Gers and west by Landes and Gironde. Area 5,385 sq.km. (2,079 sq.mi.). Pop. (1962) 275,028. The Garonne river crosses the *département* from southeast to northwest, receiving an important tributary, the Lot, in the centre. The broad, alluvial valleys of the great rivers are flanked by undulating platforms of marly limestones and clays that give fertile, if rather heavy, soils. There is little mineral wealth or manufacturing, but agriculture is productive. Both wheat and maize, as well as fodder crops, are widely cultivated; the vine is ubiquitous; and much fruit, including peaches, apricots and plums, is grown. *Prunes d'Agen* are well-known confections. Some of the wine is distilled into brandy. Tobacco is extensively cultivated for the state factory at Tonneins. Cattle, pigs and poultry are kept in large numbers, and geese are fed on maize for *pâté de foie gras*. The *département* extends westward to include the easternmost prong of the great Landes forest (*see* Landes, Les), and Casteljaloux on its margin has a paper mill and other woodworking industries.

Agen (*q.v.*), the capital, is the seat of a bishopric, with the impressive cathedral of St. Caprais, and also has a court of appeal; for educational administration, however, the *département* comes under the *académie* of Bordeaux. The *département* is divided into three *arrondissements,* centred upon Agen, Marmande and Villeneuve-sur-Lot, all modest country market towns characteristically situated on the great rivers. Navigation is carried on by the lateral canal along the Garonne valley. Villeneuve-sur-Lot, dating from 1264, is a noteworthy example of the medieval planned towns, laid out in a regular grid, that are numerous in the lowlands of Aquitaine. The Romanesque abbey church of St. Pierre at Moissac has beautiful cloisters and an elaborate doorway.

The history of the *département* is associated with Agenais, Guienne and Gascony (*qq.v.*). (Ar. E. S.)

LOTHAIR I (795–855), Frankish emperor of the Carolingian dynasty, was the eldest son of the future emperor Louis I (*q.v.*) the Pious and his first wife, Irmingard. He probably grew up in Aquitaine when his father was king there. After Louis had become co-emperor (813) and successor of Charlemagne (814), he made Lothair king in Bavaria and, in 817, joint emperor. The *Ordinatio imperii* of 817 was designed to provide for the unity of the Frankish empire after Louis I's death: Lothair's younger brothers Pepin and Louis (later called the German) were to receive their own kingdoms, namely Aquitaine and Bavaria, but were to remain under the imperial suzerainty of Lothair. In 821 Lothair married Irmingard (d. 851), daughter of Count Hugh of Tours.

Ruler in Italy from 822, Lothair was crowned emperor again, by Pope Paschal I, on April 5, 823. In 824 he issued the *Constitutio Romana,* which affirmed imperial sovereignty over Rome and demanded an oath of fealty from the pope. Then, in 829, Louis the Pious, under the influence of his second wife Judith and in violation of the *Ordinatio* of 817, granted part of the empire to his son by Judith, Charles (later called the Bald). This made Lothair break with the imperial government. Though a palace revolution enforced his reappointment as co-emperor in 830, he was again deposed shortly afterward. In 833, however, discontent at the rule of Louis the Pious culminated in a revolt of the three elder sons, led by Lothair; and Louis was deposed in Lothair's favour. As Lothair soon made himself hated for his egotism and favouritism, Louis was restored in 834 and Lothair's rule restricted to Italy. Thus the ideal of imperial unity collapsed.

When Louis I died (840), Lothair claimed again his rights under the *Ordinatio;* but his brothers, Louis the German and Charles the Bald (Pepin had died in 838), opposed him, and he was defeated in battle at Fontenoy near Auxerre on June 25, 841. The treaty of Verdun (Aug. 843) left him the "Middle Realm" of the Frankish dominions, stretching from the North sea to Italy, while Louis had the eastern and Charles the western territory, so that imperial supremacy was replaced by the joint rule of the three brothers. Lothair adhered loyally to this system and tried at several conferences (Thionville, 844; Mersen or Meerssen, 847 and 851) to iron out the differences between him and his brothers. In his own realm he reverted to subdivision, making the government of Italy over to his eldest son Louis II as early as 844 and partitioning his realm between his sons Louis (emperor from 850), Lothair and Charles (who received Provence) in Sept. 855. Then he abdicated and became a monk at Prüm, where he died a few days later, on Sept. 29, 855, and where he is buried.

See F. Lot and F. Ganshof, *Les Destinées de l'empire en Occident* (1941); T. Mayer, *Der Vertrag von Verdun* (1943). (T. Sch.)

LOTHAIR II or **III** (1075–1137), German king from 1125 (reckoned as Lothair III by those who count not only the elder but also the younger Carolingian Lothair in their numeration of sovereigns over parts of Germany) and Holy Roman emperor from 1133, also duke of Saxony from 1106, was the son of Gebhard, count of Supplinburg. He succeeded to extensive lands around Helmstedt, in Saxony, on his father's death in battle a few days after his birth (June 1075). Gebhard had been a leading opponent of the emperor Henry IV (*see* Henry, German kings), and Lothair, taking the same attitude, assisted Egbert II of Meissen in the rising of 1088. His position in Saxony was enhanced by his marriage with Richenza, daughter of Henry of Nordheim.

Having assisted the German king Henry V against his father in 1104, Lothair was appointed duke of Saxony by Henry V, when Duke Magnus, the last of the Billungs, died in 1106. His independent attitude brought him into collision with Henry V, to whom, however, he was forced to submit after an unsuccessful rising in 1112. In 1112 Lothair supported the claim of Siegfried, count of Ballenstedt, to inherit the domains of Ulrich II, count of Weimar and Orlamünde, against Henry V. The rebels were defeated, and Siegfried was killed at Warnstedt in 1113, but his son secured possession of the disputed counties. After the defeat of Henry's forces by Lothair at Welfesholz on Feb. 11, 1115, events called Henry to Italy; and Lothair appears to have been undisturbed in Saxony until 1123, when the death of Henry II, margrave of Meissen and Lusatia, raised a dispute as to the right of appointment to the vacant margraviates. A struggle ensued, in which Lothair prevailed.

When Henry V died in 1125, Lothair was elected German king at Mainz on Aug. 30, largely thanks to the efforts of the papal party, and crowned at Aachen on Sept. 13. He requested Frederick of Hohenstaufen to restore to the crown the estates bequeathed to him by Henry V. Frederick refused and was outlawed. Lothair, unable to capture Nürnberg, gained the support of the Welf Henry (*q.v.*) the Proud, the new duke of Bavaria, by giving him his daughter Gertrude in marriage, and that of Conrad, count of Zähringen, by granting him the administration of the kingdom of Arles. But Conrad of Hohenstaufen, Frederick's brother, was elected as antiking in Dec. 1127 and was quickly recognized in northern Italy. But by the end of 1129 the Hohenstaufen strongholds Nürnberg and Speyer were in Lothair's possession. This struggle was accompanied by disturbances in Lorraine, Saxony and Thuringia, but order was soon restored after Hohenstaufen resistance had been beaten down. In 1131 the king led an expedition into Denmark but met resistance and withdrew on securing a promise of tribute.

The king's attention at the time was called to Italy where Pope Innocent II and Anacletus II were clamouring for his support. At first Lothair remained neutral; but in March 1131 he was visited at Liège by Innocent, to whom he promised his assistance. Leaving Germany with a small army in Aug. 1132, he reached Rome in April 1133, accompanied by Innocent. As St. Peter's was held by Anacletus, Lothair's coronation as emperor took place in the church of the Lateran on June 4, 1133. He then received as papal fiefs the vast estates of Matilda of Tuscany, thus securing for his daughter and her Welf husband lands which might otherwise have passed to the Hohenstaufen. He returned to Germany, where he restored order in Bavaria and on the lower Rhine. Resuming the struggle against the Hohenstaufen, he soon obtained their submission, though they retained their lands. A general peace was sworn at Bamberg. The emperor's authority was now generally recognized, and the annalists speak highly of the peace and order of his later years.

The emperor seconded the efforts of his vassals Albert the Bear, margrave of the Saxon North mark, and Conrad I, margrave of Meissen and Lusatia, to extend the authority of the Germans in the districts east of the Elbe, and he assisted Norbert, archbishop of Magdeburg, and Albert I, archbishop of Bremen, to spread Christianity. In 1135 Eric II of Denmark acknowledged himself a vassal of Lothair; the Polish prince Boleslaw III promised tribute and received Pomerania and Rügen as German fiefs; and the Byzantine emperor John Comnenus solicited Lothair's aid against Roger II of Sicily.

In Aug. 1136, attended by a large army, Lothair set out on his second Italian journey. The Lombard cities were either terrified into submission or taken by storm; Roger II was driven from Apulia; and the imperial power was enforced over the whole of Southern Italy. A mutiny among the German soldiers and a breach with Innocent over the overlordship of Apulia compelled the emperor to retrace his steps. After making an arrangement about Apulia, Lothair left Italy for Germany but died at Breitenwang in Tirol on Dec. 3 or 4, 1137.

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LOTHAIR (941–986), king of France from 954 to 986, of the Carolingian dynasty, was the son of Louis IV d'Outremer and of Gerberga, sister of the German king Otto I. After his father's death he was elected king without opposition (Nov. 12, 954), but he was dominated first by Hugh (*q.v.*) the Great and then by Otto I's brother, Archbishop Bruno of Cologne. Bruno furthered Otto's policy of maintaining a balance of power in France between the Carolingian rulers and their Robertian rivals and persuaded Lothair not to annex Burgundy but to give the duchy to Otto, a son of Hugh the Great. Lothair was forced to attend a council held by Otto I at Cologne in June 965, and in the same year he married Otto's stepdaughter Emma.

Lothair failed to profit from the freedom brought by Bruno's death late in 965. Though he preserved his domain carefully, he was much distracted by feudal conflict. Also a persistent desire to get Lorraine from the German allegiance brought disastrous consequences: his support of a feudal revolt there (976) against Otto II impelled the latter to give the duchy of Lower Lorraine to Lothair's refractory brother Charles (*q.v.*); his plan to capture Otto's family at Aachen (978) miscarried and provoked a retaliatory raid into France; and a third invasion of Lorraine (985) not only failed in its purpose but determined the powerful Archbishop Adalberon of Reims to support the Robertian Hugh Capet against Lothair. Lothair was, however, preparing yet another expedition into Lorraine when he died on March 2, 986.

See F. Lot, *Les derniers carolingiens* (1891). (J. DE.)

LOTHAIR (*c.* 835–869), Frankish king from 855 of the country known as Lotharingia (*Lotharii regnum*, or Lothair's kingdom; *see* LORRAINE), was the second son of the Carolingian emperor Lothair I. When his father's "Middle Realm" was divided in 855 young Lothair received the area west of the Rhine from the North sea to the Alps. When his brother Charles of Provence died in 863, Lothair's kingdom was extended beyond Lyons, but his reign was an unending struggle for the future of this kingdom and his dynasty. In 855 he had married Theutberga, sister of Hucbert, the lay abbot of St. Maurice, but she remained childless and from 857 Lothair was trying to have the marriage dissolved and to make his mistress Waldrada, who had given him a son Hugh, his legitimate wife and queen. He made odious accusations against Theutberga (accusing her of incest with Hucbert), but her champion prevailed in the ordeal by boiling water (858) and she had to be taken back. Lothair then secured the support of his eldest brother the emperor Louis II by granting him some territory and induced two subservient archbishops, Günther of Cologne and Theutgaud of Trier, to start ecclesiastical proceedings against his wife. Two synods at Aachen dissolved his marriage after Theutberga had been compelled to make a "confession" (860), but she fled to the West Frankish king Charles the Bald, revoked her confession and appealed to Pope Nicholas I. Nevertheless a third synod at Aachen (April 862) gave Lothair permission to marry Waldrada; and he obtained the papal legate's confirmation of this decision, probably through bribery, at a synod at Metz (June 863). Nicholas quashed these decisions and deposed the two archbishops (Oct. 863), and another legate forced Lothair to take Theutberga back again (Aug. 865). Then Lothair made her ask Pope Adrian II for a divorce herself (867), and the pope received him in 869. Expecting a fresh trial, Lothair was going home when he died at Piacenza on Aug. 8, 869. He is buried at Piacenza. The treaty of Mersen (Meerssen) in 870 divided his realm between the West and the East Frankish kingdoms.

See R. Parisot, *Le Royaume de Lorraine sous les Carolingiens* (1899); F. Lot and F. Ganshof, *Les Destinées de l'empire en Occident* (1941). (T. SCH.)

LOTHARINGIA: *see* LORRAINE.

LOTHIAN, PHILIP HENRY KERR, 11TH MARQUESS OF (1882–1940), who as British ambassador to Washington from April 1939 was, after the outbreak of World War II, a superlative exponent of the British cause to a still neutral United States and displayed notable qualities as a negotiator in such matters as the destroyer bases deal. He was born in London on April 18, 1882, and was educated at the Oratory school, Birmingham, and at New College, Oxford. In 1905 he was appointed assistant secretary of the intercolonial council of the Transvaal and the Orange River colony and of the railway committee of Central South African railways. In these capacities he went to South Africa, becoming a member of the so-called "kindergarten" of Sir Alfred Milner, afterward Viscount Milner, and remaining there until 1910 as an active advocate of South African federation. After his return to England he became editor (1910–16) of the *Round Table*, a journal advocating closer imperial unity. He was secretary to Lloyd George from 1916 to 1921, in which year he became political director of the *Daily Chronicle*, having been already, since 1918, a director of the United Newspapers. He served in the cabinet as parliamentary undersecretary of the India

office (1931–32), was chairman of the Indian Franchise committee (1932) and secretary (1925–39) of the Rhodes trust which administers the Rhodes scholarships. He was appointed ambassador to the United States on April 24, 1939, a position he held until his tragically premature death in Washington, D.C., on Dec. 12, 1940.

See J. R. M. Butler, *Lord Lothian, 1882–1940* (1960). (H. G. N.)

LOTHIAN, known in medieval literature as Lyonnesse, was a primitive province of Scotland lying between the rivers Tweed and Forth. The name is of Welsh origin but of uncertain meaning and is now used in the names of the counties East, Mid- and West Lothian. Occupied in late Roman times by the Votadini, who figure in the title of the Welsh poem *Y Gododdin* (*c.* 600), it seems that Tweeddale, Teviotdale and the Merse (southern Lothian) had passed into Anglian hands by *c.* 625. If Eten is Edinburgh, Anglian control of northern Lothian, or Lothian proper, was probably won after the siege of Eten in 638, recorded in Irish annals. In 680 there was an Anglian reeve at Dunbar, and about the same time the monastery at Abercorn became an Anglian episcopal see. Angle and Pict, separated approximately by the line of the Antonine wall, were at peace for a century after *c.* 740.

The first king of Picts and Scots, Kenneth MacAlpin (*c.* 843–858), is said to have invaded England (which would have included Lothian) six times, and burned Dunbar and Melrose, while by the late 9th century the Scots were crossing the Tweed to attack Northumbria. Probably under Scottish and Viking attacks the religious life at Tyninghame, Coldingham and Melrose died, while political control by the isolated English ealdorman at Bamborough is unlikely to have been effective. Oppidum Eden (probably Edinburgh) was finally taken by the Scots *c.* 960. Lothian was ceded to the Scottish king *c.* 975 and so remained except perhaps for the decade after 1006. It was for long "in England," a benefice held by the Scottish king of the English king, and this juridical distinction was lost sight of only in the 12th century. Lothian was ceded by Edward Balliol to Edward III of England in 1333 and it was recovered only slowly by the Scots. Roxburgh fell in 1460, but Berwick has remained in English hands since 1482. For some years before he became king in 1124, David I ruled southern Lothian and founded there the abbey of Selkirk (later moved to Kelso). The infiltration of Anglo-French families, like monastic colonization, proceeded apace in his reign. Cospatrick, son of William I's earl of Northumbria, who had fled to Scotland and received Dunbar from Malcolm III, was prominent in Lothian in David's reign, and once styled himself earl. He was probably the *summus dux Laodonensium* ("chief leader of the men of Lothian") who was killed fighting for David at the battle of the Standard (1138). His descendants in the 12th century were styled earls of Lothian but in the 13th century limited their title to earls of Dunbar.

In the later 12th century sheriffs are found at Edinburgh, Linlithgow and Haddington, their bailieries corresponding to Mid-, West and East Lothian. By 1263 the sheriff of Edinburgh controlled all three with constables as his deputies in Linlithgow and Haddington. These constabularies were effectively sheriffdoms by the mid-15th century, and this status was restored to Linlithgow by 1468, but not to Haddington till after 1689. The present county names date from the 19th century. *See* SCOTLAND: *History.*

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LOTI, PIERRE (real name LOUIS MARIE JULIEN VIAUD) (1850–1923), French writer. His career of naval officer, taking him repeatedly to the middle and far east, provided him with the exotic décor of his novels and reminiscences—an exoticism which was to the taste of the period and made his works successful. He was born at Rochefort on Jan. 14, 1850. In 1867 he entered the naval school and in 1869 joined the training ship "Jean-Bart"; he was promoted ship's lieutenant in 1881 and during 1885–91 saw service in Chinese waters. His subsequent promotions were to frigate captain in 1898 and ship's captain in 1906. He retired in 1910, but, mobilized in 1914, filled various administrative posts with the army. After the publication of his first novel, *Aziyadé* (1879), he rapidly developed a parallel literary career. Novel followed novel, and he won the respect of the critics as well as the devotion of a large public. With such successful novels as *Pêcheur d'Islande* (1886) and *Madame Chrysanthème* (1887) to his credit, and with the approval of such exacting critics as Ferdinand Brunetière, Anatole France, Paul Bourget and Jules Lemaître, the way was made smooth for his reception into the Académie Française in 1891. Each year there was a new book, sometimes a novel—*Ramuntcho,* 1897; *Les Désenchantées,* 1906—often treating objectively the love affairs with which he tried to satisfy his dreams and melancholy at every landfall; sometimes a volume in which he himself figured—*Le Roman d'un enfant,* 1890; *Prime Jeunesse,* 1919; *Un Jeune Officier pauvre,* 1923—which reflect most fully his passionate nature and anguish for all that will never return. He died at Hendaye on June 10, 1923.

It would be unjust to dismiss Loti for his exoticism or his rather naïve celebration of primitive and pagan love. An exceptionally gifted observer, he was able to return from his voyages with a rich store of pictorial images and embody them in simple, musical prose. But this literary impressionism served a deeper strain in his nature; death, as much as love, lies at the heart of his work, and a profound despair at the passing of sensuous life is woven into his word painting. This despair was tempered by his tenderness and compassion for the human condition, and such books as *Le Livre de la pitié et de la mort* (1890) or *Reflets sur la sombre route* (1899) are perfect examples of his candid art—an art so simple that Lemaître asserted that it was impossible to discover "how it was done." His neglect by succeeding generations was the more undeserved because he was in fact a precursor and should have his place among those who experienced and diagnosed the questionings and obsessions of modern man: the longing to escape; the refusal of constraint; the appeal of the irrational, the unknown and the primitive; and the emphasis on "eroticism," *i.e.,* the value placed upon physical instinct as a challenge to death.

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LOTICHIUS, PETRUS SECUNDUS (1528–1560), is often considered Germany's best neo-Latin poet. Born at Niederzell near Schlüchtern on Nov. 2, 1528, he was trained as a poet by J. Micyllus, took part in the Protestant defense of Magdeburg (1547), studied for eight years at Montpellier and Padua and was professor of medicine and botany at Heidelberg from 1557 to his death there on Nov. 7, 1560. His verses are indebted to Catullus and Ovid, but his feeling for the countryside and the autobiographical directness of his love lyrics reveal a 16th-century sensibility. Though he wrote in Latin, he had evidently much in common with his great contemporary, Ronsard.

See G. Ellinger, *Geschichte der neulateinischen Poesie Deutschlands,* vol. 2 (1929). (R. R. Bo.)

LOT RIVER, in southwestern France, about 300 mi. long, is a tributary of the Garonne. Rising in the Cevennes on the Mont du Goulet at nearly 5,000 ft., it flows west from Mende in a deep gorge between the limestone plateaus of the Causses de Sauveterre and du Comtal to the south and the crystalline and volcanic plateau of Aubrac to the north. At Entraygues it receives, from the northeast, its most important tributary, the Truyère, which in its upper course is dammed for generating hydroelectric power. Below Entraygues the Lot flows west by the small coal field of Décazeville (*département* of Aveyron) to enter the lower limestone plateaus of the Causses du Quercy. Its valley opens as it continues past Cahors, a cathedral city and the old capital of Quercy, and the medieval planned town of Villeneuve-sur-Lot to the Garonne near Aiguillon, midway between Marmande and Agen. (AR. E. S.)

LÖTSCHEN PASS, an easy glacier pass (8,825 ft.) leading from Kandersteg (Bernese Oberland) to the Lötschen valley

(Valais), Switz. It is first mentioned in 1352, but was probably crossed earlier by the people of the Valais, who colonized various parts of the Bernese Oberland.

In 1384 and in 1419 battles were fought on it between the Bernese and the Valaisans, while in 1698 a mule path (of which traces still exist) was constructed on the Bernese slope, though not continued beyond. The railway between Bern and Brig (part of the Simplon tunnel route) runs beneath the pass through the Lötschberg tunnel (9 mi. long and built in 1906–12). The tunnel starts above Kandersteg and enters the Lötschen valley at Goppenstein. This pass is to be distinguished from the Lötschenlücke (10,456 ft.), another glacier pass which leads from the head of the Lötschen valley to the Great Aletsch glacier.

(A. F. A. M.)

LOTTERY, a scheme for the distribution of prizes to be determined by chance, was reputedly an invention of the Romans. In its usual form, tickets are sold bearing different numbers. Duplicates are placed in a drum or wheel from which winning numbers are drawn on a specified date.

Although the Roman emperors Nero and Augustus used lotteries to distribute slaves, houses or ships as prizes, the chances were free. Lotteries in the modern sense originated in Italy during the middle ages spreading to France, Germany and Austria where rulers used them to raise revenue.

France first used lotteries as state revenue measures in 1539 although they had been permitted there under the name of *blanques* in 1520 by edict of Francis I.

England.—The first English lottery was drawn in 1569. In 1612 the Virginia company's expedition was partly financed by a lottery; and others were used to raise money for commercial purposes, such as the supply of water to the metropolis, the construction of Westminster bridge and the building of the British museum. However lotteries encouraged mass gambling and fraudulent drawings and, after they had been attacked by W. Wilberforce, Sir Samuel Romilly and others, parliament provided for their discontinuance in 1823. Thereafter large-scale lotteries contrived to inhibit prosecution by giving large sums to charities.

A century later, following agitation for legalized lotteries, the Betting and Lotteries act, 1934, adopted the recommendations of a royal commission and continued the prohibition on all lotteries in Great Britain, though this was subject to certain exemptions. Small lotteries incidental to bazaars, sales of work, fêtes and other entertainments of a similar character, whether limited to one day or extending over two or more days, were exempted, subject to compliance with certain conditions. So also were private lotteries that are promoted for, and in which the sales of tickets or chances is confined to, either members of one society established and conducted for purposes not connected with gaming, wagering or lotteries, or persons all of whom work or reside on the same premises.

The restrictions were further relaxed by the Small Lotteries and Gaming act, 1956, which authorized the conduct of small lotteries for other than private gain by societies for raising money for charitable, sporting and other purposes.

The Betting and Gaming act, 1960, relaxed the law still further in the case of the provision of amusements with prizes at certain noncommercial and commercial entertainments. It also amended the reference to small lotteries in the act of 1934 by inserting after the word "fêtes" the words "dinners, dances, sporting or athletic events." The act of 1960 also exempted games played by means of amusement machines, subject to compliance with certain conditions.

United States.—American colonial lotteries on the English pattern were used to raise money for public improvements and to assist in the financing of colleges including Columbia, Harvard, Dartmouth and Williams. In 1762 the Pennsylvania Provincial Assembly denounced lotteries, declaring they were responsible for vice and idleness and were injurious to trade. Following the Revolutionary War lotteries flourished throughout the nation. Abuses including fraud were commonplace. Various state legislative committees recommended their abolishment. In 1833 legislation enacted in Massachusetts, New York and Pennsylvania outlawed lotteries, and early in 1834 similar action was taken by Ohio, Vermont, Maine, New Jersey, New Hampshire and Illinois. Provisions prohibiting legislatures from authorizing lotteries in the future were inserted in many state constitutions.

Following the Civil War the Louisiana Lottery company obtained from the state legislature a 25-year charter effective Jan. 1, 1869. Its ostensible purpose was to raise money for the New Orleans Charity hospital. The lottery company became tremendously wealthy, politically powerful and corrupt. Pres. Benjamin Harrison, in a special message on July 30, 1890, to the U.S. senate and house of representatives declared: "The people of all the states are debauched and defrauded . . . by the Louisiana Lottery." He recommended that "severe and effectual legislation . . . be promptly enacted to enable the Post Office Department to purge the mail of all letters, newspapers, and circulars relating to the business." Congress responded by enacting legislation making it a federal crime to deposit lottery matter in the United States mails. In the Louisiana election of 1892, the lottery was the sole issue in the governor's contest. The antilottery candidate won and the lottery was outlawed.

Since that time lotteries were illegal in the United States until 1963, when New Hampshire passed the first sweepstakes lottery law of the century. In a few states bingo (*q.v.*), a form of lottery, is permitted when conducted by specified religious or fraternal organizations for charity.

Policy.—This form of lottery flourishes among Negroes in urban areas. Pellets numbered 1 to 78 are deposited in a drum-shaped wheel, and players wager that certain numbers will appear among twelve that are selected at the drawing. A bet that three particular numbers will be selected is known as a gig, four numbers a horse and five numbers a jack. Odds against the players are enormous.

Bolita.—A lottery similar to policy is bolita, played in Puerto Rico, and in the United States among Cuban and Puerto Rican groups. In this lottery, numbered balls from 1 to 100 are placed in a canvas sack. A small tear is made in the sack and the drawer inserts his hand and grasps one of the numbered balls. The sack is then split open and the remaining balls allowed to fall out. Although the odds are actually 99 to 1, the winning number usually pays only 70 for 1.

Numbers Game.—This game differs from policy largely in the method of selecting the winning numbers. Numbers game winners are determined from specified digits in such publicized figures as bank clearances, U.S. Treasury balances or pari-mutuel payoffs in designated races.

National and State Lotteries.—In Great Britain a proposal in 1917 to assist the financing of World War I by the issue of "premium bonds" was rejected on the recommendation of a parliamentary committee; on Nov. 1, 1956, however, premium bonds (in units of £1) were adopted to supplement the waning National Savings scheme, and from Aug. 1, 1960, each £100,000 of the monthly prize fund has been divided into 1 prize of £5,000, 10 of £1,000, 10 of £500, and about 3,000 of progressively smaller sums down to £25.

France, Spain, Italy, the Republic of Ireland (the sweepstakes for the Irish hospitals) and some South American republics have state lotteries—all with a problematic effect on direct taxation, which ostensibly they relieve. Following World War II, Russia used a lottery scheme to sell bonds for financing economic development; nonwinners received no interest on their bonds, while winners received prizes. The real home of the state lottery, however, is Australia, where, with the exception of South Australia, lotteries are conducted under government sponsorship for financing public purposes, the total revenue from ticket sales in any year exceeding £20,000,000.

The oldest lottery in Australia is Tattersall's, established in Sydney (New South Wales) by the licensee of Tattersall's hotel in 1881 and moved to Brisbane (Queensland) when the New South Wales government outlawed lotteries in 1893. In 1895 Queensland followed suit and Tattersall's moved to Hobart (Tasmania), welcomed by a government on the verge of bankruptcy. When the federal parliament was established in 1902, Tattersall's was denied

the use of the mails, but defeated the ban (which was revoked in 1930) by a great variety of ruses. Its transfer to Melbourne (Victoria) in 1954 raised a storm of protest in Tasmania, which, however, partially repaired its fortunes by licensing a new lottery that began operations in 1955. Queensland's "Golden Casket" lottery (1916) was Tattersall's first serious rival.

New South Wales had lotteries as early as 1849, and although attempts were made to outlaw them from 1893 to 1930, it found that too much money was flowing to lottery-minded states, and therefore established what is now the biggest state lottery in Australia, selling more than 1,000,000 tickets a week. New South Wales also raffles houses, cars, etc., on a scale unequaled anywhere in the world.

Western Australia's lotteries are called "charities consultations" and give their profits to hospitals (thus relieving the government of part of their charge). Citizens of New Zealand, which has no state lottery, can buy tickets in Tattersall's and pay a tax of *6d* per ticket to the New Zealand government.

See also GAMBLING.

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LOTTO, LORENZO (*c.* 1480–1556), Italian painter, was born in Venice, but in the earlier years of his life lived at Treviso and always remained somewhat apart from the main Venetian tradition. His earliest dated pictures, the "Madonna and St. Peter Martyr" (1503) and the "Portrait of Bishop de' Rossi" (1505), both in Naples, together with its allegorical cover, now in Washington, D.C., have unmistakable *quattrocento* traits in the treatment of the drapery and landscape and the cool tonality. To his early period belong the "Assumption of the Virgin," at Asolo, and "St. Jerome in the Wilderness" (1506) at the Louvre; the altarpiece at Sta. Cristina near Treviso (1507); the Recanati polyptych and "Madonna and Saints" (1508), at the Villa Borghese; and "Marriage of Catherine," at Munich.

Lotto was in Rome between 1508 and 1512, when Raphael was painting the Stanza della Segnatura. A document in the Corsini library mentions that Lotto received 100 ducats as an advance payment for fresco work in the upper floor of the Vatican, but there is no evidence that this work was ever executed. In the next dated works, the "Entombment" (1512) at Jesi and the "Transfiguration," "St. James" and "St. Vincent" at Recanati, Lotto has abandoned the dryness and cool colour of his earlier style, and adopted a fluid method and a blonde, joyful colouring.

In 1513 Lotto was living in Bergamo, where he had entered into a contract for 500 gold ducats to paint an altarpiece for S. Stefano, completed in 1516 and now at S. Bartolommeo.

From the next years, spent mostly at Bergamo, date the London portrait of the della Torre brothers (1515); the "Susanna and the Elders" (1517) in the Contini collection, Florence; the Dresden "Madonna" (1518); the London portrait of the Prothonotary Giuliani (*c.* 1520) and the "Madonna and Two Saints" (1521); the Madrid "Bride and Bridegroom" (1523); the Berlin "Christ Taking Leave of His Mother" (1521) and the "Youth Against a Red Curtain" (*c.* 1525); the "Young Man in His Study" (*c.* 1524) at the Venice academy; numerous altarpieces in and near Bergamo, together with the fine series of frescoes in the Oratorio Suardi at Trescore, near Bergamo (1524), and the remarkable designs for the inlaid choir stalls in Sta. Maria Maggiore.

In 1526 or 1527 Lotto returned to Venice, where Titian ruled supreme in the world of art; and it was only natural that the example of the great master should have fired him to emulation. However, it was only a passing phase; even in the Carmine altarpiece of "St. Nicholas of Bari" (1529), which is his nearest approach to Titian, he retained his individualized, as opposed to Titian's generalized, expression of emotion. From the Venetian years 1526 to 1529 date the portraits "Andrea Odoni" at Hampton Court and "Bishop Tommaso Negri" at Split (both 1527); the so-called "Lucretia" at London, the "Man on a Terrace" at Cleveland and the "Man Holding a Claw" at Vienna (all *c.* 1527); the Recanati "Annunciation" and the Brescia "Adoration of the Shepherds" (*c.* 1528); and the strangely misnamed "Triumph of Chastity" at the Rospigliosi palace in Rome.

Among pictures executed between 1529 and 1540, chiefly in the Marches, are the Louvre "Christ and the Adulteress" (*c.* 1530); the "Youth Against a Green Curtain" (*c.* 1530) and the "St. Sebastian" and "St. Christopher" (1531) at Berlin; the "Crucifixion" (1531) at Monte San Giusto; the "Visitation" (*c.* 1530) and the "St. Lucy Altarpiece" (1532) at Jesi; the Bergamo "Holy Family and Catherine" (1533); male portraits at Villa Borghese (*c.* 1530) and Palazzo Doria (*c.* 1535) in Rome; the Uffizi "Madonna and Saints" (1534); and the monumental Cingoli "Madonna of the Rosary" (1539).

Between 1540 and 1548 Lotto was in Venice and Treviso and was once more influenced by Titian. Works of these years include the "St. Antonino Giving Alms" (1542), in SS. Giovanni e Paulo, and the "Madonna and Saints" (1546) in San Giacomo dell'Orio at Venice; the portraits of "Messer Febo da Brescia" and of "Madonna Laura da Pola" (1544) as well as the "Pietà" and the "Portrait of an Old Man" all in the Brera at Milan; the "Madonna and Saints" (*c.* 1546) in Sta. Maria della Piazza at Ancona; the "Family Group" (1547) in London; and the "Madonna in Glory" (1548) at Mogliano.

In 1549 Lotto went once again to the Marches where he painted the "Assumption" now in the Ancona museum. In 1550 he lost his voice and partly his eyesight. In 1554 he made over all his belongings to the Holy House at Loreto and began one of his most sensitive masterpieces, the "Presentation in the Temple," which remained unfinished at his death in the autumn of 1556.

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LOTTO: *see* BINGO.

LOTUKO (LATUKA, LOATUKO), a Nilo-Hamitic people of southern Sudan, living near Torit; they numbered about 30,000 in the 1960s and there were an additional 30,000 Lotuko-speaking people divided into many small, independent subtribes. Lotuko are agricultural and grow millet, maize, peanuts and tobacco; they also have many cattle. They are remarkable for their large, fortified villages, often with several hundred huts and divided into named quarters. They lack a centralized chieftaincy but recognize the rule of hereditary rainmakers, each of whom has ritual and political authority over one of the nine rain areas. There is also a number of exogamous, patrilineal, totemic clans with a distribution that is distinct from that of rain areas.

The rainmakers control an elaborate age-set system. There are annual initiation rites for males who have reached puberty; four such annual groups are together initiated into sets based upon a village; when this is completed all members are initiated into wider sets on a rain-area basis; every 16 years there is a last initiation that involves the lighting of a new fire by friction. Hereditary diviners who can counter witchcraft have considerable power. Lotuko believe in a supreme being, Naijok. *See* also AFRICA: *Ethnography (Anthropology)*: *Northeast Africa* and *East Africa;* EQUATORIA; NILO-HAMITES.

See G. W. B. Huntingford, *The Northern Nilo-Hamites* (1953).
(J. F. M. M.)

LOTUS, a popular name applied to several different plants. The lotus fruits of the Greeks belonged to *Zizyphus lotus,* a bush native in south Europe. It has large fruits containing a mealy substance that can be used for making bread and fermented drink. In ancient times the fruits were an article of food among the poor. A wine made from the fruit was thought to produce contentment and forgetfulness (hence the "Lotophagi" or lotus-eaters). *Zizyphus* is a member of the buckthorn family (Rhamnaceae).

The Egyptian lotus is a white water lily, *Nymphaea lotus*, as are the sacred lotus of the Hindus, *Nelumbium nelumbo*, and the American lotus, *N. pentapetalum* (or *Nelumbo luteum*). The lotus tree, known to the Romans as the Libyan lotus, was probably *Celtis australis*, the nettle tree (*q.v.*), a southern European tree, a member of the elm family, with fruits like small cherries, first red and then black.

PHOTO, J. HORACE MC FARLAND CO.

BLOSSOM AND SEED POD OF THE HINDU LOTUS (NELUMBIUM NELUMBO)

The *Lotus* of botanists is a genus of the pea family (Leguminosae), containing a large number of species of herbs and undershrubs widely distributed in the temperate regions of the old world. It is represented in Britain by *L. corniculatus*, bird's-foot trefoil, a low-growing herb, common in pastures and waste places, with clusters of small bright yellow pealike flowers, which are often streaked with crimson; the popular name is derived from the pods, which when ripe spread like the toes of a bird's foot. (X.)

Lotus in Decoration.—The lotus, through gradual conventionalization, became one of the most prolific ornamental forms. The flower itself is represented as a common votive offering and was frequently painted as though tied on to shrines or house pillars. The conventionalized form used in decorating the capitals (*q.v.*) of columns—the lotus bud capital and the late lotus flower capital—also served in various ways as a basis for borders and allover patterns. Two stylized varieties, the trilobe or three-leaved lotus and the lotus palmette (in which the flower is combined with a semicircle or semiellipse of radiating petals above it), were largely used by the Assyrians and all the peoples along the eastern shore of the Mediterranean. Thus the lotus is at the basis of such varying forms as the Assyrian sacred tree and those Phoenician stele capitals which were the parents of the Ionic order.

Lotus flower bud and palmette forms are also the origin of a great number of Greek, painted ceramic patterns and from them evolved into the eggs and dart and into the anthemion (*q.v.*). The Romans not only borrowed and modified these Greek lotus derivatives but also received further lotus forms from Etruscan art. Lotus derivatives, like many other Roman decorative motives, appear in modified form throughout Byzantine and Romanesque art. Lotus forms or derivatives are common even in the 20th century; thus their influence can be traced continuously back from modern times, through the Renaissance, medieval, Roman, Greek and western Asiatic work to its source in Egypt at least 5,000 years ago. (T. F. H.)

Lotus as a Symbol.—The earliest attested use of the lotus as a symbol is doubtless in Egypt, but it is symbolically important throughout the greater part of Asia, particularly in countries of Hindu and Buddhist obedience. Fundamentally the lotus symbolizes fertility, and its other meanings seem to stem from this aspect. Hence, the lotus as a seat for divinities emphasizes their generative force. In India, for example, the lotus is identified with Lakshmi, the wife of Vishnu and a form of the Mother Goddess, associated with prosperity. In Buddhism the lotus throne stands for purity and divine birth. Like the lotus, which germinates under the water and arises to the surface to unfold, so too the Buddha is born in the impure world but through his enlightenment rises above it. In Egypt divinized dead were believed to be reborn from lotus flowers, henceforth belonging to the world of the gods. Tantric Buddhism emphasizes a sexual symbolism; the lotus stands for the feminine, hence generative, principle through which, in union with the masculine principle represented by the thunderbolt (*vajra*), the phenomenal world comes into being. The ancient notion of fertility persists in Japan, where eating the lotus flower or stalk is popularly thought to promote human fecundity.

The lotus also symbolizes the sun. In Egypt it stood for Horus as ruler of the sky. Hiding its flower at night and opening with the first morning rays, the lotus naturally suggested itself as a symbol for Nefertem, the god who personified the rising sun and who supposedly emerged from a lotus every morning and retired into it every night. In Buddhism the fully open lotus preserves a strong solar character, its leaves being obviously identifiable with the rays of the sun, its stem being a kind of sacred cosmic pivot. (E. D. S.)

LOTUS-EATERS (LOTOPHAGI), a people encountered by Odysseus in the journey recounted in the *Odyssey*. They lived on a plant called *lotos*, which they offered to Odysseus' men. Those who ate of it forgot home and friends and wanted only to remain there and eat of that food.

It should be plain enough that the lotus-eaters and their country are situated in fairyland, but in addition to interpreting the story allegorically, many ancient scholars amused themselves by trying to identify them with some people of northern Africa, since that continent produces one or two edible plants called *lotos* by the Greeks. This foolishness has been imitated by some moderns.

The phrase "to eat lotus" is used metaphorically by numerous ancient writers to mean "to forget," "to be unmindful."

See HOMER; ODYSSEUS.

LOTZE, RUDOLF HERMANN (1817–1881), German philosopher who bridged the gap between classical German philosophy and 20th-century idealism, was born at Bautzen, on May 21, 1817, the son of a physician. After studies in the *Gymnasium* of Zittau he entered the University of Leipzig in 1834. Four years later he gained doctorates of philosophy and of medicine.

Lotze's studies were governed by two distinct interests. The first was scientific, based upon mathematical and physical studies under the guidance of E. H. Weber, W. Volckmann and G. T. Fechner. The second was his aesthetical and artistic interest, which was developed under C. H. Weisse. His vocation then seemed to be the reconciliation of science with art, literature and religion; and hence the central point of his philosophy has been described as an analysis of the concept of the mechanism of nature with the object of proving that this concept necessarily leads to the assumption of an ideal principle of existence. While a lecturer at Leipzig he published two short works, his *Metaphysik* (1841) and his *Logik* (1843), which laid the foundation of his system. In 1844 he was appointed professor of philosophy at Göttingen, where he remained until 1881. During this period he produced his most important works.

The first of Lotze's works to attract attention were articles contributed to Rudolf Wagner's *Handwörterbuch der Physiologie* in which Lotze combated the then current vitalistic theories. He first became generally known through his *Allgemeine Pathologie und Therapie als mechanische Naturwissenschaften* (1842; 2nd ed., 1848). To the same period belong his more systematic *Allgemeine Physiologie des körperlichen Lebens* (1851) and his *Medizinische Psychologie oder Physiologie der Seele* (1852). Notwithstanding the idealistic position adopted in his earlier works, his polemic against vitalistic theories led him to be regarded as a materialist, and to correct this misinterpretation he published his *Streitschriften* (1857).

In 1856 Lotze had published the first volume of his chief work, the *Mikrokosmus*, the second volume of which appeared in 1858 and the third in 1864. This contained a comprehensive account of his philosophical views. In 1868 he published his *Geschichte der Aesthetik in Deutschland*. He then planned to set out in three further volumes a more systematic account of his philosophy as a whole. The first of these, *Logik*, appeared in 1874 (2nd ed., 1880), the second, *Metaphysik*, in 1879. The third, dealing with practical philosophy, art and religion, was uncompleted at Lotze's death, which took place on July 1, 1881, a few months after he had moved from Göttingen to the chair of philosophy at Berlin.

Lotze belongs to the earliest phase of the transition from a conception of philosophy which claims or assumes that by deductive reasoning or reflection discoveries can be made about the nature of the universe to the view that philosophy is concerned only with the analysis and clarification of concepts. Though influenced

in his early studies by Fichte, Schelling and Hegel, Lotze came to reject the methodology of these philosophers and more especially the dialectical method of Hegel. But neither in the method nor in the content of his philosophy did he differ so widely from his predecessors as he himself believed. Though rejecting dialectical methods, he relied upon reflection to defend hypotheses concerning the nature of reality which cannot be presented as self-evident or as evidenced by scientific observation. His conclusions were in accord with the idealist tradition. He believed that all that appears to us must be conceived as a reality, the nature of which must be construed as akin to our own nature and our own mental life. He held that this ultimate reality is an infinite divine being, within which finite individuals act and live.

More distinctive were Lotze's views concerning mechanism and teleology. He opposed the prevailing doctrine that mechanical laws apply only to inorganic matter and that processes in living things are determined by final causes and vital forces. His contention was that the laws that govern particles of matter in the inorganic world governed these particles also when they were combined in a living body. But he also rejected the view still widely assumed that explanations in terms of efficient causes and explanations in terms of final causes are alternative and incompatible. He held that mechanism is the instrument of purpose—that we explain why a living thing does what it does in terms of ends and how it does what it does in mechanistic terms. (This conception of the relation of mechanism and teleology later derived support from biological studies of directed behaviour and from the work of cyberneticians, who constructed mechanisms which behave like goal-directed living things; *see* CYBERNETICS.) Lotze argued that God in creating and maintaining the world and in attaining his ends does so entirely through the laws disclosed by the natural sciences.

As professor of philosophy at Göttingen, where he followed Herbart and was followed by G. E. Müller, Lotze takes his place in a distinguished succession of philosophers who influenced the development of psychology as an independent science. His *Medizinische Psychologie* was the prototype of the many physiological psychologies which were to follow. His doctrine of "local signs" still receives attention from students of the theory of space perception. Retaining the doctrine of the soul, he attempted a more detailed analysis than had hitherto been attempted of the phases through which physical stimulation generates sensation and other experiences.

His interest in art and in morals and the biological approach necessary to the study of medicine combined to lead him to place special emphasis upon feeling and emotion. His contributions to the philosophy of mind and to psychology distinguish him both from the rationalist philosophers and from the intellectualist, sensationist and associationist psychologists. His influence was to be reinforced by other developments in biology, notably the Darwinian theory of evolution.

Lotze's influence upon the development of experimental psychology was mainly through his pupils and disciples such as C. Stumpf and G. E. Müller. His psychological doctrines were interpreted by James Ward in Great Britain and by George T. Ladd in the United States. Each occupied in his own country a position similar to that of Lotze in Germany, and both played a significant part in the transition of psychology from being a philosophy of mind to being the study of its natural history.

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(C. A. MA.)

LOUBET, ÉMILE FRANÇOIS (1838–1929), 7th president of the French republic, was born on Dec. 31, 1838, the son of a farmer at Marsanne (Drôme). He practised at the Paris bar and in the crisis of 1870 backed Léon Gambetta's policy. He entered the chamber of deputies in 1876 and worked for the republican cause, especially for education, attacking the clerical system established by the *loi Falloux*, and working for the establishment of free, obligatory and secular primary instruction. Loubet entered the senate in 1885 and became minister of public works in the Tirard ministry (Dec. 1887–March 1888).

Forming his own ministry on Feb. 28, 1892, Loubet held the office of minister of the interior as well as the premiership, and so had to deal with the anarchist outrages and strikes of that year. His ministry fell in November over the Panama scandal, but for a short time Loubet continued to serve as minister of the interior under Alexandre Ribot. In 1896 he became president of the senate, in Feb. 1899 president of the republic.

Loubet's presidency was marked by three major crises. In June 1899 he summoned René Waldeck-Rousseau to form a ministry to settle the Dreyfus case and appealed to republicans of all shades to rally behind it. (*See* DREYFUS, ALFRED.) Acting on the advice of Gen. Gaston Galliffet, minister of war, Loubet eventually remitted the sentence passed on Dreyfus at Rennes. Secondly, friction between France and the Vatican intensified after Pius X became pope (Aug. 1903). It reached its height in March 1904 when Pius protested against Loubet's official visit to the king of Italy in Rome. Under Émile Combes anticlericalist policies triumphed, and in 1905 church and state were separated amid violent controversy.

International tensions also reached their height, but frictions with Great Britain were satisfactorily ended by the Anglo-French entente of 1904. Loubet's tough peasant qualities, combined with a genial simplicity and an unaffected dignity, enabled him to fulfill with success one of the most exacting presidencies of the third republic. After his term of office ended in Feb. 1906 he retired to private life, and died at Montélimar on Dec. 20, 1929.

See A. Combarieu, *Sept ans à l'Élysée avec le Président Émile Loubet* (1932). (D. TN.)

LOUD-SPEAKER (SPEAKER), a device for converting electrical into acoustical signal energy that is radiated into a room or open air. The term "signal energy" indicates that the electrical energy has a specific form such as that corresponding to a speech or music signal. The speaker should preserve the essential character of this signal energy in converting the energy from electrical to acoustical form. This definition of a loud-speaker excludes such devices as buzzers, gongs, sirens and the like in which the acoustical signal does not correspond in form to the electrical signal. The part of the speaker that converts electrical into mechanical energy is frequently called the motor. The motor vibrates an element called the diaphragm that in turn vibrates the air in immediate contact with it. This vibration results in slight pressure changes in the air above and below atmospheric pressure. These pressure changes are transmitted into the room or open air as a sound wave (*see* SOUND).

Kinds.—Speakers are conveniently classified by the kind of motor employed to convert the electrical into mechanical energy. Common types are the moving coil or "dynamic," and the magnetic armature or "magnetic." Less common are the piezoelectric or crystal, and electrostatic or condenser types. The moving-coil and magnetic-armature types are both technically defined as magnetic types because the mechanical forces result from the interaction of a steady magnetic field and a magnetic field produced by the electrical current. In the moving-coil motor the signal current passes through a coiled conductor and produces a varying magnetic field that interacts with a steady field. This interaction results in a force that moves the coil, which in turn moves the attached diaphragm. The strength or magnitude of the force is proportional to the strength of the current. In the magnetic-armature type the signal current passes through a fixed coil that induces a magnetic field in a movable element of magnetic material called the armature. Speakers using the latter motor are popularly called "magnetic." Those using moving-coil motors, particularly when they are of the large direct-acting diaphragm type, are popularly called "dynamic." The fixed magnetic field required by magnetic speakers may be supplied by a permanent magnet or by an electro-

magnet. The term "electrodynamic" is said to have been applied originally to early commercial versions of moving-coil speakers. The prefix "electro" had no bearing on the source of the fixed or steady magnetic field supplied by either electromagnets or permanent magnets.

In piezoelectric or crystal speakers the force produced by a crystal having piezoelectric properties moves the diaphragm. In electrostatic or condenser speakers a very light conducting diaphragm is used as one electrode of a condenser or capacitor and is suspended so that it vibrates freely. The fixed electrode (or electrodes) is closely spaced from the moving one. Both of these types have had limited application because of their relatively low conversion efficiency and power output limitations at low frequencies.

Alternatively speakers are classified as horn, and hornless or direct-radiator types. A horn speaker has a horn attached to a relatively small diaphragm. The large or mouth end of the horn behaves as a large lightweight diaphragm that radiates sound more efficiently than the small diaphragm. The horn proportions, including the rate of area expansion or flare, are selected to give the desired compromise between efficiency, frequency response, directional properties and size. To reproduce low frequencies the rate of expansion or flare must be small, necessitating a long horn, and the mouth must be large. Low-frequency horns are therefore large. High-frequency horns are small and are often used as the high-frequency speakers in multispeaker systems. Horn speakers may be made quite efficient. They are therefore primarily used where efficiency and high acoustic power output are important and size less important.

In the direct-radiator or hornless speakers the diaphragm is made large enough to radiate directly into unconfined air. To prevent the low-frequency front and back waves from interfering or neutralizing each other, a rigid surface or baffle must be interposed as an extension of the diaphragm support. This extension may take the form of an open-back box or cabinet, a totally enclosed box, a box closed except for a vent or port, or a conduit or duct which may be folded. The open cabinet is commonly employed in radio and television receivers. The closed box is lined with sound-absorbing material and is used when the radiation from an open back is objectionable. The closed box tends to give more uniform low-frequency response and is less influenced by proximity to a room wall but sacrifices some efficiency. The vented enclosure augments a portion of the low-frequency range. The "boomy" or excessively resonant low-frequency response present in some types arises primarily from the use of too small an enclosure and a speaker with excessive diaphragm support stiffness.

Development.—Historically the horn-type speaker first attained commercial success. The electrical signals generated by early radio receivers were very feeble, and a telephone receiver had to be held to the ear to obtain an audible signal. Because of their relatively widespread introduction in World War I, vacuum tubes or valves were rapidly incorporated in the radio set design of the postwar era. This practice made available the much greater electrical signal energy required to operate a speaker. Many early speakers consisted of a telephone receiver, sometimes slightly modified to accept the greater signal energy, to which a horn was attached. The horn improved the efficiency of the electrical-to-acoustical energy conversion process although at the expense of naturalness of reproduction. The need for greater electrical energy for speakers led to the development of more powerful tubes and these in turn permitted the use of less efficient but more natural sounding speakers. Magnetic-armature speakers employing large-area conical paper or cloth diaphragms were followed by the moving-coil or "dynamic" types employing moderate-size conical paper diaphragms. The latter are used almost universally in radio and television receivers because of their low cost, simple construction, frequency range and small size even when designed to reproduce relatively low frequencies. Their major disadvantage is low efficiency but this became of relatively little importance in view of the ease with which adequate signal energy could be obtained in receivers or amplifiers operated from external power sources.

Design Problems.—The major speaker-design problems arise from the frequency range to be produced and the need for attaining adequate efficiency. Other factors such as uniformity of response with frequency, uniform directivity or spatial distribution of the emitted sound, linearity or proportionality of the acoustic output and electrical input over the necessary signal-intensity range must also be considered. An ideal speaker would be capable of faithfully reproducing at least any sound the human ear can hear. This range involves sound intensities differing by a factor of more than 10,000,000,000,000, frequencies from about 20 to 20,000 cycles per second and sounds varying rapidly in character. In practice these difficult requirements are modified by the limitations of the associated sound-reproducing system, by the infrequent occurrence and relative unimportance of certain sounds and by the tolerance or charitability of the ear. Background noise at the microphone and at the listener's location and electrical disturbances in the signal-transmission system limit the minimum speaker signal intensity that can be heard. The intensity of the louder common speech and music sounds is substantially below the maximum intensity the ear will tolerate without pain. These factors reduce the ratio of maximum to minimum intensity required of a complete sound-reproducing system, including speaker, to approximately 1,000,000 to 1—an attainable but not commonly realized value. These numerical values are large but psychological tests have shown that over much of the useful intensity range the intensity has to be increased by a factor of from five to ten for the listener to judge that the loudness has doubled. The ideal frequency range required of the speaker is also reduced by the noise that obscures or masks the very high and very low frequencies, which are difficult to hear. The infrequent occurrence of these extreme frequencies also reduces their importance. Consequently even a range from 40 to 15,000 cycles is useful primarily in experimental and controlled studio reproduction. A range from 80 to 8,000 cycles in an otherwise distortion-free system is capable of giving very realistic and emotionally satisfying reproduction.

The speaker should treat all frequencies alike. This requirement means uniform electrical-signal-to-sound conversion efficiency at all frequencies—a goal difficult to attain in a single speaker. In a high-quality speaker the change in efficiency with frequency will occur gradually and compensation may be provided for this in the electrical system. The speaker should also treat all frequencies alike for all listener locations. This requirement involves the factors of distance to the listener and angle between the principal axis of the speaker and the listener location. Outdoors and in large auditoriums the speakers are directed toward the more remote listeners to attempt to maintain the intensity in their region. It is hard to radiate all frequencies equally well toward each listener location. Radiation, interference, focusing and similar space effects in the sound field depend on the relation between the diaphragm size and shape and the length of the sound wave. The length of 8,000- and 80-cycle sound waves is 1.7 and 170 in. respectively (these vary inversely with frequency), a variance which accounts in large measure for the difficulty of obtaining uniform space distribution and radiation efficiency over the broad frequency range. When the sound wave is long compared to the maximum dimension of the horn mouth or exposed diaphragm the speaker is nondirectional. When the wave is very short there tends to be marked concentration of the sound in a narrow beam. This effect is reduced by subdividing a horn into a number of small horns or cells (which accounts for their designation as "cellular horns"), by the use of acoustical lenses and by special mouth shapes involving a narrow dimension that produces less concentration. In the case of large exposed or direct-radiating diaphragms the effect is reduced by providing concentric circular diaphragm segments that help confine the diaphragm vibration to the region near the apex at high frequencies, thereby reducing the effective diaphragm size and broadening the radiated beam. More uniform space distribution and conversion efficiency are also obtained by using two or more speakers, each covering a portion of the frequency range.

The acoustical environment of the speaker influences its performance. Both direct and reflected sound reach the listener. In small rooms the reflected sound may markedly influence the speaker performance and what the listener hears. Much poor low-

frequency performance attributed to speakers actually arises because a small room has few low resonant frequencies and these are widely separated in frequency. Consequently the speaker can transmit sound energy efficiently through the room to the listener only in narrow low-frequency bands.

See also HIGH-FIDELITY SOUND SYSTEMS.

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LOUGHBOROUGH, a municipal borough (1888) in the Loughborough parliamentary division of Leicestershire, Eng., near the Soar river and on the Loughborough canal, 11 mi. N.N.W. of Leicester by road. Pop. (1961) 38,621. There was a settlement there before the Roman invasion, but evidence of the Roman occupation is scanty. In Saxon times Loughborough was becoming a place of some size, and later reference is made to the township in Domesday Book. Grants for markets and fairs were made in the 13th century, when the wool trade was an important feature of the district. Lacemaking later became the chief industry, but when the machines of John Heathcoat (*q.v.*) were destroyed by the Luddites the industry lost much of its importance.

The town is a marketing centre in a large and fertile agricultural district, lying to the east of Charnwood forest. The town hall and corn exchange (1855) stand prominently in the market place. Loughborough's principal industries are electrical engineering, bell founding and the manufacture of hosiery, lifting machinery and pharmaceutical goods.

Loughborough is an educational centre, Loughborough College of Technology being of wide repute, while the Training college is the largest in the country for men schoolteachers; there are also colleges of further education and art. The grammar school was founded by Thomas Burton, a wool merchant, in 1495. He and the Taylors, who established the bell-founding industry, are commemorated in the parish church. The memorial for World Wars I and II is a tower, with a carillon of 47 bells, which was built by public subscription and opened in 1923.

LOUGHREA (BAILE LOCHA RIACH), a market town of County Galway, Republic of Ireland, on the northern shore of Lough Rea, 116 mi. W. of Dublin by road. Pop. (1961) 2,784. There are slight remains of an Early English Carmelite friary, dating from about 1300. Loughrea is the seat of the Roman Catholic bishop of Clonfert, and has a cathedral built in 1900–05. A part of the castle of Richard de Burgh, founder of the friary, still survives, and there are traces of the town fortifications. In the neighbourhood are a cromlech, "souterrains" (underground passages and chambers) and two ruined towers. Crannogs (*q.v.*), or prehistoric stockaded islands, have been found in the lough.

LOUIS I THE PIOUS OR LE DÉBONNAIRE (778–840), Carolingian emperor from 813 to 833 (sole emperor from 814) and from 834 to 840, was the son of Charlemagne (*q.v.*) and of Hildegarde. His father made him king of Aquitaine in 781, to satisfy Aquitanian separatism, but in practice retained control long after Louis had grown up. Louis, however, was allowed considerable freedom in his measures to conquer and govern Catalonia. Having first attacked Barcelona in 801, he organized a large expedition, reinforced with troops sent by his father in spring 803, and this time took the town. He also carried out Charlemagne's plans for repopulating certain areas and for establishing new monasteries in Septimania and south of the Pyrenees and kept the Gascons in subjection. From time to time he joined his father's Italian and Saxon campaigns.

In his plan of 806 for dividing his territory between his three sons, Charlemagne left all southwestern Gaul in Louis' hands. Subsequently, however, the deaths of his two brothers (in 810 and 811) made Louis the sole possible heir to the imperial dignity, and Charlemagne crowned him at Aachen in Sept. 813. Louis assumed effective power on his father's death (Jan. 814). By his wife Irmingard (Ermengarde) he had three sons, later known as the emperor Lothair I, Pepin of Aquitaine and Louis the German.

Character and Policy of Louis.—The new emperor was very different from Charlemagne. He was a thinker rather than a warrior, and he applied the logic of his faith more consistently than any other member of the Carolingian dynasty. Unfortunate in having to succeed a personality so dominating, he was faced, moreover, with the consequences of many ill-considered judgments of his father's. Also, whereas Charlemagne had maintained order by sheer mastery, Louis sought by fair and upright dealing to enlist the co-operation of his subjects, but they mistook for weakness his anxiety to make his actions conform to the teachings of the church. For instance, the public penance which Louis imposed on himself and on his court at Attigny (822) to expiate the death of his nephew Bernard, king of Italy—whose blinding he had ordered in punishment for rebellion (818)—was regarded by contemporaries as an unwarrantable subjection of imperial to sacerdotal authority. Finally, Louis inherited from Charlemagne an ardent sensuality, which made him unduly dependent on his two successive wives.

The lay coronation of 813 was supplemented in Oct. 816 by a second ceremony, performed by Pope Stephen IV (V) at Reims. Louis was already showing that piety and preoccupation with Christian political theories which laid him open to the charge of excessive deference to the church. Even so, in his edicts of 816–817 and of 818 or 819, he forcibly imposed on the church a reform and reorganization of monasteries and dioceses that Charlemagne had never attempted. Likewise, in his *Ordinatio imperii* (817) he tried to reconcile the safeguarding of Christian order and unity with the old Frankish custom of partition and with regional separatisms within the empire. In this *Ordinatio* he planned the disposition of the empire: he would have no division of the imperial authority, which Lothair was to inherit, but he mapped out kingdoms for his other two sons. To spread Christianity he sent missions among the Scandinavians and the Slavs; and to establish contact with the latter he created the Bavarian march of Friuli.

Very few periods are more obscure and more diversely interpreted by historians than the years 825–830. Louis warned his subjects in 825 to make good their omissions in every sphere, and a thorough inquest conducted by *missi dominici* seemed to presage important reforms; but nothing further was done. It seems certain that the emperor was fully occupied in dealing with the intrigues of certain aristocratic families, some of them close to the crown. Among these were probably the relations by marriage of his sons Pepin and Lothair. The treason of Lothair's father-in-law, Hugh, count of Tours, and of Matfrid of Orléans, who had been sent to Spain with reinforcements in 827, shows that the balance established by Charlemagne between the crown and its delegate counts was shifting in the counts' favour.

The Period of Rebellions (830–840).—The empress Irmingard had died on Oct. 3, 818; and four months later Louis had married Judith of Bavaria, who in 823 bore him a son Charles (*see* CHARLES II the Bald). The emperor's attempts to provide this son with a patrimony were destined to provoke a series of internecine wars. At an assembly convened at Worms in 829 to deal with the problem of the counts Louis took the opportunity of endowing Charles with a kingdom carved out of the very heart of the empire. Lothair, who objected strongly, was sent off to Italy; and Bernard, previously governor of Septimania, now became Louis' chief counselor.

There followed an open struggle between the palace and a group of magnates who worked on the jealousies of Lothair and Pepin. A first revolt, in April 830, brought about the imprisonment of the empress at Poitiers, Bernard's flight and the restoration of Lothair's friends as royal counselors, but by the end of the year Louis had regained the upper hand. Judith was formally reinstated at court in Feb. 831, with the assent of her stepsons, who had abandoned their accomplices; and a fresh partition of territory was considered. By 833, however, Louis was being denounced on all sides, by prelates and exiled lay vassals alike, as having destroyed the unity of the empire which the *Ordinatio* of 817 had achieved. Lothair returned from Italy, having persuaded Pope Gregory IV to try to "convince" Louis that he should give place to an emperor better able "to maintain the unity of christendom." The rival parties came face to face on the Lügenfeld (Field of Lies), near Colmar in Alsace (June 833). Though Louis was still

supported by many of the clergy, the presence of the pope on the side of Irmingard's sons and the defection of leading prelates constrained him to yield. Lothair made him do a humiliating penance and renounce the throne.

A year later the three victors, having partitioned the Frankish lands, were at odds among themselves. Pepin and Louis turned against Lothair, the magnates were divided, the pope withdrew his support, and monastic opinion was for Louis. Louis and Judith were back on the throne at Easter 834. Lothair was once more exiled to Italy and his supporters punished, particularly the bishops. Thereafter there was relative calm for the rest of the reign, though in his lands in the east Louis the German remained in a state of constant revolt. After Pepin's death (838), Louis was able to persuade Lothair, in 839, that Charles should have Aquitaine. Even so Louis' death on June 30, 840, was the signal for the struggle between his sons to begin anew; and even before that time the Vikings had begun to attack the empire from without.

See L. Halphen, *Charlemagne et l'empire carolingien* (1947); H. Fichtenau, *Das Karolingische Imperium* (1949). (J. De.)

LOUIS II (822 or 824–875), Frankish emperor from 850, was the eldest son of the emperor Lothair I. Nominated in 839 by his grandfather, Louis I the Pious, to be his successor in Italy, he took over the administration there on his father's behalf in 844. Pope Sergius II crowned him king of the Lombards in Rome on June 15, 844; and Pope Leo IV crowned him emperor in Rome in April 850. From that time onward he ruled independently. When Lothair I's "Middle Realm" was divided in Sept. 855, Italy was definitely given to Louis; and after Lothair's death a few weeks later Louis was sole emperor. This dignity, however, now implied only rule over part of the Carolingian dominions, with no pre-eminence over the whole. Even so, Louis upheld his authority over Rome and kept good relations with the papacy, except for a short conflict with Nicholas I in 864 because the pope had annulled the divorce of his brother Lothair (II); and in 871 he stressed the legitimacy of his Western, truly Roman empire in a famous letter to the Byzantine emperor Basil I. Meanwhile after the death of his brother Charles in 863, he had added Provence to his dominion.

Louis II's most important task was the war against the Arabs, who raided Italy and had even surprised Rome in 846. He combined this with the old plan of the Lombard kings to extend their dominion also over the southern half of the peninsula and thus to unite all Italy. In 866 he began a great campaign which culminated, with the help of the Greek fleet, in the conquest of the Arab headquarters at Bari (Feb. 2, 871). Then, just when he seemed to be reaching his goal, Louis was made prisoner at Benevento by Duke Adelchis in Aug. 871. Though he was set free after a month and though he won another victory, near Capua in 872, his power and his energy no longer sufficed for a decisive blow against the Arabs. He gave up his hopes and withdrew to northern Italy, where he died near Brescia on Aug. 12, 875; he was buried in the church of S. Ambrose in Milan. As he had only a daughter, Irmingard, married to King Boso of Lower Burgundy, the elder male line of the Carolingian dynasty died out with him.

(T. Sch.)

LOUIS III THE BLIND (*c.* 880 or 882–928), Frankish emperor from 901 to 905, was a son of Boso, king of Provence or Lower Burgundy, and Irmingard, daughter of the emperor Louis II. The emperor Charles III the Fat took him under his protection on Boso's death in 887; but Louis was not recognized as king of Provence until 890, when Irmingard had secured the support of the East Frankish king Arnulf and of Pope Stephen V. In 900, he was called to Italy by a group of nobles in opposition to Berengar of Friuli: he crossed the Alps, was crowned king of the Lombards at Pavia in Oct. 900 and received the imperial crown from Pope Benedict IV at Rome in Feb. 901. He gained a temporary authority in northern Italy, but was soon compelled by Berengar to leave the country (902). In 904, however, he went again to Italy, where he secured the submission of Lombardy; but on July 21, 905, he was surprised at Verona by Berengar, who blinded him and sent him back to Provence, where he remained until his death. He married Adelaide, possibly a daughter of Rudolf I of Upper Burgundy. His son Charles Constantine, who succeeded only to the county of Vienne, was perhaps a bastard.

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LOUIS IV THE BAVARIAN (1282–1347), Holy Roman emperor—though with a controversial title—from 1328, also duke of Bavaria from 1294 and German king—as such reckoned sometimes as Louis V—from 1314, was born on April 1, 1282, probably in Munich, the second son of the Wittelsbach Louis II, duke of Upper Bavaria and count of the Rhenish Palatinate, and his consort Mechthild, daughter of the Habsburg German king Rudolf I.

The Wittelsbach Succession.—After his father's death (Feb. 2, 1294) Louis became joint ruler of Upper Bavaria and the Palatinate together with his elder brother Rudolf, though he remained in wardship till April 1, 1302. His brother, however, did not wish to share the government, and in the resultant quarrel Louis was helped by his Habsburg relatives, at whose court in Vienna he may have been educated; in the end he was granted the northwestern part of Upper Bavaria, with Ingolstadt as capital (Oct. 1, 1310). A new quarrel broke out over the wardship of the young dukes of Lower Bavaria, but this was ended by the peace of Munich (June 21, 1313), which again instituted common rulership by the two brothers. After that Louis fell out with his cousin and future rival, Frederick of Austria, who had also intervened in Lower Bavaria; Louis defeated him at Gammelsdorf, near Munich, on Nov. 9, 1313. In 1317 he made his brother resign his claims on Bavaria in return for an annual subsidy; but though Rudolf died on Aug. 13, 1319, differences between Louis and Rudolf's heirs were settled only by the compact of Pavia (Aug. 4, 1329), by which Louis granted to his nephews the Rhenish Palatinate and the Upper Palatinate (part of the northern Bavarian area, with its capital at Amberg). In 1340 when the ducal family of Lower Bavaria became extinct, Louis united Upper with Lower Bavaria.

The German Kingship.—Louis had already been a candidate for the German crown in 1308 after the assassination of King Albert I. After the death of Henry VII he was elected German king by five electors before the gates of Frankfurt on Oct. 20, 1314, thanks mainly to the support of the archbishops Baldwin of Trier and Peter Aspelt of Mainz against his rival Frederick of Austria (*see* FREDERICK III, German king). He was crowned at Aachen on Nov. 25, 1314, with false insignia by the archbishop of Mainz (who had no right to perform this ceremony). It was not until Sept. 28, 1322, that Frederick was finally defeated, in the battle of Mühldorf. Frederick was then imprisoned for three years in Trausnitz castle (in the Upper Palatinate), but even so Louis had to continue fighting against Frederick's brother Leopold till 1326. The plan whereby the two kings were to rule jointly did not prove feasible, and Frederick eventually limited himself to ruling Austria.

The Emperor and the Papacy.—After his victory at Mühldorf, Louis considered himself the rightful German king, with a consequent claim to the imperial dignity; and in 1323 he sent his marshal, Berthold von Neiffen, to Italy to safeguard the imperial rights. Pope John XXII, however, declared the German throne to be vacant. On Oct. 8, 1323, in Avignon, the pope accused Louis "the Bavarian" of having illegally assumed political rights; threatened him with excommunication if he did not resign the royal crown within three months; and for the meantime nominated King Robert of Naples as imperial vicar for Italy. Louis denied that papal approbation was required for the grant of the German crown, which could only be made by the German electors, and he appealed to a general council of the church. Despite the scruples of several cardinals, he was excommunicated by the pope on March 23, 1324, and deposed on July 11. Louis opposed this decision in several public appeals, in which he also hinted that the pope was a heretic.

In Jan. 1327 Louis marched to Italy; he was crowned in Milan as king of Lombardy on May 31, 1327, and as emperor in Rome by Sciarra Colonna and representatives of the Roman people on Jan. 17, 1328. This elevation to the imperial dignity without any

ecclesiastical participation was given theoretical justification by the Franciscans Marsilius (*q.v.*) of Padua and Jean de Jandun, who based all political power on the will of the people. Louis then set up the Franciscan, Pietro Rainalducci, as his antipope under the style of Nicholas V and launched an unsuccessful campaign against Robert of Naples. In Feb. 1330, however, he returned to Germany, after which Nicholas V submitted to the curia at Avignon.

Louis continued his war of propaganda against the Avignon papacy, mainly with the help of the learned leaders of the Franciscan Order, who at this time had their centre in Munich: namely the general of the Order, Michael of Cesena; the procurator, Bonagratia of Bergamo; and the head of the English province, William Ockham. Nevertheless Louis tried repeatedly to reach an understanding with the papacy, even offering his own abdication. After John XXII's death (Dec. 4, 1334), negotiations with his successor, the French Cistercian Benedict XII, proved promising at first, and Louis agreed to submit to a canonical suit of reconciliation; but the interference of Philip VI of France scotched this plan. Consequently Louis allied himself with Edward III of England against the common enemy, France.

The implacability of the curia finally provoked the German electors to take sides openly against the papacy at the assembly of Rhens (Rense, on the Rhine; July 16, 1338) in order to safeguard their electoral rights and the rights of the empire. At the diet of Frankfurt (Aug. 4, 1338) the decree *Licet juris* reaffirmed that the election to the German crown takes place without any participation of the papacy and establishes in itself a claim to the imperial dignity. In Sept. 1338 Edward III appeared at the diet of Coblenz; Louis recognized his claim to the French throne and made him vicar-general of the empire.

German public opinion, both among the laity and among the clergy, was now clearly on the side of Louis, but he did not exploit this favourable situation. Instead he broke off the alliance with Edward III at the beginning of 1341 (he had anyhow given him no help against France) and concluded an alliance with the French king, apparently hoping thus to achieve reconciliation with the curia. This did not come about, however, either with Benedict XII (who died in April 1342) or with his successor Clement VI, another Frenchman. The German princes too were changing their minds because of Louis' unscrupulous dynastic policy. His first wife Beatrice, daughter of the Silesian prince Henry III of Glogau (Glogow), having died in 1322, Louis had in 1324 married Margaret, daughter of Count William III and I of Holland and Hainaut; and when her brother William IV (II) died in 1345 in battle against the Frisians, Louis invested his wife with these counties. Similarly, when the heiress of Tirol, Margaret Maultasch, had driven her husband John Henry of Luxembourg out of her country (Nov. 1341), Louis annulled their marriage and married Margaret to his own son Louis, whom he had already invested with the margraviate of Brandenburg in 1324 (the Ascanian line of margraves having died out in 1320). Pope Clement VI could consequently exploit the anxiety of the German princes and, in particular, the resentment of the house of Luxembourg in order to obtain the election of John Henry's brother Charles of Moravia (*see* CHARLES IV, Holy Roman emperor) as antiking on July 11, 1346. Philip VI of France adhered to the Luxembourg faction, but he and Charles's father, King John of Bohemia, were defeated by Edward III at Crécy (Aug. 26, 1346). Thereupon Louis renewed negotiations with the English king; but he died on a bear hunt near Munich on Oct. 11, 1347. He was buried in Our Lady's church in Munich, but his body has disappeared; his tomb is a beautiful cenotaph of the 15th century.

Conclusions.—The emperor died undefeated, though he had had to fight for 33 years against ever new enemies and till 1338 practically without the support of the electoral princes. With no regard for his own person he consistently defended the right of the empire to elect a king independently of the papacy. His protection of the towns and his care for commerce and communications are quite remarkable. The Bavarian law code of 1333–34 was a valuable contribution to law and order, which he furthered also by trying to establish public peace throughout Germany. Yet he appeared inconsequent and irresolute because of his unfortunate choice of means with which to carry out his policy and because of his yielding, time and again, to changing influences.

See also references under "Louis IV" in the Index.

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(K. RE.)

LOUIS I (1786–1868), king of Bavaria from 1825 to 1848, was born on Aug. 25, 1786, in Strasbourg, the son of the future king of Bavaria, Maximilian I Joseph, and his consort Auguste of Hesse-Darmstadt. Against his inclination he saw service at Napoleon's headquarters in the campaigns of 1806–07 against Prussia and of 1809 against Austria. He objected to the Confederation of the Rhine and to Bavaria's alliance with France, which he regarded as treason against Germany. He also objected to his father's ecclesiastical policy, particularly to the secularization of the monasteries. For all these policies he blamed the leading Bavarian minister, Maximilian von Montgelas, in whose fall from power (Feb. 2, 1817) he played an active part. The Bavarian constitution promulgated in 1818 owed something to ideas that Louis had expressed when its draft was under consideration.

Because of his liberal tendencies and his emphatically German outlook, the accession of Louis to the throne was generally welcomed on his father's death (Oct. 13, 1825). Politically he did not fulfill his subjects' hopes. He soon came into conflict with the diet, and after the July revolution of 1830 in France he distrusted all democratic institutions. Up to 1837, however, the conciliatory minister for internal affairs, Ludwig, prince von Öttingen-Wallerstein, the king's personal friend, prevented the situation from worsening. Then, in 1837, a new ministry took office, under Karl von Abel, who had won the king's favour by promoting the restoration of the monasteries. Abel adopted a strictly reactionary and clericalist course, which lost the king many sympathies. Moreover, Louis I's lofty conception of royalty and his near-deafness made him more and more unyielding. Despite his strong German patriotism he made no move to change the unsatisfactory structure of the German confederation. His enthusiasm for Greece—where he traveled in 1835–36—made him promote the election of his second son to be king of Greece (*see* OTHO) in 1832. The difficulties caused by Abel's mistaken policies were further aggravated by the king's passion for the dancer Lola Montez, whom he created Gräfin Landsfeld. Eventually, on March 20, 1848, revolution broke out and Louis abdicated next day in favour of his son Maximilian II.

Louis I's real significance lay in his patronage of the arts. From his journeys as a crown prince to France and Italy he had already brought home valuable sculptures and portraits, which later formed the nucleus of the collections in the Glyptothek and the Pinakothek in Munich. As king he began the large-scale planning of Munich, whose present layout bears his stamp. L. Klenze and F. von Gaertner, his favourite architects, created the noble style of Munich classicism. Louis also united the royal collections of paintings under the guidance of G. von Dillis, enlarged them generously and commissioned Klenze to build the Alte Pinakothek as a suitable permanent home for them (1846–48). A series of representative buildings in Munich (Königsbau of the royal palace, Alte and Neue Pinakothek, Glyptothek, Propyläen, church of St. Boniface, the layout of Ludwigstrasse and Königsplatz, etc.) and in the country (Walhalla near Straubing, Hall of Liberation near Kehl) owe their existence to Louis. He also moved the Bavarian university from Landshut to Munich in 1826.

Louis died in Nice on Feb. 29, 1868. By his marriage (1810) with Therese of Saxe-Hildburghausen he had four sons (Maximilian II of Bavaria; Otho of Greece; the future regent Luitpold of Bavaria; and Adalbert) and four daughters.

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A. Thies, *König Ludwig I. und die Schönheiten seiner Galerie* (1954). (K. O. v. A.)

LOUIS II (1845–1886), king of Bavaria from 1864, was born at Nymphenburg on Aug. 25, 1845, the son of Maximilian II and his consort Marie of Prussia. On March 10, 1864, at his father's death, he succeeded to the throne, just when he was about to begin his university studies. His first difficulties and disappointments were caused by his romantically enthusiastic relations with the composer Richard Wagner, whom he called to Munich in 1864. He paid Wagner's debts and became utterly absorbed in his plans. This friendship with Wagner provoked strong objections both from the government and from the population. Rumours to the effect that Wagner exerted influence over politics and Wagner's own improprieties accentuated the conflict, so that in Dec. 1865 Louis had to expel him from the country, although he was always to remain his friend and patron.

In the Seven Weeks' War of 1866 Bavaria, on the advice of the prime minister Ludwig von der Pfordten, took Austria's side. After the defeat Louis appointed as prime minister Chlodwig, prince von Hohenlohe-Schillingsfürst, to whose abilities Wagner had drawn his attention. Hohenlohe, with Louis' approbation, conducted a policy that loyally fulfilled the obligations of the Prussian alliance of 1867 and resisted all attempts by the French emperor Napoleon III to win Bavaria over to his side, but at the same time safeguarded Bavaria's rights of sovereignty against Prussian encroachments. After the French declaration of war against Prussia in 1870 Louis at once joined Prussia's side; and in December he let himself be persuaded by Bismarck to address a letter to the German princes and free cities suggesting that they form a German empire with a German emperor. Though Bavaria obtained a number of special rights within this empire, the king's demands for increase of territory and for the alternation of the imperial title between the Bavarian and Prussian dynasties remained unfulfilled.

Louis was not satisfied with the solution of the German question and was mortified by the patriotic enthusiasm of the Bavarian population. His ministers' resistance to his wish to improve the position of the Roman Catholic Church was a further disappointment for him. Also his romantic ideas of royalty clashed with the limits set by the constitution. Consequently the king retired more and more into his dreams: only rarely could his ministers obtain an audience. From 1882 onward his seclusion from the world became increasingly morbid. His patronage of the arts finally developed into a romantic mania for building: in Herrenchiemsee he created a copy of Versailles which was never entirely completed (1878–85); the castles of Linderhof (1869–78) and Neuschwanstein (1869–86) were completed; the plans for another castle at Falkenstein and for a Byzantine palace remained on paper. Finally, he was declared insane because of advanced paranoia, and on June 10, 1886, his uncle, Prince Luitpold, assumed the regency. The proceedings of the state commission that visited Neuschwanstein on that day were, however, shamefully tactless. Louis was taken to Berg, on Lake Starnberg, by the psychiatrist Bernhard von Gudden. There, on June 13, 1886, he drowned himself, and Gudden, too, lost his life in an attempt to save him.

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(K. O. v. A.)

LOUIS III (1845–1921), king of Bavaria from 1913 to 1918, was born in Munich on Jan. 7, 1845, the son of the future regent Luitpold. He was badly wounded in the Seven Weeks' War (1866). In 1868 he married Maria Theresa, daughter of the archduke Ferdinand of Austria-Este. In Dec. 1912, on his father's death, he took over the regency for the insane King Otto, but on Nov. 5, 1913, he assumed the royal title himself. Louis was interested chiefly in agriculture and transport, but also continued the traditional Wittelsbach patronage of the arts. In World War I he showed no initiative whatever, though from 1917 he was convinced that Erich Ludendorff's policies would prove to be erroneous. The Bavarian revolution of Nov. 7–8, 1918, took him completely by surprise. Though he did not abdicate he released his officials and officers of their oath of loyalty on Nov. 13, 1918. An embittered man, he died on Oct. 18, 1921, at Sarvar in Hungary.
(K. O. v. A.)

LOUIS the German (*c.* 806–876), king of the East Franks from 843, was the third son of the Carolingian emperor Louis I (*q.v.*) the Pious. At the partition of the empire in 817, he received Bavaria, which remained the core of his kingdom, with its centre at Regensburg. He began his rule in 826 and married Emma (d. 876), daughter of Count Welf and sister of his stepmother Judith in 827. Louis took part in the revolts against his father (830–833) and joined with his half brother Charles the Bald in opposing the claim of Lothair I (*q.v.*) to imperial suzerainty over the whole empire after the death of their father in 840. Louis and Charles defeated Lothair at Fontenoy (June 25, 841) and confirmed their alliance by the oaths of Strasbourg (Feb. 14, 842), famous as early records of the Romance and Germanic languages. The treaty of Verdun (843) gave Louis all lands east of the Rhine except Friesland, together with Speyer, Worms and Mainz west of the Rhine. He thus obtained the East Frankish empire, comprising territory of the Franconians, the Swabians, the Bavarians and the Saxons, which was in the course of time to become Germany.

At the time, the division of 843 was not held to be final. The opponents of Charles the Bald, now king of the West Franks, appealed to Louis for help, and he sent his son Louis (*q.v.*) the Younger with an army to Aquitaine in 854 and went himself to the west, with the intention of deposing Charles, in 858. Both expeditions, however, were unsuccessful, and at the peace of Coblenz (June 7, 860) Louis renounced his claims. When his nephew Lothair (*q.v.*) of Lotharingia wanted to divorce his wife, Louis at first supported him in return for a promise of the cession of Alsace (860); but in 865 he made a treaty with Charles and in 867 they envisaged a division of Lothair's kingdom. After Lothair's death (869) Charles claimed all Lotharingia, but at the treaty of Mersen (Meerssen), in 870, Louis insisted on a division following roughly the course of the Meuse river. Not yet thinking in terms of a permanent East Frankish realm, Louis in 865 and 872 divided the country between his sons Carloman, Louis the Younger and Charles III the Fat. Internal quarrels as well as discontent at the partitions led to revolts by one or another of the sons in the period 861–873, but these were no serious danger to the realm.

Louis the German's kingdom was also free of grave danger from abroad. The sack of Hamburg in 845 was the only damaging raid by the Northmen. The most important problem in foreign affairs was posed by the long frontier with the Slavs, which was also the frontier of Western Christian civilization. In the north Louis contented himself with minor defensive expeditions, especially against the Obodrites and Sorbs; his main interest was directed toward Bohemia and Moravia, where he also supported the Christian missions. These, however, did not make much progress among the Czechs, though 14 nobles were baptized at Regensburg in 845. Moravia was given by Louis as a fief to the Christian noble Rastislav in 846, but the latter revolted in 855 and called the Greek missionaries Cyril and Methodius into his country (862–863), thus counteracting the Frankish Catholic influence. In 870 Rastislav was deposed by his nephew Svatopluk (Zwentibold), whose victorious war against Louis enabled him to found the kingdom of Greater Moravia and to achieve independence at the peace of Forchheim (874), even though he had to pay tribute to Louis.

Louis was unsuccessful in his endeavour to gain the imperial dignity and the succession in Italy for his line after the death of his nephew the emperor Louis II. The empress Angilberga in 872 and Louis II in 874 had declared in favour of Carloman, Louis the German's eldest son; but when Louis II died (Aug. 12, 875) Charles the Bald had himself crowned by Pope John VIII (Christmas 875). Louis the German was preparing for war against Charles when he died, at Frankfurt, on Aug. 28, 876. He is buried at Lorsch.

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(T. Sch.)

LOUIS THE YOUNGER (*c.* 830–882), king of part of the East Frankish realm, was the second son of the Carolingian Louis (*q.v.*) the German and his Welf wife Emma. He was married to Liutgard (d. 885), daughter of the Saxon noble Liudolf, ancestor of the Liudolfing dynasty. He invaded Aquitaine unsuccessfully in 854, on his father's orders. According to the arrangements of 865 and 872, he received Franconia, Thuringia and Saxony after his father's death (876). His victory at Andernach over the West Frankish king and emperor Charles the Bald (Oct. 8, 876) assured him the possession of eastern Lotharingia, which the treaty of Mersen (Meerssen) of 870 had assigned to the Eastern kingdom. By intervening in West Frankish affairs he acquired also western Lotharingia through the treaties of Verdun (879) and Ribémont (880). He died in Frankfurt on Jan. 20, 882, and is buried at Lorsch.

See E. Dümmler, *Geschichte des Ostfränkischen Reiches,* vol. 2–3, 2nd ed. (1887–88); P. Kehr, *Die Kanzleien Karlmanns und Ludwigs des Jüngeren* (1933). (T. SCH.)

LOUIS THE CHILD (893–911), East Frankish king from 900, was born at Altötting in Bavaria, the son of King Arnulf and his wife Ota. Declared heir to the kingdom in 897 and, after Arnulf's death, crowned king at Forchheim on Feb. 4, 900, he also received the allegiance of the Lotharingians after the death (Aug. 900) of his half-brother Zwentibold, who had ruled Lotharingia from 895. In theory the boy king was himself the ruler, in fact the government was exercised by Archbishop Hatto I (*q.v.*) of Mainz. The kingdom was too weak to stop the raids of the Magyars, more and more frequent from 900: they defeated the Bavarians at Bratislava on July 4, 907, and the king's army near Augsburg in Aug. 910. Bavaria, Franconia, Swabia and Saxony all fell under the sway of local aristocrats, the ancestors of the later ducal dynasties. Louis died on Sept. 24, 911; he is buried near Regensburg. He was the last of the East Frankish Carolingians.

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LOUIS I, king of France: *see* LOUIS I the Pious, Carolingian emperor.

LOUIS II LE BÈGUE OR THE STAMMERER (846–879), king of France (*i.e.,* Francia Occidentalis, the West Frankish kingdom) from 877 to 879, was the son of Charles II the Bald and of Ermentrude. After the death of his younger brother Charles (866), he was made king of Aquitaine but remained under his father's tutelage.

Elected king in Dec. 877, after his father's death, Louis provoked almost immediate opposition from the magnates by attempting to redistribute the great offices of state and had to abandon his plans. Pope John VIII, who held a council at Troyes (878), quickly saw that he could hope for no assistance from this ailing king. In the same year Louis agreed with his cousin, Louis the Younger, ruler of the East Frankish kingdom, to maintain the division of Lotharingia, arranged by their respective fathers in the treaty of Mersen (870). Louis II, who had been ill for some months, died at Compiègne on April 10, 879.

See L. Halphen, *Charlemagne et l'empire carolingien* (1947). (J. DE.)

LOUIS III (*c.* 863–882), king of France (*i.e.,* Francia Occidentalis, the West Frankish kingdom), from 879 to 882, was a son of Louis II le Bègue. He and his brother Carloman succeeded to the throne on their father's death in April 879; but the legitimacy of the two young kings was questioned, and Louis the Younger, ruler of the East Frankish kingdom, invited by the West Frankish nobles, twice attacked their kingdom and was bought off only by the grant of that part of Lotharingia which Charles the Bald had acquired in 870.

Louis III ruled northern France from the channel to the Loire. He took part in the concerted Carolingian campaign against the usurper Boso of Provence in 880–881. For himself he won a brilliant victory over the Normans at Saucourt in Aug. 881 and freed the Loire from another Norman incursion in 882. He died, after an accident, on Aug. 5, 882.

See E. Dümmler, *Geschichte des Ostfränkischen Reiches,* 2nd ed. (1887–88); L. Halphen, *Charlemagne et l'empire carolingien* (1947). (J. DE.)

LOUIS IV D'OUTREMER OR FROM OVERSEA (921–954), king of France from 936 to 954, was the son of Charles III the Simple and of Eadgifu, daughter of the Anglo-Saxon king Edward the Elder. When his father was imprisoned (923) Louis was taken to England, and he remained there until he was summoned back to France by Hugh (*q.v.*) the Great. Elected king in June 936, he surprised the factions that had hoped to exploit him by his forceful policy. He showed his independence of Hugh by moving from Paris to Laon and by choosing as his chancellor not Hugh but Archbishop Artaud of Reims. He intended, moreover, to recover the alienated properties of the crown. To counterbalance the immense power in Neustria of Hugh the Great and Herbert of Vermandois, he tried to build up a strong base in the east. He reconquered key positions on the Meuse, but his attempt to take control of Lotharingia by accepting the homage of its duke Giselbert in 939 brought the German king Otto I, Hugh and many of his vassals into coalition against him. After Giselbert's death Louis married his widow Gerberga, who was also Otto's sister, but Otto recovered Lotharingia. In Nov. 942 the two kings made the peace of Vise, whereupon Hugh had to submit.

Meanwhile, perhaps in accordance with a plan to set up ecclesiastical feudatories in opposition to the secular vassals, Louis had in 940 given the county of Reims to Artaud. This provoked an attack on Reims by many of the magnates; Louis lost the town and Artaud fled. However, a tour of Aquitaine and southeastern France (941) elicited support for Louis in those areas; and William Long-Sword, duke of Normandy, did homage to him. When the Normans invaded Brittany after the accession of William's young son Richard I (942), Louis cleverly involved Hugh, who had wanted to stir up trouble, in his intervention against them; but in the summer of 945 he was captured by treachery and handed over to Hugh's power. He had to buy his freedom with the cession of Laon. Then Otto came to his aid; together they recaptured Reims, Artaud was restored as archbishop, and Hugh was excommunicated at the synod of Ingelheim (948), which condemned all attempts against the king's authority. When Louis died at Reims on Sept. 10, 954, few of his projects had been realized, but the succession of his son Lothair was assured.

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LOUIS V LE FAINÉANT OR DO-NOTHING (967–987), king of France, sole ruler from 986 to 987, was crowned on June 8, 979, during the lifetime of his father Lothair. Shortly afterward he was married to Adelaide, widow of an Aquitanian count, and established as king in Aquitaine; but his frivolity and his abandonment of his wife, who finally ran away, brought him into discredit. Sole king on his father's death (March 986), Louis disregarded the advice of his mother, Queen Emma, and Archbishop Adalberon of Reims, who wanted him to come to terms with the German king Otto III; instead, he sought the aid of Hugh Capet (*q.v.*) against Otto. Hugh, however, would not commit himself. Louis had just begun military operations and a lawsuit against Adalberon when he died, as a result of a hunting accident, on May 21 or 22, 987. He was the last Carolingian king of France, as Hugh Capet was chosen to succeed him instead of his unpopular uncle, Charles of Lower Lorraine, the only surviving member of the dynasty.

See L. Halphen and F. Lot (ed.), *Recueil des actes de Lothaire et de Louis V* (1908); F. Lot, *Les Derniers carolingiens* (1891). (J. DE.)

LOUIS VI LE GROS OR THE FAT (1081–1137), king of France, was the son of Philip I and Bertha of Holland. Associated with his father as king elect from *c.* 1098, he succeeded to the crown on Philip's death (1108). He married Adelaide of Savoy *c.* 1115.

Louis VI was the first among the Capetians to appreciate and to take in hand the basic problem confronting the dynasty, that of enforcing order within the royal domain. To assure safe travel,

particularly along the route from Paris to Orléans, Louis waged relentless war against the pillaging lords of the Île de France, men such as Hughes du Puiset (1109 and 1118), Hughes de Crécy (1118) and Thomas de Marle, whose stronghold of Coucy (*q.v.*) he finally captured in 1130. During the same period he was engaged in a series of wars (1109–13 and 1116–20) against Henry I of England, who had captured his own eldest brother Robert in 1106 and so had become effective master of Normandy. Though worsted in these wars, Louis continued to support Robert's son, William Clito, to whom he gave the county of Flanders in 1127, after the murder of Count Charles the Good (the Flemings, however, supported a rival candidate, Thierry of Alsace, who became count after William's death in 1128). When the Holy Roman emperor Henry V invaded France in alliance with the English king, in 1124, all the great vassals rallied to Louis and the emperor retreated. In all these campaigns Louis led his armies in person, gaining a great reputation as a warrior.

Louis gave some encouragement to the growth of communes—preferably, however, in towns on his vassals' lands and only rarely to towns in the royal domain. In his own territory he created privileged rural communities, such as that of Lorris-en-Gâtinais, aiming to attract the peasants to work in them. He established good relations with the clergy, protecting ecclesiastical property from the attacks of brigand lords; and he supported the reforming work of the Cistercians and Premonstratensians. His principal counselors were likewise ecclesiastics: namely Étienne de Garlande (the most powerful member of a family much favoured by Louis), who became his chancellor; and Suger (*q.v.*), abbot of St. Denis, his most trusted and influential minister after Étienne had fallen into disfavour (1124) and who became his biographer. When Louis died, on Aug. 1, 1137, he had just effected the marriage between his heir, Louis VII, and Eleanor, heiress of Aquitaine.

Bibliography.—A. Luchaire, *Louis VI le Gros; annales de sa vie et de son règne, 1081–1137* (1890); E. Lavisse, *Histoire de France*, vol. ii (1901); Suger, *Vita Ludovici regis*, ed. by H. Waquet as *Vie de Louis VI le Gros* (1929). (M. Pac.)

LOUIS VII le Jeune or the Young (*c.* 1120–1180), king of France as sole ruler from 1137, was the son of Louis VI and Adelaide of Savoy. He was associated with the throne and crowned king in 1131 after the death of his elder brother Philip. He married Eleanor (*q.v.*), heiress of Aquitaine, in July 1137 and began his effective reign upon his father's death a few days later. His desire to appoint to the archbishopric of Bourges one of his chaplains, Cadurc, instead of Pierre de La Châtre, the canonically elected candidate, brought him into serious conflict not only with the Holy See but also with Thibaut IV of Blois, who since 1125 was also count of Champagne. As Louis refused Pierre entry into Bourges, Pope Innocent II laid an interdict on France, and Thibaut, who had come into the quarrel by giving refuge to Pierre, was further impelled to support the pope when Raoul of Vermandois, the king's seneschal, repudiated his wife, Thibaut's niece, in order to marry a sister of Queen Eleanor. Louis invaded Champagne, burnt Vitry-sur-Marne (1142) and occupied various other towns. Pope Celestine II, however, who succeeded Innocent in 1143, raised the interdict on condition that Pierre de La Châtre should retain Bourges; and in 1144 St. Bernard made peace between the king and Thibaut.

Soon afterward (Easter 1146) Louis VII took the cross when St. Bernard preached the second crusade at Vézelay. Louis set out for Palestine in June 1147, leaving Suger, abbot of St. Denis, as his regent; but the crusade (*see* Crusades) was not a success and the king returned to France in Nov. 1149. From that time onward Louis devoted himself to developing the resources of the royal demesne; and he increased the number of peasant agricultural communes, of the sort first encouraged by his father. He was now, moreover, on good terms with the church, and appeals by the clergy for his protection enabled him to intervene with profit outside his own demesne, notably in Auvergne, in Burgundy and in Narbonne. In 1147 he welcomed Pope Eugenius III as a refugee in France; and in 1162 he likewise received Alexander III, whom indeed he had been one of the first rulers to recognize (1160) after the emperor Frederick I Barbarossa had set up the antipope Victor IV (1159). Even so, in a fit of pique, he went so far as to meet Frederick and Victor IV at St. Jean-de-Losne in Aug. 1162; but he came to no agreement with them.

By far the most outstanding threat to Louis VII's position came from the growing power of the counts of Anjou (*q.v.*). Geoffrey IV Plantagenet conquered Normandy (1140–44) in the name of his wife Matilda; and when Louis, on remote grounds of consanguinity, had had his marriage with Eleanor annulled (March 1152), it was Geoffrey's son and successor Henry whom she married (May) thus bringing Aquitaine to him. The Angevin power thus appeared to overshadow the French monarchy in France itself; and in 1154 the count became king of England also, as Henry II (*q.v.*). From then until Louis VII's death the two rulers pursued their rivalry by recurrent warfare and perpetual intrigue. Louis was on the whole successful in preserving his demesne from incursions; and he was aided by the quarrel (1164–70) between Henry II and Thomas Becket, archbishop of Canterbury, and later by the revolt (1173–74) of Henry's sons, whom Louis actively encouraged. Against Henry of England, he was able to obtain an alliance with the brothers Thibaut V of Blois and Henry I of Champagne, whose sister Alice or Adela he married after the death of his second wife, Constance of Castile, in 1160. He was also supported by Philip of Flanders, and, less steadily, by Raymond V of Toulouse. Louis died in Paris on Sept. 18, 1180.

Bibliography.—A. Luchaire, *Études sur les actes de Louis VII* (1885); R. Hirsch, *Studien zur Geschichte König Ludwigs VII von Frankreich, 1119–1160* (1892); E. Lavisse, *Histoire de France*, vol. iii (1) (1901); J. Boussard, *Le Gouvernement d'Henri II Plantegenêt* (1956); M. Pacaut, *Louis VII et les élections épiscopales dans le royaume de France* (1957), *Louis VII et son royaume* (1964). (M. Pac.)

LOUIS VIII Coeur-de-Lion or Lionheart (1187–1226), king of France from 1223, was born in Paris on Sept. 5, 1187, the eldest son of Philip II and Isabella of Hainaut. He was married in 1200 to Blanche (*q.v.*), daughter of Alfonso VIII of Castile, the French receiving as her dowry the long-disputed lordships of Issoudun and Graçay in Berry. As eager as his father to extend Capetian authority, Louis lacked Philip's diplomatic finesse; and his seizure in 1212 of St. Omer and Aire on the Flemish border drove the count of Flanders, Ferrand or Ferdinand of Portugal, into alliance with the emperor Otto IV and John of England. When they invaded France in 1214, Louis opposed John in Poitou, routing him at the battle of La Roche-aux-Moines (*q.v.*).

During the autumn of 1215 John's rebellious barons offered Louis the English crown, and in April 1216, at a great assembly held at Melun, the French prince's claim to England by right of his wife, a granddaughter of Henry II, was propounded. It was also fictitiously alleged that John's crown had been declared forfeit by the court of France as early as 1203 in punishment for the murder of Arthur of Brittany. Louis landed in England in May 1216 and joined the rebel barons in London. Though he and his adherents were almost immediately excommunicated, his cause prospered until John's death in October removed the excuse for the adventure, rendering Louis an embarrassment rather than an asset to his supporters. These were severely defeated at Lincoln in May 1217 and a French force was destroyed off Dover in August; by the treaty of Kingston in Sept. 1217 peace was made in England and Louis agreed to withdraw. By a secret arrangement he was paid 10,000 marks.

Louis had been in the south of France during the elder Simon de Montfort's crusade against the Albigenses in 1215; he returned there briefly in 1219, and with Simon's son Amaury directed the massacre of heretics at Marmande.

Philip II died in July 1223 and Louis VIII was crowned at Reims on Aug. 6. He attacked the English power in the southwest in 1224, overrunning Poitou and part of Gascony. He led an army against the Albigenses in 1226, forcing Avignon to capitulate on his way south, and receiving the submission of Languedoc. These achievements facilitated his plans for the appanages which in his will he devised for his younger sons, Robert, count of Artois, Alphonse, count of Poitiers, and Charles, count of Anjou. Louis died at Montpensier in Auvergne on his way back to Paris on Nov. 8, 1226, and was succeeded by his eldest son Louis IX.

Bibliography.—C. Petit-Dutaillis, *Étude sur la vie et le règne de Louis VIII* (1894); E. Lavisse, *Histoire de France*, vol. iii (1901); R. Fawtier, *Les Capétiens et la France* (1942), Eng. trans. by L. Butler and M. J. Adam, *The Capetian Kings of France. Monarchy and Nation 987–1328* (1960).

LOUIS IX (Saint Louis) (1214–1270), king of France from 1226, was born at Poissy, near Paris, on April 25, 1214, the eldest surviving son of Louis of France, afterward Louis VIII, and Blanche of Castile. His father, who became king in 1223, died on Nov. 8, 1226; Blanche became regent for her young son and arranged for his immediate coronation at Reims (Nov. 29, 1226). During the following years the queen mother had to suppress a serious feudal revolt, the principal leaders of which were Peter of Dreux (Pierre Mauclerc), duke of Brittany, and the king's uncle Philippe Hurepel, count of Boulogne, supported by Count Raymond VII of Toulouse and by the English king Henry III. In her struggle Blanche was advised and supported by the papal legate Romano Cardinal Frangipani. By the treaty of Meaux, often called the treaty of Paris (1229), the count of Toulouse was reduced to submission. The marriage (1239) of his daughter and heiress Joan with Louis IX's brother Alphonse of Poitiers was planned; the annexation of the *sénéchaussées* of Nîmes, Béziers-Beaucaire and Carcassonne to the royal domain was confirmed; and measures to assure the extermination of the Albigensian heresy in Languedoc were agreed. The other rebels were subdued in 1230; a further rebellion by Mauclerc (1234) was of short duration. Blanche arranged the king's marriage (May 1234) to Margaret (*q.v.*), daughter of Raymond Berengar of Provence. Louis had by then been for several years old enough to undertake the government himself, but his mother continued to conduct affairs at least until 1242, possibly later, and she was regent in France from the time of Louis' departure on crusade (Aug. 1248) until her death (Nov. 1252).

However, once he had assumed control of affairs, Louis ruled his kingdom with wisdom and authority, achieving order at home and peace abroad. His reputation for sanctity attracted many near-contemporary biographers, the best-known of whom was Jean, sire de Joinville (*q.v.*). The accounts of hagiographers might well be suspect, but the records of Louis IX's administrative enquiries and ordinances clearly show his strength and ability. Moreover, England under Henry III was suffering a series of constitutional crises, and in Germany the emperor Frederick II's quarrel with the papacy was followed by the Great Interregnum (1254–73) during which there was no effective sovereign; France, therefore, naturally became the predominant power in western Europe.

Louis' Achievements in France.—Just as he was assuming control of affairs, the young king was faced with a fresh baronial revolt (1242) in the south and southwest, fomented by Henry III. Louis defeated the English at Taillebourg and at Saintes; and Raymond of Toulouse, who had been a leader of the revolt, was obliged to make peace with him at Lorris in Jan. 1243. After this, Louis IX's reign was peaceful. He kept very close control over his officers, *baillis* and seneschals, frequently sending other officials to investigate their conduct and to hear complaints from those subject to their authority. These large-scale inquests or enquiries showed that Louis' provincial administration was on the whole efficient and his officials honest. The duties and obligations of officials in the royal domain were carefully outlined in the ordinances of 1254 and 1256; they had to swear not to take bribes or practise extortion and they were obliged to remain for 40 days in a district after their term of office had expired, so that any plaintiff would have time to prefer a case against them. Moreover, they were forbidden to frequent taverns or to gamble; and business activities such as the purchase of land or the marriage of their daughters could only be carried out with the king's consent. Subsequent ordinances further centralized and strengthened the government of the royal domain; and that of 1258, abolishing the judicial duel or ordeal by battle, already forbidden by the church at the fourth Lateran Council of 1215, increased the scope of royal justice. Louis was also concerned with public order; prostitution and gambling were forbidden and the edict of 1268–69 imposed particularly severe penalties for blasphemy. Ordinances of 1263 and 1265 gave compulsory circulation to the royal coinage; Louis minted several silver coins and one gold one (with a *titre fine* to 999/1,000); counterfeiting was heavily penalized and the relative value of other currencies in the kingdom was fixed. Louis established a closer control over the city of Paris, transferring some of its financial burdens to the royal treasury and appointing as provost Étienne de Boileau, who wrote the *Livre des métiers*, the earliest known collection of the rules and statutes of the various city guilds.

During Louis' reign, and certainly as a result of his influence, a certain specialization of function and personnel began to develop in the *curia regis*, the king's traditional feudal court. Certain of its sessions became reserved exclusively to judicial, others to financial affairs. In the course of time these distinct sessions came to bear special names, the judicial meeting developing into the *curia in parliamentum domini regis* (that is, the *parlement*) and the financial meeting into the *curia in compotis* or court of accounts.

Louis continued the policy of increasing the royal domain wherever possible. Already enlarged by the provisions of the treaty of Meaux-Paris (1229), the domain was further increased by the acquisition of Clermont-en-Beauvaisis, Mortain and Domfront after the death of Philippe Hurepel (1234) and by the purchase of the county of Mâcon from Burgundy (1239). The king's policy of granting appanages to his brothers and younger sons has sometimes been criticized; for the former, however, he was merely carrying out the terms of his father's will; and in any case he was strong enough to control his family, while the careful administration of rulers such as Alphonse of Poitiers in fact tended to extend rather than diminish the royal power.

Foreign Relations.—Since his dominating aim was to recover the holy places for Christendom, Louis was particularly anxious to achieve and maintain peace among Christian princes.

The Treaties of Paris and Corbeil (1258–59).—After his victories at Taillebourg and at Saintes, Louis IX's relations with Henry III of England gradually improved, and negotiations begun in 1254 led to the treaty concluded in Paris in May 1258 and ratified in Dec. 1259. This agreement settled matters which had been in dispute since the time of Philip II Augustus of France and John of England. Henry III was recognized as duke of Aquitaine, for which he did homage to Louis; but he abandoned his claim to Normandy, Maine, Anjou, Touraine and Poitou. Louis in return not only gave back all that Henry's predecessors had held in fief or domain in the dioceses of Limoges, Cahors and Périgueux, but also promised Henry the reversion of the lands of Alphonse of Poitiers in Agenais and Saintonge, south of the Charente river, should Alphonse die childless.

Louis made a similar compromise agreement with James the Conqueror, king of Aragon. By the treaty of Corbeil (1258) he gave to James complete suzerainty over Roussillon and the county of Barcelona, while in return James renounced his claims to Provence and all of Languedoc except Montpellier.

The Papacy and Sicily.—In the struggle between the emperor Frederick II and the papacy Louis managed to maintain a neutral attitude; only when Pope Innocent IV fled to Lyons did he warn Frederick against pursuing him there. When his brother Charles of Anjou accepted the kingdom of Sicily (1265) from the pope, his support of the enterprise was passive, being limited to a permission to his subjects to fight in Charles's army.

The Seventh and Eighth Crusades.—Louis IX took the cross for the first time late in 1244, after an illness. He was particularly sensitive to the difficulties of Baldwin II, the Latin emperor of Constantinople who visited France in 1236 and in 1245–47 in an effort to raise money and men to maintain his inheritance not only against the Muslims but also against the Greeks. Baldwin sold Louis a relic of the Crucifixion, the Crown of Thorns, to enshrine which Louis had the Sainte-Chapelle built (1245–48) in Paris. But the prolonged dissension between papacy and empire, and difficulties of organization delayed the French king's departure until Aug. 1248. Embarking at Aigues-Mortes in the south of France, the crusaders sailed, by way of Cyprus, to attack Egypt, the main centre of Muslim power. They captured Dami-

etta but were defeated at Mansurah (Feb. 8, 1250) and Louis was taken prisoner. He was subsequently ransomed and spent the next four years in Syria, where he fortified the towns held by the Latins and ransomed as many Christian captives as he could. He re-embarked for France in April 1254, believing that his mother's death made his return necessary. Even so, he remained determined to launch another crusade; though when at last he announced his plans in March 1267 they aroused markedly little enthusiasm among his counselors and court and his old friend Joinville openly told him that the plan was folly. Nevertheless, on July 1, 1270, the crusaders left Aigues-Mortes for Tunisia, which was to be used as a base for another attack on Egypt. The crusading army disembarked at Carthage but was immediately decimated by an epidemic of plague. Louis himself succumbed, and died before Tunis on Aug. 25, 1270.

Character and Achievements.—Louis was one of the greatest of the Capetian kings, a strong ruler and renowned for his sanctity. In Joinville's narrative we see him practising all the conventional pieties; but he translated his faith into action and sought not only to live but also to rule according to the precepts of religion. His piety rarely led him into undue subservience to the church; he kept firm control over episcopal appointments and allowed complaints against excessive papal taxation. Holding a very high conception of the office, rights and duties of a king, Louis was powerful enough to implement his theories. He was particularly anxious to maintain correct feudal relationships; thus, though some of his counselors grumbled that he was too generous to Henry III in the treaty of Paris, he was content because Henry became his vassal for Aquitaine. At the same time his conception of royal dignity made it inevitable that he should always uphold kingly power; when, by the Mise of Amiens (1264), he arbitrated between Henry III and the rebellious English barons, his decision could not have been other than in Henry's favour.

Louis regarded a king as the supreme judge in his kingdom; he gave personal attention to many of the pleas of his subjects, often holding court under an oak tree in the park adjoining his château at Vincennes. His reputation as a fair judge brought appeals for arbitration from all parts of Christendom; as well as giving judgment in the English dispute he had, by the Mise of Péronne (1246), settled the succession to the county of Flanders, disputed between the houses of Avesnes and of Dampierre. Louis IX's achievements and his reputation for undoubted sanctity brought immense prestige to the Capetian monarchy; in later times his reign was regarded as a period of great prosperity and happiness. He was canonized by Pope Boniface VIII on Aug. 11, 1297, and his feast day is Aug. 25.

See also references under "Louis IX" in the Index.

Bibliography.—The best contemporary account of Louis IX is the *Histoire de Saint Louis* by Joinville; for various editions of this work *see* Joinville, Jean, Sire de. The accounts of Louis' great inquests were edited by M. L. Delisle, *Les Enquêtes administratives du règne de Saint Louis* in M. Bouquet (ed.), *Recueil des historiens des Gaules*, vol. xxiv (1904). *See* also H. A. Wallon, *Saint Louis et son temps* (1875); E. Berger, *Saint Louis et Innocent IV* (1893) and *Histoire de Blanche de Castile* (1895); E. Lavisse, *Histoire de France*, vol. iii (2) (1901); C. Petit-Dutaillis and P. Guinard, *L'Essor des états d'occident* (1937) being vol. iv (2) of the series *Histoire du moyen âge* in the *Histoire générale* ed. by G. Glotz; R. Fawtier, *Les Capétiens et la France* (1942); A. Garreau, *Saint-Louis et son royaume* (1949); L. Buisson, *König Ludwig IX der Heilige und das Recht* (1954); M. Bloch, *La France sous les derniers Capétiens, 1223–1328* (1958). (M. Pac.)

LOUIS X le Hutin or the Stubborn (1289–1316), king of France from 1314 to 1316, had previously been king of Navarre from 1305 to 1314. The eldest son of Philip IV of France and of Joan (Jeanne) of Navarre, he was born in Paris on Oct. 4, 1289. He took the title of king of Navarre on his mother's death (April 4, 1305), but when he succeeded his father as king of France (Nov. 30, 1314) he resigned Navarre to his next brother, the future Philip V of France. In 1305 Louis had married Margaret, daughter of Robert II, duke of Burgundy, but in the last months of Philip IV's reign she was convicted of adultery and was later strangled in prison (1315). Louis married (July 1315) as his second wife Clémence, daughter of Charles I of Hungary; they were both anointed at Reims on Aug. 3, 1315.

Baronial discontent, which had become serious in the last year of Philip IV's reign, continued into that of Louis X. Louis' main policies were designed to allay this discontent and to gain support and money for a projected campaign against Flanders. He dismissed and imprisoned many of his father's unpopular ministers and allowed the execution of Enguerrand de Marigny. Charters were granted to groups of nobles in almost every province of France. Louis bought the support of the clergy by similar means, but whereas they gained for the church some real privileges, the use of ambiguous formulas made the baronial charters virtually worthless. Louis also sold their liberty to the serfs of the royal domain.

He led an expedition to Flanders in Aug. 1315, in order to enforce the treaty of Athis-sur-Orge (*q.v.*) made between his father and the Flemings in 1305, but bad weather obliged the French to retire. Louis died of pleurisy at Vincennes on June 5, 1316. By Margaret of Burgundy he had one daughter, Jeanne (1312–49), who married Philip, count of Évreux and (in her right) king of Navarre. By Clémence of Hungary Louis left a posthumous son, King John I.

Bibliography.—R. Fawtier, *L'Europe occidentale de 1270 à 1328* (1940); A. Artonne, *Le Mouvement de 1314 et les chartes provinciales de 1315* (1912); P. Lehugeur, *Histoire de Philippe le Long*, 2 vol. (1897–1931).

LOUIS XI (1423–1483), king of France from 1461, was born at Bourges, in Berry, on July 3, 1423, the son of Charles VII of France by his consort Mary of Anjou. When Louis was born the English were ruling a large part of France (*see* Hundred Years' War), and he spent most of his childhood at the Loches in Touraine. Ugly, fat, spindleshanked and with a large head, Louis grew up in austere seclusion, to become secretive, rancorous, ruthless, superstitious though devout, careless in his dress and boorish in his manners, yet intelligent, well-informed, active, supple in diplomacy, courageous in war and able to command loyalty. Known as "the universal spider," he could still claim to personify the French national consciousness; as he was later to say to his rebellious feudatories, "I am France."

Dauphin, Rebel and Exile.—Louis was married to Margaret, daughter of James I of Scotland, at Tours in 1436—an unhappy union formed solely for political reasons. In 1439 the king sent him to superintend the defense of Languedoc against the English and then to act as royal lieutenant in Poitou. Louis, however, was impatient to reign and was induced by malcontent princes to put himself at the head of the Praguerie (*q.v.*) in 1440. Charles VII pardoned his rebellion and gave him direct control over the government of Dauphiné.

Louis took part in his father's campaigns of 1440–43 and in 1443 forced the English to raise their siege of Dieppe. When the Anglo-French truce of 1444 left numbers of mercenary troops without employment, he led a large body of them to attack Basel, in ostensible support of the German king Frederick IV (later emperor as Frederick III) in his quarrel with the Swiss confederacy. Having failed to take Basel, he launched his force against the Habsburg possessions in Alsace, since Frederick would not grant them the promised winter quarters. Meanwhile Charles VII had invaded Lorraine and was holding court at Nancy. When Louis rejoined him there, Charles was completely under the influence of Agnès Sorel and Pierre de Brézé. Father and son became wholly estranged after the death (1445) of the dauphine Margaret, whom Charles had liked. Detected in a plot against Brézé (Dec. 1446), Louis was exiled to Dauphiné. He was never to see his father again.

It was in Dauphiné that Louis served his apprenticeship as a ruler. Assuming the task of government himself, he set up a central chancellery (1447); divided the local administration between two *bailliages* and a *sénéchaussée* (1447); founded the University of Valence (1452); instituted a *parlement* (1453); reduced the nobles to obedience; and confirmed the privileges of the towns. He also applied himself to exploiting the country's mines and forests and to promoting its trade on the Rhône and across the Alps. Exercising full sovereignty, he pursued a foreign policy sometimes at variance with his father's. He fixed the frontiers

of Dauphiné by obtaining Savoy's renunciation of claims to Valentinois and Diois and the papacy's cession of its part of Montélimar (1447). A secret alliance with Savoy for a partition of the duchy of Milan (also 1447) was followed by the dauphin's marriage to Charlotte, daughter of Duke Louis I of Savoy, despite Charles VII's prohibition (1452). Subsequently, however, Louis fell out with Savoy; and in 1456, when Charles approached his frontiers with an army and summoned him to his presence, he fled to the Netherlands to the court of Philip the Good, duke of Burgundy.

Installed at Genappe in Brabant as Philip's guest, Louis could acquaint himself thoroughly with the working of the great Burgundian state, whose ruin he was later to seek so persistently (Charles VII remarked that Philip was feeding the fox that would eat his hens). At the same time Louis kept himself posted by spies with every detail of his father's illness, thus laying himself open to the unsubstantiated accusation, believed by Charles himself, that he had hastened his death by poison. At last, after five years of impatient exile, Louis became king of France when Charles died (July 22, 1461).

King of France.—On Aug. 15, 1461, Louis was anointed and crowned king at Reims. His first act was to strike at Charles VII's ministers. Pierre de Brézé and Antoine de Chabannes were imprisoned, but they and some of their more serviceable colleagues were subsequently reinstated. Relying largely on men drawn from the lower nobility or from the middle class, Louis formed a circle of loyal advisers who helped him to impose his authority, to enlarge the royal domain and to develop the wealth of the kingdom. Among them, Étienne Chevalier and Tristan Lhermite, as well as Brézé and Chabannes, had already served Charles VII, but Jean de Daillon, Oliver Le Daim (*q.v.*) and, from 1472, Philippe de Commynes (*q.v.*) were Louis' own recruits.

Louis XI's major preoccupation was with the princes and great feudatories of the kingdom, who were ready to enleague themselves with each other or with England against him. Former officers of Charles VII, such as Jean, comte de Dunois, stirred up hostility against the king's new men; Jean II, duc de Bourbon, and Francis II (*q.v.*) of Brittany emerged as the leaders of the malcontent nobility; Philip the Good's son and future successor, Charles the Bold, brought the power of Burgundy to the support of the king's enemies; and the king's own brother Charles de France (1446–72), at first duc de Berry, became a tool of the rebels.

In 1465 the malcontent princes formed the Ligue du Bien Public or League of the Public Weal to make war against Louis. All France seemed on the verge of anarchy, but the lesser gentry refused to rise against the king and the *bourgeoisie* rallied to him. After a successful campaign in Bourbonnais, Louis turned to confront the Burgundians, who were marching on Paris. He fought a battle with them at Montlhéry (July 16) and then defended Paris against a siege. The league was brought to an end by the treaty of Conflans with the Burgundians (Oct. 5, 1465) and by that of St. Maur-des-Fossés with Brittany (Oct. 29), but Louis had to yield much: the Somme towns, which he had redeemed from Philip the Good for 400,000 crowns in 1463, were given back to the Burgundians; and Normandy was granted, in exchange for Berry, to Charles de France, so that all northern France, from Brittany to Burgundian Artois, would be linked in the hands of the former rebels. By Jan. 1466, however, the king had reoccupied Normandy, which in 1468 the assembly of the estates-general at Tours declared inalienable from the royal domain.

Charles the Bold, having become duke of Burgundy on Philip the Good's death (1467), allied himself with Francis of Brittany and with Edward IV of England; but in 1468 Louis invaded Brittany and, in September, detached Francis from the alliance. He then went to his disastrous interview with Charles the Bold at Péronne (Oct. 9–14, 1468). During the negotiations Charles learned of an insurrection in Liège, fomented by the French king's agents. Furious, he put Louis under house arrest, forced him to make far-reaching concessions and finally took him to Liège to witness the suppression of the revolt.

After his humiliation at Péronne, Louis attempted to nullify the Anglo-Burgundian alliance by assisting the Lancastrians against Edward IV, but the final defeat of the Lancastrians (May 1471) put an end to this hope. Having already attacked Burgundy, Louis found himself facing a new host of enemies, comprising not only Charles the Bold, Edward IV and Francis of Brittany but also powers in the southwest, namely Charles de France, to whom Louis had granted the duchy of Guienne in 1469, Jean V d'Armagnac and John II of Aragon, who hoped to recover Roussillon. However, the death of Charles de France, on May 24, 1472, occurred very opportunely for Louis; both Charles the Bold, who failed in his attack on Beauvais in the summer, and Francis of Brittany signed truces before the end of the year; the royal army overran Armagnac early in 1473; and in Sept. 1473 France and Aragon agreed to suspend hostilities in Roussillon. Charles the Bold then began scheming for a partition of France between Burgundy, England and other states and concluded the treaty of London with Edward IV (July 1474). Edward after nearly a year's delay launched the invasion of France for which his allies had been waiting, but Louis then bought him off with the treaty of Picquigny (Aug. 1475). Truces were then signed with Burgundy at Souleuvre (Sept. 13) and with Brittany at Senlis (Sept. 29). Already in March 1475 Louis had taken advantage of Aragon's difficulties to seize Perpignan.

After 1475 it remained for Louis to destroy the power of Burgundy. He subsidized the Swiss confederates and René II of Lorraine in their war against Charles the Bold, and Charles was defeated and killed in battle at Nancy on Jan. 5, 1477. Louis thereupon proceeded to dismember the Burgundian state, eager to reunite its French fiefs to the royal domain and to take as much else as he could. Charles the Bold's daughter Mary, however, married the Austrian archduke Maximilian (*see* Maximilian I, Holy Roman emperor), who defended her inheritance against Louis. Finally, by the treaty of Arras (1482), Louis retained full sovereignty over the duchy of Burgundy, Picardy and Boulonnais and possession of Franche-Comté and Artois as the dowry of Margaret of Austria, fiancée of his infant son and heir, the future Charles VIII. The Austrians kept Flanders and the rest of the Netherlands.

Louis regarded war as a precarious enterprise and made it only with reluctance, though he maintained the standing army that Charles VII had instituted and strengthened the artillery. Diplomacy and inheritance were the means that he preferred for extending the royal domain. He purchased the rights of the heiress of the house of Penthièvre to the Breton succession; and he annexed Anjou and the French part of Bar on the death of René I, the titular king of Naples, in 1480 and Maine and Provence on the death of Charles II of Maine in 1481. Lorraine, however, was left to the house of Anjou; and Louis was too prudent to try to realize the Angevin claim pretensions to Naples.

Even so, Louis pursued an active policy in Spain and in Italy. His success in Roussillon was largely due to his exploitation of Aragon's difficulties in Catalonia and in the matter of the Castilian succession (from 1474). After Charles the Bold's death there was no one to prevent Louis from exercising a virtual protectorate over Savoy, where his sister Yolande was regent; and he made himself the arbiter of the affairs of northern Italy.

In France itself, having broken the resistance of the princes, Louis could impose his authority everywhere. Known for the strictness of his justice, he exacted prompt obedience from the *parlements* and thought of codifying the local customary laws. Ecclesiastical elections were taken under the royal control. The estates-general were convened only once, in 1468—and then merely to settle the question of Normandy (*see* above), not to air their grievances. Louis XI raised his revenues without consulting the estates and exacted sums of unprecedented magnitude from town and countryside alike. Yet the *bourgeoisie* continued to support him: Jean de Beaune of Tours, Pierre Doriole of La Rochelle and Guillaume Restout of Rouen were among his most trusted advisers, some of whom he used as diplomatic agents abroad. Seeing the national wealth as a factor in the power of the kingdom, Louis sought to manage the economy, strengthening the guilds and promulgating numerous laws for industry. He encouraged mining, textile manufactures (notably the silk industry of Lyons and

Tours) and the introduction of printing at the Sorbonne (1470). Following the example of Jacques Coeur (*q.v.*), whose old assistants Jean de Villages and Guillaume de Varye he consulted, he took an interest in Mediterranean trade and even dreamed of a company to monopolize the spice trade. The fairs of Lyons and Rouen profited from his treaties with England and with the Hanseatic towns.

Of delicate health, Louis XI was a tireless worker, and overwork may have precipitated the cerebral arteriosclerosis which finally affected him. For his last two or three years he lived in seclusion at Plessis-les-Tours, in Touraine, where he died on Aug. 30, 1483. There is an edition of Louis XI's letters by E. Charavay and J. Vaesen, eight volumes (1883–1902).

See also references under "Louis XI" in the Index.

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LOUIS XII (1462–1515), king of France from 1498, was born at Blois on June 27, 1462, the son of Charles, duc d'Orléans, and Mary of Cleves. He succeeded his father as duc d'Orléans in 1465. In 1476 he was constrained to marry the saintly but misshapen Jeanne de France (1464–1505), daughter of his second cousin King Louis XI. During the minority of King Charles VIII he launched the revolt which ended in his defeat at St. Aubin-du-Cormier (July 28, 1488). Restored to favour in 1491 (after rigorous imprisonment), he commanded troops at Asti during Charles VIII's invasion of Italy (1494–95). When Charles was retreating he took Novara from the Milanese and held it during a long siege.

King of France on Charles VIII's death (April 8, 1498), Louis was crowned at Reims (May 27) and obtained from Pope Alexander VI the annulment of his marriage (Dec. 17). He then married Charles VIII's widow, Anne (*q.v.*) of Brittany, thus saving the personal union of her duchy and his kingdom. His next concern was to make good his claim to the duchy of Milan (*q.v.*), based on the marriage of his grandfather Louis de France, duc d'Orléans, to Valentina Visconti. His army, spreading terror deliberately, drove his rival Ludovico Sforza from Milan in summer 1499, and he visited Milan as duke in October. Ludovico reoccupied Milan in Feb. 1500 but was captured in April and died a prisoner in France.

Pursuing Charles VIII's claims to the kingdom of Naples (*q.v.*), Louis concluded the treaty of Granada (Nov. 1500) with Ferdinand II of Aragon for a partition of that kingdom, which was conquered in summer 1501; but a year later France and Spain were at war over the partition. Negotiating with Ferdinand's son-in-law Philip, ruler of the Netherlands, Louis concluded the treaty of Lyons (April 1503) whereby Naples would go to Philip's son Charles, fiancé of the French king's daughter Claude (1499–1524), heiress to Brittany. Ferdinand, however, adroitly disavowed this treaty; Louis kept his army near Rome in the summer of 1503, hoping that his favourite Georges d'Amboise (*q.v.*) would be elected pope; and by March 1504 the French had lost all Naples. By the treaty of Blois of Sept. 1504, Philip's father, the prospective Holy Roman emperor Maximilian I, recognized Louis as duke of Milan in return for a promise that Milan and also Burgundy should go to Charles and Claude on their marriage unless Louis should have a son; and by the treaty of Blois of Oct. 1505 Louis renounced his claim to Naples in favour of his niece Germaine de Foix, whom Ferdinand married. To save France from losing Claude's heritage, representatives of the three estates were assembled by Louis at Tours in May 1506 to insist on Claude's betrothal to his heir presumptive, Francis of Angoulême, instead of Charles.

Having crossed the Alps again to subdue a rebellion in Genoa, Louis met Ferdinand at Savona in June 1507 to consolidate their new entente. Ferdinand and Pope Julius II adhered to the League of Cambrai, formed in Dec. 1508 for action by Louis and Maximilian against Venice; and on May 14, 1509, Louis won his great victory of Agnadello over the Venetians. In 1510, however, Julius turned against France. Louis retorted by sponsoring a general council of the Roman Catholic Church, to meet at Pisa in 1511; but Maximilian made a separate truce with Venice in April 1511, the pope, Spain and Venice formed their Holy league against France in October, and Henry VIII of England promptly joined it. The French victory at Ravenna in April 1512 proved fruitless, the Holy league's Swiss allies took Milan in the summer, and Maximilian joined the league in November. Louis secured an alliance with Venice and a truce with Ferdinand in spring 1513. But the French attack on Milan was defeated by the Swiss at Novara on June 6; Henry VIII won the battle of the Spurs, in Artois, on Aug. 16; and the Swiss invaded Burgundy in September. The Anglo-French peace of London (Aug. 1514) was cemented by the marriage of Louis, a widower since Jan. 1514, with Henry's sister Mary (*see* MARY [MARY TUDOR]) in October. Louis XII's overambitious Italian enterprises had ended in catastrophe. Diplomatically he had been outwitted twice by Ferdinand and once by Julius; and his doublecrossing of Maximilian over Claude's marriage had been repaid by Maximilian's final desertion of him.

In France itself Louis XII was highly popular: from the time of the assembly at Tours (1506), he was known as "the Father of the People." He simplified and improved the administration of justice (ordinance of March 1499); sought to protect his lowest subjects against oppression; financed his wars, up to 1509, without increase of direct taxation; and kept his kingdom free from civil war and, until the end of the reign, from invasion. His Gallican policy for the church was stiffened by the breach with Julius II. The theory of royal absolutism was sedulously promoted.

Louis XII died in Paris on Jan. 1, 1515, leaving two daughters: Claude and Renée (*q.v.*), later duchess of Ferrara.

LOUIS XIII (1601–1643), king of France from 1610, was born at Fontainebleau on Sept. 27, 1601, the eldest son of Henry IV of France by his second consort Marie de Médicis. On his father's assassination (May 14, 1610), Louis became king under his mother's regency. In pursuance of her policy of allying France with the Catholic Habsburgs, Marie arranged that Louis and his sister Elizabeth should marry the Spanish king Philip III's children, Anne of Austria and the future Philip IV of Spain respectively. These marriages were concluded in Nov. 1615. In France meanwhile the regency and the immediate period after the king's coming of age (1614), during which the queen mother continued to govern with the help of her favourite the marquis d'Ancre, were troubled by intrigues and civil war. In 1617 the king, resentful at being excluded from power, authorized the assassination of the marquis d'Ancre on the advice of his own favourite Charles d'Albert, later duc de Luynes. From then onward his relationship with his mother was one of ill-disguised or open hostility. (*See* further FRANCE: *History*.)

The decisive event for Louis XIII's life, private and public, was the entry of the cardinal duc de Richelieu, hitherto a partisan of Marie de Médicis, into the royal council in 1624. Thenceforward French policy was conducted by Richelieu. Yet nothing could be more mistaken than the traditional view of Louis as a feeble king dominated by an omnipotent minister. Poor in health, stuttering and timid, but prone to fits of violent rage, Louis was very conscious of his royal authority. Very religious, he felt himself responsible to God for all that was done in his name. Consequently it is in his personal psychology that the explanation of his relationship with Richelieu must be sought. Louis at first tolerated him, then gave him his confidence and his friendship; and, though subsequently he felt alarm at having given Richelieu so much power, he was yet convinced that no one else was working more effectively for the glory of his realm and so never allowed himself to be separated from the cardinal. Nevertheless, no important decision was taken without the king's consent. This as-

sociation of king and first minister constituted the regime sometimes described as the *ministériat*.

After the capture of La Rochelle from the Huguenots (1628), Louis XIII was forced to choose between two alternatives presented by Richelieu: an active and costly foreign policy or the internal rehabilitation of France. Louis chose the former. From that moment, internal policy was only a matter of securing, by empirical means, general obedience from the nobility, from the officials, from the *parlements* and from the tax-laden people. The royal finances and, above all, the treasury henceforth depended on tax farmers who made huge profits, while the peasantry, helpless against the consequences of bad harvests (as in 1631) and epidemics, led a life of constant hardship and sometimes of abject destitution.

Richelieu, vainglorious, grasping and convinced that ostentation upheld his authority, amassed a large personal fortune and lived in princely state. His foreign policy involved alliances with Protestant princes in Germany and, from 1635, an arduous war against Catholic Spain (*see* THIRTY YEARS' WAR). The need to alleviate the people's sufferings, Richelieu's own arrogance and the scandal of alliances with heretics were all a constant source of worry to Louis and might have prompted him to break with the cardinal. In Nov. 1630 the queen mother, who made herself the mouthpiece of the aggrieved nobility, nearly obtained the dismissal of Richelieu and the restoration to power of the pro-Spanish Catholic party headed by the brothers Michel and Louis de Marillac (the one keeper of the seals, the other a marshal of France); but from this crisis, known as the Day of Dupes, the minister's authority emerged all the stronger. The queen mother went into exile abroad—a course that her younger son Gaston, duc d'Orléans and the king's heir presumptive, had already taken.

The increasing challenge to the royal authority brought Louis round to Richelieu's merciless methods: stern examples were required to impress public opinion. When the duc de Montmorency (Henry II), governor of Languedoc, took up arms for the exiles and was captured in battle, Louis went to Toulouse during the trial of the rebel and refused to reprieve him on his being condemned to death (1632). In the war against Spain, neither the serious reverses of 1636 nor the subsequent difficulties deterred Louis from pursuing Richelieu's policy; but intrigues for peace with Spain flourished in circles around Anne of Austria and the king's confessor, Nicolas Caussin. To counter hostile influences, Richelieu took care to place people whom he could trust in the king's entourage, but he was mistaken in sponsoring the rise of the marquis de Cinq-Mars, the last of Louis XIII's youthful favourites. Cinq-Mars, flattered by the cardinal's enemies, involved himself in a conspiracy with the duc d'Orléans and Spain (1642); and at the same time Louis, wanting peace for the sake of his suffering people, began to view the cardinal with mistrust. Finally, however, the revelation of his favourite's treason brought Louis to rely more than ever on his minister. Moreover, Richelieu's work had borne fruit: the army, more obedient to the government than before, had not only put down the most dangerous peasant revolt, that of the Va-nu-pieds in Normandy (1639), but also had won solid successes against the Spaniards. The *parlements* and the clergy had been reduced to greater docility and the king of France was respected abroad as one of the most powerful kings in Europe. The birth of a dauphin, the future Louis XIV, in 1638 and of a second son, Philippe, later duc d'Orléans, in 1640, after the queen's long period of childlessness, precluded the danger of the crown's passing eventually to Gaston or to the house of Condé.

Louis XIII could thus suppose in the last months of his life that soon the victory of his armies would make possible an advantageous peace, so that he could devote himself to the relief of his subjects. Accordingly, when Richelieu died in Dec. 1642, he kept the cardinal's team of ministers in office; but Louis himself, having long been in ill health, died on May 14, 1643.

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LOUIS XIV (1638–1715), king of France from 1643, was born at St. Germain-en-Laye on Sept. 5, 1638, the long-awaited first child of Louis XIII and Anne of Austria. The death of his father on May 14, 1643, made him king at the age of four, under the regency of his mother. Power lay in the hands of the regent and of her minister, Cardinal Mazarin, who had to face the last stages of the Thirty Years' War in Germany, the internal troubles of the Fronde and finally the continuation of the war with Spain that had begun in 1635. Though in 1651 the royal authority was so weak against the Frondeurs that the populace, inflamed by rumours of an intended flight of the government from Paris, was admitted to see the king in his bed, Mazarin nevertheless triumphed over his domestic and his foreign opponents: the Fronde was at an end by 1653, the peace of Westphalia (1648) and the peace of the Pyrenees (1659) marked the success of the arms and of the diplomacy of France. The peace of the Pyrenees was cemented by the marriage of Louis to his cousin, the infanta Marie Thérèse (Maria Teresa de Austria).

The Regime of Personal Government.—The king entered Paris in triumph in 1660. Mazarin died the next year; and the king, who since his coming of age in 1651 had left the control of affairs in Mazarin's hands, at once announced his intention of being his own first minister. He built up a thoroughly personal system of government and presided constantly over the council and many of its committees. Throughout the reign, policy was to be directed from the *conseil étroit* or *conseil d'état d'en haut* (upper council of state), to which the king summoned anyone whom he wished to consult, but which regularly comprised only a few men, who received the dignity of ministers of state. At the beginning of the king's personal reign these men were Michel Le Tellier, Hugues de Lionne and Nicolas Fouquet. Neither the chancellor nor all the secretaries of state (the effective ministers) were members of the upper council. After Fouquet's disgrace, Jean Baptiste Colbert took his place; and after Lionne's death in 1671, Le Tellier's son the marquis de Louvois entered the council. The ministers, however, were at the same time secretaries of state, and departmental specialization became firmly established. Louvois followed his father as secretary of state for war; the marquis de Pomponne (Simon Arnauld) succeeded Lionne in the foreign department, to be succeeded in turn by Charles Colbert de Croissy and by the latter's son Jean Baptiste, marquis de Torcy; and the great Colbert looked after the finances (as *contrôleur-général*), the navy, the royal household and fine arts. No one ever held a predominant position, since Louis XIV detested the idea of a ministerial regime such as the cardinal duc de Richelieu had conducted. Diligent and constant in his attendance not only at the upper council of state, but also at the other councils (dispatches, finances, judicial affairs), the king was always the supreme and effective head of policy.

Imbued with the same sense of royal mission that his father had had, Louis also took a real pleasure in the exercise of the profession of king. Neither the queen mother nor the queen consort, neither the king's brother Philippe, duc d'Orléans, nor the dauphin, neither any of the princes of the blood nor any cardinal ever had any effective part in affairs, which were kept in the sole hands of the king and his ministers. In the eyes of the nobility, reduced to appointments at court or in the army, it was a reign of low, bourgeois government (*un règne de vile bourgeoisie*). The king's acknowledged mistresses, Louise de La Vallière and the marquise de Montespan, were allowed no secret influence on policy, despite the rank accorded to them and the unparalleled honours granted to their children (some of whom were not only legitimized but even included among the princes of the blood). On the other hand the marquise de Maintenon, whose marriage to the king took place in secret at an unknown date (probably autumn 1683) and who had no status at court except that of a friend enjoying the king's confidence, may have exerted some influence on decisions, since her intelligence and experience led Louis frequently to ask for her advice; but her tact and her prudence were such that no trace of this influence can be convincingly shown.

The Glory of the Monarchy.—Did Louis XIV, in his personal

rule, adhere to a definite political program? If a general theme characterizing the reign had to be discerned, it would consist essentially of the pursuit of the king's glory. This does not mean that Louis XIV was exclusively concerned to win glory by war; he was attentive to anything that could enhance the brilliance of his reign. He rightly valued the zeal of ministers who reformed the internal administration, reduced the sovereign courts, representative assemblies and municipal bodies to obedience, encouraged industry, secured discipline in the army, built up the navy and, by patronage, stimulated a spirit of competition among writers and artists. Making himself the patron of French classicism, Louis personally encouraged the greatest writers of the time, such as Molière, Boileau and Racine, though his own tastes inclined him rather toward the court ballet and the opera, to which his protégé Jean Baptiste Lully (a naturalized Italian) gave a French air. Passionately fond of building, Louis saw to the completion of the Louvre and to the building of Versailles (with constant modifications), Les Invalides and Marly-le-Roi. Regarded by Louis from 1661 as the ideal place for holding his magnificent fêtes (which might last for several days at a time), Versailles became in 1685 the permanent seat of the king and the court. Fontainebleau during the hunting season and the charming château of Marly-le-Roi, exemplifying a refinement in the royal taste for beautiful houses, served for amusements. Court life, ruled by meticulous etiquette, had no meaning except to enhance the king's prestige, both in France and abroad.

Foreign Policy.—Louis XIV's desire for unrivaled power guided his foreign policy. There can be no doubt that he wanted to become the foremost prince in Europe. Envying Leopold I's imperial dignity, he even aspired to be Holy Roman emperor himself some day. Meanwhile he set to work to achieve the final ruin of Spanish power and to turn the German and Italian princes and the English king Charles II into subsidized dependents of France.

After the death of his father-in-law Philip IV of Spain (1665), Louis in his queen consort's name undertook the War of Devolution (1667–68); and the treaty of Aix-la-Chapelle gave him several strategically important towns in the Spanish Netherlands. He then decided on a punitive expedition against the United Provinces of the Netherlands, whose commercial rivalry with France and whose republican politics seemed intolerable to him (1672). Winning a rapid victory, he overreached himself in the negotiations for peace by making his demands too stringent and soon had to face a coalition that brought Spain and the emperor Leopold I into the war against him. Even so he pursued hostilities successfully until 1678, when he stopped them in time to prevent Great Britain's joining the coalition. The treaties of Nijmegen (1678–79) gave him new territory in the Spanish Netherlands and Franche-Comté. Now at the peak of his power, the king received the title of "Louis the Great" from the Hôtel de Ville of Paris (1680). (*See* DUTCH WARS.)

The king's next step was to set up the so-called *chambres de réunion* to furnish juridical grounds for the annexation of all territories which had in earlier times been dependencies of territories now French. Under this system not only Alsace but also other extensive areas on the left bank of the Rhine were to be severed from the Holy Roman empire. Then, in 1681, Louis seized Strasbourg on the Rhine frontier and Casale in Montferrat south of the Alps. In the same year he also attacked Luxembourg, to effect a "reunion"; and after interruption and resumption of warfare in 1682–83 that fortress also fell to the French in 1684. The armistice of Regensburg (1684) between France and the empire accorded to Louis possession for 20 years of Strasbourg, Luxembourg and all territories "reunited" to France before Aug. 1681.

Changes, however, had already taken place in Europe, of which neither Louis nor his ministers had taken the measure. German public opinion, irritated by his tyrannous aggression, could be worked up against him: southern Germany escaped from his influence after the death of the elector Ferdinand Maria of Bavaria (1679) and inclined once more toward the Austrian Habsburgs, whose prestige rose through the breaking of the Turkish siege of Vienna (1683) and the reconquest of Hungary; and in northern Germany the rising power of Brandenburg, which had formerly been one of France's client states, became an adversary after the revocation of the Edict of Nantes (*see* below). In England, strengthened by an expanding economy, parliament and nation condemned the francophile policy of the Stuart kings; and the revolution of 1688 put Louis XIV's implacable enemy, William III of Orange, on the English throne. Thus the era of the great coalitions against France began. The League of Augsburg (1686) was followed in 1689 by a far more formidable combination which, in the War of the Grand Alliance, convinced Louis that he would have to renounce the greater part of what had been claimed under the program of "reunions" if he was to conserve his most important gains, notably Alsace (peace of Rijswijk, 1697). He accordingly gave up the idea of French hegemony in Europe and resigned himself to preserving the balance of power. All the same, he was unable to obtain general agreement among the powers for an equitable division of the Spanish inheritance at the death of the childless Charles II of Spain. Charles II's last will named as his heir Philippe, duc d'Anjou (*see* PHILIP V of Spain), who was a grandson of Louis XIV but was apparently precluded from the direct line of succession to the French throne by his elder brother and the latter's son. Hoping to preserve the peace of Europe, Louis XIV accepted this will (1700), but there ensued the most terrible war of the reign (*see* SPANISH SUCCESSION, WAR OF THE). Louis sustained this long war with courage and wisdom; and the peace treaties of Utrecht and Rastatt (1713, 1714), though they reduced the territory of France a little, yet allowed him to keep the essential acquisitions.

Religious Affairs.—Louis XIV, proud of his title of "most Christian king," was resolute in protecting the Catholic religion. He himself was faithful to it, despite the irregularities of his private life. Though the French Protestants were now docile subjects, he made it a matter of principle to withhold both his favour and even their rights under ordinary justice from them. The Edict of Nantes was applied in accordance with a strictly literal interpretation of its clauses; and to please the king an odious system of petty persecution was set afoot, resulting in servile conversions on the one hand or in the voluntary exile of the most steadfast Protestants on the other. Finally, in 1685, by the Edict of Fontainebleau, Louis revoked the Edict of Nantes, and Protestantism was no longer tolerated in France. The Protestant revolt of the Camisards, in reaction against this treatment, aggravated the troubles of the kingdom during the War of the Spanish Succession.

In the Catholic Church itself there were other problems. As all resistance to royal decisions was regarded as tending toward rebellion, Louis XIV let himself be persuaded that Jansenism was a dangerous opinion which had to be suppressed. The community at Port Royal, a rallying point for the so-called Jansenists, was subjected to intermittent persecution; and after a temporary lull in the controversy Louis obtained the bull *Vineam Domini* (1705) from Pope Clement XI. As the nuns at Port Royal would not accept this bull without reservations, Louis in 1709 had their community dispersed; and in 1713 he obtained an even more forceful condemnation of Jansenism in the bull *Unigenitus*. Another opinion, Quietism, was likewise condemned, mainly through the influence of Bossuet, despite Fénelon's defense of certain Quietists.

Meanwhile, however, notwithstanding his zeal against Protestants, Jansenists and Quietists, Louis had been involved in grave quarrels with two popes. In 1664 he threatened war against Alexander VII because of disrespect to the French ambassador in Rome, François de Créquy, by the pope's Corsican guard. A long dispute with Innocent XI about the extension of the *régale* or royal right of appointment to benefices led in 1681 to the convening of an assembly of the Gallican Church to settle the question; and in 1682 this assembly proceeded to formulate the famous "Four Articles," which made such a challenge to the pope's jurisdiction that France seemed on the brink of schism from Rome. Not until 1693 did Louis abandon these articles, forced to do so by the general situation.

Little able to judge for himself in doctrinal controversies, Louis

above all looked for obedience and unity among his subjects in matters of faith as in all else. The policy that he sponsored provoked the growth of opposition and the spread of unbelief.

The Conclusion of the Reign.—When Louis, duc de Bourgogne (1682–1712), eldest son of the dauphin Louis (1661–1711), reached his majority, Louis XIV proudly remarked that hitherto in France, no one had ever seen father, son and grandson all of age together and that the danger of a minority was averted for a long time. Yet when the king died, at Versailles on Sept. 1, 1715, death had already removed the two intermediate generations, and the heir to the old king was his five-year-old great-grandson, Louis XV, third and only surviving son of the duc de Bourgogne. Great sadness had clouded the last years of the reign and Louis XIV was little regretted by his subjects.

Voltaire extolled the reign in his *Siècle de Louis XIV* (1751); and later historians have variously appreciated a man and a regime which, in the difficult circumstances of the times, through wars and economic crises, yet made a great contribution to the progress and grandeur of France in Europe as well as to the lasting prestige of the French nation.

See also references under "Louis XIV" in the Index.

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(V. L. T.)

LOUIS XV (1710–1774), king of France from 1715 to 1774, was born at Versailles on Feb. 15, 1710, the great-grandson of Louis XIV and the third son of Louis, duc de Bourgogne, and Marie Adélaïde of Savoy. His parents and his only surviving brother having all died in 1712, he became king at the age of five on Louis XIV's death (Sept. 1, 1715). Until he attained his legal majority in Feb. 1723 France was governed by Philippe, duc d'Orléans, as regent. At first the child's delicate health made it seem unlikely that he would live long. In his infancy he was educated by his governess, the duchesse de Ventadour (C. E. M. de La Mothe-Houdancourt), and after 1714 by his tutor, the bishop of Fréjus, the future cardinal André Hercule de Fleury. He was betrothed in 1721 to the infanta Mariana, daughter of his uncle Philip V of Spain, and in Oct. 1722, five months before his majority, he was consecrated king at Reims.

After the death of the duc d'Orléans (1723), Louis took as his premier minister Louis Henri, duc de Bourbon. During this administration the Spanish betrothal was canceled, and the king was married in Sept. 1725 to Marie Leszczynska, daughter of the dispossessed Stanislaw I of Poland. A well-educated, pious and charitable woman but plain in appearance and nearly seven years her husband's senior, she was to bear him two sons and seven daughters. When Fleury had taken Bourbon's place as premier minister (1726), the dynastic connection with Poland led to French intervention in the War of the Polish Succession in 1733. France intervened nominally in support of the claims of Louis XV's father-in-law but really in order to secure, as compensation for the loss of Poland, the transfer of the duchy of Lorraine to Stanislaw and its eventual reversion to France through Marie. This provision was agreed to by Austria in the preliminary peace treaty of Vienna (Oct. 1735), so that when Stanislaw died in 1766 Lorraine came effectively under French sovereignty.

Louis XV's personal influence on French policy became perceptible only after Fleury's death (Jan. 1743). His first major decision was to announce that henceforth he would have no premier minister. Theoretically, this should have meant that the business of the central government would be conducted, as under Louis XIV, between the king and each secretary of state or departmental minister and that the co-ordination of policy would be left, not to the royal council, but to the king himself. Unfortunately, Louis had neither the energy nor the sense of duty requisite for the performance of such a task. Handsome, intelligent, devoted to his children and courageous on the field of battle, he was yet timid and lacking in self-confidence as a ruler, morbid in his personal fancies, a slave to his passions and a religious bigot. Indifferent to his subjects' welfare, he kept himself increasingly isolated at court, where he sought relief from oppressive etiquette and administrative routine in hunting and sensual excesses. Consequently the authority of the royal council was undermined, no firm direction was given to national policy and the ministers themselves, while attempting to dominate, often became the victims of court factions and intrigue.

Because Louis rapidly degenerated into a *roi fainéant*, ambitious generals and ministers were induced to press their claims to advancement or political predominance through the royal mistresses. Though the influence of the latter never amounted to "petticoat government," as has often been supposed, it did contribute further to establish the rule of court factions. Pauline de Mailly-Nesle, marquise de Vintimille, who was the king's mistress from 1739 to 1741, sponsored the anti-Austrian court faction led by the future marshal de Belle-Isle, which prepared French intervention in the War of the Austrian Succession, despite previous French acceptance of the Holy Roman emperor Charles VI's Pragmatic Sanction. Her sister Marie, duchesse de Châteauroux, who was the king's mistress between 1742 and her death in Dec. 1744, backed the designs of the duc de Richelieu (L. F. A. du Plessis) to succeed to the political influence of Fleury. The most celebrated of these "political" mistresses, the marquise de Pompadour, whose influence over the king lasted from Sept. 1745 till her death in April 1764, was a staunch protector of the literary clique of the *Encyclopédistes* and a supporter of Louis' other powerful minister, the duc de Choiseul. The comtesse du Barry, last of the king's favourites, apart from contributing to the dismissal of Choiseul in 1770, exercised little or no political influence.

The king's interest in Polish affairs and his wish to influence directly the course of foreign affairs were at the root of his system of "secret diplomacy," the so-called *secret du roi*. The original object of this, from 1743 onward, was to promote the candidature of Louis François de Bourbon, prince de Conti, to the elective Polish throne by means of secret agents maintained by the king in various European capitals. From 1752 the head of this unofficial network of diplomacy was Charles François, comte de Broglie, French ambassador to Poland. The king's personal policy in foreign affairs was often at variance with that conducted by his official advisers, who remained for the most part ignorant of its details and objectives. In general, this secret diplomacy aimed at maintaining the waning strength of France's traditional allies in northern and eastern Europe, namely Sweden, Poland and Turkey; but the incoherence of French official and secret diplomacy was seen at its worst in 1772, when Prussia, Austria and Russia were able to partition Poland and virtually to eliminate French influence in central Europe. The existence of the *secret du roi* had meanwhile become well known to foreign powers: it was used by the Austrian statesman Wenzel Anton von Kaunitz, in his initial secret overtures to the French court, which culminated in the conclusion of the Franco-Austrian treaties of alliance of May 1756 and May 1757 after Prussia, which had previously been France's ally against Austria; had come to terms with France's other traditional enemy, Great Britain. This reversal of alliances or diplomatic revolution was largely the product of the inertness of French official foreign policy between 1748 and 1756, resulting from the king's subordination of the ministry of foreign affairs to his secret agents. It did not redound to the French advantage in the ensuing Seven Years' War, since it bound the government to unprofitable continental commitments during the crucial maritime and colonial struggle with Great Britain and made it harder to maintain French influence in Turkey. The loss of most of the French possessions in Canada and India followed.

During the later years of Louis XV's reign an attempt was made to strengthen the waning authority of the crown by withdrawing from the *parlements* the privilege of obstructing royal legislation. This privilege, suspended by Louis XIV, had been restored to the *parlements* during the regency. The judicial magistrates had later consolidated their position as opponents of the crown by claiming, in the absence of the estates-general, to be defenders of the fundamental laws of the kingdom and by uniting the provincial *parlements* in a close union with the *parlement* of Paris. In this way they had overthrown the financial system of John Law, had helped to procure the expulsion of the Jesuits in 1764 and had, for a time, disrupted the provincial administration of Brittany. The *parlements* also stood resolutely in the way of financial reform. In 1771 the chancellor, René de Maupeou, determined to strike at this abuse by restricting the *parlement* of Paris to purely judicial functions and by abolishing the sale of judicial offices. Despite some popular opposition, the new judicial system functioned effectively till the king's death and might have saved the Bourbon monarchy from the path that led to revolution if his successor had not gratuitously abandoned the reform. Apart from this reform, Louis XV's long reign had been marked by a decline in the crown's moral and political authority and by reverses in foreign and military affairs. Popular in his youth as "Louis the Well-Beloved," the king died at Versailles on May 10, 1774, hated as much as Louis XIV had been.

See FRANCE: *History; see* also references under "Louis XV" in the Index.

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LOUIS XVI (1754–1793), king of France from 1774, was born at Versailles on Aug. 23, 1754, the third son of the dauphin Louis and his consort Maria Josepha of Saxony. At first known as the duc de Berry, he became the heir to the throne on his father's death in 1765, since his second elder brother had died in 1754 and his eldest brother in 1761. His education was entrusted to the duc de La Vauguyon (Antoine de Quélen de Caussade), who made little effort to ensure that he should be properly trained for his responsibilities. Louis nevertheless possessed an excellent memory, acquired a sound knowledge of Latin and English and took an interest in history and geography. In 1770 he married the Austrian archduchess Marie Antoinette (*q.v.*), daughter of Maria Theresa and the Holy Roman emperor Francis I.

On the death of his grandfather Louis XV, Louis succeeded to the French throne on May 10, 1774. At that time he was still immature, lacking in self-confidence, austere in manner and, because of a physical defect (later remedied by an operation), frigid in his relations with his young wife. Well-disposed toward his subjects and interested in the conduct of foreign policy, Louis had not sufficient strength of character or power of decision to combat the influence of court faction or to give the necessary support to reforming ministers, such as Turgot or Necker, in their efforts to give greater stability to the tottering finances of the *ancien régime*. The prestige of the monarchy was also compromised early in his reign by the decision in Aug. 1774 to restore the political powers of the *parlements*, which had been withdrawn in 1771. Louis XVI's reign before 1789 coincided with the increasing strength of the aristocratic reaction. It was aristocratic opposition to the fiscal, economic and administrative reforms of the controller general of finance, Calonne, in 1787 that forced the king, in July 1788, to summon the estates-general for the following year and thus led to the Revolution (*see* FRANCE: *History;* FRENCH REVOLUTION).

After 1789 Louis XVI's incapacity to rule, his irresolution and his surrender to reactionary influences at court were partially responsible for the failure to establish in France the forms of a limited constitutional monarchy. Louis had at first rightly regarded the Revolution as the product of an aristocratic Fronde and should, therefore, have grasped the opportunity of forming an alliance between the crown and the middle-class reformers in the Constituent Assembly. Instead he allowed himself, in the spring of 1789, to be dominated by the reactionary clique surrounding his younger brother Charles, comte d'Artois (*see* CHARLES X, king of France), and to be converted to the policy of defending the privileges of the clergy and nobility. He continued to believe, even after the increasingly radical trend of popular movements in Paris and the provinces had demonstrated the futility of such hopes, that the Revolution would burn itself out.

By this time the fundamental weakness of the king's character had become evident: lethargic in temperament, lacking political insight and therefore incapable of appreciating the need to compromise, Louis continued to practise his personal hobbies (making locks and doing a little masonry) and to offset his overindulgence in food and drink by hunting. He dismissed Necker in early July 1789 and showed his reluctance to sanction the Declaration of the Rights of Man and the destruction of the feudal regime in August. His resistance to popular demands was one of the causes of the forcible transfer of the royal family from Versailles to Paris on Oct. 6. Yet he made still more mistakes, refusing to follow the secret advice tendered to him after May 1790 by Mirabeau, abdicating his responsibilities and acquiescing in the disastrous attempt to escape from the capital to the eastern frontier on June 20, 1791. Caught at Varennes and brought back to Paris, he seems thenceforward to have been completely dominated by the queen, on whom must accordingly fall the chief blame for the court's subsequent political duplicity and outright treason.

From the autumn of 1791 the king tied his hopes of political salvation to the dubious prospects of foreign intervention. At the same time he encouraged J. P. Brissot's policy of war with Austria in the expectation that French military disaster would pave the way for the restoration of his authority as the reward for his mediation with the Austrians. Prompted by Marie Antoinette, Louis rejected the advice of the moderate constitutionalists, led by Antoine Barnave, loyally to implement the constitution of 1791, which he had sworn to maintain, and committed himself to a policy of subterfuge and deception. The outbreak of the war with Austria in April 1792, the suspected machinations of the queen's "Austrian committee" and the publication of the manifesto by the duke of Brunswick threatening the destruction of Paris if the safety of the royal family were again endangered led to the capture of the Tuileries palace by the people of Paris and the provincial *fédérés* on Aug. 10, 1792. It also led to the temporary suspension of the king's powers by the Legislative Assembly and the proclamation by the Convention of the first French republic on Sept. 21. Proof of Louis XVI's secret dealings with Mirabeau and of his counterrevolutionary intrigues with the foreigners were forthcoming in Nov. 1792, after the discovery of incriminating evidence in the Tuileries. On Dec. 3 it was decided that Louis, who together with his family had been imprisoned in the Temple since August, should be brought to trial for treason. He himself appeared twice before the Convention (Dec. 11 and 23). Despite the last-minute efforts of the Girondins to save him, Citizen Capet, as he was then called, was found guilty by the Convention and condemned to death on Jan. 18, 1793, by 387 votes (including 26 in favour of a debate on the possibility of postponing execution) against 334 (including 13 for a death sentence with the proviso that it should be suspended). When a final decision on the question of a respite was taken on Jan. 19, Louis was condemned to death by 380 votes against 310. He was guillotined in the Place de la Révolution in Paris on Jan. 21, 1793.

Louis XVI's courage on June 20, 1792, when the royal palace was invaded by the Paris mob after his dismissal of the Girondin ministry, and his dignified bearing during his trial and at the moment of execution did something to redeem, but did not re-establish, his reputation. He was unfitted by temperament and education for the duties of kingship and he never responded to the challenge of the liberal and democratic forces in France. As he never understood those forces, he feebly attempted first to resist and then to betray the Revolution, which might well, as Mirabeau had seen, have consolidated the royal authority.

See also references under "Louis XVI" in the Index.

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Louis XVI et Marie Antoinette, 2 vol. (1941–43); B. Fay, *Louis XVI* (1955). (A. Gn.)

LOUIS XVII (1785–1795?), titular king of France from 1793, was born at Versailles on March 27, 1785, the second son of Louis XVI and Marie Antoinette. Baptized as Louis Charles, he bore the title of duc de Normandie until he became dauphin on the death of his elder brother, Louis Joseph, on June 4, 1789. A delicate child, he was frequently ill. On the suspension of the monarchy after Aug. 10, 1792 (*see* FRANCE: *History;* FRENCH REVOLUTION), he was imprisoned with the rest of the royal family in the Temple in Paris. Louis XVI was beheaded on Jan. 21, 1793, whereupon the royalists acknowledged his son as king of France.

On July 3, 1793, Louis XVII was taken from his mother: the Paris commune feared royalist attempts to rescue this valuable hostage; and in any case the trial of Marie Antoinette was about to begin. The commune put Louis under the surveillance of a cobbler, Antoine Simon, who treated Louis as a child of the people but cannot be shown to have been positively cruel to him.

On Oct. 6, 1793, P. G. Chaumette and J. R. Hébert, with some other commissioners of the Paris commune, came to interrogate Louis and tried to extract infamous accusations against his mother from him. Next day, Louis saw his sister Marie Thérèse (the future duchesse d'Angoulême) for the last time. On Oct. 16, Marie Antoinette was guillotined.

On Jan. 5, 1794, Simon resigned the custody of Louis XVII, and on Jan. 16 the commune decided that Louis XVII should have a guard of four commissioners, to be renewed daily. This arrangement took effect from Jan. 19. Louis was kept alone in one room, his food being passed to him through a turnbox. On July 28, the day after the fall of Robespierre, Barras went to see him. Recognizing that the child was ill, Barras sent P. J. Desault, chief doctor at the Hôtel Dieu, to see him and appointed a new warder, the Martiniquais J. J. C. Laurent. During the night of Oct. 28 a surprise inspection of the Temple was made by two members of the committee of general security; and the appointment (Nov. 8) of a man called Gomin to assist Laurent seems to have been the consequence of this visit. On Dec. 19 there was an inspection by J. B. Harmand (de la Meuse), J. B. C. Mathieu and J. Reverchon, who found the dauphin ill with a tumour on his elbow. On Jan. 22, 1795, Cambacérès asked the Convention to decide whether Louis and his sister should be kept in prison or expelled from French territory. He himself favoured the former alternative, which the Convention adopted.

On March 31, 1795, Laurent was replaced by Étienne Lasne, a house painter. In May, Lasne and Gomin warned the committee of general security that "the Capet child" was gravely ill. At that time peace talks were going on with Spain and the idea of exchanging Louis XVI's children for the members of the Convention who were prisoners of Austria had been envisaged. Desault, sent to the Temple on May 6, found Louis extremely weak and unresponsive and began to tend him conscientiously, but suddenly died himself on June 1. He was replaced by P. J. Pelletan, chief surgeon at the Humanité hospital, who first visited Louis on June 6 and had him moved to the smaller tower so that he should get more light and air. Louis XVII died, however, on June 8, 1795. An inquest on June 9 having established that the child, "of about ten years of age," had died of scrofula, he was buried on June 10 in the cemetery of Ste. Marguerite, with nothing to mark the site of his grave.

The secrecy surrounding the last months of Louis XVII's life naturally gave rise to rumours: some said that he was not dead but had escaped from the Temple, others that he had been poisoned. The theory of an escape was first put forward in London by a Chouan, Joseph de Puisaye, as early as Oct. 1794. It was passed on by Yves Cormier to Lady Atkyns (née Charlotte Walpole; d. 1836), who convinced herself of its truth. It was then given wide currency by J. J. Regnault-Warin's novel *Le Cimetière de la Madeleine* (1800–01), according to which the dauphin was handed over to the Chouans and another child substituted for him in the Temple. This climate of opinion produced numerous false dauphins or pretenders: J. M. Hervagault in 1798, Mathurin Bruneau in 1815, the baron de Richemont (H. E. L. V. Hébert) in 1828 and more than 30 others, of whom the chief was K. W. Naundorff (*q.v.*). A vast literature grew up on the subject, culminating in the foundation of a monthly *Revue historique de la question Louis XVII* (1905).

There is no real evidence for the theory of poisoning. Louis Hastier (*see* below, *Bibliography*) argues that Louis XVII died in the Temple in Jan. 1794 and was then replaced by another child (who died in turn on June 8, 1795); but the evidence adduced for this theory does not stand up to critical examination.

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LOUIS XVIII (1755–1824), king of France by title from 1795 and in fact from 1814 (except for the interruption of the Hundred Days), was born at Versailles on Nov. 17, 1755, the fourth son of the dauphin Louis (son of Louis XV) and Maria Josepha of Saxony. He received the names Louis Stanislas Xavier and the title comte de Provence. His education was supervised by the devout duc de La Vauguyon (Antoine de Quélen de Caussade), but his own taste was for the writings of Voltaire and the *Encyclopédistes*. He was married on May 14, 1771, to Louise Marie Joséphine of Savoy.

The dauphin's two eldest sons, Louis duc de Bourgogne and Louis duc d'Aquitaine, had died in 1761 and 1754 respectively, and the dauphin himself died in 1765. Consequently the surviving elder brother of the comte de Provence became king as Louis XVI when his grandfather died in 1774. The comte de Provence then had the style Monsieur, as the elder of the king's two brothers; and as long as Louis XVI remained without male issue, Monsieur was heir presumptive to the crown. He courted popularity and took an active part in politics, but the birth of a dauphin in 1781, followed by that of the future Louis XVII in 1785, was a blow to his ambitions. He opposed the revival of the *parlements* (1774), wrote a number of political pamphlets, and at the Assembly of Notables (1787) presided, like the other princes of the blood, over a bureau, to which was given the name of the *Comité des sages;* he also advocated the double representation of the *tiers état* in the estates-general convened for 1789. At the same time he cultivated literature, entertaining poets and writers both at the Luxembourg and at his château of Brunoy and gaining a reputation for wit in the salon of his mistress, the comtesse de Balbi (Anne de Caumont-La Force). When the French Revolution began, he did not emigrate immediately after the taking of the Bastille but, possibly from motives of ambition, remained in Paris. In June 1791, however, at the time of Louis XVI's flight to Varennes, he also fled (by a different route) and, in company with the comte d'Avaray (Antoine Louis François de Besiade, who later replaced Madame de Balbi as his confidant and largely influenced his policy), reached Brussels. There he joined his younger brother, the comte d'Artois, later Charles X of France.

Proceeding to Coblenz, Monsieur put himself at the head of the counterrevolutionary *émigrés* there and set himself up in royal state, appointing ambassadors and soliciting help from the European sovereigns, especially from Catherine II of Russia. Prompted by the comte d'Artois and by the former minister Calonne, he pursued an entirely selfish policy without regard to the situation of Louis XVI and Marie Antoinette in Paris: he obstructed the representatives of the king and queen and issued uncompromising manifestoes (such as those of Sept. 1791 and Aug. 1792). After the French victory at the battle of Valmy (Sept. 1792) he had to retire to Hamm in Westphalia, where, on the death of Louis XVI (Jan. 1793), he proclaimed himself regent. He then went south with the idea of encouraging the royalist feeling in the south of France and settled at Verona, where on the death of Louis XVII (June 8, 1795) he took the title of Louis XVIII.

From this time until 1814 the story of Louis XVIII's life is a record of constant wanderings, negotiations and conspiracies. In April 1796 he joined Condé's army on the German frontier, but shortly afterward he was requested to leave the district and accepted the hospitality of the duke of Brunswick at Blanckenberg till late in 1797. Then the Russian emperor Paul I permitted him to settle at Mittau in Courland, where he stayed till 1801. All this time he was in close communication with the royalists in France, but was much embarrassed by the conflicting policy pursued by the comte d'Artois from England and was largely at the mercy of corrupt and dishonest agents. At Mittau in 1799 he realized his cherished plan of marrying Madame Royale (Thérèse de France, daughter of Louis XVI) to the duc d'Angoulême, elder son of the comte d'Artois. From Mittau, too, was sent his letter to Napoleon Bonaparte (1800) calling on him to use his power to restore the Bourbons—a proposal contemptuously refused. Louis in turn declined to accept a pension from Bonaparte and later, in 1803, though his fortunes were at their lowest ebb, refused to abdicate at his suggestion and accept an indemnity.

Suddenly expelled from Mittau in 1801 by the capricious Paul I, Louis made his way, in the depth of winter, to Warsaw, where he stayed for three years. All this time he was trying to convert France to the royalist cause, and had a *conseil royal* in Paris, founded at the end of 1799 by Pierre Paul Royer-Collard, the abbé Montesquiou, and the marquis de Clermont-Gallerande, but after 1800, and still more after Napoleon's assumption of the title of emperor (May 1804), the royal cause appeared hopeless. In Oct. 1804 Louis met the comte d'Artois at Calmar in Sweden, whence they issued a protest against Napoleon's action. Warned that he must not return to Poland, Louis gained permission from the new tsar Alexander I again to retire to Mittau. After the treaty of Tilsit (1807), however, he was again forced to depart, and took refuge in England, where he stayed first at Gosfield in Essex, then, from 1809, at Hartwell in Buckinghamshire. In 1810 his wife died. When Avaray died (1811), Louis took the equally intransigent but abler Pierre Louis Casimir, comte de Blacas, as his favourite.

After Napoleon's defeats in 1813 the hopes of the royalists revived, and Louis issued a fresh manifesto in which he promised to recognize some results of the Revolution. Negotiations were also opened with Bernadotte (*see* CHARLES XIV John, King of Sweden and Norway), who seemed willing to support his cause, but was really playing for his own hand. In March 1814 the allies entered Paris, and thanks to Talleyrand's negotiations the restoration of the Bourbons was effected. Louis XVIII entered Paris on May 3, 1814, after issuing the declaration of St. Ouen in which he promised to grant the nation a constitution. He did this on June 4 by his *Charte constitutionnelle*.

Louis XVIII was now nearly 60, wearied by adversity and a sufferer from gout and obesity. But though clear-sighted, widely read and a good diplomatist, his impressionable and sentimental nature made him too subject to personal and family influences. His concessions to the reactionary and clerical party of the *émigrés*, headed by the comte d'Artois and the duchesse d'Angoulême, aroused suspicions of his loyalty to the constitution, the creation of his "military household" alienated the army, and the constant presence of Blacas made the formation of a united ministry impossible. After the Hundred Days, when Napoleon's return to France (March 1815) forced Louis to flee to Ghent, the dismissal of Blacas was made one of the conditions of his second restoration. On July 8, 1815, he again entered Paris, "in the baggage train of the allied armies," as his enemies said, but in spite of this he was received with the greatest enthusiasm by a people weary of wars and looking for constitutional government. He was forced to retain Talleyrand and Fouché in his first ministry, but rid himself of them when the elections of 1815 assured him of a strong royalist majority in the chamber (the *chambre introuvable*, a name given it by Louis himself). At this time he came into contact with the young Élie Decazes (*q.v.*), prefect of the police under Fouché, who now became his favourite. Having obtained a ministry he could trust, with the duc de Richelieu at its head and Decazes as minister of police, the king gave it his loyal support and did his best to shield his ministers from attacks by the royal family. In Sept. 1816, alarmed at the violence of the *chambre introuvable*, he was persuaded by Decazes to dissolve it. The Ultras (extreme royalists) failed in an attempt to regain their ascendancy over the king by conniving at the sudden return of Blacas from Rome to Paris.

The king's policy throughout was one of prudence and common sense. While Decazes was in power, the king's policy to a large extent followed his and was rather liberal and moderate. But after the assassination of his nephew the duc de Berry (1820), Louis saw that Decazes, who had been president of the council since Nov. 1819, could no longer carry on the government, and sorrowfully acquiesced in his departure. He then transferred his support to Richelieu, the head of the new ministry.

In the absence of Decazes a new favourite was found to amuse the king's old age, the comtesse du Cayla (Zoé Talon), a protégée of the vicomte Sosthène de La Rochefoucauld and consequently a creature of the Ultras. As the king became more and more infirm, his power of resistance to the intrigues of the Ultras became weaker. The birth of a posthumous son to the duc de Berry (Sept. 1820), and the resignation of Richelieu (1821), left him entirely in their hands, and after Villèle had formed a ministry of an ultra-royalist character, the comte d'Artois was associated with the government, which passed more and more out of the king's hands. The power of the Ultras was further strengthened by the success of the French military intervention in Spain in favour of Ferdinand VII and the absolutist party. Complete control over the chambers was brought about by the creation of 27 new Ultra peers and by the results of the general election of 1824, which produced in the chamber of deputies so strong a royalist majority that Louis, recalling the *chambre introuvable*, named it the *chambre retrouvée*.

Louis XVIII died at the Tuileries, in Paris, on Sept. 16, 1824. He had the Bourbon characteristics, their love of power, a certain nobility of demeanour and a great consciousness of dignity. He also showed tenacity of purpose during his exile and patience during the illness which preceded his death. But he was cold, unsympathetic and calculating, and had always greatly coveted the crown. He had a talent for intrigue, to which was added an excellent memory and a ready wit.

Louis XVIII's *Relation d'un voyage à Bruxelles et à Coblentz, 1791* was published in 1822. Some of his letters are contained in special collections such as *Lettres et instructions de Louis XVIII au comte de Saint-Priest*, edited by P. B. de Barante (1845); *Lettres d'Artwel: correspondance politique et privée de Louis XVIII*, addressed to Avaray (1880); and *Correspondance inédite du prince de Talleyrand et du roi Louis XVIII pendant le congrès de Vienne*, edited by M. G. Pallain (1881; Eng. trans. 1881).

See also references under "Louis XVIII" in the Index.

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(G. DE B. DE S.)

LOUIS I THE GREAT (1326–1382), king of Hungary from 1342 and of Poland from 1370, was born on March 5, 1326, the third son of Charles I of Hungary (Charles Robert or Carobert of Anjou-Naples) and Elizabeth, daughter of Wladyslaw I of Poland. Crowned king of Hungary in succession to his father on July 21, 1342, he was concerned for the greater part of his reign with Italian affairs, fighting against Venice for control of the Adriatic seaboard and against the Neapolitans for dynastic reasons. In 1346 he was defeated by the Venetians at Zara (Zadar), that city having put itself under Hungarian protection. Then in 1347 he led an expedition against the kingdom of Naples: his younger brother Andrew, consort of his second cousin Queen Joan I (*q.v.*) had been murdered there in 1345; and Joan had subsequently married another cousin, Louis of Taranto, a suspected accomplice in the murder. Though Louis of Hungary occupied Naples in 1348, he soon had to retire; a new invasion (1350) also came to nothing, though he was most unwilling to ratify the peace of 1352.

In 1353 Louis married Elizabeth, daughter of Stjepan Kotro-

manic of Bosnia. He next succeeded in forming, in 1357, a great league against the Venetians, who were forced to cede most of the Dalmatian towns to Hungary (treaty of Zara, Feb. 1358).

In central Europe, meanwhile, Louis maintained generally friendly relations with the Habsburgs (differences with Rudolf IV of Austria were peacefully composed at meetings in 1360) and cordial relations with his maternal uncle Casimir III of Poland. The latter, being childless, designated Louis as his successor; and after Casimir's death Louis was crowned king of Poland (Nov. 17, 1370). The Poles, however, never let him exert much real authority over them, though in 1374 he forced them to recognize his infant daughter Maria (*see* below) and her betrothed husband Sigismund of Luxembourg as their future queen and king.

Louis took little action against the growing Turkish threat to Hungary. Instead he reverted to his Italian concerns. When the papal schism of 1378 broke out, he helped his protégé Charles of Durazzo (*see* CHARLES III) to supplant Joan of Naples, after she had mistakenly declared herself for the antipope Clement VII; and at the same time he undertook a third war against Venice. This ended with the treaty of Turin (Aug. 18, 1381), whereby Venice virtually ceded Dalmatia and promised an annual tribute of 7,000 ducats to Louis.

Louis died suddenly at Nagyszombat (Trnava) on Sept. 10, 1382, leaving his daughters Maria (1371–95) and Jadwiga (1374–99) under his widow's guardianship (an elder daughter, Catherine, had died in 1378). Though he had intended that Jadwiga should have the Hungarian succession and Maria (with Sigismund) the Polish, this arrangement was eventually reversed.

LOUIS II (1506–1526), the last Jagiello king of Hungary and Bohemia, was born on July 1, 1506, the only son of Uládszló (Vladislav) II of Hungary and Bohemia and his French consort Anne de Candale. Prematurely born, he was a sickly child who needed all the resources of medical science to keep him alive, but his intelligence was good and he early learned several languages. In his infancy he was crowned king of Hungary (June 4, 1508) and of Bohemia (May 11, 1509) in order that the succession should be assured to him on his father's death, which took place in March 1516; and he was declared of age to rule on Dec. 11, 1521. Married on Jan. 13, 1522, to Maria of Austria, sister of the Holy Roman emperor Charles V, he embarked with her on a life of riotous pleasure which soon disqualified him for affairs. An object of ridicule at his own court, he was kept by the dominant magnates in such penury that he had often to pawn his jewels to raise money for food and clothing, while his kingdom was rent by faction. After precautions against Turkish invasion had been neglected for four years, Hungarian territory was attacked in the summer of 1526. With an inadequate force, Louis advanced against the Turks and was utterly defeated at Mohács on the Danube, on Aug. 29, 1526. He is said to have been drowned in flight from the battlefield. The German king Ferdinand I, husband of Louis II's sister Anna, then claimed the succession to Hungary and Bohemia.

LOUIS, the name of one king consort and of three titular kings of Naples.

LOUIS OF TARANTO (1320–1362) was born in Naples, the second son of Philip of Anjou, prince of Taranto, who was a younger brother of King Robert. After the murder, in 1345, of Andrew of Hungary, first husband of Queen Joan I (*q.v.*), Louis, who was probably implicated in the crime, himself married Joan in 1347; and when King Louis I of Hungary invaded Naples to avenge Andrew, Louis of Taranto fled with Joan to Pope Clement VI at Avignon. Restored in Aug. 1348, Louis withstood another Hungarian attack (1350–52) and then obtained papal consent to his being formally associated with the throne: he and Joan were crowned by a legate on May 27, 1352. On the first anniversary of this event he founded the Knightly Order of the Holy Spirit. His expedition to Sicily (1356–57) had recovered much of the island from the Aragonese when he was recalled to the mainland to suppress a baronial revolt. He died in Naples on May 24 (or 25–26), 1362.

LOUIS I (1339–1384), the first king of the Valois house of Anjou, was born at Vincennes on July 23, 1339, the second son of the future John II of France, from whom he received the countship of Anjou in apanage before being created duc d'Anjou in 1360. Also in 1360 he was married to Mary of Brittany, daughter of Charles of Blois. Meanwhile he had commanded the French right wing at the battle of Poitiers (1356). Sent to England as a hostage under the treaty of Brétigny (*q.v.*), he escaped back to France; and when Anglo-French hostilities were resumed in 1369 he served his brother King Charles V well. When the papal schism of 1378 broke out, Queen Joan I of Naples, who supported the antipope Clement VII, asked Charles V, who also supported Clement, for help and at the same time named Louis as her heir; but Charles V's death (1380) and the needs of the ensuing regency in France prevented Louis from going promptly to Italy. In June 1382, however, having asserted his control over Provence, he advanced into Italy, gathering considerable forces; but Joan was already murdered by the rival claimant to Naples, Charles of Durazzo (*see* CHARLES III), before Louis reached the kingdom. Avoiding an encounter in Campania, Louis moved into Puglia, whither Charles of Durazzo advanced against him. Before the armies could meet, Louis died at Bisceglie on Sept. 21, 1384.

LOUIS II (1377–1417) was born at Toulouse on Oct. 7, 1377, the son of Louis I, whose titles and claims he inherited in 1384. Three years after Charles III's successor Ladislas (*q.v.*) had been expelled from Naples, Louis took possession of that kingdom (1390); but Ladislas defeated him at Taranto and took the city of Naples in 1399, whereupon Louis withdrew to Provence. He was married in 1400 to Yolande, daughter of John I of Aragon. In 1409, the Council of Pisa's pope, Alexander V, called on Louis for help in driving Ladislas out of the papal states; and after entering Rome with Alexander's successor John XXIII in April 1411 Louis moved southward and defeated Ladislas at Roccasecca on May 19. He failed however to exploit his victory and was driven back to Rome in July, whence he withdrew again to Provence in August. When Ladislas died (1414), Louis appealed to the German king Sigismund for recognition, but in vain. He died at Angers on April 29, 1417.

LOUIS III (1403–1434) was born in Anjou on Sept. 25, 1403, the son of Louis II. When Pope Martin V, in accord with a faction in Naples, recognized him as successor designate to the childless Joan II (*q.v.*), Louis in 1420 mustered support in Italy and sailed to blockade Naples, where Joan had adopted Alfonso V of Aragon instead of him. War between Angevin and Aragonese ensued; and in 1423 Joan disinherited Alfonso and adopted Louis instead; but to keep him away from the capital she sent him to govern the duchy of Calabria. Disinherited by Joan in Alfonso's favour in April 1433 but readopted in the following June, Louis died at Cosenza on Nov. 15, 1434, during a campaign against Alfonso's partisan Gian Antonio Orsini, prince of Taranto. His titles passed to his brother René (*q.v.*).

See E. G. Léonard, *Les Angevins de Naples* (1954). (E. Po.)

LOUIS, king of Portugal: *see* LUIS I.

LOUIS OF NASSAU (1538–1574), one of the leaders in the revolt of the Netherlands against Spanish rule, was the most remarkable of the brothers of William the Silent (*q.v.*), prince of Orange. He was born at Dillenburg on Jan. 10, 1538. Very capable, a good diplomat and a wholehearted Protestant (Lutheran by birth, Calvinist in his later years), he was the right man to take care of his elder brother's relations with German princes and French Huguenots, with the lesser nobility or with the Protestant groups in the Low Countries, or again with the Gueux (*q.v.*) abroad. Living at Brussels from 1556, he became in 1566 one of the leaders of the malcontent gentlemen. Like so many others, he went into exile in the following year, but in 1568 he came back at the head of an army invading the northern Netherlands. Victorious over a Spanish force at Heiligerlee, east of Groningen (May 23), an action in which his brother Adolphus was killed, he was himself decisively beaten by the duque de Alba at Jemgum on the Ems (July 21). He then accompanied William of Orange on an equally abortive campaign in the south and thence to France. There he remained till 1572, fighting in the ranks of the Huguenots, establishing excellent relations with Gaspard de Coligny and through him with the king, Charles IX. A series of attacks on the Netherlands by the Orangists, in alliance with France, was

planned for 1572. The action of the Gueux precipitated events. Louis, with a small army, captured Mons in Hainaut (May 23), where he was besieged from June 3 till Sept. 19. Attempts at relief having failed and the massacre of St. Bartholomew's day (Aug. 24) having shattered all hopes of France's entering the war, he capitulated. Even so, by tying down the main Spanish army during the summer, he had given the rebels in Holland the opportunity to consolidate their positions. In order to lighten Spanish pressure on Holland, Louis in 1574, with a force raised in Germany, tried to cross the Meuse, but Sancho d'Avila, heading him off, crushed his troops on the Mookerheide, south of Nijmegen, on April 14. Both Louis and his younger brother Henry were killed.

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LOUIS, JOE (JOSEPH LOUIS BARROW) (1914–), U.S. boxer, held the heavyweight championship of the world longer (1937–49) than any other champion in the division. Born May 13, 1914, at Lexington, Ala., he began his boxing career in Detroit, Mich., winning 43 of 54 amateur bouts by knockouts. In his prime Louis stood 6 ft. 1½ in. and weighed about 200 lb. He had his first professional fight in 1934, and a year later, fought five times in 25 days during one stretch.

Louis knocked out James Braddock in eight rounds to win the world title in Chicago, June 22, 1937, and become the second Negro heavyweight champion. He knocked out six world champions—Primo Carnera, Jack Sharkey, Braddock, Max Baer, Max Schmeling and Joe Walcott. He defended his title 25 times, or more times than the preceding eight champions together. He grossed an estimated $4,225,000 and participated in three of boxing's $1,000,000 gates. Louis retired in May 1949, came out of retirement on Sept. 27, 1950, and lost a 15-round decision to Ezzard Charles in a title match. *See* also BOXING. For portrait *see* article NEGRO, AMERICAN. (J. D. McC.)

LOUIS, a term applied to gold coins that circulated in France before the Revolution. The franc (*q.v.*) and livre were silver coins that had shrunk in value to such an extent that by 1640 coins of a larger denomination were needed. The French kings therefore had gold coins struck and called after their name "Louis" or "Louis d'or." After the Revolution, Napoleon continued the practice but called the coins "Napoleons." They had a value of 20 francs.

LOUISA ULRICA (1720–1782), queen consort of Sweden from 1751 to 1771, was born in Berlin on July 24, 1720, the fifth surviving daughter of Frederick William I of Prussia and Sophia Dorothea of Hanover. She was educated with her brothers and sisters by French governesses and tutors. Her father's favourite, she was made coadjutor of Quedlinburg in 1743. Her marriage to the Swedish crown prince, Adolphus Frederick, which took place in 1744, was arranged by the empress Elizabeth of Russia; her brother Frederick the Great would have preferred the prince to marry Louisa's youngest sister Amalia. Louisa's eldest son, the future Gustavus III of Sweden, was born in 1746.

In 1750 Louisa Ulrica quarreled with her former friend Count Carl Gustaf Tessin, the most powerful representative of the nobles' interests. On her husband's accession to the throne in 1751 she became the leader of the "court party," seeking to abolish the existing constitution and to strengthen the monarchy against the nobles. Frederick the Great advised her to be more cautious and refused to lend her money to buy support for her plans. After the failure of a *coup d'état* in 1756, she was unable to prevent Sweden's entering the war against Prussia in 1757 (*see* SEVEN YEARS' WAR); but the disastrous course of the war strengthened her position, and she was instrumental in promoting negotiations for peace in 1762. On her husband's death, in Feb. 1771, she went to Berlin, where she stayed till 1772. Frederick tried to help her in her difficulties with her son Gustavus, now king of Sweden; but Gustavus showed himself increasingly antagonistic to her till her death, at Svartsjö castle near Stockholm, on July 16, 1782.

Louisa Ulrica encouraged the arts and sciences and did much to promote French cultural influence. She was a notable patron of Linnaeus; she invited Voltaire to settle in Sweden; and in 1753 she founded the Royal Academy of Literature, History and Antiquities (from which, however, the brilliant Tessin was excluded).

Her memoirs and letters were edited by F. Arnheim and published in 1885 and 1909–10, respectively.

See O. Jägerskiöld, *Lovisa Ulrika* (1945).

LOUISBURG (LOUISBOURG), a national historic park in Cape Breton county, Nova Scotia, 26 mi. S.E. of Sydney. After 1713 the French constructed the continent's strongest and most costly fortress at that site. It was captured by New England volunteers in 1745, returned to the French by the treaty of Aix-la-Chapelle in 1748, and recaptured by Gen. Jeffrey Amherst and Adm. Edward Boscawen a decade later. The settlers, numbering about 4,000, were dispersed, and the fortifications were completely demolished. A major restoration of the fortress was begun in 1962.

The modern town of Louisburg (pop. [1961] 1,417) is situated across the harbour. It is a winter shipping port and a centre of fish processing and packing. (C. W. RD.)

LOUISE OF SAVOY (1476–1531), mother of Francis I of France and twice regent for him, was born at Pont d'Ain on Sept. 11, 1476, the daughter of Philippe, comte de Bresse (later duke of Savoy as Philip II), and Marguerite de Bourbon, sister of three successive ducs de Bourbon. In 1488 Louise was married to Charles de Valois-Orléans, comte d'Angoulême, but he died in 1496, leaving her with two children: Margaret (*q.v.*), the future queen of Navarre; and the son who was to become king of France as Francis I (*q.v.*). The accession of her husband's first cousin to the French crown as Louis XII (1498) made Francis heir presumptive to it, and Louise then brought her children to the French court and received Amboise as her residence.

When Louis XII died, on Jan. 1, 1515, Francis became king. Devoted to her son, Louise thenceforward took a major part in the government. Created duchesse d'Angoulême, she was appointed regent when Francis undertook his expedition to Italy (1515–16).

Louise's niece Suzanne de Bourbon died in 1521, leaving all her heritage to her husband, Charles, the constable duc de Bourbon (*q.v.*). Louise, however, claimed part of this heritage, and this claim did much to push the constable into his treason (1523). Regent again in 1525–26 during the king's second Italian expedition and his captivity in Spain, Louise negotiated to detach Henry VIII of England from alliance with the Holy Roman emperor Charles V. On the other hand her insistence on receiving her personal income from the superintendent of finances, Jacques de Semblançay, when money was needed for the army in Italy, is said to have caused the deficiency for which Semblançay was charged with peculation and executed (1527). It was Louise who, with Margaret of Austria, negotiated the peace of Cambrai or "Ladies' peace" between Francis and Charles (1529). Louise died at Grez-en-Gâtinais, near Fontainebleau, on Sept. 22, 1531. An excessively edited version of her *Journal* is printed in the *Nouvelle Collection des Mémoires*, vol. v (1836).

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LOUISIADE ARCHIPELAGO, a group of islands and coral reefs to the southeast of the easternmost promontory of the island of New Guinea, administered by Australia as part of the territory of Papua. Although the islands, which number almost 100, extend over 10,000 sq.mi. of sea, the largest, Sudest (Tagula), measures only about 40 by 7 mi. The principal interest of the islands lies in their structure; rugged and mountainous, they are nevertheless surrounded by the largest coral-fringed lagoons in the southwest Pacific. Misima Island, however, formerly a small gold-mining area, has no lagoon. The group contains no European-owned plantations, but there is a small production of coconuts from native growers. The population numbers about 4,000. Discovered by Luis Vaez de Torres in 1606, the islands were named by L. A. de Bougainville after Louis XV in 1768.

(D. W. F.)

LOUISIANA, one of the west south-central states of the United States at the mouth of the Mississippi river, on the north coast of the Gulf of Mexico. Shaped like a boot, it is bounded on the north by Arkansas; on the east by the Mississippi river and the state of Mississippi; on the south by the Gulf of Mexico; on the west by Texas. The state has an area of 48,523 sq.mi., of which 3,417 are inland water (including 1,060 sq.mi. of landlocked bays called lakes). It borders the Gulf of Mexico for 366 mi. It ranks 31st in size among the states and is popularly known as the "Pelican state"; sometimes as the "Bayou state" and the "Creole state." It was admitted to the union April 30, 1812, and was the 18th state to enter. The 64 political subdivisions called parishes correspond to counties in the other states (see *Government*, below). Baton Rouge is the capital. The state flag consists of a field of dark blue bearing a white pelican feeding and protecting her brood and a white ribbon below with the state motto, "Union, Justice and Confidence." The unofficial state bird is the eastern brown pelican; the official state flower is the magnolia blossom and the official state tree is the bald cypress.

PHYSICAL GEOGRAPHY

Physical Features.—Louisiana lies roughly between 28° and 33° N. and between 89° and 94° W. Geologically it is a new creation and is classified as a coastal plain province. Its soils were formed as submarine deposits. The average elevation of the state is approximately 100 ft.; the highest point is in Bienville parish, 535 ft. above sea level. The physiographic features may be placed in five classifications: uplands, bluffs, alluvial plains, prairies and coastal marshes. These were successive stages in the geologic process of forming the state. The uplands, or pine hills, are divided into three areas: (1) north of Lake Pontchartrain and east of the Mississippi river; (2) west of Red river; and (3) the north Louisiana uplands lying between the Red and Ouachita rivers. The bluffs run through the second tier of parishes west of the Mississippi above the mouth of the Red river. The alluvial lands are in the flood plains of the rivers, especially the Mississippi, Ouachita and Red. The prairies become increasingly common south of the Red river and constitute the entire southwestern part of the state. The prairies are generally treeless except for marginal timber along the sluggish meandering streams. They are generally 20 to 30 ft. above sea level and shade off into the coastal marshes. The coastal marshes are generally 20 to 30 mi. wide but may reach a width of 60 mi. The alluvial lands and the coast swamps comprise about 20,000 sq.mi. or better than 40% of the area of the state.

Louisiana has within its borders about 7,500 mi. of navigable waters, including harbours, bays and sounds. The principal rivers are the Mississippi, which flows nearly 600 mi. through and along the border of the state, the Red, the Ouachita, the Tensas, the Atchafalaya, the Calcasieu, the Vermilion, the Sabine and the Pearl. Louisiana is the only state that is divided by the Mississippi river. There are a number of bayous which are of great economic importance for navigation, drainage and scenic beauty. The largest of these are Bartholomew, Dorcheat, Macon, Boeuf, Plaquemine, Lafourche and Teche. The alluvial portion of the state, especially below the mouth of the Red river, is an intricate network of these bayous: before their closure by a levee system they served partially, in time of flood, to carry off the escaping surplus of river waters.

The alluvial region of the state is mainly protected against overflow by a system of levees, or earthen walls, that hold the waters within the stream channels. The state and federal government co-operated in the construction and maintenance of this system, although the national government did not give aid, except for a grant of swamplands in 1850, until 1879, when it began acting through a board of engineers known as the Mississippi River commission. The levee system and flood-control projects represent an expenditure of upward of $500,000,000. Some of the levees are 50 ft. high with a base 100-ft. wide. There are more than 1,700 mi. of levees in the state along the Mississippi, Red, Ouachita and Atchafalaya rivers and other streams.

Some of the lakes, such as Lakes Pontchartrain, Maurepas, Borgne and Sabine, are merely landlocked salt-water bays, the waters of which rise and fall with the tides. Other lakes are cut-off meanders of the Mississippi and Red rivers, known as oxbow lakes. Others are the result of clogging or blocking the outlets of a river, which impeded the flow and forced the water into swamps and low places. Examples are found along Red river.

Climate.—The climate is semitropical and exceptionally equable over large areas. The mean temperature for southern Louisiana is 68.2° F. (20° C.), and is affected by prevailing southerly winds and the network of bays, bayous and lakes. The differences of mean annual temperature are almost wholly caused by differences of latitude or elevation. The mean annual temperature for northern Louisiana is 65.2°. The lowest temperature recorded at New Orleans is 7° (about −13° C.) and the highest 102° (about 33° C.). The lowest and highest temperatures recorded at Shreveport, about 300 mi. N.W., are −5° and 110° respectively. New Orleans has an average of 60 in. of rainfall annually and the mild climate makes possible a growing season averaging 330 days per year. Shreveport has an average precipitation of 44.8 in. and the growing season averages about 209 days. The first severe frost seldom comes before Nov. 15 in the Shreveport area, and the last one is usually before March 15.

Soil.—Louisiana lies entirely in the coastal plain and the soil was once marine sediments. The soil of the uplands, or rolling hills, is now relatively low in nutrient level. This soil is relatively coarse and adapted to forest growth, especially pine trees. It requires fertilizers to produce good crops of cotton and corn. The alluvial and bluff soils are fertile and produce abundant crops. The prairie soil is clay and clay-loam and is well adapted to rice culture and to pasturing. The coastal marshes are used primarily for the production of fur-bearing animals and for sanctuaries for birds and migratory fowl, for which the state is well known.

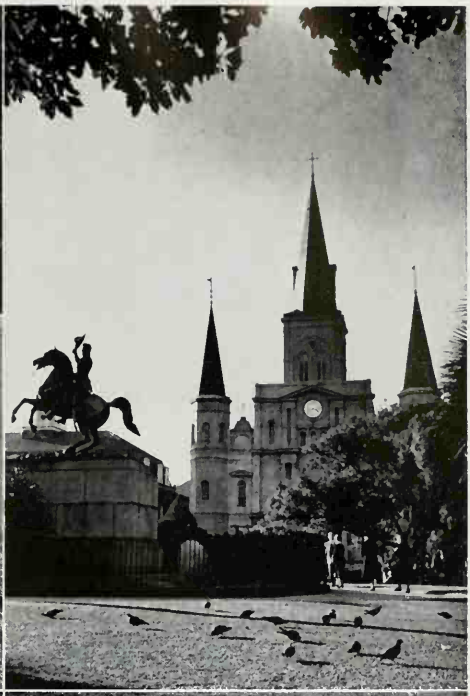
Vegetation.—The state has approximately 150 species of trees. The several kinds of pine are the most valuable. The cypress of the swamps; the tupelo gum, slash pine, sweet and black gums of the lowlands; the shortleaf and longleaf pines, the hickory, 15 varieties of oak and birch on the uplands; plus the trees of minor importance make up the state's forests. Although most of the virgin stands of pine, cypress and tupelo gum have been cut, farmers with woodland plots and owners of cutover tracts have engaged in reforestation and more than half the land area is in forests. The Kisatchie National forest, in the central part of the state, is one of the largest of the reforestation projects. Approximately 12,500,000 pine seedlings were planted there during one 12-month period.

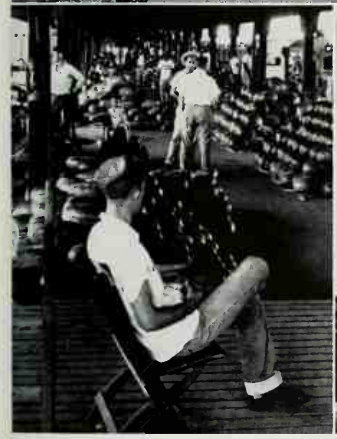
Louisiana has a great variety of wild flowers and shrubs. Azaleas, camellias, crape myrtles, redbuds and magnolias bloom in profusion, both wild and cultured.

Animal Life.—The variety and number of wild animals and fowl give the state the reputation of being a hunter's paradise. The white-tailed deer is found throughout the state and the black bear and the wildcat inhabit the swamp forests. The smaller mammals include opossum, raccoon, otter, skunk, gray fox, squirrels, cottontail and marsh rabbit, weasel, mink, rats, muskrat and moles. Louisiana leads all other states in the number of fur-bearing animals and formerly led in the value of furs produced, but in the second half of the 20th century the value of Louisiana furs declined considerably.

It has been found that 108 species of amphibians and reptiles are native to the state. There are 42 amphibians with 18 belonging to the salamander group; the remaining 24 are frogs and toads. The native reptiles are represented by 66 species, of which the alligator is the largest. There are ten different kind of lizards and 35 species of snakes. Fortunately, only five species of snakes are poisonous. These are the coral snake, the copperhead, the water moccasin, the ground rattler and the canebrake rattler. Twenty species of turtle are native to the state.

The coastal marshes are the greatest winter resort in North America for wild ducks and geese. The commonest varieties of ducks are the mallard, teal, shoveler, gadwall and pintail. It is thought that most of the blue geese of North America winter in the marsh area of the state. The coastal area is visited by many





BY COURTESY OF (TOP LEFT) BATON ROUGE CHAMBER OF COMMERCE, (CENTRE LEFT) NEW ORLEANS DISTRICT CORPS OF ENGINEERS, (BOTTOM CENTRE) LOUISIANA DEPARTMENT OF COMMERCE AND INDUSTRY; PHOTOGRAPHS, (TOP RIGHT, BOTTOM LEFT) A. E. WOOLLEY, (BOTTOM RIGHT) BRADLEY SMITH

SCENES IN LOUISIANA

Top left: Aerial view of state capitol at Baton Rouge. The capitol is on the edge of a small lake and surrounded by a 50-acre park

Top right: St. Louis cathedral facing Jackson square at New Orleans. Bronze commemorates Gen. Andrew Jackson (1767–1845) who defeated the British here during the War of 1812

Centre left: View of the Gulf-Intracoastal waterway west of the Vermilion river in the south-central part of the state. The waterway provides a protected route from the Rio Grande river to Apalachee Bay, Florida

Bottom left: The French market in the Vieux Carré at New Orleans

Bottom centre: World War I memorial tower at Louisiana State university, Baton Rouge

Bottom right: Hunting muskrats from a pirogue in the bayou country of southern Louisiana. The pirogue, a dugout canoe adapted from the Indians, is said "to float on dew"

LOUISIANA

BY COURTESY OF (TOP RIGHT, CENTRE LEFT) LOUISIANA DEPARTMENT OF COMMERCE AND INDUSTRY, (CENTRE RIGHT, BOTTOM LEFT) CITIES SERVICE COMPANY; PHOTOGRAPHS, (TOP LEFT) WALLACE LITWIN, (BOTTOM RIGHT) A. E. WOOLLEY

HISTORICAL AND INDUSTRIAL VIEWS OF LOUISIANA

Top left: Industrial chemical plant at New Orleans. Manufacturing of petrochemicals is a major industry in Louisiana

Top right: Underground mining of salt. Three of the largest salt mines in the world are located in the southern section of the state

Centre left: Old state capitol at Baton Rouge. It was burned during the Civil War and rebuilt in 1882

Centre right: Shrimp boats at anchorage in Venice, in the delta region of the Mississippi river. Shrimp are an important product of the coastal fisheries

Bottom left: Loading oil at the Calcasieu river docks in the city of Lake Charles, southwestern Louisiana

Bottom right: Museum at St. Martinville which was settled by the Acadians, exiled from Nova Scotia, about 1760

sea birds, such as the laughing gull, royal tern, brown pelican, plover, black skimmer and sandpiper. The area is the habitat, also, of the marsh wren, seaside sparrow, Louisiana heron, Wilson's snipe, woodcock and red-winged blackbird.

Among the swamp-loving birds are the American egret, wood duck, great blue heron, ivory-billed woodpecker, bald eagle, cardinal and warbler. In addition to the ducks and geese, the principal game birds are the turkey, bobwhite, upland plover and dove. The wild turkey is found on or near the bluffs adjacent to the stream bottoms. In the upland areas can be found the thrasher, wood thrush, blue jay, mockingbird, catbird, southern whippoorwill, flicker, redheaded woodpecker, Baltimore oriole, bluebird, tanager and bunting.

State and National Parks.—The most important of the state parks are Audubon, Abita Springs, Bogue Falaya, Chemin-A-Haut, Chicot, Fontainebleau, Ft. Macomb, Ft. Pike, Lake Bistineau and Longfellow-Evangeline. The state has a number of game preserves for wildlife and migratory fowl in particular. The most important of these are the Louisiana State Wild Life refuge, State Public Game and Fish preserve, the Terzia Wild Life refuge, Sabine Migratory Waterfowl refuge, Lacassine Migratory Waterfowl refuge, Russell Sage Wild Life Refuge and Game preserve, Rockefeller Wild Life Refuge and Delta Migratory Waterfowl refuge. There are a number of fish hatcheries, pine seedling nurseries and the state forest near Alexandria.

Chalmette National Historical park was the scene of part of the battle of New Orleans (*see* also *Historic Sites*, below). The Caney Creek and Cornie Creek parks are recreational and forestry development areas under the supervision of the federal government.

Historic Sites.—The first permanent European settlement in the present state of Louisiana was Fort St. Jean Baptiste (Natchitoches) built in 1714 by Louis Juchereau de St. Denis. Fort Los Adais, near Robeline, was built in 1721 by the Spanish. Other historic sites include Fort Jesup in Sabine parish, Forts Jackson and St. Philip in Plaquemines parish and Fort Humbug in Caddo. Chalmette National Historical park is in the Chalmette battlefield and the Pleasant Hill and the Mansfield battlefields have areas set aside as parks. The *Vieux Carré* in New Orleans contains many historic buildings such as the Cabildo and St. Louis cathedral; the U.S. military barracks in Baton Rouge were constructed in 1822. The most noted Indian sites are the Indian mounds at Jonesville, Marksville and Poverty Point on Bayou Macon near Delhi.

HISTORY

Indians inhabited the northern portion of the state approximately 2,500 years before Columbus' voyages to the new world, as revealed by the mounds at Poverty Point on Bayou Macon. At the time and for a few hundred years preceding the arrival of Europeans in the region, various tribes of the Caddoan confederacy occupied the northern half of the state. At the time white men came, remnants of various other tribes were found in the eastern and southern portions of the state.

The Spanish knew of the land on the northern shores of the Gulf of Mexico by 1510 and it is possible that one or more Spanish explorers saw the mouth of the Mississippi river before the followers of Hernando de Soto. Alonso Álvarez de Piñeda was in the region in 1519, as was the expedition led by Panfilo de Narváez, 1529–31, but there is no positive proof that either saw the Mississippi. De Soto crossed the river below Memphis and it is probable that he entered the present state of Louisiana before he died. Survivors of his expedition descended the river to its mouth in 1543. Having found no gold or silver mines, the Spanish made no effort to plant colonies on or near the Mississippi river. In 1682 René Robert Cavelier, sieur de La Salle, went down the river from the French possessions in Canada and claimed all the land drained by the river and its tributaries for Louis XIV of France and named it Louisiana. La Salle obtained permission to establish a colony in 1684, failed to find the mouth of the river and landed on the coast of Texas. His efforts to locate the river were futile and he was slain by some of his men in 1687. Eleven years later Pierre le Moyne, Sieur d'Iberville (1661–1706), took up the task of colonizing Louisiana and in 1699 built a fort near the present city of Biloxi, Miss. The next year he erected a fort on the Mississippi 18 leagues (about 40 mi.) above its mouth. This was the first settlement in what is now the state of Louisiana. Antoine Crozat (1655–1738) was granted possession of Louisiana in 1712 for a period of 15 years. The proprietary contract was terminated in 1717, but the first permanent settlement in the present state was made at Natchitoches, on the Red river, in 1714. Louisiana was too much of a drain on the royal treasury and the territory was granted in 1717 to a company organized by John Law (*q.v.*), who did much for the colony before surrendering Louisiana to the crown in 1731. Jean Baptiste le Moyne, Sieur de Bienville (1680–1768), a younger brother of D'Iberville, was the guiding spirit of the colony from 1699 until 1743. It was he who founded New Orleans in 1718. The French began the cultivation of rice, tobacco and sugar cane, but it was not until 1795 that sugar cane became a commercial crop.

The Spanish Period.—The secret treaty of Fontainebleau, Nov. 3, 1762, transferred Louisiana from France to Spain. The next year England received that portion of Louisiana lying east of the Mississippi and Iberville rivers and Lakes Maurepas and Pontchartrain. Many colonists were unhappy over the transfer to Spain and the leaders resisted Spanish possession. When the director of Louisiana, D'Abbadie, issued the proclamation of transfer in 1764 the colonial leaders petitioned to remain French. The first governor Spain sent over, Antonio de Ulloa (1716–95), never took formal possession and was ordered to leave in 1768. Alexander O'Reilly, an Irish officer in the Spanish army, was sent to the colony with a force of about 3,000 men. His affability caused suspicion to subside until he had ascertained the identity of the leaders who opposed Spanish rule. He then invited them to a reception, arrested them, executed five and sent the others to prison in Havana, Cuba. The succeeding Spanish rulers were liberal and tolerant. While Spanish was the official language, the colony remained French in manners and customs. The Spanish governors, while neglecting to enforce the regulations of commerce, instituted a number of reforms that proved beneficial to the people and in the course of time the populace came to appreciate the benefits of Spanish rule. The Spanish officials received the French exiles from Acadia and granted them lands along Bayou Teche. These Acadians made a distinct contribution to the cultural and economic life of the territory.

Some of the Spanish governors endeavoured to induce the people living in the region east of the Mississippi river and west of the Appalachian mountains to secede and join Spanish Louisiana. The river, as the highway of transportation, was used as a bargaining weapon in these efforts.

In 1800 Napoleon coerced Spain into ceding Louisiana to France. The United States frowned upon the transfer because free navigation of the Mississippi was imperative to the people who lived in the valley. Napoleon sold Louisiana to the United States, which took formal possession Dec. 20, 1803. William C. C. Claiborne was appointed by President Jefferson to receive Louisiana from the French official, Pierre Clement de Laussat. A short time thereafter Claiborne was made governor of the territory. (*See* LOUISIANA PURCHASE.)

Territory and Statehood.—Congress provided a government for the territory on March 25, 1804. The act divided the Louisiana Purchase into two territories. The portion south of 33° N. became the Territory of Orleans, with an estimated population of 30,000. The act forbade importing slaves from foreign countries, made English the official language and provided a government less democratic than if the inhabitants had been Anglo-Saxon. The people desired immediate statehood. After the census of 1810, the people in the territory of Orleans held a convention to frame a state constitution and Louisiana became a state April 30, 1812.

Spain refused to surrender the area east of the Mississippi river, and this area south of 31° N., east to the Pearl river and north of Lake Pontchartrain, revolted in Sept. 1810 and established the Republic of West Florida. Three months later, however, it came under the jurisdiction of Governor Claiborne. A few days after

Louisiana was admitted to the union, congress added West Florida to the state. This area is often referred to as the "Florida parishes."

Claiborne was elected the first governor of the state in 1812 and in that year the first steamboat descended the Mississippi river to New Orleans. Gen. Andrew Jackson's forces defeated a British army under Gen. Edward Pakenham at Chalmette, near New Orleans, Jan. 8, 1815, two weeks after the treaty of Ghent was signed ending the War of 1812.

Up to 1860 the state increased in population and prospered from agriculture and commerce. During this period the sugarcane and cotton plantations were flourishing. The river steamboats dominated transportation and New Orleans was the gateway for the trade of the Mississippi valley. The capital was moved from New Orleans to Donaldsonville, 1828–31, and to Baton Rouge, 1849–64, and again after 1882. At other times New Orleans was the capital and a number of state offices have always remained there.

Civil War and Reconstruction.—Louisiana formally seceded from the union Jan. 26, 1861 and six weeks later joined the Confederate States of America. During 1861, many of the young men in military units were sent to Tennessee, Kentucky and Virginia to defend the borders of the Confederacy. New Orleans was taken in April 1862 by a naval force under David G. Farragut and an army commanded by Gen. B. F. Butler. Butler's military administration became so notorious that he was replaced in Dec. 1862 by Gen. N. P. Banks. The capture of Vicksburg and Port Hudson by Union forces in July 1863 opened the Mississippi to navigation. The attempt to capture Shreveport on the Red river resulted in the defeat of General Banks by the Confederates under Gen. Richard Taylor at Sabine Crossroads, near Mansfield, April 8, 1864.

The reconstruction of the state began in Dec. 1862, when President Lincoln ordered the Union military government to hold elections for congress. Those chosen were seated in Feb. 1863. Civil government superseded military rule in March 1864 and during the year a convention assembled to rewrite the state constitution. The reconstructed government represented half of the area, two thirds of the population of the state and was backed by the army.

The Confederate government under Gov. Thomas O. Moore (1860–64) and Gov. Henry W. Allen (1864–65) was at Shreveport. Thus Louisiana had two governments during most of the war. The people of Louisiana accepted military defeat and by 1866 the former Confederates had succeeded in gaining possession of most of the local government and most of the state offices, although not of the governorship. The radicals were not pleased with the situation and wanted to convene a convention to rewrite the constitution. Unable to call a convention through the medium of state government, they endeavoured to reconvene the constitutional convention of 1864. The effort to disperse the illegal convention in 1866 resulted in the death of almost 50 persons, mostly Negroes. The incident was used by politicians to overthrow presidential Reconstruction and institute congressional Reconstruction in 1867. The state constitution of 1868 gave suffrage to the Negroes and disfranchised a large number of white citizens. Probably no other southern state suffered as much as Louisiana under the corrupt carpetbag government of 1868–76, during the administrations of Henry Clay Warmoth (1868–72), P. B. S. Pinchback (one month in 1872) and William Pitt Kellogg (1872–76). The Democrats claimed the election of John McEnery in 1872, but the federal government supported the Republican, Kellogg. A number of clashes occurred between the factions, the most noted of which was Sept. 14, 1874, in New Orleans, when the White league briefly wrested control of the city from the Republican police. In 1876 the Democrats claimed that Gen. Francis T. Nicholls was elected but the Republicans claimed that S. B. Packard had won. Their claims were intertwined with the choice of presidential electors for that year. The Republicans manipulated the state returning board and sent two sets of election returns to congress and the Democrats sent their returns. The electoral commission accepted the Republican electors, just as it did those in dispute from South Carolina, Florida and Oregon. Both Nicholls and Packard took the oath as governor in Jan. 1877 and set up rival governments which continued until President Hayes ordered the withdrawal of federal troops from the capital on April 20, 1877, and the white Democratic party was left in control.

After 1877 the state began to reconstruct its economy. Efforts were made to attract settlers; a new constitution was written in 1879; the channel of the Mississippi river was deepened at its mouth by the construction of jetties to increase maritime shipping, and railroads were built to facilitate overland transportation; levees were constructed to prevent floods; and efforts were made to curb the ravages of malaria and yellow fever. By 1900 the state had made some headway and was on the threshold of spectacular economic developments through the exploitation of the state's abundant natural resources of oil, gas, sulfur, salt and timber.

20th Century.—In the spring of 1927 the most devastating flood in the history of the state inundated 1,300,000 ac., drove 300,000 people from their homes and destroyed millions of dollars' worth of property. The catastrophe proved the inadequacy of the existing levees and demonstrated that flood control of the Mississippi river was a responsibility of the federal government. In 1928 congress responded by appropriating $325,000,000 for that purpose.

The government of Louisiana was dominated by landed gentry until 1928 when the election of Huey P. Long as governor challenged the old regime and a tumultuous political era began with the rural and working classes pitted against the urban leaders. Long won a vast following and built a formidable political machine. In the U.S. senate (1930–35) he attracted national attention with his Share the Wealth program before he was assassinated in 1935. He had modernized the highway system; expanded the Louisiana State university and hospitals; provided free textbooks for school children; constructed a new state capitol and governor's mansion; and built a sea wall, an airport, a bridge over the Mississippi river and a spillway at New Orleans. His political machine lost in the governor's election of 1940, after Oscar K. Allen and Richard W. Leche had been elected governor in 1932 and 1936, respectively, and Alvin O. King (Jan. to May 1932), James A. Noe (Jan. to May 1936) and Earl K. Long (June 1939 to May 1940) had served to fill unexpired terms.

The so-called reform administrations of governors Sam H. Jones and James H. Davis appeared to achieve some improvement. Earl K. Long, brother and political heir of Huey, was elected in 1948 and expenditures for education, hospitals and welfare were greatly increased. Robert F. Kennon defeated Long's candidate, Judge Carlos G. Spaht, in 1952 but Long was elected again in 1956. Governor Long, in three mental institutions within a period of a month in 1959, sought to circumvent the constitutional provision that a governor could not succeed himself but eventually filed as a candidate for lieutenant governor on the ticket of James A. Noe. The ticket was defeated in the primary. Long was subsequently nominated for congressman from the 8th district but died suddenly on Sept. 5, 1960, before the election. Governmental expenditures in Louisiana increased precipitously after 1930, in greater proportion than did those of neighbouring states.

In national politics the traditionally Democratic state was carried by the Dixiecrats in a three-cornered fight among the States' Rights Democrats, Democrats and Republicans in 1948. In 1952 both Democratic and Republican presidential candidates campaigned in the state for the first time in many decades. The Democratic candidate, Adlai Stevenson, carried the state. In 1956, with less than 40% of the electorate voting, a Republican presidential candidate, Dwight Eisenhower, carried the state for the first time since Reconstruction (1877). In 1960 Louisiana returned to the Democratic fold, voting for John F. Kennedy, but in 1964 again went Republican, for Barry Goldwater.

GOVERNMENT

The Roman law was the basis of legal procedure in Louisiana under both French and Spanish regimes. The French and Spanish had divisions of territory for religious administration. These religious divisions, known as parishes, were conveniently used for civil administration, hence the names of saints in parish nomen-

clature. The territorial act of 1804 used "county" to designate governmental subdivisions. In 1807 the nomenclature for these units was changed back to "parish" and that term still is used for 64 local units of government.

Louisiana has had ten constitutions since becoming a state in 1812; the present constitution, adopted June 18, 1921, has been amended more than 300 times.

The legislative branch of government consists of two houses—the senate with 39 senators elected from 33 districts and the house of representatives of 101 members. The regular session of the legislature, convening in May of the even-numbered years, is limited to 60 days. The session convening in May of the odd-numbered years is limited to 30 days and can only consider financial legislation unless three-fourths of the members consent.

The judicial authority is vested in a supreme court, 7 courts of appeal and 25 judicial district courts, with each police jury (parish governing body) authorized to establish justice of peace courts, and with municipalities having the power to create juvenile and municipal courts. The supreme court is composed of a chief justice and six associate justices, elected from six supreme court districts (district one elects two). Their term is for 14 years with the term of one expiring every two years. The state, exclusive of the parish of Orleans, is divided into two circuits, with three courts of appeal in each and an additional court for Orleans parish. Each court of appeal has three judges elected for a term of 12 years. There are 25 judicial districts, with one judge elected for a period of six years to serve each judicial district court, except three districts that have two or three judges each.

The executive branch of government consists of the governor, lieutenant governor, auditor, treasurer, secretary of state, registrar of the land office, commissioner of agriculture and labour, commissioner of conservation, attorney general and superintendent of public instruction.

Suffrage is granted to every citizen of the state who has attained the age of 21 and who has resided in the state two years, in the parish one year and in the precinct three months preceding the election; who is legally enrolled as a registered voter; and who is of good character.

Real-estate taxes have become a minor source of state revenue. The chief source of revenue is the general sales tax; other sources of revenue are severance taxes; mineral leases and royalties; gasoline, income, tobacco, beverage and gas-gathering taxes; vehicle licences and fees; corporation franchise taxes; excise licence taxes; and insurance licences and fees. The chief expenditures are for education, public welfare, highways, hospitals and institutions, homestead exemptions, debt service and general government.

Law.—Louisiana civil law is based to a great extent on the French and Spanish laws and especially the Code Napoléon. The other states base their laws on the common law of England. Louisiana was first of the southern states to abolish the poll tax and the first state to provide free textbooks and free lunches for elementary-school students. A law was enacted in 1936 to exempt from taxation homesteads up to a valuation of $2,000.

POPULATION

The descendants of the French are found in the area bounded roughly by a line from the southwest corner of the state to the juncture of the Red and Mississippi rivers and from that point along the Mississippi to the Gulf of Mexico. Few Spanish came during the 35 years the colony belonged to Spain. St. Bernard has the largest Spanish influence. The Italians, the most numerous of the modern immigrant groups, are principally in the cities. Hungarians are found in the strawberry belt, Slovenians in the fishing and citrus-fruit districts and Germans in and near New Orleans.

The population of Louisiana has increased steadily since 1810 when it was 76,556; in 1850 it was 517,762; in 1900, 1,381,625; in 1950, 2,683,516; and in 1960 was 3,257,022. The population per square mile in 1960 was 67.1 as compared with 55.3 in 1950 and with 49.6 for the U.S. in 1960. The 1960 census gave 63.3% of the population living under urban conditions as compared to 54.8% in 1950 and 41.5% in 1940 which indicates a marked acceleration of the urbanization trend first noted about 1900. The

*Louisiana: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	3,257,022	2,683,516	2,363,880	1,798,509	1,381,625
Abbeville	10,414	9,338	6,672	3,461	1,536
Alexandria	40,279	34,913	27,066	17,510	5,618
Bastrop	15,193	12,769	6,626	1,216	787
Baton Rouge	152,419	125,629	34,719	21,782	11,269
Bogalusa	21,423	17,798	14,604	8,245	—
Bossier City	32,776	15,470	5,786	1,094	—
Bunkie	5,188	4,666	3,575	1,743	873
Covington	6,754	5,113	4,123	2,942	1,205
Crowley	15,617	12,784	9,523	6,108	4,214
Daigleville	5,906	4,809	—	—	—
Denham Springs	5,991	2,053	1,233	500	—
De Ridder	7,188	5,799	3,750	3,535	—
Donaldsonville	6,082	4,150	3,889	3,745	4,105
Eunice	11,326	8,184	5,242	3,272	316
Franklin	8,673	6,144	4,274	3,504	2,692
Goosport	16,778	8,318	—	—	—
Gretna	21,967	13,813	10,879	7,197	—
Hammond	10,563	8,010	6,033	3,855	1,511
Harahan	9,275	3,394	1,082	—	—
Houma	22,561	11,505	9,052	5,160	3,212
Jeanerette	5,568	4,692	3,362	2,512	1,905
Jefferson Heights	19,353	—	—	—	—
Jennings	11,887	9,663	7,343	3,824	1,539
Kaplan	5,267	4,562	2,838	876	—
Kenner	17,037	5,535	2,375	1,882	1,253
Lafayette	40,400	33,541	19,210	7,855	3,314
Lafayette Southwest	6,682	—	—	—	—
Lake Charles	63,392	41,272	21,207	13,088	6,680
Lake Providence	5,781	4,123	3,711	1,917	1,256
Mansfield	5,839	4,440	4,065	2,564	847
Minden	12,785	9,785	6,677	4,105	1,561
Monroe	52,219	38,572	28,309	12,675	5,428
Morgan City	13,540	9,759	6,969	5,429	2,332
Natchitoches	13,924	9,914	6,812	3,388	2,388
New Iberia	29,062	16,467	13,747	6,278	6,815
New Orleans	627,525	570,445	494,537	387,219	287,104
North Shreveport	7,701	—	—	—	—
Oakdale	6,267	5,598	3,933	4,016	—
Opelousas	17,417	11,659	8,980	4,437	2,951
Pineville	8,636	6,423	4,297	2,188	617
Plaquemine	7,689	5,747	5,049	4,632	3,590
Port Allen	5,026	3,097	1,898	920	—
Rayne	8,634	6,485	4,974	2,720	1,007
Reserve	5,297	4,465	—	—	—
Ruston	13,991	10,372	7,107	3,389	1,324
Saint Martinville	6,468	4,614	3,501	2,465	1,926
Shreveport	164,372	127,206	98,167	43,874	16,013
Slidell	6,356	3,464	2,864	2,958	1,129
Springhill	6,437	3,383	2,822	718	—
Sulphur	11,429	5,996	3,504	1,714	—
Tallulah	9,413	7,758	5,712	1,316	—
Thibodaux	13,403	7,730	5,851	3,526	3,253
Ville Platte	7,512	6,633	3,721	1,364	163
West Monroe	15,215	10,302	8,560	2,240	775
Westwego	9,815	8,328	4,992	4,083†	1,763†
Winnfield	7,022	5,629	4,512	2,975	—

*Populations are reported as constituted at date of each census. †Ward 4 of Jefferson parish, which includes Westwego.
Note: A dash indicates place did not exist during reported census or data not available.

five standard metropolitan statistical areas (Baton Rouge, Lake Charles, Monroe, New Orleans and Shreveport) in 1960 contained about 50% of the total population of the state. The number of Negroes is not increasing as rapidly as the white race and the Negroes are moving to urban areas. Negroes constituted 31.9% of the population in 1960 and 33% in 1950. The number of people over 65 and the number under 15 years of age constitute a larger relative percentage of the total population; that is, the age group, 15 to 65, is not increasing in numbers as rapidly as the younger and older age groups. The number of births per 1,000 population in 1960 was 27.7% and in 1950 it was 29.7%.

EDUCATION

Elementary and Secondary.—Education was the function and responsibility of the church during the French period. During the Spanish period, although the church exerted the most powerful influence, the government did make a pretense of establishing a free public-school system in 1771 when four professors were sent from Spain and Governor Unzaga was ordered to pay their salaries out of the general fund until permanent taxes for the purpose could be provided. Only one such school was opened (in 1772) and it never enrolled more than 30 students.

During the early years of the American period the people were too busy developing the new country to devote much energy and attention to schools. This was especially true of the Anglo-Saxon Protestants who settled the uplands of northern Louisiana before 1860. The Anglo-Saxons who settled in the southern portion of the state were, generally speaking, sons of slave owners of Vir-

ginia and the Carolinas, who believed that education was the responsibility of parents and who hired tutors or sent their children to private schools. This class, together with the older French settlers, who considered education to be a function of the church, usually controlled the government of the state and never made a sincere effort, such as New England made, to establish a free tax-supported school system. Hence education received only token support and few free schools were opened outside New Orleans. John McDonogh, a wealthy New Orleans merchant and financier who died in 1850, left half his fortune for the promotion of education in New Orleans. Before the American Civil War most of the free schools there were supported from this fund.

A few tax-supported schools were opened in the 1880s but the economic conditions of the state did not make possible the development of a free-school system until 1910. Tremendous progress has been made since that time in the number of children in school; the number and training of the teachers; the financial expenditures; and the construction of school plants. Although earlier statutes authorized parish police jurors to provide free textbooks for the children of parents unable to purchase them, Governor Long in 1928 sponsored a free-textbook law for all the children of the state. Later governors instituted free-lunch programs and paper, pencils and other materials were provided from tax funds. The automobile and the development of good roads made possible the consolidation of schools so that better-trained teachers and modern library, laboratory and classroom facilities became generally available. The one-room school has disappeared. The first compulsory school attendance laws were enacted in 1916. By 1950 attendance in elementary schools was compulsory for children between the ages of 7 and 15, inclusive, and approximately 94% of the children between 6 and 18 years of age attended school; public high schools enrolled a larger proportion of the elementary school graduates than ever before and a greater proportion of high-school graduates entered college. Education had become the most important enterprise in the state and took the largest portion of the tax dollar. The annual state budget for education increased precipitously in the decade after 1950, reaching more than $175,000,000 or about $55 per child for the more than 900,000 children of school age in the state; expenditures per pupil in average daily attendance reached $330.

Administration.—The head of the public-school system is the state superintendent of public education who is elected for a term of four years by popular vote. An 11-member state board of education, elected by popular vote for overlapping terms, has general jurisdiction over all tax-supported elementary, high, special and trade schools and institutions of higher learning except Louisiana State university, its branches in New Orleans and Chambers and its medical school, also in New Orleans, which are under the supervision of a special board of 15 members appointed by the governor for a term of 14 years, the term of two members expiring every two years. In addition, each of the parishes and three of the cities have school boards, with a superintendent.

In the second half of the 20th century there were about 24,000 teachers and principals in the tax-supported elementary and secondary schools. Of these approximately 16,000 were white, staffing about 850 schools with approximately 400,000 students; about 8,000 were Negroes staffing about 550 Negro schools with approximately 126,000 students. The salary schedule is the same for all teachers of equal training and experience. After World War II the state made impressive efforts to provide equal facilities for white and Negro children.

Private and parochial schools for white children numbered about 240 with about 3,000 teachers and approximately 95,000 students. There were about 100 such schools for about 23,000 Negro students, taught by about 650 teachers.

Segregation.—Following the U.S. supreme court decision (1954) declaring racial segregation in the public schools to be unconstitutional, the Louisiana legislature in 1956 exempted from the compulsory attendance laws any school ordered by the federal courts to desegregate, and the state constitution was amended, authorizing the legislature to maintain segregation. The 1960 legislature enacted additional measures but court decisions that same year indicated that all such acts would be held unconstitutional, and while they might delay integration they could not prevent it. The courts ordered integration in New Orleans (Orleans parish) and in East Baton Rouge, St. Helena, St. Bernard and Tangipahoa parishes by 1964. Roman Catholic Archbishop Joseph F. Rummel ordered all Catholic parochial schools integrated as soon as the public schools in those parishes were integrated. Many Catholics objected and at least three of the segregation leaders were excommunicated.

Higher Education.—The growth and development of higher education was dependent upon the elementary- and secondary-school system and therefore lagged behind it. The State Seminary of Learning and Military institute opened near Alexandria in 1860 with William T. Sherman as president and eventually grew into the Louisiana State University and Agricultural and Mechanical college. It is one of the state's two land-grant schools, the other being Southern University and Agricultural and Mechanical college (for Negroes). The buildings burned in 1869 and the institution was moved to Baton Rouge where it was housed in the State School for the Deaf until 1885. The Agricultural and Mechanical college was moved from Donaldsonville to Baton Rouge in 1877, to be operated in conjunction with the university because of limited finances; the temporary union has proved to be permanent. Two brothers, David French Boyd and Thomas Duckett Boyd, directed the institution for most of the period, 1884–1927, the latter serving as president from 1896 to 1927. Gov. John Milliken Parker advocated a greater Agricultural and Mechanical college in 1920 and purchased a plantation for the site. The university rejoined the college on its 4,700 ac. campus in 1925. The medical school was established in New Orleans (1934) as a branch of the university and in 1958 Louisiana State university in New Orleans was opened as another branch. A junior-college branch was established at Chambers in 1959. The university was ordered by the U.S. courts to admit Negroes to its graduate and professional schools (1951) and then to its undergraduate branch at New Orleans (1958). At various dates the courts ordered Negro admission to Southeastern Louisiana college, the University of Southwestern Louisiana (formerly Southwestern Louisiana institute), McNeese State college and the state trade schools.

The Louisiana State Normal school, opened at Natchitoches in 1884, was made a four-year college in 1917 and the name was changed. For 30 years it enjoyed a monopoly of training teachers for the public schools. After the other state colleges began training teachers, the Normal college expanded its services and the name was changed to Northwestern State College of Louisiana. It is divided into five schools: arts and sciences, applied arts and sciences, education, nursing and the graduate school.

Louisiana Polytechnic institute, Ruston, was established in 1895 as the Louisiana Industrial Institute and college. It was made a four-year college in 1917 and its name was changed in 1926. The organization consists of six schools: arts and sciences, agriculture and forestry, business administration and economics, education, engineering and home economics. The teacher-training program began in 1917 and a graduate program for the master's degree in 1958.

The University of Southwestern Louisiana, Lafayette, was opened in 1901 as the Southwestern Louisiana Industrial institute. The name was changed to Southwestern Louisiana institute in 1920 and to the present name in 1960. It is organized into schools of agriculture, commerce, engineering, home economics, liberal arts and nursing. With over 5,000 students, it has the second largest enrollment of any state-supported college. It began a graduate program for the master's degree in 1956.

Southeastern Louisiana college, Hammond, operated as the Tangipahoa junior college in the early 1920s, then as the Florida Parishes junior college and was taken over by the state and made a four-year college in the late 1930s. It is organized into three schools: liberal arts, applied sciences and education.

Northeast Louisiana State college, Monroe, had its origin in the Ouachita Parish Junior college in the early 1930s. It was taken over by the Louisiana State university in 1934 and operated as a branch junior college. In 1950 the legislature made it a four-

year college and placed it under the jurisdiction of the state board of education with the name changed to the Northeast Louisiana State college. It has schools of arts and sciences, pure and applied sciences, education, fine arts and pharmacy.

McNeese State college, Lake Charles, began as a junior-college branch of Louisiana State university in 1939. The legislature, in 1950, changed its name, made it a four-year college and placed it under the jurisdiction of the state board of education.

The Francis T. Nicholls State college was authorized in 1946 as the Francis T. Nicholls junior college of Louisiana State university. In 1956 the legislature designated it as a four-year college and placed it under the state board of education. The instruction is divided into three divisions designated as colleges: applied sciences, arts and sciences and education.

The state operates two institutions of higher education for its Negro citizens: Southern University and Agricultural and Mechanical college and Grambling college. Southern university was founded in 1880 in New Orleans and was moved to Scotlandville (near Baton Rouge) in 1914. Progress was slow during the early years because the state was not in a financial condition to support higher education until around 1920 and relatively few students sought a college education before that date. Increasing prosperity enabled the state to provide more funds for buildings, equipment and salaries, the increase in funds being precipitous in the period 1940–60. The institution has divisions of arts and science, agriculture, home economics and industrial and technical education (formerly mechanic arts), health and physical education, business, music, a graduate school and a law school. The enrollment is more than 5,000. A branch of Southern university opened in New Orleans in 1961.

Grambling college had its origin in 1900 when Booker T. Washington, president of Tuskegee institute, sent one of his recent graduates, Charles Adams, to establish a private school for Negroes at Grambling. Lincoln parish assumed support of the school in 1915 and the state took it over in 1928 and operated it as a normal school to train teachers and leaders in agriculture. It was made a four-year college of liberal arts and a teachers college in 1940 and has had a phenomenal growth since the end of World War II. The institution is operated by departments under the immediate supervision of the dean of the college.

Private institutions of higher learning include four Roman Catholic schools in New Orleans: Loyola university (for men, founded 1912); Notre Dame seminary (for men, 1923); St. Mary's Dominican college (for women, 1920); and Xavier University of Louisiana (1925). Also in New Orleans are Dillard university (Congregational Christian and Methodist, 1930); Tulane university (nonsectarian, 1834); and Newcomb college (The H. Sophie Newcomb Memorial College of Tulane university) (for women, 1886). Centenary College of Louisiana (Methodist, 1840) is at Shreveport and Louisiana college (Louisiana Baptist convention, 1906) is at Pineville. Tulane was integrated in 1961.

HEALTH AND WELFARE

Beginning about 1906 Louisiana made rapid progress in eradicating and controlling disease. Laws were passed and enforced to destroy the breeding places of mosquitoes, thereby reducing malaria and yellow fever; rats were exterminated to reduce the spread of such diseases as bubonic plague; the hookworm disease was attacked; houses were screened; public drinking cups were outlawed to help control the spread of tuberculosis; and other measures in the interest of better health were enacted.

Hospitals.—The first charity hospital was built in New Orleans in 1736 with the bequest of a sailor, Jean Louis. This was the forerunner of the Charity hospital there constructed by the state in 1930 at a cost of $13,000,000. Additions costing approximately $7,500,000 have been made. Charity hospitals are found in all the larger urban centres, as, for example, the Confederate Memorial hospital in Shreveport, the E. A. Conway hospital in Monroe and the Huey P. Long Charity hospital in Pineville. The East Louisiana hospital for the mentally ill at Jackson is the oldest (1847) and largest of its kind in the state. The mentally ill also are provided for in the Central Louisiana State hospital at Pineville and the Southeast Louisiana hospital at Mandeville and there are sections and wards for the mentally ill in most of the state hospitals. The federal government has two magnificent hospitals for veterans of the armed forces, at Pineville and Shreveport.

The Spanish Governor Miro (1785–92) was responsible for establishing a hospital for lepers (Hansen's disease) in New Orleans. This was the beginning of a state leprosarium, established at Carville in 1894 and taken over by the federal government in 1921. Officially designated the U.S. Marine Hospital No. 22, it is the only leprosarium in the continental United States.

In addition to the tax-supported hospitals there are a number of private- and church-supported institutions. The Roman Catholic Church has had unusual success in operating hospitals and the Protestant denominations, the Baptist in particular, have entered this field of service.

Welfare.—A state-wide poor law was passed as early as 1880 requiring every parish in the state to provide for its poor and infirm through local taxation. Various laws after 1900 provided pensions for dependent mothers, compensation to incapacitated workers and child welfare. The first state-wide system of relief grew out of the need resulting from the depression of the early 1930s. In 1932 an unemployment relief committee was set up to supervise the distribution of relief funds provided by the federal Reconstruction Finance corporation. Within a period of three years a local welfare agency was in existence in every parish. A state department of public welfare was created by act of the legislature June 26, 1936.

The welfare services have expanded to enormous proportions. The budget of the welfare department in the second half of the 20th century was almost equal to the budget for education. The largest items of expenditure were for old-age assistance, for dependent children, for the permanently and totally disabled and for general assistance. By the 1960s, 70% of the population age 65 and over were receiving some form of relief.

THE ECONOMY

Louisiana has a mild climate and more and more people have been attracted to the state to live, as is borne out by the number of adults who move into the state and by the growing population. The state also has attracted a number of industries since passing in 1946 a law granting new industry tax exemption for a period of ten years.

The trend toward better homes was pronounced after 1935. New construction was of better quality and more of the rural homes were painted. By the second half of the 20th century practically all urban homes had electricity, running water and indoor plumbing and an increasing number of rural homes had these conveniences. Most of the homes, even in the rural areas, were heated by natural or manufactured gas. The wood formerly burned for heating and cooking was sold for pulpwood and other uses.

Agriculture.—Agriculture was the chief occupation and the main source of income for the people until World War II. Agriculture is still important although it has been superseded by manufacturing as the leading industry in the state. The number of farm workers declined from about 200,000 at the end of World War II to about 150,000 in the second half of the 20th century. The number of farms also decreased from about 150,000 to about 110,000 while the average value of farms rose from about $3,500 to almost $10,000 and the size of the average farm increased from about 65 ac. to more than 100 ac. (but about 46% of the farms were less than 30 ac. in size). At the same time the number of acres that were harvested decreased from almost 3,500,000 ac. to about 2,500,000 ac. This trend was evident in the reduction of acres in row crops and the increasing acreage in pasture for livestock and for growing forests. In the second half of the 20th century the total annual value of Louisiana agricultural products reached $400,000,000, of which livestock products accounted for about $140,000,000, plus $30,000,000 in government payments.

The major crops, ranked according to value, were cotton lint and cottonseed, rice, sugar cane, corn, hay and sweet potatoes. In the ten years after World War II the average acreage planted in cot-

ton was about 825,000 ac. with an average production of about 600,000 bales (500 lb. per bale) worth more than $100,000,000. The acreage planted in cotton, however, was decreasing, in some years dropping to fewer than 400,000 ac. planted and a production of less than 300,000 bales. Louisiana has led all the states in the production of rice. During the post-World War II years an average of about 600,000 ac. were planted with the annual production exceeding 1,000,000,000 lb. worth approximately $60,000,000. Louisiana produces most of the sugar from sugar cane in continental United States, with Florida producing a small amount. The average acreage planted in sugar cane in the post-World War II period was about 250,000 ac. which produced more than 5,000,000 tons of sugar worth more than $33,000,000. The corn planted during the period averaged almost 800,000 ac. and production was about 14,000,000 bu. valued approximately at $20,000,000; the hay crop averaged about 350,000 ac. with 434,000 tons valued at $10,000,000. Louisiana ranks first in the production of sweet potatoes. The crop averaged about 90,000 ac. and produced 500,000,000 lb. worth more than $15,000,000. Rice and sugar cane are the only field crops with restricted areas of production. The sugar-cane region is confined, almost exclusively, to the Mississippi delta and Bayou Teche regions, while the chief area of rice production is the prairie region of the southwestern part of the state.

The rice farms were almost the only farms irrigated until the second half of the 20th century. The water was procured from the streams flowing through the rice-growing area and from deep wells. During the 1950s lightweight aluminum pipe became available and enabled vegetable and even cotton and corn crops to be irrigated during dry years. The water was procured largely from streams and ponds.

The growing of vegetables has not been exploited to any great extent to utilize the soil and climate. It has developed most in the vicinity of New Orleans. With the growth of other large urban centres, the growing of vegetables in these vicinities has increased. Louisiana ranks first among the states in the production of strawberries. The strawberry area is in the Florida parishes, east of Baton Rouge, but the plant can be grown in most of the state. Other commercial vegetable crops are Irish potatoes, snap beans, green peppers, shallots, cabbages, tomatoes, watermelons, onions and cucumbers. The crop of oranges, grown south of New Orleans, is important. Peach growing in north Louisiana has proved profitable. Other important farm products are pecans, peanuts, figs, tung oil nuts and soybeans.

Livestock is playing an increasing role on Louisiana farms notwithstanding the rapid decline in the number of horses, mules, hogs and sheep. Mechanization is rapidly replacing the horse and the mule. In the ten years after World War II they numbered an average of 210,000. By 1960 the number decreased to less than 100,000. Hogs averaged 574,000 head in the post-World War II period. By 1960 the number was below 400,000. Sheep declined from an average of almost 120,000 to fewer than 100,000 head, but the value increased from less than $1,000,000 to more than $1,100,000. In livestock, cattle led in value followed by commercial broilers, hogs, horses and mules, chickens and sheep.

Industry.—The industries of Louisiana are those associated, for the most part, with petroleum, lumbering, sugar, rice and cottonseed. Manufacturing could be classified, also, as those processing: (1) food and kindred products; (2) petroleum; (3) forest products; and (4) chemical and allied products. Industries processing agricultural raw material are seasonal. Examples are cottonseed oil mills, sugar refineries, sirup mills and canning plants. Manufacturing increased at a rapid rate after World War II, especially in the rubber, petroleum-chemical, aluminum making and papermaking industries. In the second half of the 20th century there were more than 3,000 manufacturing plants operating in the state with almost 150,000 production workers and an annual payroll of more than $600,000,000. The value added by manufacturing amounted to approximately $1,500,000,000 annually.

While the amount of board feet of lumber produced declined in the second half of the 20th century the amount of wood pulp increased from 590,000 tons annually before World War II to approximately 1,500,000 tons. Louisiana has approximately 16,000,000 ac. in forests with 41,436,000,000 board feet of standing timber; the annual growth is approximately equal to the amount harvested. The pine and cypress forests make up most of the softwoods while the leading hardwoods are oak, red gum and tupelo gum. It has been demonstrated that pine trees grow faster in Louisiana than anywhere else in the world. The soil, rainfall and long growing season of the state are ideally adapted to the growth and manufacture of timber and timber products.

Mining.—The principal minerals of the state are petroleum (including gas), salt, sand and gravel, and sulfur. The value of minerals produced in the second half of the 20th century was more than $2,000,000,000 a year. Louisiana usually ranks second or third of all the states in the value of minerals and produces more than 10% of the total value of all minerals in the nation. Nine-tenths of the total labour force in the mineral industry was producing petroleum, natural gas and natural-gas liquids. Petroleum production increased from 23,000,000 bbl. (42 gal. per barrel) in 1930 to more than 400,000,000 bbl. in the 1960s. Natural-gas production increased from about 700,000,000,000 cu.ft. after World War II to about 3,000,000,000,000 cu.ft. in the second half of the 20th century and natural-gas liquids rose from 17,000,000 bbl. to 26,000,000 bbl. The total proved reserves in the second half of the 20th century were petroleum, more than 5,000,000,000 bbl., natural gas, 72,000,000,000,000 cu.ft., and natural-gas liquids, 1,000,000,000 bbl.

Only Texas and California produce more petroleum and natural gas than Louisiana and they are the only states that have more proved reserves. Louisiana ranks fourth among the states in the production of salt, and sulfur production for industrial use began in the state. Louisiana has been surpassed by Texas, but the opening in 1933 of the Grande Écaille mine, about 50 mi. S. of New Orleans, and in the 1960s of a big offshore mine in the Gulf of Mexico greatly increased sulfur production in Louisiana. The mining of sulfur along the gulf coast by the Frasch process is accomplished by pumping superheated steam into the sulfur rock, melting and forcing it to the surface through pipes. The sulfur is often hundreds of feet beneath the surface of the earth and sometimes there is a layer of quicksand above the sulfur. The annual average production of sulfur, about 1,000,000 tons before 1950, after 1950 reached more than 2,000,000 tons valued at more than $50,000,000. Sulfur and petroleum form the base for the growing petroleum-chemical industry in the state. The average annual production of salt, about 2,000,000 tons before 1950, after 1950 rose to approximately 4,500,000 tons. There are a number of known untouched salt domes in the state. The best-known mines are at Avery Island, Jefferson Island and Winnfield. The average annual production of cement, about 4,500,000 bbl. before 1950, after 1950 increased to about 7,500,000 bbl. The cement is procured from clays and oyster shells. The mining of miscellaneous clays, which previously averaged about 300,000 tons, more than doubled in the second half of the 20th century.

The value of all mineral production in the state exceeds $2,000,000,000 annually, with petroleum the most valuable, accounting for more than $1,000,000,000, natural gas for $250,000,000 and natural-gas liquids for $80,000,000. The number of producing oil wells, fewer than 10,000 in 1948, increased to more than 25,000 in the 1960s. The average daily production per well, however, decreased from 54.7 bbl. to 41.3 bbl.

Fisheries and Wildlife.—Louisiana is widely known for the quality and great variety of its fresh- and salt-water fish. The value of the annual catch is approximately $33,000,000 and 31,000 persons are employed in the industry. The leading salt-water fish are shrimp, oysters, crabs, pompanos, redfish, bluefish, Spanish mackerel, flounder, grouper (yellow bass) and drumfish. The fresh-water streams abound in perch, basses, barfish, catfish, gaspergou (a fresh-water drumfish), sacalait (also known as crappie, warmouth and killfish), bullfrogs and buffalo fish. The annual catch of buffalo fish approaches 12,000,000 lb. and that of catfish approximates 5,000,000 lb. Louisiana supplies approximately 34,000,000 lb. of shrimp annually worth about $10,000,000. The 10,000,000 lb. of oysters taken annually from 477,000 ac. of oyster beds have a value approximating $3,000,000. The oyster shells are

important as a source of lime for making cement, and for liming or "sweetening" acid soils. The state is the leading producer, also, of diamondback terrapins, crabs and bullfrogs.

The original French settlers came to Louisiana for the fur trade and the state leads all others in the number but not in the value of furs produced. The annual yield approaches 2,500,000 pelts worth approximately $3,000,000. The muskrat leads in number and value, followed in value by mink, nutria, otter, raccoon and opossum. The wildlife and fisheries commission spends approximately $500,000 annually supervising the wildlife and fisheries.

Trade.—New Orleans ranks second among the ports of the U.S. in value of exports and imports; approximately 10% of the national foreign trade passes through the port. More than 100 steamship lines offer regular sailings from the port. Approximately 65 firms in the towing barge business operate through New Orleans with 15,000 mi. of commercial waterways converging on the city bringing over 150,000,000 tons of freight annually. The port annually handles more than 10,000,000 tons of foreign goods valued at more than $1,500,000,000. The most valuable imports are bananas, coffee and molasses.

The ports of Lake Charles, Baton Rouge and Morgan City have, in the second half of the 20th century, become increasingly important in the foreign trade of the state. In the second half of the 20th century about 25,000 retail firms annually sold more than $2,225,000,000 worth of merchandise and about 3,500 wholesale firms approximately $150,000,000 worth. Business activity by 1960 was 70% above the average of ten years earlier. Over 600,000 persons were employed in the state, with average weekly earnings of about $83; the per capita income for the state was a little over $1,500 compared to the national average of about $2,000.

Transportation and Communication.—In the second half of the 20th century there were ten major railroads, with 6,000 mi. of track; nine commercial airlines and more than 100 airports; 5,000 mi. of navigable streams; 1,100 mi. of intercoastal canals; and almost 50,000 mi. of vehicular roads, of which more than 15,000 mi. were under state control, and of these approximately 14,000 mi. were paved with asphalt or concrete. There are over 5,000 bridges in the highway system. Two bridges at New Orleans, one at Baton Rouge and one at Natchez span the Mississippi river. Other important bridges span the Red, Ouachita and Atchafalaya rivers at important points.

There are about 20 daily newspapers with paid circulation of more than 700,000. Practically every town of a few thousand population has a radio station and the larger cities have one or more television stations.

Culture and Recreation.—Most of the larger urban centres have little-theatre groups for the performance of amateurs on the stage. The New Orleans Opera association and similar organizations at most of the colleges and universities stage plays, produce operas and give concerts of creditable quality. A number of musical groups such as the New Orleans Symphony orchestra, the Shreveport symphony and others give excellent group and solo performances. The educational extension department of Louisiana State university has attempted to preserve the folklore, folk dances and artcrafts of the Acadians. The Louisiana State library has promoted the establishment of parish libraries with bookmobiles to transport the books directly to rural families. The university, through its agricultural extension department, has endeavoured to organize "communities" of farm families throughout the state for recreational purposes.

There are a number of fairs to teach and demonstrate improved machinery, utensils, livestock and poultry. The largest of these is the state fair at Shreveport. There are a number of festivals with colourful pageants and ceremonies, such as the Shrimp festival at Morgan City, the Rice festival at Crowley, the Forest festival at Winnfield, the Yambilee at Opelousas and the Peach festival at Ruston. The Mid-Winter Sports carnival at New Orleans, which sponsors the Sugar Bowl football game on New Year's day, and the Christmas festival at Natchitoches are well known. The oldest and most famous of the festivals is Mardi Gras in New Orleans. *See* also references under "Louisiana" in the Index.

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LOUISIANA PURCHASE. In 1803 the United States purchased from Napoleonic France the then vaguely delineated western half of the Mississippi river basin. This region was then known as "Louisiana," and its acquisition by the United States is referred to as the Louisiana Purchase. The term is commonly applied to the territory involved as well as to the act of purchase itself.

The Louisiana territory had been the object of old world interests for many years before 1803. Explorations and scattered settlements in the 17th and 18th centuries had given France control over the river itself and title to most of the Mississippi valley.

The first serious disruption of French control over Louisiana came during the Seven Years' War (*q.v.*). In 1762 France ceded Louisiana west of the Mississippi river to Spain and in 1763 transferred virtually all of its remaining possessions in North America to Great Britain. This arrangement, however, proved temporary. French power rebounded under the subsequent military leadership of Napoleon Bonaparte and on Oct. 1, 1800, Napoleon induced a reluctant King Charles IV of Spain to agree for a consideration to cede Louisiana back to France. King Charles gave at least his verbal assent on the condition that France would never alienate the territory to a third power. And with this treaty of retrocession, known as the treaty of San Ildefonso, would go not only the growing and commercially significant port of New Orleans but the strategic mouth of the Mississippi river.

Reports of the supposed retrocession soon were received by official Washington—and with deep misgivings. During the preceding 12 years, Americans had streamed westward into the valleys of the Cumberland, Tennessee and Ohio rivers. The very existence of these new settlers depended on their right to use the Mississippi river freely and to make transshipment of their exports at New Orleans. By terms of the treaty of San Lorenzo, Spain in 1795 had granted to the United States the

right to ship goods originating in American ports through the mouth of the Mississippi without paying duty and also the right of deposit, or temporary storage, of American goods at New Orleans for transshipment. But in 1802 Spain in effect revoked the right of deposit, and so it was in an atmosphere of growing tension in the west that Pres. Thomas Jefferson was confronted with the prospect of a new, wily and more powerful keeper of the strategic window to the Gulf of Mexico.

The news of the retrocession remained unconfirmed for months, and understandably so. Quite apart from persistent and conflicting rumours that would naturally surround secret negotiations of this magnitude, it was subsequently revealed that King Charles had put off signing the retrocession order until Oct. 15, 1802. But even though it was extremely difficult for American agents in Paris to ascertain the exact facts pertaining to the status of Louisiana, the information that did reach President Jefferson was disquieting. The president, sensitive to America's growing interests in the west, would look upon any foreign power that controlled the Mississippi river mouth as a "natural and habitual enemy" of the United States, and he was quick to view the possible possession of this region by Napoleon with added misgivings. "The day that France takes possession of New Orleans," the normally pro-French Jefferson wrote Robert R. Livingston, the U.S. minister at Paris, ". . . we must marry ourselves to the British fleet and nation."

Jefferson meanwhile instructed Livingston to take two steps: (1) to approach Napoleon's minister, Charles Maurice de Talleyrand, with the object of preventing the retrocession in the event this act had not yet been completed; (2) to try to purchase at least New Orleans if the property had actually been transferred from Spain to France. Direct negotiations with Talleyrand, however, appeared to be all but impossible. For months Livingston had to be content with tantalizing glimmerings of a possible deal between France and the United States. But even these faded as news of the Spanish governor's revocation of the right of deposit reached the U.S. minister. With this intelligence he had good reasons for thinking the worst: that Napoleon Bonaparte may have been responsible for this unfortunate act; that his next move might be to close the Mississippi river entirely to the Americans. Livingston had but one trump to play and he played it with a flourish. He made it known that a *rapprochement* with Great Britain might, after all, best serve the interests of his country, and at that particular moment an Anglo-American *rapprochement* was about the least of Napoleon's desires.

No one can write with certainty of the mental deliberations of the first consul. But there are good reasons for believing that French failure in Santo Domingo, the imminence of renewed war with Great Britain and financial stringencies may all have prompted Napoleon in 1803 to offer for sale to the United States the entire Louisiana territory. At this juncture, James Monroe arrived in Paris as Jefferson's minister plenipotentiary; and even though the two American ministers possessed neither instructions nor authority to purchase the whole of Louisiana, the negotiations that followed, with Barbé-Marbois acting for Napoleon, moved swiftly to a conclusion. A treaty was signed on May 2, but was antedated to April 30. By its terms the Louisiana territory, in the form France had received it from Spain, was sold to the United States. For this vast domain the United States agreed to pay $11,250,000 outright and assumed claims of its citizens against France in the amount of $3,750,000. Interest payments incidental to the final settlement made the total price $27,267,622.

Minister Livingston, with the help of Monroe, had bargained well, and he knew it. As he was about to affix his signature to the documents, Livingston is reported to have said: "We have lived long, but this is the noblest work of our whole lives. . . . From this day the United States take their place among the powers of the first rank . . ." Napoleon, too, reflected upon what he had done and remarked to Barbé-Marbois: "This accession of territory (by the Americans) affirms forever the power of the United States, and I have just given England a maritime rival that sooner or later will lay low her pride."

But what had the Americans really bought? According to art. i of the terms of sale, "The colony or province" of Louisiana consisted of the "same extent" that it had under Spain at the time of the retrocession (1800) and that it had when France possessed it (prior to 1762); art. ii specifically took in all adjacent islands (and this would, of course, include the vital Isle of Orleans); "all public lots and squares, vacant lands and all public buildings, fortifications, barracks, and other edifices which are not private property"; and archives.

The wording of art. i was vague; it did not precisely describe the boundaries. It gave no assurances that West Florida was to be considered a part of Louisiana; neither did it delineate the southwest boundary. The American negotiators were fully aware of this. When Livingston later questioned Talleyrand on the matter, the reply was: "I do not know . . . I can give you no direction; you have made a noble bargain for yourselves, and I suppose you will make the most of it."

But before the United States could establish fixed boundaries to Louisiana there arose a basic question concerning the constitutionality of the purchase. Did the constitution of the United States provide for an act of this kind? The president, in principle a strict constructionist, thought that an amendment to the constitution might be required to legalize the transaction; but, after due consideration and considerable oratory, the senate approved the treaty by a 24 to 7 vote.

The setting of fixed boundaries awaited negotiations with Spain and Great Britain. The exasperating dispute with Spain over the ownership of West Florida and Texas was finally settled by the purchase of the Floridas from Spain in 1819 and the establishment of a fixed southwest boundary line. This line followed the Sabine river from the Gulf of Mexico to the parallel of 32° N.; ran thence due north to the Red river, following this stream to the meridian 100° W.; thence north to the Arkansas river and along this stream to its source; thence north or south as the case might be (the source of the Arkansas was not then known) to the parallel of 42° N. and west along this line to the Pacific ocean. The northern boundary was amicably established by an Anglo-American convention in 1818. It established the 49° parallel N. between the Lake of the Woods and the Rocky mountains as the American-Canadian border. The Rocky (then referred to as "Stony") mountains were accepted as the western limit of the Louisiana territory, and the Mississippi river was considered for all practical purposes the eastern boundary of the great purchase. The new territory, which comprised 828,000 sq.mi. and doubled the size of the United States, was acquired at a cost of less than three cents per acre. Much of the territory turned out to contain rich mineral resources, productive soil, valuable grazing land, forests and wildlife resources of inestimable value. Out of this empire were carved in their entirety the states of Louisiana, Missouri, Arkansas, Iowa, North Dakota, South Dakota, Nebraska and Oklahoma; in addition, the area included most of the land in Kansas, Colorado, Wyoming, Montana and Minnesota.

The acquisition of the Louisiana territory greatly strengthened the United States, materially and strategically. It provided a powerful new impetus to westward expansion of the American people, and in a constitutional sense it established in practice the doctrine of implied powers of the federal constitution. The Louisiana Purchase was what often has been said of it, the greatest bargain in American history. *See* also LOUISIANA: *History*.

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LOUIS PHILIPPE (1773–1850), king of the French from 1830 to 1848, was born at the Palais Royal in Paris on Oct. 6, 1773, the eldest son of Louis Philippe Joseph de Bourbon-Orléans,

at that time duc de Chartres, later duc d'Orléans, and Adélaïde de Bourbon-Penthièvre (for the allegation that he was a supposititious child *see* MARIA STELLA). At first styled duc de Valois, he was educated by Madame de Genlis. When his father became duc d'Orléans (1785), Louis Philippe became duc de Chartres, titular colonel of a dragoons regiment of that name, and titular governor of Poitou.

The Jacobin Officer (1790–93).—At the beginning of the French Revolution, following his ambitious father's example, Louis Philippe joined the Jacobin club in 1790 and was considered one of the most progressive members of the nobility, especially when he resigned command of his infantry regiment in 1791. In 1792 he joined the army of the north as colonel of the 14th dragoons. His exemplary conduct in the first engagements soon won him promotion to command of a brigade; and in September he became lieutenant general on Kellermann's staff and was present at the battle of Valmy (Sept. 20, 1792; *see* FRENCH REVOLUTIONARY WARS). His father, meanwhile, had changed his name to Philippe Égalité and had been elected to the National Convention in Paris. Louis Philippe subsequently served under Dumouriez in Belgium and was present at the victory of Jemappes (Nov. 6, 1792) and at the defeat of Neerwinden (March 18, 1793). Some weeks later, however, though his father in Jan. 1793 had voted for the execution of Louis XVI, Louis Philippe associated himself with Dumouriez in deserting the revolutionary cause and in coming to terms with the Austrians. But he did not put his services at the disposal of the enemies of France; instead, he went to Switzerland, for a short while joining his sister Adélaïde who had earlier gone there from Tournai. His father was then arrested in Paris.

Exile (1793–1814).—For a time the refugee Louis Philippe taught at the college at Reichenau in the canton of Graubünden (Grisons), using the assumed name of Chabaud de la Tour. The execution of Philippe Égalité in Nov. 1793 now made him duc d'Orléans and he became the centre of the Orleanist intrigues. But he refused to countenance any plan to set himself up as king in France, possibly because he was negotiating with the revolutionaries for the release of his two brothers, the duc de Montpensier and the comte de Beaujolais, who had been arrested at the same time as their father. Louis Philippe traveled in Scandinavia for about a year (1795–96); then he sailed to the United States and settled in Philadelphia, where in Feb. 1797 he was joined by his brothers. They spent more than two years in America, until, on hearing of Napoleon Bonaparte's *coup d'état* of 18 Brumaire (Nov. 9, 1799), Louis Philippe decided to return to Europe. But when he and his brothers reached England early in 1800, the power of the first consul was so well established that there was no hope of intervening in France. Instead, the house of Orléans became reconciled with the elder branch of the Bourbon family. Even so, Louis Philippe never took up arms to fight with *émigré* forces for the royalist cause against other Frenchmen, as the princes de Condé had done: perhaps Louis XVIII mistrusted Philippe Égalité's son too much to allow him any close contact with French troops; or perhaps Louis Philippe himself merely preferred to remain with his brothers, who had both developed tuberculosis (Montpensier died in 1807, Beaujolais in 1808).

After a long residence at Twickenham in Middlesex, Louis Philippe in 1809 went to join the Neapolitan royal family at Palermo in Sicily; and on Nov. 25 he married Marie Amélie (*q.v.*), a daughter of King Ferdinand IV of Naples. About this time there was some suggestion that Louis Philippe should join the English forces in the Peninsular War; but nothing came of it, probably because Louis XVIII again feared any activity that might further the Orleanist cause.

The Bourbon Restoration (1814–30).—Louis Philippe returned to France at the first Restoration (1814). Though Louis XVIII refused to grant him the style of royal highness (later allowed to him by Charles X), he received from the king the dignities traditionally held by the head of his family; *e.g.*, that of colonel general of hussars. More important perhaps, he regained possession of the family estates and forests that had not been sold after his own emigration and his father's execution. During the Hundred Days (1815) he returned to England instead of following the court to Ghent.

Under the second Restoration the duc d'Orléans was a steady and more or less open adherent of the liberal opposition, entertaining its most prominent deputies and journalists at the Palais Royal and giving open patronage to the opposition newspaper *Le Constitutionnel* and tacit support to the more radical and Orleanist organ *Le National* (started in Jan. 1830). He may have had cognizance of various plots against the regime, such as that of Jean Paul Didier at Grenoble in 1816. Meanwhile, he sent his sons *en bourgeois* to be educated at the Collège Henri IV in Paris instead of employing private tutors as was customary among the nobility; he was a member of the Paris Philhellenic committee; and above all, he was occupied in recovering and restoring the estates and property that had belonged to his family before the Revolution. Though the indemnity granted in 1825 to the *émigrés* for estates seized during the Revolution was opposed by his political friends, the duc d'Orléans was one of its principal beneficiaries: it added several million francs to his fortune. Even so, he had to provide for six sons and three daughters (*see* BOURBON: Table IV) and thus was glad to help the baronne de Feuchères to win recognition at court in return for her services in persuading her lover, the last prince de Condé, to make Louis Philippe's son Henri, duc d'Aumale, his residuary legatee. Later when he had become king and his eldest son Ferdinand Philippe was heir to the royal domain, he could reserve the Orléans inheritance for his other sons, instead of merging it with the crown lands.

The July Revolution.—The publication by Charles X of the ordinances which provoked the July revolution of 1830 gave Louis Philippe his long desired opportunity. During the days of crisis he kept away both from the court at St. Cloud and from the revolutionaries in Paris, waiting first at his château at Neuilly and later at Le Raincy, where he was in less danger of sudden arrest by the king's guard. Late on July 30 he went to Paris. The next morning, wrapped in the tricolour flag beloved alike by Republicans and by Bonapartists, Orléans went to the Hôtel de Ville, where he was embraced by Lafayette, commander of the national guard and the veteran hero of the liberal opposition. Meanwhile the deputies of the existing legislature had elected him lieutenant general of the kingdom (July 31). Charles X confirmed him in this appointment two days later, before abdicating in favour of his ten-year-old grandson, the duc de Bordeaux (the comte de Chambord). On Aug. 7 the provisional government of deputies and peers present in Paris declared the throne vacant; following the terminology of 1791 Louis Philippe was, on Aug. 9, proclaimed "king of the French by the grace of God and the will of the people." A modified version of the charter of 1814 was issued, which the new king was obliged to accept.

The King of the French (1830–48).—The July monarchy, with its citizen king, could never command the support of Legitimists, Republicans or Bonapartists; and its opponents resorted to political intrigue, to insurrection and even to attempted assassination, such as the attack made by Giuseppe Fieschi (*q.v.*). Indeed, it was said that "for shooting kings there is no close season." Nevertheless Louis Philippe showed increasing determination to strengthen his own control over affairs; and when the Party of Resistance, which wanted to maintain the new order and to prevent any more radical development, came into office with Casimir Périer in March 1831, the speech from the throne proclaimed that, "France has desired that the monarchy should become national, it does not desire that it should be powerless." Republican and socialist agitation, culminating in a series of dangerous risings such as that at Lyons in Nov. 1831 and that at Paris in June 1832, enabled the king to represent himself as the defender of middle class interests; and since the middle classes alone were represented in the assembly, Louis Philippe came to regard his position as unassailable. The nature of the opposition that he encountered at home served to conciliate opinion abroad where this "king of the barricades" had at first been regarded as a usurper. The Russian and Austrian courts, however, never really overcame their doubts about him: the Austrians, for instance, refused to give the archduchess Maria

Theresa (a niece of the emperor Francis I) in marriage to his son Ferdinand, now duc d'Orléans and heir to the throne. Louis Philippe had eventually, in 1837, to accept as daughter-in-law the princess Helena of Mecklenburg, who thus became the first Protestant member of the French royal family for more than 300 years. The accidental death of the popular duc d'Orléans in July 1842 not only grieved Louis Philippe very deeply but also seriously weakened the dynasty: the new heir to the throne, the duc's son Louis Philippe Albert, comte de Paris, was an infant for whom a regency had to be prearranged.

It is difficult to assess the motives behind the king's changing attitude toward Great Britain. At first the marriage (Aug. 1832) of his daughter Louise with Queen Victoria's uncle Leopold I, king of the Belgians, established an excellent relationship between Paris and London, almost foreshadowing the Entente Cordiale. This was imperiled in 1840 when Louis Adolphe Thiers, as foreign minister, tried to achieve an exclusively French solution of the dispute between Turkey and Egypt. François Guizot, who succeeded Thiers, managed to repair the breach, and Queen Victoria visited France in 1843 and 1845; but the British were finally alienated by Louis Philippe's policy on the "Spanish marriages." In an attempt to revive the traditional family alliance between the French and Spanish Bourbons he had at first wanted to marry his sons, the duc d'Aumale and the duc de Montpensier, to the Spanish queen Isabella II and to her sister and heiress presumptive, the infanta Luisa, respectively. In view of British objections to this threat of French predominance in Spain he had in 1843 agreed that Isabella should marry neither Aumale nor the British nominee, Prince Leopold of Saxe-Coburg, but some Spanish Bourbon instead, and that Montpensier's marriage to Luisa should not take place until Isabella should have produced an heir or heiress apparent. Consequently the British government was enraged at French duplicity when, on Oct. 10, 1846, Montpensier was married to Luisa simultaneously with Isabella's marriage to Don Francisco de Asís, a cousin supposedly too decrepit to become a father.

By this time French opposition to the regime had become much more embittered. Louis Philippe's constant refusal of any electoral reform meant that many members of the lower middle class from whom he might still have drawn support remained without the vote. Finally, his narrow-minded conservatism and his unwillingness to seek any solution for pressing political and social problems drove many divergent interests into union against him.

The Revolution of 1848.—The July monarchy was but one casualty of the great revolutionary movement that swept through Europe in 1848. But in any case a change had come to seem unavoidable in France. In face of the "banquets campaign," begun in 1847 by those desiring parliamentary reform, Louis Philippe and his minister Guizot remained supine. Faced with insurrection, Louis Philippe abdicated on Feb. 24, 1848, in favour of his grandson the comte de Paris. With Queen Marie Amélie he escaped to Honfleur and thence to England. Under the incognito of comte and comtesse de Neuilly they settled at Claremont in Surrey, placed at their disposal by Queen Victoria. There Louis Philippe died, on Aug. 26, 1850.

Evaluation.—The July monarchy was really an anachronism. To the French people, for whom, whether or not they favoured the institution, monarchy meant the splendours and absolutism of the *ancien régime*, the spectacle of a sovereign who walked unattended in the streets, clad in a sober bourgeois suit and carrying a furled umbrella, and who shook hands with his subjects, soon aroused contempt. Louis Philippe's determination to amass estates and wealth could also be lampooned as a bourgeois quality and few who criticized it knew of his private generosity to individuals and charitable causes. He faced with great courage the frequent attempts made upon his life, showing the same steadfastness that had brought him through many vicissitudes to the throne. In power Louis Philippe strove to implement his desire to rule as well as to reign. But the political difficulties with which he was faced revealed in him the weaknesses of an obstinate man; increasingly his only response to crises was words and theories, and ultimately inaction lost him his crown.

Louis Philippe's own memoirs are contained in the *Journal du duc de Chartres, 1790–91* (1792); *Mon journal: Évènements de 1815*, two volumes (1849); *Discours, allocutions et réponses de sa majesté Louis Philippe, 1830–1846* (1847); and *Correspondance, mémoires et discours inédits de Louis Philippe d'Orléans*, edited by E. Dentu (1863).

See FRANCE: *History;* and references under "Louis Philippe" in the Index.

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LOUIS STYLES refer to the artistic trends during the reigns of Louis XIII, XIV, XV and XVI of France; the styles coincide roughly with the broader classifications of late Renaissance, baroque, rococo and neoclassical art (*qq.v.*), respectively. With Louis XIII (1610–43) the contemporary Italian influence, as exemplified in the Luxembourg palace, was strong. Under Louis XIV (1643–1715) the building of the Versailles palace, establishment of the academies and royal manufactury of tapestries, furniture and ceramics gained cultural hegemony for France. The sober restraints of the baroque grand manner were cast off with Louis XV (1715–74) in favour of the capricious, graceful rococo, which flourished in such smaller Parisian residences as the Hôtel Soubise. The simple classic ideal, as seen in the Petit Trianon, once again reasserted itself in Louis XVI's reign (1774–93).

See also references under "Louis Styles" in the Index.

See S. F. Kimball, *The Creation of the Rococo* (1943). (WM. F.)

LOUISVILLE, the largest city of Kentucky, U.S., and seat of Jefferson county, is the metropolitan centre of the state. It is located on the south bank of the Ohio river opposite the Falls of the Ohio, the rock ledge which divides the water levels, about 90 mi. S.W. of Cincinnati. The city spreads across the broad level shoulder of the Ohio flood plain between the river and the rim of knobs. This plain is a fertile area, which was once overflowed and enriched by the Ohio river. In the past the city had recurrent floods which caused heavy damage to property, notably the great flood of Jan.–Feb. 1937. In 1956, a 17-mi. levee was completed along the river front to seal out floodwaters.

Metropolitan Louisville spreads over almost three-quarters of the 375 sq.mi. of Jefferson county. Pop. (1960) city, 390,639; county, 610,947; standard metropolitan statistical area (Jefferson county, Ky., and Clark and Floyd counties, Ind.), 725,139. (For comparative population figures *see* table in KENTUCKY: *Population.*)

History.—Legend has it that the sieur de La Salle visited the site in 1669, but this is indeed doubtful. French and British traders stopped at the Falls of the Ohio before the middle of the 18th century, but details of their visits are unrecorded. On July 8, 1773, Capt. Thomas Bullitt reached the falls with a commission from William and Mary college in Virginia to survey the lands in this area. Though the county surveyor refused to approve this survey, Lord Dunmore, the governor of Virginia, conveyed it in Dec. 1773 to his friend John Connolly. In June 1774 Daniel Boone and Michael Holsteiner came from Virginia to warn the survey party of the outbreak of Lord Dunmore's War against the Indians.

In May 1778, George Rogers Clark (*q.v.*) landed his militia company on Corn Island opposite the mouth of Beargrass creek and began preparation for the conquest of the British-held Old Northwest. Clark built blockhouses for his stores, and cabins for some of the colonists who had come with him. Most of the settlers moved to the mainland the following winter and established themselves in Fort-on-Shore (Ft. Nelson) within the present limits of Louisville. Trustees were appointed to lay out a town and a town government was organized in April 1779; on May 14, 1780, the Virginia legislature, petitioned by the townsfolk, declared that Connolly had forfeited his title (he had been actively pro-British during the American Revolution) and incorporated the settlement under the name of Louisville, in recognition of the assistance given by Louis XVI of France to the colonies in the Revolutionary War. Between 1780 and 1811 Louisville became an important frontier and flatboat trading place, and its

growth was greatly stimulated by the successful introduction of steam navigation. Nicholas Roosevelt docked the "New Orleans," the first steamboat on the western waters, in 1811 and inaugurated the steamboat era which was one of the town's most dramatic. By 1820 Louisville had become a major river port and the development of its facilities was further stimulated by the construction (1825–30) of the canal around the Falls of the Ohio. The steamboat spread the city's commercial influence over a vast area. Louisville merchants were engaged in trade with both the south and the middle west and cotton planters depended upon them for supplies. The town's printers furnished books and periodicals to an ever-widening educational trade area, and its newspapers were read from Alabama to Illinois.

In 1828 the town was chartered as a city and received successive charters in 1851, 1870, 1893 and 1926.

In the American Civil War, Louisville was early occupied by Federal troops who made it a military headquarters and a major supply depot throughout the struggle. Though no fighting took place in the city, its war history constitutes one of its most exciting chapters. Except for the disruption of trade and the normal intercourse with the rest of Kentucky, Louisville escaped the ravages of war. Large numbers of slaves flocked to the town from the plantations seeking passes to enable them to cross the river to Indiana and freedom.

Immediately after the war, Louisville businessmen began a campaign to reclaim the South's trade. The Louisville and Nashville railroad was already directed toward the heart of the south, and this important rail line was extended to Mobile, Ala., and New Orleans, La., and then to Jacksonville, Fla. Both merchant and railway officials helped locate store sites in the south as outlets for goods transported by rail from Louisville distributors.

In March 1890 a tornado caused the loss of more than 100 lives and did extensive property damage. Louisville's economy remained stabilized but was given a boost during World War I with the building of Camp Zachary Taylor just outside the city and the influx of thousands of soldiers. Later the enlargement of nearby Ft. Knox (*q.v.*) had a similar effect. By mid-20th century newer industries, notably the 1,000-ac. manufacturing plant called Appliance Park, quickened the city's economic pulse.

Industry.—Since 1865 Louisville manufacturers have produced a highly diversified assortment of goods. Traditional manufactures are processed meats, flour, wagons and carriages, whisky, beer, tobacco products, plumbing fixtures, processed foods, wood products, chemicals, textiles, sporting goods, musical instruments, metal goods and clothing. Newer industries include automobiles, tractors, farm implements, rubber goods, electrical machinery and aluminum products. Louisville is still an important printing centre producing large numbers of magazines, comic books, catalogues, commercial brochures and beer and whisky labels. The American Printing House for the Blind, which publishes books in braille, is located there.

Culture and Recreation.—From its beginning Louisville was an important cultural centre. Its newspapers, especially the *Louisville Journal*, edited by George D. Prentice, 1830–68, and the *Louisville Courier-Journal*, edited 1868–1918 by "Marse" Henry Watterson, are distinguished in the history of U.S. journalism. Among the cultural institutions which have given the city character are the Louisville Free Public library, the Speed Memorial Art museum and the Filson club (founded 1884 as a historical library and museum).

The city's system of public education began in 1829. The University of Louisville (founded in 1798 as Jefferson seminary and chartered under its present name in 1846) has, among others, faculties of law, medicine and engineering, and is municipally owned. Among the other educational institutions are the Roman Catholic colleges Bellarmine (1950), Nazareth (1920) and Ursuline (established in 1921 as Sacred Heart junior college and chartered under its present name in 1938); and the Southern Baptist Theological seminary (1859) and the Louisville Presbyterian Theological seminary (1901). The Louisville public school system was one of the first large southern city systems to abandon the practice of racial segregation in compliance with the 1954 supreme court decision, which held segregation to be unconstitutional.

Louisville has abundant recreational facilities. Cherokee park, a 406-ac. woodland in the rolling hills east of the city, is a fine natural playground. Adjoining this tract is Seneca park which contains a golf course, a small lake and public playgrounds. Central park, in the heart of the city, has tennis courts, wading pools, a natural amphitheatre and other recreational facilities.

Louisville is a well-known sporting centre. Since 1875 it has been the scene of the annual Kentucky Derby, America's horse-racing classic, run at Churchill Downs. The Kentucky state fair, one of the oldest agricultural fairs in the U.S., features an annual horse show which almost rivals the derby in interest. The large armoury building and Freedom hall have been the scenes of numerous amateur and professional sporting events, including basketball, prize fights, wrestling matches and ice hockey. The Louisville Colonels, an American association baseball team until that league's suspension in 1962, had a history dating back to 1867 when the Louisville Eclipse team was organized. The city played an important part in the organization of the National league in 1876. Pete Browing, an early professional player, is credited with introducing the design for the "Louisville Slugger" baseball bat which is manufactured there. (T. D. C.)

LOURDES, a town of southwestern France famous for its Roman Catholic religious shrine. It is in the *département* of Hautes-Pyrénées, at the foot of the Pyrenees, on the banks of the Gave de Pau. Lourdes is 12 mi. S.S.W. of Tarbes on the main line of the railway from Toulouse to Bayonne. Pop. (1962) 15,691.

The origin of Lourdes is uncertain. From the 9th century onward it was the most important place in Bigorre, largely because of its famous fortress. In 1360 it passed by the treaty of Brétigny from the French to the English, who lost it to the French in 1406. During the religious wars the castle held out successfully against the Protestant troops. From the reign of Louis XIV to the beginning of the 19th century the castle was used as a state prison. After the visions of Bernadette Soubirous, between Feb. 11 and July 16, 1858, and the authorization by the pope of the cult of Our Lady of Lourdes, the quarter on the left bank of the Gave sprang up, and more than 2,000,000 pilgrims from all over the world annually visit the town. (*See* also BERNADETTE, SAINT.)

Lourdes is divided into an old and a new town by the Gave de Pau. The old quarter on the right bank surrounds a scarped rock, on which stands the fortress with its large square 14th-century keep. A tower of the 13th or 14th century, surmounting a gateway known as the Tour de Garnabie, is part of the old fortifications. The old quarter is united with the new by a bridge which is continued in an esplanade leading to the basilica, the church of the Rosary and the Massabielle grotto, where the Virgin Mary is believed in the Roman Catholic world to have revealed herself 18 times to Bernadette Soubirous. A statue of the Virgin stands on a rock projecting above the grotto, the walls of which are covered with crutches and other votive offerings; the spot is marked by a basilica built in 1876 above the grotto. The Byzantine church of the Rosary was built in front of and below the basilica from 1884 to 1889. Near the grotto are other caves, where prehistoric remains have been found. The underground basilica of Pope St. Pius X, large enough to hold 20,000 persons, was completed in 1958, the 100th anniversary of the visions, and was awarded the Grand Prix d'Architecture the following year.

The district has slate quarries, and the pastures support a breed of valuable Aquitaine cattle.

See René Laurentin, *Meaning of Lourdes* (1960); Fulton Oursler, *Happy Grotto* (1948). (PI. L.)

LOURENÇO MARQUES, capital of Portuguese East Africa (Mozambique) and of the Lourenço Marques district, lies on the coast in the south of the country within 50 mi. of the boundary of the Republic of South Africa. It is situated on the north bank of the Espirito Santo river at its entrance to Delagoa bay fronting the Indian ocean, and is 395 mi. E. of Johannes-

A. D'ALPOIM GUEDES, MOÇAMBIQUE

A PRIVATE HOME IN LOURENÇO MARQUES DESIGNED BY AMANCIO GUEDES

burg, S.Af., by rail. Pop. (1960, with suburbs) 183,798.

Lourenço Marques has a healthful climate. The mean annual temperature is 71° F.; the average in summer (November to April) is 78° F. and the heat is tempered by sea breezes. The average annual rainfall is 26 in., most of it in the summer.

The city is well laid out with many fine thoroughfares and modern buildings. From MacMahon square adjoining the railway station and docks, the main shopping and business streets (Rua Major Araujo, Rua Consiglieri Pedroso, Avenida da Republica) run parallel to the waterfront, from which at right angles the Avenida Joaqim de Aguiar leads to the imposing Mousinho de Albuquerque square. The square is flanked by the modern town hall and the Roman Catholic cathedral, a handsome modern building. There are Anglican and Methodist churches. The museum, housed in a building in the Portuguese Decorated style, contains collections (natural history, mineral, etc.) of Mozambique origin, and the military museum in the old fortress has many relics of the early colonial period. Schools include the imposing Lyceum Salazar adjoining the museum and two British educational institutions. The city and environs are notable for the work of the Portuguese architect Amancio Guedes, whose buildings in concrete (houses, flats, office blocks, factories) with their sculptural curves and mural decoration have affinities with those by Antonio Gaudi (*q.v.*). Lourenço Marques has excellent bathing beaches (notably the Polana with its shark-proof bathing enclosure), several excellent hotels, theatres and good recreational facilities. Since World War II it has become increasingly popular as a holiday resort for South Africans and Rhodesians. It has attractive botanical gardens near the city centre and a zoological park on the outskirts. The principal suburbs are Ponta Vermelha, Polana, Alto Mahé, Malhangalene and Somerschields.

Lourenço Marques is the seaport nearest to the Rand, the great gold mining and industrial centre of South Africa. The port is well equipped, with more than 1 mi. of concrete wharves, warehouses and electric cranes, a small dry dock and tugs. There are plants for loading ships with export coal (chiefly from Witbank, S.Af.) and a jetty for tankers at Matola, a few miles upriver. The great bulk of the traffic is that in transit with the Republic of South Africa, and most of the imports (foodstuffs, iron and steel, fuel oils, timber and livestock) figure also as exports, being forwarded to the Transvaal. The chief local import is wine and the chief exports by sea are coal, cotton, sugar, sisal, oilseeds, copra, hardwoods and fruit. Much of the trade is handled by British firms, although retail and native trade is largely in the hands of Indians. Industries include brewing and the manufacture of cement, pottery, furniture, footwear, soap, rubber and macaroni. A number of factories as well as a grain mill and timber yards are at Matola.

Several shipping lines schedule regular calls at Lourenço Marques. The main railway connections, of 3 ft. 6 in. gauge, are northwestward into Transvaal, S.Af., through Komatipoort; northward into Southern Rhodesia; and southwestward to Goba near the Swaziland frontier. Motor roads run through Stegi, Swaziland, to Durban (425 mi. S.S.W.); through Komatipoort, S.Af., to Johannesburg and Pretoria (357 mi. W.); and through Vila Luiza to Inhambane (388 mi. N.E.). Lourenço Marques airport, 5 mi. N.W. of the city, is served by international and local airlines.

Lourenço Marques (which derives its name from a Portuguese trader who first explored the region in 1544) was created a corporate town in 1887 and superseded the old town of Mozambique as the capital of Portuguese East Africa in 1907. The administrative district of Lourenço Marques had a population (1960) of 447,278 and an area of 4,009 sq.mi. For the history of the city *see* DELAGOA BAY. (N. C. P.)

LOUSE, a name commonly applied to small wingless insects parasitic upon birds and mammals and belonging to the orders Mallophaga (biting lice) and Anoplura (sucking lice). The word louse is also applied in a popular sense to many animals other than the true lice, *e.g.,* wood louse, fish louse (*see* CRUSTACEA), book louse of the insect order Psocoptera (*q.v.*), plant louse (*see* APHID) and bark louse (*see* SCALE INSECT). The true lice are hairy, flattened insects with short, three- to five-segmented antennae; the eyes may be reduced or wanting; and the tarsi are one- or two-segmented with strongly developed claws for clinging to their hosts. The eggs are attached to hairs, feathers or clothing, and the young lice are active as soon as they emerge. In structure and habits the immature lice resemble the adults, but they pass through several molts before reaching sexual maturity. When lice are numerous they cause great irritation to the hosts, upon whose bodies their whole life is passed.

The Mallophaga or biting lice constitute a separate order of insects, although they were previously classed as a suborder of the Anoplura. Biting lice attack birds chiefly, and some mammals; however, they are not parasites of man, except perhaps accidentally and then only temporarily. They are rarely over one-fourth inch in length, and range in colour from whitish, through yellow, red and brown, to black (*see* MALLOPHAGA).

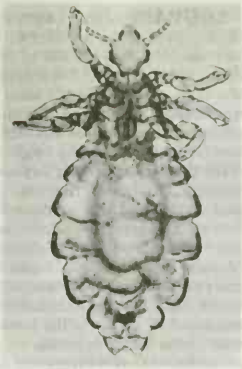
The order Anoplura (also known as the Siphunculata) is restricted to the sucking lice, all of which have extrusible mouthparts adapted for piercing and sucking. They live by imbibing the blood or tissue fluids of mammals. None are parasitic on birds or reptiles. They are usually smaller than biting lice, all being less than one-third inch in length, and range in colour from whitish to yellow.

Sucking lice show distinct host specificity; that is, one species of louse is restricted to a species or a small group of species of hosts, usually within a single genus. Genera of lice are characteristic of certain families or related families of mammals. The louse family Pediculidae is peculiar to the primates (monkeys, apes, man), the Echinopthiriidae to the marine carnivores (seals, sea lions, walruses) and the Haematopinidae to the rodents, rabbits and ungulates with very few exceptions. Vernon L. Kellogg has suggested that the presence of related lice on related groups of hosts is evidence of parallel evolution of parasites and hosts.

In addition to man and his domestic mammals a wide variety of wild mammals are infested by these insects, each host, genus or species having its own characteristic parasites. A few hosts such as man, the domestic cow and some rodents have two characteristic species of sucking lice, but usually only one species is found on a host. Although sucking lice are largely restricted to old world primates, marine carnivores, rodents, rabbits and ungulates, several species are known from insectivores. The domestic dog is one of the few land carnivores parasitized by sucking lice. No species of Anoplura are known from monotremes (platypus, etc.), Australian marsupials (kangaroo, etc.), bats, elephants or cetaceans (whales, dolphins, etc.).

The best-known species of louse is the sucking louse of man, *Pediculus humanus,* which infests the human race wherever modern hygienic practices have not been instituted. Its distribution is almost coextensive with that of the human race and the antiquity of this association is demonstrated by the presence of lice on ancient mummies from Egypt and the southwestern United States. This species has apparently been inherited by man from his remote primate ancestors. There are two varieties of the common human

louse, namely, *Pediculus humanus* var. *capitis*, the head louse, and *P. humanus* var. *corporis*, the body louse or "cootie." The human louse in heavy infestations may cause serious skin irritations, but far more serious is its role as the carrier from man to man of the pathogenic agents of epidemic typhus fever (*see* TYPHUS FEVER), trench fever of World War I and louse-borne relapsing fever (in contrast to tick-borne relapsing fever) (*see* RELAPSING FEVER). The terrible role of these diseases in the history of man is related by Hans Zinsser in *Rats, Lice and History* (1935).



ROSS E. HUTCHINS

HUMAN BODY LOUSE (PEDICULUS HUMANUS), ABOUT 20 TIMES ENLARGED

Epidemic typhus fever has been a scourge whenever populations have been disrupted or concentrated by war, famine or floods and the attendant insanitary conditions.

The only other louse that infests man is the pubic or crab louse, *Phthirus pubis*, which is occasionally found in the hair of the armpits, in the eyebrows and beard as well as in the pubic regions. It is not known to be an important disease vector.

Related species of lice are *Pediculus schäffi* of the chimpanzee and *Phthirus gorillae* of the gorilla. The other lice from old world primates are included in the genus *Pedicinus*. *Pediculus mjöbergi*, which is almost indistinguishable from the human louse, is recorded from several species of new world monkeys. It is generally considered that these monkeys have acquired the parasite by contact with man, although it may be established on wild monkeys. Some of the common lice of domestic animals are *Haematopinus suis* of the pig, *H. asini* of the horse, *H. eurysternus* and *Linognathus vituli* of the cow and *L. setosus* of the dog.

In infestations on man DDT, lindane and other chemical dusts have proved effective insecticides for lice, and poisonous gases, chemical solutions and heat sterilization have been used to delouse infested clothing. Chemical dips or sprays are used on infested domestic animals.

See INSECT; *see* also references under "Louse" in the Index.

See C. F. Craig and E. C. Faust *Clinical Parasitology*, thoroughly rev. by E. C. Faust and P. F. Russell, 6th ed., chap. 38 (1957); U.S. Department of Agriculture, "Insects," *1952 Yearbook of Agriculture* (1952). (W. L. J.; X.)

LOUTH (CONTAE LUGHBHAIDH), a maritime county in the northeastern corner of the province of Leinster, Republic of Ireland, is bounded northeast by Carlingford lough, east by the Irish sea, southwest by Meath, northwest by Monaghan and north by Armagh (N.Ire.). The smallest county of Ireland, its area is 317 sq.mi., with a population (1961) of 67,378, of whom two-thirds are in towns, notably Dundalk and Drogheda, both of which are ports and industrial centres of Norman origin and long-standing significance.

Louth is one of the most interesting and varied of the Irish counties. It includes the hilly, scenically attractive Carlingford peninsula, named from the historic town of Carlingford (*q.v.*), which faces the lough of the same name. On the north side of the lough is the fine range of the Mourne mountains in County Down. The Carlingford peninsula has a remarkable double line of crests, formed of gabbros, with Carlingford mountain (1,935 ft.) as the highest point, and of granites which are smoother, more rounded hills such as Clermont Carn (1,674 ft.). There are granite basins between the gabbro crests. On the granites there are deep peat bogs, actively cut in recent years, but the gabbros form craggy slopes almost devoid of vegetation. The lowland fringe of the peninsula is made up of Carboniferous and Silurian beds (the latter on the Carlingford lough side), thickly plastered with glacial drifts. The rest of the county is part of the central lowland, and floored by Silurian strata, generally about 200 ft. above sea level but rising to more than 800 ft. in the Callow hills between the Dee and Boyne valleys. Everywhere a plastering of glacial drift occurs and away from the crest it gradually assumes the form of drumlins, though these merely diversify rather than dominate the lowland of County Louth. Only one-eighth of the area is unimproved agricultural land, of which the largest continuous stretch is in the mountains of the Carlingford peninsula. Glacial drifts have given varied soil and drainage conditions, but many of the small patches of peat bog have long been cleared and the land used for pasture or even crops such as potatoes.

History.—Louth was the scene of some of the great mythical or semimythical exploits of the hero Cú Chulainn, perhaps about the beginning of the Christian era. It was the scene of the *Táin Bó Cúailnge* or "cattle raid of Cooley," which gave rise to the seven years struggle between the men of Ulster and those of Connaught.

The kingdom of Oriel was established in the 4th century, comprising Monaghan, Louth and Armagh, and Louth was for many centuries associated with Ulster rather than with Leinster. The kingdom of Oriel was finally wiped out by Anglo-Norman invaders. In 1185 Prince John annexed to the crown the barony of Louth. He established Theobald de Verdun (or Verdon) as lord of Dundalk and Roger de Pippard as lord of Ardee. Under Richard II Louth was included in the English Pale, and it remained part of the small area which the Dublin government could still effectively rule during the later middle ages. The towns of Drogheda and Dundalk were of considerable importance, and parliaments were sometimes held in them as well as in Dublin. In Tudor times, when Ulster had become the core of resistance to extending English rule, Dundalk was a frequent marshaling place for armies which advanced north through the Dundalk gap. Like other parts of the Pale, Louth had its own rather turbulent landed nobility, many of whom were ruined and replaced during the 17th century.

There are some fine relics of the monastic period of the Celtic Church, notably at Mellifont and Monasterboice. Castles of the Anglo-Norman phase are relatively numerous and include some small ones apparently intended for the defense of the Pale. Of the towns, Ardee, Drogheda and Dundalk possess Norman charters, but Collon and Dunleer are apparently later foundations.

Administration and Economy.—A county council meets at Dundalk, the county town, and there is a county manager. Drogheda (pop. [1961] 17,085) and Dundalk (19,790) are urban districts, and Ardee is administered by town commissioners. The county returns three members to *dáil éireann*.

Agriculturally, the county shows the transition from the small-

BORD FÁILTE ÉIREANN

RUINS OF MELLIFONT, THE FIRST CISTERCIAN ABBEY IN IRELAND, FOUNDED 1142

farm regimes of Counties Down and Armagh to the large grazing farms of County Meath. In the Carlingford peninsula many of the farms are of 30–50 ac., with somewhat intensive production of a mixed type. Much of the land in the peninsula is used for crops, notably potatoes, oats, barley and turnips, with lambs, young cattle, poultry and butter as the main cash staples. Through the lowland from the Dundalk area southward there is a gradual increase of farm size: near Dundalk, for example, there are medium-sized holdings with cattle grazing and arable cropping, largely for oats, but farther south toward Drogheda there are large grazing farms. In the whole county over one-quarter of the improved land is used for crops, the biggest of which is wheat, followed by barley, potatoes, oats and turnips.

Dundalk and Drogheda are on the main railway line from Dublin to Belfast. Dundalk has a wide range of industries including brewing (a new brewery producing lager was opened in 1962); mineral water (soft drink) production, grass seed purifying, milling and bacon curing, with tobacco and textile works—the last providing a variety of cotton and linen goods. Larger modern factories have been established for the footwear industry. Drogheda has a line of factories along the Boyne, of which several use the port; they include shoe factories, a chemical manure works, various mills for grain, and linen mills. On the Boyne outside Drogheda there is a large cement works. Ardee is a quiet market town in a fertile agricultural area. (T. W. Fr.; Hu. S.)

LOUTH, a market town and municipal borough in the Parts of Lindsey, Lincolnshire, Eng., lies 26 mi. E.N.E. of Lincoln by road on the river Lud where it flows out of the Wolds. The Greenwich meridian passes through the town. Pop. (1961) 11,556. Louth is the chief marketing centre for agricultural and general produce in north Lincolnshire, and its weekly cattle market is the busiest in the county. Near the town hall (1853) are the chief market buildings, the Market hall (1866–67) and the Corn Exchange (1854). The town's industries (*e.g.*, the making of agricultural machinery) are mainly connected with agriculture and horticulture; but plastics and packaging materials are also produced.

Louth owed its early prosperity to the nearby Cistercian abbey founded in 1139 by Alexander, bishop of Lincoln. It received its charter in 1551 from Edward VI. Among the pupils at King Edward VI grammar school (first mentioned in 1276) where John Smith, an early settler of Virginia; the poet Alfred, Lord Tennyson, and his brother Charles; and Sir John Franklin, discoverer of the northwest passage. The Perpendicular parish church of St. James was built between 1500 and 1515. About 1 mi. W. of the town is the 40-ac. park of Hubbards hills. (Wa. H.)

LOUTHERBOURG (Lutherburg), **PHILIPPE JACQUES DE** (1740–1812), landscape painter, engraver and especially successful theatrical scene designer of Polish origin who became a naturalized Englishman, was born at Fulda, Ger., on Oct. 31, 1740. He received his first training under his father, a miniature painter. Later, about 1755, he worked at Paris under Charles van Loo and Francesco Casanova. He was received into the academy in 1767 and exhibited battle scenes, landscapes and marine paintings at the Salon, where he won the praise of Diderot who considered him as an inferior Vernet with an admixture of Berghem. In 1771 he went to London with an introduction to David Garrick who paid him £500 a year as his regular adviser on scenic effects at Drury Lane theatre from 1773. In 1781 he turned his talents to the Eidophusikon, an elaborate moving panorama combined with dramatic lighting effects and music, which enjoyed considerable success. Later he retired to Hammersmith where he practised as a faith healer. He also devised a system for reproducing paintings in colour which occasionally deceives even modern critics. He died on March 11, 1812.

Loutherbourg had a marked talent for ingenious dramatic effects in oil paintings, but as he seldom referred to nature, his theatrical work was probably better adapted to his abilities than landscape painting.

See W. T. Whitley, *Artists and Their Friends in England 1700–1799*, vol. 2 (1928); E. K. Waterhouse, *Painting in Britain 1530 to 1790* (1953). (F. J. B. W.)

LOUVAIN (Flem. Leuven), a town of Belgium on the Dyle (Dijle) river in the province of Brabant, of which it was the capital from 1190 until the rise of Brussels, 16 mi. to the east by road. Pop. (1961) 32,524. Local tradition attributes the establishment of a camp there to Julius Caesar, but Louvain only became important in the 11th century as a residence for the counts of Louvain, afterward the dukes of Brabant. The name is derived from the Low German *loo* ("bushy height") and *veen* ("swamp"). In 1356, at the time of the famous *Joyeuse Entrée* (*q.v.*) of Wenceslas, the principal charter of Brabant, Louvain had a population of at least 50,000 and was a centre of the cloth trade. The guild of weavers numbered 2,400 members. The old walls, 4½ mi. in circumference, have been replaced by boulevards. Soon after the *Joyeuse Entrée* a feud began between citizens and patricians. After a struggle of more than 20 years' duration, the White Hoods, as the citizens called themselves, were crushed. In 1379 they massacred 17 nobles in the town hall, but this brought the vengeance of the duke, to whom in 1383 they made the most abject surrender. Many weavers fled to Flanders and England, the duke took up residence in the strong castle of Vilvorde, and Brussels prospered at the expense of Louvain.

What it lost in trade it partially recovered as a seat of learning, for in 1425 Pope Martin V founded at Louvain the first university in the Netherlands, which has always been renowned for its Catholic teaching. From 1432 the university occupied the old Cloth Workers' hall, a building dating from 1193 and many times restored, with long arcades and graceful pillars supporting the upper stories. In the 16th century there were about 6,000 students and 50 colleges attached to the university; there are now seven faculties and 21 affiliated institutes with a student membership exceeding 13,000. The aula and the university library were burned in the German invasion of 1914. A new library (designed by the U.S. architect Whitney Warren) was built (1921–28) with American funds, and books and fittings were donated by many nations. It was again destroyed by fire during the German attack in May 1940, but has been restored and restocked with about 800,000 volumes.

The town hall, one of the richest examples of pointed Gothic, was built by Mathieu de Layens, master mason (1448 to 1463), in three stories, each with ten pointed windows facing the square. The church of St. Peter, originally dating from the early 11th century, was twice destroyed before being restored as a Gothic structure (1425–97); it was again damaged in World Wars I and II. It has seven chapels, in two of which are fine pictures by Dierick Bouts, formerly attributed to Memling. Much of the iron and brass work is by Quentin Massys. Other interesting buildings include the churches of Ste. Gertrude, St. Quentin, St. Michael and St. Jacques, the two *béguinages* and the "Round Table" (former meeting place of merchant guilds).

Industries include flour milling, brewing and radio valve (tube) manufacture. Mirrors are made, mainly for export, and there is a bell foundry. (R. M. An.)

LOUVER (Louvre, Luffer), in architecture, was originally a lantern or cupola built on the ridge of the roof of the great hall of a medieval house to let out the smoke. The term was later generally applied to a system of slanting boards, sheets of metal or glass, or other material, so arranged as to permit the passage of air while restricting the view, the sun, rain water, or any combination thereof. Three large adjustable horizontal louvers were used in each room of the Ministry of Education building in Rio de Janeiro (Oscar Niemeyer, 1936) as sun protection. Immense adjustable vertical aluminum louvers, one story high (repeated on each story) serve as sun protection on all four sides of the Pan American Life Insurance building, New Orleans, La. (Skidmore, Owings and Merrill, 1951). Since louvers are practical, simple and usually attractive they have become a popular feature of contemporary architecture. (H. Mn.)

LOUVET (DE COUVRAY), JEAN BAPTISTE (1760–1797), French man of letters prominent as a Girondin during the Revolution, was born in Paris on June 12, 1760, a paper merchant's son. For a few years he used the additional name "de Couvrai" or "de Couvray" to distinguish himself from other Louvets. He was working for a bookseller when he won fame

with a licentious novel, *Une année de la vie du chevalier de Faublas,* 5 parts (1786–87), supplemented by *Six semaines de la vie . . . ,* 2 volumes (1788). Later completed with *La Fin des amours du chevalier de Faublas,* 6 volumes (1790–91), the work was many times reprinted as *Les Amours . . .* or as *Les Aventures du chevalier de Faublas.* A jeweler's wife, Marguerite Denuelle, whom he abducted and to whom he gave the name Lodoïska, shared in all the future vicissitudes of his life.

At Nemours when he heard that the Parisians had stormed the Bastille (July 1789), Louvet was the first to sport the tricolour cockade there. He was at Versailles when the Parisian marchers arrived to take the royal family back to Paris (October); and when J. J. Mounier denounced these proceedings, Louvet defended them in a pamphlet. A member of the Jacobin club, he yet continued his frivolous writing for some time. In Dec. 1791, however, he presented to the Legislative Assembly the petition from the Lombards section of Paris which was answered by the decree of Jan. 2, 1792, against the king's brothers and other *émigrés.* Elected to the Jacobins' correspondence committee, he launched a poster newssheet, *La Sentinelle,* in March 1792, to combat the court's policy. This newssheet was soon subsidized by the ministry of the interior, then under J. M. Roland, and its success helped Louvet's election to the Convention as deputy for Loiret. By now a member of Madame Roland's circle, Louvet took the side of the Girondins (*q.v.*) in the Convention: his attack on Robespierre (Oct. 29, 1792) was sensational; and to Robespierre's reply (Nov. 5) he retorted with a pamphlet, *À Maximilien Robespierre et à ses royalistes,* full of misrepresentations. At Louis XVI's trial he voted for the death sentence with a suspension. On the overthrow of the Girondins (June 2, 1793), he went into hiding in Paris before joining his friends in Caen. After withdrawing to Brittany and then by sea to the Gironde, he went secretly to Paris in Dec. 1793 but next took refuge in Switzerland until the Thermidorian reaction allowed his return to Paris in Oct. 1794. Readmitted to the Convention on March 8, 1795, he remained a republican while other Girondins turned royalist. He protested against the excesses of the reaction after the rising of Prairial (May 1795). Under the Directory he sat for Haute-Vienne in the council of 500. Louvet died in Paris on Aug. 25, 1797. (A. So.)

LOUVOIS, FRANÇOIS MICHEL LE TELLIER, Marquis de (1639–1691), French statesman, secretary of state for war and the most influential minister of the middle period of Louis XIV's reign. He was born in Paris and baptized on Jan. 18, 1639, of a family of modest origin, being the son of Michel Le Tellier (*q.v.*), whose unpretentious manner did much to induce Louis XIV to accept the young man's services. Granted the *survivance* or right of succession to his father's secretaryship of state for war in Dec. 1655 (during Cardinal Mazarin's ministry for Louis XIV), Louvois was authorized to sign himself secretary of state in Feb. 1662, soon after the beginning of the king's personal rule. Marriage (March 1662) to Anne de Souvré, marquise de Courtenvaux, raised him in the social hierarchy.

In strictly military matters Louvois acknowledged the superiority of the great Turenne and for a time showed great humility in his letters to him, though his authoritarian temperament rebelled against the need for such deference. In Feb. 1672, however, Louvois was admitted to the king's upper council, with the title of minister of state; and then his strong personality could assert itself. When Louis XIV opened his war against the United Provinces of the Netherlands in March 1672 (*see* Dutch Wars), altercations between Louvois and Turenne ensued. A notable one arose over the right to be addressed as *Monseigneur* instead of *Monsieur* in official letters. When Louvois persuaded the king that secretaries of state, writing on the king's behalf, should no longer write *Monseigneur* to dukes or to persons enjoying the rank of "foreign prince" at the French court, Turenne, a "foreign prince" of the house of La Tour d'Auvergne, protested so forcefully that he retained the distinction for his house; but Louvois conversely obtained that secretaries of state should themselves be addressed as *Monseigneur* except by dukes or princes. Turenne's death in battle (1675) and the great Condé's retirement in the same year left Louvois free to conduct the war in his own way. Thenceforward it was usually he who composed the king's directives to the generals.

Le Tellier, who had provisionally resigned his own secretaryship of state in 1667, resigned it definitively in 1677, on becoming chancellor of France. Louvois thus became sole secretary of state for war. Year by year his influence grew till he emerged as the king's indispensable adviser, prime minister in all but name for his last ten years. From the beginning of Louis XIV's personal rule, however, Louvois and J. B. Colbert (*q.v.*) had been rivals for the king's favour—although not to the extent alleged by malicious contemporaries or to the detriment of their work. Even so, some difficulty arose over the secretaryship of state for foreign affairs. When Hugues de Lionne died (1671), his destined successor, Simon Arnauld de Pomponne, was absent from France as ambassador to Sweden; and Louvois, put in temporary charge of foreign affairs, acquired such a taste for them that he continued to correspond directly with ambassadors even when Pomponne had taken up his duties. Pomponne complained, and angry disputes took place in the king's council. Louvois and Colbert, who also disliked Pomponne, together prevailed at last on the king to dismiss him; but Louvois was not pleased to see the post taken by Colbert's brother, Charles Colbert de Croissy.

Louvois maintained his influence over the king largely because he was always ready to second his schemes for aggrandizement (whereas Colbert never stopped arguing for economies) and constantly proposed military solutions for problems. Moreover, though he never commanded an army in the field, he had a remarkable talent for military administration. Since his father had already reorganized the army, Louvois had nothing much to create; but he knew how to maintain discipline and to ensure that armies were never without munitions, rations or pay. In 1688, when a new European war was breaking out (*see* Grand Alliance, War of the) he introduced a type of compulsory military service: for every levy of troops, every *généralité* in the kingdom was to elect a quota of unmarried men between the ages of 20 and 25, who would then be equipped with arms and clothing at the expense of their parishes and enrolled in "provincial militias." The system of election, however, soon gave rise to abuses and was replaced by the drawing of lots.

The duc de Saint-Simon, author of the *Mémoires,* recognized the capacity of Louvois but resented his part in the humiliation of the dukes and described him as "a haughty man, brutal in all his ways." Brutality was indeed a salient characteristic of Louvois. During the Dutch War he received complaints about the cruel treatment of civilians by French soldiers, but wrote to the general in command: "I pray you not to relax your ruthlessness, but to push things forward, in this respect, with all imaginable vigour." He also played a part in promoting the system of *dragonnades* for the harassing of Huguenots before the revocation of the Edict of Nantes. Louvois died at Versailles on July 16, 1691. A *Testament politique de Louvois,* published in 1695, is of doubtful authenticity. His bad handwriting makes his manuscripts, in the archives of the Ministère de la Guerre, very hard to decipher.

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LOUŸS, PIERRE (pseudonym of Pierre Louis) (1870–1925), French novelist and poet who sought to express pagan sensuality with stylistic perfection. He was born in Ghent, of French parents, Dec. 10, 1870, and was educated in Paris at the École Alsacienne, where he met André Gide. He frequented Parnassian and Symbolist circles and was a friend of Debussy. He founded *La Conque* (1891), one of the first reviews to publish poems by Paul Valéry (*q.v.*). His *Chansons de Bilitis* (1894), prose poems about Sapphic love purporting to be translations from the Greek, deceived even experts. *Aphrodite* (1896), a novel depicting courtesan life in ancient Alexandria, made him famous. His best work is *La Femme et le Pantin* (1898), a psychological novel set in Spain. Louÿs spent his last years in semiseclusion, and died in Paris, June 4, 1925.

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LOVAT, SIMON FRASER, 11TH BARON (*c.* 1676–1747), Scottish Jacobite, chief of clan Fraser, noted for his violent feuds and changes of allegiance, was the eldest surviving son of Thomas, fourth son of the 7th Lord Lovat. Educated at King's college, Aberdeen, Simon combined culture with barbarity—his main fascination for posterity. His ambition was "to be the greatest Lord Lovat that ever was," and his endeavours to win the estates and title largely explain his tortuous career. He persuaded the weak 9th Lord Lovat to settle the liferent of his estates on Thomas Fraser in 1696, but the destination of the estates had already been settled in favour of Lovat's daughters. On the death of the 9th lord, Simon Fraser tried to solve this problem by a politic marriage with the eldest daughter, Amelia, but his design failed. He then forcibly married the dowager Lady Lovat and thus incurred a long and bitter feud with her kinsmen, the Murrays of Atholl. As a consequence in 1698 Simon was tried and sentenced to death, but through the intercession of the earl of Argyll he won a pardon from William III. It was not a complete pardon, however, and in 1701 Fraser was tried for the "rapt" of Lady Lovat. For failing to stand trial he was once more outlawed. After spending some time in London he crossed to France where he soon made contact with the court of the exiled Stuarts.

In 1702 young Amelia Fraser of Lovat married Alexander Mackenzie, son of Lord Prestonhall; the honours of Lovat were confirmed to her, and in an unsuccessful bid to win the affections of clan Fraser her husband assumed the designation of Mackenzie of Fraserdale.

Simon Fraser returned to Scotland in 1703 on a Jacobite mission which he betrayed to the duke of Queensberry, head of the Scottish ministry. Lovat's treachery leaked out and on his return to France he was held captive for ten years, first at Angoulême and then at Saumur. He escaped and returned to Scotland in 1715 where he found that Fraserdale had joined the Jacobite rebels. This decided Lovat's allegiance for the time and he rendered good service to the government. For this he was pardoned and granted a liferent of the coveted estates. Not content with this he strove to gain the full title, aided by the eminent lawyer Duncan Forbes of Culloden. To enlist government support Fraser co-operated with Gen. George Wade in his efforts to pacify the Highlands after 1725, but at the same time he did much to revive the flagging spirit of clanship. He received the title in 1730 but did not gain complete possession of the estates until 1733.

Lovat hoped for greater rewards if the Stuarts were restored, and he was largely instrumental in founding (1739) the Jacobite association. In 1740 he was secretly created duke of Fraser by James, the Old Pretender. But Prince Charles Edward's failure to bring arms and troops with him in 1745 nonplussed Lovat. He forced his son Simon to join the rebels while he himself pretended loyalty to George II. After the Jacobite victory at Prestonpans, however, Lovat openly espoused the Stuart cause although he played no appreciable part in the rebellion. After the Jacobite defeat at Culloden he urged Charles Edward to continue the campaign; but all was lost and Lovat was eventually captured. He was condemned by the house of lords on March 18, 1747, and, with a great show of bravado to the last, he was executed on April 9, 1747, on Tower hill, London.

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LOVEBIRD: *see* PARROT.

LOVEJOY, ELIJAH PARISH (1802–1837), U.S. abolitionist, was born at Albion, Me., on Nov. 9, 1802, and graduated at Waterville (now Colby) college in 1826. The following year he moved to St. Louis, Mo., where he established a school and entered journalism. Later he began to publish a religious paper called *The Observer* in which he strongly condemned slavery and recommended gradual emancipation. A letter in 1835 signed by a number of the important men of St. Louis requested him to moderate the tone of his editorials. He replied in an editorial reiterating his views and his right to publish them. Threats of mob violence forced him to move his press across the Mississippi river to Alton, Ill. There his press was destroyed by mobs several times in one year, and on the night of Nov. 7, 1837, when a mob attacked the building, Lovejoy was killed in its defense. The news of his death stirred the people of the north profoundly and led greatly to the strengthening of abolitionist sentiment.

LOVELACE, RICHARD (1618–1657), described by Edward Phillips in *Theatrum Poetarum* (1675) as "Souldier, Gentleman & Lover, and a fair pretender to the Title of Poet," came of an old Kentish family but was probably born in Holland, where his father was in the Dutch military service, in 1618. He was educated at Charterhouse and at Gloucester hall, Oxford, when, according to Anthony à Wood's *Athenae Oxonienses,* he was "accounted the most amiable and beautiful person that ever eye beheld." After leaving Oxford he retired "in great splendor to the Court." At 16, according to Wood, but possibly a little later, he wrote *The Scholars,* a comedy acted at Whitefriars, of which the prologue and epilogue survive. He took part in the two expeditions to Scotland (1639–40) and during the second wrote *The Soldier,* a tragedy never acted and now lost.

Returning to his estates in Kent, Lovelace, who had torn up a disloyal petition at the quarter sessions at Maidstone, was chosen to present (1642) a royalist petition to a hostile house of commons. For this he was imprisoned in the Gatehouse, London, where he wrote "To Althea, from Prison." Released "upon good Security" after about seven weeks, he probably went to Holland. He passed much of the next four years abroad and was wounded fighting for the French against the Spaniards at Dunkirk in 1646.

On Oct. 26, 1647, with Thomas Rawlins and Peter Lely, Lovelace, now a colonel, was admitted to the freedom of the Painters company—an unusual and significant honour. In 1648 he was again imprisoned. James Thompson, a lawyer, writing on Oct. 26, said that soldiers searching for Lovelace's brother Francis seized "divers Delinquent Jewells" in Richard's cabinet and that the incensed poet, taking it upon him "stiffly to argue property," was arrested on the pretense that something had been found in his papers (see *The Oxinden and Peyton Letters, 1642–70*). During his imprisonment, Lovelace prepared *Lucasta* (1649) for the press. Wood identified Lucasta with one Lucy Sacheverell, but if a real person, as is probable, she is as likely to have been a Lucas.

Lovelace continued to write commendatory verses for various publications, a practice he began at 20. Wood says he died in misery and poverty in 1658 and was buried in St. Bride's church, London, but an elegy on him was printed in 1657. He had certainly sold much of his estates, and he who was noted for generosity to ingenious men was himself helped in need by Charles Cotton, but none of the elegies supports John Aubrey's story of his unhappy death.

That Lovelace was himself planning a second volume is shown by Eldred Revett's lines "On his second poems," but *Lucasta. Posthume Poems of Richard Lovelace Esq.* (1659) was edited by his brother Dudley, assisted by Revett, and includes *Elegies,* dated 1660.

Lovelace was the friend of musicians, painters and writers such as Henry Glapthorne, who named his daughter Loualis after him, James Howell, Alexander Brome, Andrew Marvell and John Hall, the last of whom liked people who were "celebrated for some excellent endowment," but was so far from being a royalist that *Mercurius Elencticus* (1648) asked if he could be a fit associate for such ingenious and candid souls as Lovelace, John Sherburne, James Shirley or Thomas Stanley, who includes the other three in his "Register of Friends." Lovelace was scholarly and cultured, interested in languages, literature, music, painting, hunting, falconry and everything thought befitting a gentleman.

In his poems Lovelace generally follows the "conceited" fashions of his time, though his best songs owe much to a simplicity of thought and diction which possibly led Sir Walter Scott, when misquoting "To Lucasta, Going to the Warres" in *The Talisman,* to claim it for the earl of Montrose. Obvious criticism is summed up by John Ferriar's "Lovelace strikes, by fits a note divine," but

even when Lovelace's verses are only exercises in ingenuity there is audible the voice of one whose conversation was "witty and incomparably graceful," and who succeeded in giving to plain emotions the utterance that is most effective and memorable in song.

See *The Poems of Richard Lovelace,* with an introduction by C. H. Wilkinson, 2 vol. (1925). (C. H. Wn.)

LOVELL, FRANCIS LOVELL, Viscount (1454–1487?), English politician and supporter of Richard III, was a son of John (d. 1465), 8th Baron Lovell of Tichmarsh, an adherent of Henry VI. Francis was knighted by Richard, duke of Gloucester (later Richard III), during the Scottish expedition of 1480 and was created viscount in Jan. 1483. After the death of Edward IV in 1483 he was made chief butler of England in May; chamberlain of the household from June 1483 to August 1485; and at Richard's coronation in July 1483, he bore the third sword. As one of Richard's most trusted ministers he was denounced in William Collingbourne's celebrated couplet:

> The catte, the ratte, and Lovell our dogge
> Rulyth all Englande under a hogge.

Lovell fought for Richard at Bosworth and after the battle fled to sanctuary at Colchester. The following year he escaped to organize a dangerous revolt in Yorkshire. When this was put down, he escaped to the Netherlands, where Margaret of York helped him. He accompanied John de la Pole, earl of Lincoln, and Martin Schwartz, with a force of men to Ireland in May 1487 in support of Lambert Simnel's imposture. They then crossed to England and were defeated by Henry VII's forces at Stoke in June 1487. Lovell was seen fleeing after the battle, but was never heard of again. In 1708 there was found in a secret vault at Lovell's house at Minster Lovell, Oxfordshire, the skeleton of a man seated at a table, on which were a book, paper and a pen. It is thought that Lovell had hidden himself there and died of starvation.

See J. H. Ramsay, *Lancaster and York,* vol. ii (1892); J. D. Mackie, *The Earlier Tudors: 1485–1558* (1952); *Notes and Queries,* vol. 1, 2nd series (1856) and vol. 10, 5th series (1878). (A. R. M.)

LOVETT, WILLIAM (1800–1877), English Chartist leader mainly responsible for the drafting of the People's Charter (*see* Chartism), was born at Newlyn, near Penzance, on May 3, 1800. He was apprenticed to the trade of ropemaking, but turned to carpentry and moved to London in 1821. He established himself as a cabinetmaker, not without difficulty, but spent all his available spare time in self-education, particularly in the study of economics and politics. He was a follower of Robert Owen and in 1829 became honorary secretary to the British Association for the Promotion of Co-operative Knowledge, a seminal organization in the development of working-class radicalism. After losing all his savings in the failure of an attempt to set up a shop he became storekeeper of the London Co-operative association. He met many London radicals, and was one of the group that sponsored *The Poor Man's Guardian* and later the London Workingmen's association (1836). It was this body that launched the People's Charter in 1838. Lovett was a zealous and high-minded Chartist, who found it impossible to work with or under the leadership of Feargus O'Connor (*q.v.*). His role in Chartism, therefore, was limited, but he was secretary of the Chartist convention of 1839 and was arrested after Chartist disturbances in Birmingham when the convention moved there in May. He was sentenced to 12 months' imprisonment in Warwick jail. While there he wrote jointly with John Collins, his fellow prisoner, a little book *Chartism: A New Organization of the People.* Lovett now identified political advance with education. He had always disliked and despised talk of political force, and he put his trust increasingly in voluntary "self-improvement." In 1841 he created the National Association for Promoting the Political and Social Improvement of the People, to which he devoted most of his energies. He kept open a "national hall" until 1857, after which he wrote a number of textbooks designed for working-class students. He also wrote his autobiography, published in 1876. He died in London on Aug. 8, 1877. (A. Bri.)

LOW, SIR DAVID ALEXANDER CECIL (1891–1963), one of the most outstanding of modern political cartoonists and caricaturists, was born at Dunedin, N.Z., on April 7, 1891, of Scottish and Irish parentage. Briefly educated at Christchurch High school and a self-taught artist, he was already contributing cartoons to a local weekly paper at the age of 11. At 17 he set out as a full-time freelance artist, combining this work from 1911 with a post on the *Bulletin* of Sydney, Austr. Having acquired a certain notoriety with some highly successful and impudent cartoons of Australia's Labour prime minister "Billy" Hughes (*The Billy Book,* 1918), Low was invited to England by the *Daily News* in 1919. He found himself on the *Star,* however, remaining there until 1927, when he joined the *Evening Standard* at the invitation of Lord Beaverbrook. Thriving in opposition to this paper's right-wing political views—a situation cleverly encouraged by its proprietor—Low produced work perhaps unequalled in this field. He reached his peak with the political cartoons of the years before and during World War II which earned him world fame and the especial hatred of Adolf Hitler. His immortal fictional character "Colonel Blimp" also was born in the *Evening Standard.* Of all newspaper cartoonists, Low came to terms most successfully with the limitations of topicality, newsprint and the reader. The melodramatic simplicity of his conception and the almost oriental facility of his brushwork combined with telling effect, especially when dealing with the black and white issues of fascism and oppression. Much work on these themes is contained in *The Years of Wrath* (1949). Thirty Low collections were published, from *Low's Annual* (1908) to *The Fearful Fifties* (1960). Low's *Autobiography* appeared in 1956. He left the *Evening Standard* for the *Daily Herald* in 1950—a flirtation as unsatisfactory as it was short-lived. In 1953 he joined the *Guardian,* with which he had long been associated, contributing three cartoons weekly from semi-retirement. He was knighted in 1962 and died in London on Sept. 19, 1963. (Rd, S.)

LOW, SETH (1850–1916), U.S. municipal reformer, university builder and philanthropist, was born in Brooklyn, N.Y., Jan. 18, 1850. He graduated as valedictorian of Columbia college in 1870, thereupon entering his father's prosperous importing business and becoming a leader in the silk trade.

Low was twice elected mayor of Brooklyn, and his administration (1882–85) was characterized by civil service reform, administrative efficiency, public school reorganization and advocacy of home rule, all of which attracted national attention.

Low served as president of Columbia from 1890 to 1901, transforming Columbia from a small college on a crowded city block to a large university on an impressive campus on Morningside heights. He gave coherent form to the university spirit, organized the university council, the graduate faculties of philosophy and pure science, and by absorption or alliance brought the College of Physicians and Surgeons, Barnard college, Teachers college and other important components more closely into the Columbia university system. He set an example of philanthropy by his gift of the imposing central building on the new campus, by his support of professorships and by his aid, through Barnard, of education for women. In 1899 he was a delegate to the first Hague Peace conference.

Elected mayor of greater New York in 1901, Low eliminated plaguing paternalism and demonstrated municipal administration on business principles. Failing re-election in 1903, he nonetheless continued outstanding public service, furthering education for Negroes as chairman of the trustees of Tuskegee institute from 1907 until his death, and labour-management relations as arbitrator in major disputes. He served also as president of the National Civic federation and the New York Chamber of Commerce.

Low died Sept. 17, 1916, at his home in Bedford Hills, N.Y.

Bibliography.—John W. Burgess, *Reminiscences of an American Scholar* (1914); R. Gordon Hoxie *et al., A History of the Faculty of Political Science, Columbia University* (1955); F. P. Keppel, *Columbia* (1914); B. R. C. Low, *Seth Low* (1925); David K. Nothstein, "Mayor Seth Low," *Columbia University Quarterly,* vol. 32 (Dec. 1940) and articles in *Columbia Alumni News,* vol. 8 (Oct. 20, 1916). (R. G. He.)

LOWDEN, FRANK ORREN (1861–1943), U.S. lawyer and politician, governor of Illinois from 1917 to 1921, was a nationally prominent advocate of reforms in governmental administration and of improvements in the social and economic condition

of farmers. He was born at Sunrise City, Minn., Jan. 26, 1861, but from the age of seven grew to manhood in Hardin county, Ia. There he worked as farm hand and schoolteacher, and graduated from the state university in 1885. Quick success as an attorney followed his move to Chicago in 1886 and his graduation the next year from the Union College of Law. His marriage in 1896 to Florence, daughter of George M. Pullman (*q.v.*), had an important influence on his career. During the next decade, while counseling, directing or organizing business corporations, he established his home at "Sinnissippi," an estate near Oregon, Ill. There and on his Arkansas plantations he experimented with field crops, livestock and forestation.

His long apprenticeship in Chicago politics ended in 1904 in an unsuccessful bid for the Republican gubernatorial nomination. From then to 1912 he was a moderately progressive national committeeman of his party. In congress, 1906–11, he sponsored measures to improve the foreign service and benefit agriculture.

As governor of Illinois, in addition to vigorously upholding Pres. Woodrow Wilson's war policies, Lowden initiated a widely-imitated state budgetary and administrative structure, centralized under executive control. Although his political career climaxed in a deadlock with Leonard Wood for the Republican presidential nomination in 1920, which resulted in their both being by-passed in favour of Sen. Warren G. Harding, Lowden declined the vice-presidential nomination in 1924, sought the presidential nomination in 1928, and, as "Sage of Sinnissippi," often advised politicians and political scientists until his death at Tucson, Ariz., March 20, 1943.

Following 1920, however, farmers' welfare was Lowden's principal concern. In frequent speeches and articles and through many organizations he championed marketing co-operatives, purebred dairy cattle, and improved methods of tillage. After 1925, with the agricultural depression deepening, he supported the McNary-Haugen bills for extending federal aid to farmers. The Domestic Allotment law of 1936 embodied his proposal, made seven years previously, to tie in government assistance with soil restoration.

Lowden's papers are in Harper Library, The University of Chicago.

See William T. Hutchinson, *Lowden of Illinois,* 2 vol. (1957). (W. T. Hn.)

LOWE, SIR HUDSON (1769–1844), English general and governor of St. Helena at the time of Napoleon's exile, was born at Galway in Ireland on July 28, 1769. He was an ensign in the East Devon militia in his 12th year and in 1787 was gazetted ensign in the 50th Foot. Throughout the war with France after 1793, Lowe was continually on active service, holding many important commands. He was knighted in 1814. Charged with the duties of quartermaster general of the army in the Netherlands in 1814–15, he was about to take part in the Belgian campaign when he was transferred to the command of the British troops at Genoa. While in the south of France he received (Aug. 1, 1815) news of his appointment to the position of custodian of Napoleon I. Soon after he was made governor of St. Helena, the place of the ex-emperor's exile, and he arrived in the island in April 1816.

The appointment was considered by many people, including the duke of Wellington, as unsuitable. Lowe was a man of little education and no imagination. The responsibility of his position weighed on him unduly with the result that he was excessively punctilious in carrying out his orders. Friction soon arose between Lowe and his prisoner. The news that rescue expeditions were being planned by the Bonapartists in the United States led to the enforcement of stricter regulations in Oct. 1816. Nevertheless Lowe recommended that the government allowance of £8,000 a year to the Longwood household should be increased by one-half. After the death of Napoleon in May 1821, Lowe returned to England and received the thanks of George IV, although his treatment of Napoleon aroused widespread criticism. He commanded the forces in Ceylon (1825–30), but was not appointed to the governorship when it fell vacant in 1830. Lowe died in London on Jan. 10, 1844.

Bibliography.—W. Forsyth, *History of the Captivity of Napoleon at St. Helena,* 3 vol. (1853); R. C. Seaton, *Napoleon's Captivity in Relation to Sir Hudson Lowe* (1903); R. Korngold, *The Last Years of Napoleon* (1959).

LOWELL, ABBOTT LAWRENCE (1856–1943), U.S. educator, president of Harvard university from 1909 to 1933, was born in Boston, Mass., on Dec. 13, 1856. He graduated from Harvard, A.B. 1877, LL.B. 1880, and practised law in Boston for 17 years before turning to teaching at Harvard. In 1909 he succeeded Charles William Eliot as president. Within a few years he had realized a new scheme of "concentration and distribution" to modify Eliot's "free elective" system, devised general examinations to de-emphasize isolated course-credits, and set up a tutorial plan to supplement undergraduate lectures. During his administration Harvard more than doubled student enrollments, nearly trebled the faculty, increased endowments from $22,000,000 to $130,000,000, and added new professional schools of architecture, business administration, education and public health. Beginning in 1930 he reorganized the Harvard undergraduate body of about 3,200 students into seven separate, self-contained residential "Houses." He also originated and endowed the Society of Fellows, a selected group of younger research scholars, freed from conventional restrictions on graduate study. Author of several textbooks on European governmental systems, his influence on U.S. education is better typified by *Conflicts of Principle* (1932, rev. ed. 1956) and *At War with Academic Tradition in America* (1934), both illustrative of his lifelong concern for academic freedom. He died in Boston on Jan. 6, 1943. (N. M. Py.)

LOWELL, AMY (1874–1925), U.S. poet, critic and lecturer, an exponent of the poetic doctrines of Imagism (*q.v.*), was born on Feb. 9, 1874, in Brookline, Mass., of a prominent and public-spirited family. She was educated by her mother and in private schools, afterward traveling widely abroad. At 28 she began to devote herself seriously to poetry, but published nothing until 1910, when a poem appeared in the *Atlantic Monthly*. Her first volume, *A Dome of Many-Coloured Glass* (1912), was succeeded by *Sword Blades and Poppy Seed* (1914), which included her first poems in *vers libre* and "polyphonic prose"; *Six French Poets* (1915); *Men, Women and Ghosts* (1916); *Tendencies in Modern American Poetry* (1917); *Can Grande's Castle* (1918); *Pictures of the Floating World* (1919), which reflected her new preoccupation with oriental poetry; *Legends* (1921); *Fir-Flower Tablets* (1921), with Florence Ayscough; *A Critical Fable* (1922); a biography of John Keats (1925); *What's o'Clock* (1925); *East Wind* (1926); and *Ballads for Sale* (1927). Throughout this period she wrote critical articles for periodicals and frequently lectured. After several years of illness, she died suddenly on May 12, 1925, at Brookline.

During her later years Miss Lowell was the most striking figure in American poetry. Her vivid and powerful personality, her independence and zest made her conspicuous, as did her scorn of convention in such defiant gestures as smoking cigars. Having been displaced by her as the leader of the Imagists, Ezra Pound promptly restyled them the "Amygists" in tribute to her domineering qualities. A bold experimenter in form and technique, she remained conservative at the core, retaining conventional verse forms and in her last years severing connections with all radical schools of poetry. Characteristic qualities of her work include her mastery of the free verse technique, her brilliant use of sensuous impressions in depicting the external world, and the restrained beauty of many of her shorter poems.

Bibliography.—Miss Lowell's complete poetical works appeared in 1955. For her own definitions of the principles of *vers libre* and "polyphonic prose" *see* the prefaces to *Sword Blades and Poppy Seed* and *Can Grande's Castle,* articles in *North American Review* (Jan. 1917) and *Dial* (Jan. 17, 1918). Biographies include W. Bryher, *Amy Lowell: A Critical Appreciation* (1918); R. Hunt and H. Snow, *Amy Lowell* (1921); S. F. Damon, *Amy Lowell: A Chronicle* (1935); Horace Gregory, *Amy Lowell: Portrait of the Poet in Her Time* (1958). For bibliography *see* Robert E. Spiller *et al.* (eds.), *Literary History of the United States,* 3rd ed. (1963).

LOWELL, JAMES RUSSELL (1819–1891), U.S. poet, critic and diplomat, who wrote extensively on a wide variety of subjects, but whose major significance probably lies in the interest in literature he helped develop through his writing, editing and teaching. Born in Cambridge, Mass., Feb. 22, 1819, he was

the grandson of John Lowell and a member of the distinguished New England family which in the 20th century produced the poets Amy Lowell (*q.v.*) and Robert Lowell. His lifelong love of nature was nurtured by his rearing in the open countryside, and he had read avidly in Alexander Pope as well as in Spenser, Scott and the old ballads before he entered Harvard, where he followed his enthusiasms more than the instructions of the faculty. He graduated in 1838 and in 1840 took his degree in law, which helped fit him for his later diplomatic posts, although he did not care to practise law as a profession.

His first period, up to about 1850, was dominated by humanitarian interests, notably abolition, in accord with the pressures of the era in New England. In 1844 he was married to the gifted poet Maria White, who was also an ardent humanitarian and who had helped inspire his poems in *A Year's Life* (1841). After a three-months' editorship (with Robert Carter) of the abortive periodical *The Pioneer* in 1843, attracting work by Hawthorne, Poe and Whittier, Lowell published the appreciative *Conversations on Some Old Poets* (1845), in which literary discussion did not exclude sentimental pleas for freeing the slave and for utopianism transcending nationalism. From 1845 to 1850 he wrote about 50 antislavery articles for such periodicals as the *Pennsylvania Freeman*, the *London Daily News* and the *National Anti-Slavery Standard*. Even more effective were his *Biglow Papers* which he began to serialize June 17, 1846 (the first series of which was collected in book form in 1848); written in New England dialect, these satirized the Mexican War as an attempt to extend the area of slavery. This "miraculous year" 1848 also saw the publication of the somewhat Tennysonian *Vision of Sir Launfal*, with its humanitarian theme that "the gift without the giver is bare," and the rollicking and witty *Fable for Critics*, urging American readers to "forget Europe wholly" in glorifying native humanitarian poets such as Whittier.

Lowell's second period, roughly from 1850 to 1867, shows him gradually turning from his earlier antitraditional humanitarianism to nationalism or Unionism, in response to new pressures of the time, notably secession. A trip to Italy and England (July 1851–Oct. 1852) made him less antitraditional, as "Leaves from My Italian Journal" (1854) suggests; and the death of three of his children, followed by the death of his beloved wife in 1853, gave him a taste of sorrows beyond the remedy of legislative reform. In 1855 his lectures on English poets before the Lowell institute led to his appointment as Smith professor of modern languages at Harvard, succeeding Longfellow; these lectures were richly appreciative of the older poets but centred (as "The Function of the Poet") on the theme that America has ample resources to inspire great poetry. Again he went to Europe to study in Germany and Italy, returning in Aug. 1856 for his fruitful professorship of 20 years. In 1857 he married Frances Dunlap, who had cared for his only remaining child, Mabel; and in that year he began his four years' editorship of the new *Atlantic Monthly*, to which he attracted nearly all the major New England authors who (partly through association at the Saturday club) provided mutual stimulation and ushered in a golden day of American literature. As editor, Lowell encouraged them to find the ideal in the real, in the "simply natural" American scene and vernacular as he tried to illustrate in his second series of *Biglow Papers*, devoted to Unionism and collected from the periodicals in 1867. These include "Sunthin' in the Pastoral Line" which, along with "New England Two Centuries Ago" (1865), illustrates the way in which, in the face of the threat to the Union, he drew upon his native Puritan heritage of ordered liberty, which he contrasted to what seemed to him the program of anarchy involved in disunion. His central hope in this period was that "a strong nation begets strong citizens," that (as he says in the "Ode Recited at the Harvard Commemoration" of her dead) the mutable many might find worthy perpetuation in the immutable One, a coercive Union, which he glorified in essays such as "E Pluribus Unum." "Washers of the Shroud" (1862) had warned that the nation could be preserved only if Americans subordinated "the Many's plaudits" and "Opinion's Wind" to "Knowledge, Will," and especially to obedience to the divine "Law before all time." The "Commemoration Ode," glorifying "the pith and marrow of the nation," had included the moving tribute to the martyred Lincoln in whom there was "nothing of Europe"—Lincoln who was the product of "the unexhausted West" which was to interest Lowell increasingly as one of the chief nurseries of what he regarded as distinctive national traits—self-reliant individualism, equality and optimism.

Lowell's third period, from about 1867 to the end, was inspired by the growing proof, in the corruptions of the Grant administration, that the Union's having been preserved did not automatically beget morally strong citizens. He saw that he must now change emphasis again and centre his work on ways and means of making the individual man "sole sponsor of himself," on self-mastery in the midst of greed and perpetual temptation. One of the chief means Lowell used to help a new people, which he thought unduly optimistic and without steadying aids, was tradition, the examples of the heroes of the entire past, especially as embodied in literature. Thus, partly through his editorship (with C. E. Norton) of the *North American Review* (1864–72), Lowell published his successive critical essays on the great masters such as Dante, Chaucer, Spenser, Shakespeare, Cervantes, Calderón, Milton, Dryden, Pope, Fielding, Lessing, Gray, Wordsworth, Carlyle and Emerson. Guided by Edmund Burke's view of an organic tradition and by Coleridge (the "first of critics"), Lowell sought to winnow and sift ideas of the past which could fruitfully be brought to bear with all their "plastic force" on the needs of contemporary Americans. Thus he exalted the Greeks' "sense of proportion, their distaste for the exaggerated"; Dante's sense of free-willed responsibility in the face of the individual's inward conflict between appetite and aspiration; and Shakespeare's view that this conflict can be resolved not so much on the theological as on the sunlit human plane. Historical tradition ("clarified experience") teaches "the value of personal character as a chief factor in what used to be called destiny." In his long reflective poem, "The Cathedral," in which he spoke of God as being "so far above, yet in and of me," Lowell wistfully concluded that the supernatural faith of the middle ages is "irrecoverable," but he concluded that modern science, agnostic as it seems, can be made to accord with a modified religious faith, that the "cure-all equality" and the "brute's license of unfettered will" need the reinforcement of "private virtue strong in self-restraint." His "Three Memorial Odes" held that true freedom is the fruit of self-control guided by the human ideal synthesized by culture and a sense of the steadying power of tradition; these lofty "public" poems called for "symmetry of self-control," for self-discipline, for "making man sole sponsor of himself," for "rounding a whole life to the circle fair of orbed fulfillment." His achievement was rewarded by honorary degrees from Oxford (1873) and Cambridge (1874).

Lowell's literary cosmopolitanism was crowned by diplomatic responsibilities: Pres. Rutherford Hayes rewarded his support in the Republican convention in 1876 by appointing Lowell minister to Spain (1877–80) and ambassador to England (1880–85). Few diplomats have had Lowell's personal success in creating international good will and understanding. In England he served as president of the Wordsworth society, succeeding Matthew Arnold, with whom he is often compared in his idealism and many-sided social criticism; he was popular as a speaker on many notable cultural occasions, and as president of the Birmingham and Midland institute in 1884 he delivered his remarkably wise and persuasive discourse on "Democracy," centring on the elements common to the British and U.S. governmental traditions which he contrasted in the vein of Burke with the antitraditionalism of the French Revolution. His only difficulty during his responsibility in England was with a small number of Irishmen in English prisons (during the Fenian turmoil), who tried to get Lowell to intercede on the pretense that they had been U.S. citizens. In the change of administrations Pres. Grover Cleveland appointed a successor and Lowell returned home in June 1885, his wife having died in February. He made four more summer visits to England. He died in the house of his birth in Cambridge, Mass., on Aug. 12, 1891.

Lowell's tolerant defense in reviews of such realists as W. D. Howells and Henry James (who wrote two eulogistic essays on him), his long succession of critical disciples such as Barrett

Wendell, George Woodberry and Edmund Clarence Stedman, not to mention writers devoted to the use of the racy vernacular, such as George Eggleston and J. C. Harris, attest to the vitality of his influence. Norman Foerster in 1928 concluded that in combining impressionism, historical understanding and judicial criticism, Lowell's literary creed "is the most representative of man's artistic experience through the ages yet attained in America."

BIBLIOGRAPHY.—The most comprehensive collection of his works is the Elmwood edition of *The Complete Writings of James Russell Lowell*, 16 vol. (1904), ed. by C. E. Norton, including the *Letters* (3 vol.); *Lowell: Representative Selections* (1947), ed. by H. H. Clark and N. Foerster, contains an extensive critically annotated bibliography of studies about Lowell, as well as a documented introduction of about 140 pages including Foerster's essay on his criticism. H. E. Scudder's *Lowell: A Biography* (1901) is supplemented by Leon Howard's *Victorian Knight-Errant* (1952), which covers the period up to 1855 and makes use of fresh manuscript material, and by R. C. Beatty's *James Russell Lowell* (1942), which reflects the southern attitude toward his political work. (H. H. CL.)

LOWELL, PERCIVAL (1855–1916), U.S. astronomer and founder of the Lowell observatory, was born in Boston, Mass., on March 13, 1855. A member of a brilliant family, he graduated with honours at Harvard in 1876 and after a year of travel returned to Boston where he was active in business. From 1883 to 1893 his energies were chiefly devoted to literature and travel, much of the time in the far east, which he pictured in *Choson* (1885), *The Soul of the Far East* (1888), *Noto* (1891) and *Occult Japan* (1895).

During part of this period he was counselor and foreign secretary to the special mission from Korea to the United States. In the 1890s, inspired by Schiaparelli's discovery of the "canals" on Mars, he determined to devote his fortune and energy to a study of the planets and after careful scrutiny of desirable sites founded the great observatory which bears his name at Flagstaff, Ariz.

Lowell held the theory that intelligent inhabitants of dying Mars are struggling to keep alive by a planet-wide system of irrigation from the water of the melting polar snowcaps and that the canals are bands of cultivated vegetation dependent on such irrigation. Among his books on this subject, *Mars and Its Canals* (1906) is a good example. Early in the 20th century he made an elaborate mathematical study of the perturbations of Uranus which he attributed to the action of an unseen planet beyond Neptune (*Memoir on a Trans-Neptunian Planet*, 1915); and in 1905 he organized a systematic search for such a planet by the staff of his observatory. Fourteen years after his death, this search culminated successfully in the discovery of Pluto (1930). Although Lowell's Martian theory met with opposition, the value and sincerity of his work were recognized and he received numerous honours.

Lowell died at Flagstaff, Nov. 12, 1916.

See L. Leonard, *Percival Lowell* (1921); J. A. Paterson, "Percival Lowell—His Life and Work," *Journ. Roy. Ast. Soc. Canada*, vol. 16, pp. 230 ff. (1922); A. Lawrence Lowell, *Biography of Percival Lowell* (1935). (J. C. DN.)

LOWELL, a city and one of two seats of Middlesex county (the other is Cambridge) in the northeast section of Massachusetts, U.S., 25 mi. N.W. of Boston and 7 mi. from the New Hampshire boundary, is on the Merrimack river at the mouth of the Concord river. It is a leading manufacturing city, one of the oldest in the United States. Pop. (1960) 92,107; standard metropolitan statistical area (Lowell city and six towns in Middlesex county) 164,243. (For comparative population figures *see* table in MASSACHUSETTS: *Population.*)

At the close of the 18th century there was only a small village at the juncture of the Merrimack and Concord rivers. A carding mill was built in 1801, and in 1804 the Middlesex canal was completed around Pawtucket falls, where the Merrimack drops 35 ft. Water power provided by these falls was an important factor in the city's location and industrial development. The town was incorporated in 1826 and was named for Francis Cabot Lowell, regarded as the originator of American cotton manufacturing. In 1836 the town was chartered as a city. A city-manager form of local government was adopted in 1944. The canal system, important in the growth of Lowell, comprises about 15½ mi. of waterways, parts of which run at right angles to the rivers and divide the city into sections. The waterways, along with a network of highways, compose an interrelated transportation system for industry and commerce.

In the 19th century large numbers of foreign workers were attracted by the textile industry which reached its peak in the early 1920s and decreased thereafter. Many mills had moved to the southern states by the 1950s, causing a decline in population. However, new industries began to replace textiles and Lowell's economy became more diversified.

About 200 ac. were set aside as an industrial park under the control of a commission, and new industries located there include electronics, plastics and light metals. Other manufacturing establishments produce a wide range of goods including chemicals, machine parts, electronic equipment, fabricated rubber, household tools, cloth and art supplies.

Lowell as an early 19th-century industrial city aroused the interest of Europeans and prompted many to journey across the Atlantic to visit and write of their impressions. Michel Chevalier, the French scholar, came in 1834. Two English observers, Charles Dickens and Anthony Trollope, followed a decade later. For a greater part of the 19th century Lowell was known as the "spindle city" and the "Manchester of America." Although best known for its pioneering textile industries, Lowell is also famous as the birthplace of the American artist, James Abbott McNeill Whistler, whose house has been converted into a museum. The city has provided two governors for Massachusetts—Benjamin F. Butler (1883–84), and Francis T. Greenhalge (1894–96).

Lowell has a state teachers college (1894); Lowell Technological institute (1895), which offers research facilities to local industry; a city hospital and two private hospitals; one of the largest city libraries in New England; and a city memorial auditorium used for community cultural and civic assemblies. (L. G. H.)

LOWER AUSTRIA: *see* AUSTRIA, LOWER.

LOWER CALIFORNIA: *see* CALIFORNIA, LOWER.

LOWER SAXONY (NIEDERSACHSEN), one of the *Länder* (states) of the Federal Republic of Germany, was established on Nov. 1, 1946, by merging the Prussian province of Hanover with the historical *Länder* of Brunswick, Oldenburg and Schaumburg-Lippe. Area 47,382 sq.km. (18,295 sq.mi.). Pop. (1961) 6,640,855. Lower Saxony extends eastward from the Netherlands border to the German Democratic Republic, bounded on the north by the North sea and the *Länder* of Bremen, Hamburg and Schleswig-Holstein and on the south by the *Länder* of North Rhine-Westphalia and Hesse. The capital is Hanover.

The three main divisions are the large lowland of heath, bog and polders in the north; a narrow east-west zone of loess and loam (the *Börde*) farther south; and, in the south of the *Land*, a large portion of the Mittelgebirge or central uplands. The northern lowland is blanketed by glacial sands called *Geest*. The low-lying part, the *Moor* (swamp), with the water table near the surface, is covered with bogs of sphagnum grasses. The more elevated part, on better drained sands, is clothed with heather, juniper, scattered woods of oak and birch and pine plantations; its highest (330–500 ft.) and most characteristic area is the Lüneburger Heide (*q.v.*) between the Weser and lower Elbe rivers. The coastal belt of drained and diked polders (*Marschen*) is dominated by the great ports of Bremen and Hamburg (which form separate *Länder*) and by the lesser and more recent Emden and Wilhelmshaven.

The *Börde*, a belt of treeless arable land which includes the foothills of the Harz mountains, supports a dense farming population on its fertile soils. Rural and urban settlement is mostly on the border of the central uplands, where many small towns were established at the junction of land routes in medieval times.

Wide valleys lead southward through the central uplands between the Rhine plateau and the Thuringian highlands. This southern section includes the Weser uplands, which extend from the Teutoburger Wald eastward to the Harz mountains and are drained by the Weser and Leine rivers. These occupy wide fertile troughs between wooded hills and formed historic natural routeways to Frankfurt am Main and southern Germany.

In the period 1939–56 the population of Lower Saxony increased

by 43%, principally from the influx of more than 2,000,000 refugees and expellees. The population density exceeds 360 per square mile, the greatest concentration being in the *Börde*—notably in Hanover and Brunswick. The other chief towns are Emden, Wilhelmshaven and Cuxhaven on the coast; Oldenburg and Delmenhorst in the northern lowland, with Lüneburg and Celle, respectively, north and south of the Lüneburger Heide; Osnabrück, Hameln, Hildesheim, Wolfsburg, Salzgitter, Goslar and Göttingen in the *Börde* and central uplands. (*See* also articles on the various towns.)

The name Lower Saxony applies to a geographic cultural entity that took shape in the middle ages but had no political connotation until 1946. The nucleus is the 19th-century kingdom of Hanover, with its strong ties with England (*see* HANOVER). Administratively the state is divided into 8 districts (*Regierungsbezirke*), 60 rural districts (*Kreise*), 16 municipalities and 4,267 communes. It is governed within the framework of the federal constitution by a state diet of 159 members under a minister president. Institutes for higher education include the famous University of Göttingen with about 7,500 students, technical universities (*technische Hochschulen*) at Hanover and Brunswick, a veterinary college at Hanover, a college of social studies at Wilhelmshaven and a mining academy at Clausthal.

About 30% of the labour force works in agriculture or fishing, 36% in manufacturing and building, 15% in commerce and transport and 18% in private or public service.

The sparsely peopled northern lowland has a predominantly farming population on holdings seldom exceeding 50 ac. The northern marshland, diked and drained, is partly rich meadows and partly arable, producing good wheat crops. Dairy farming and the raising of beef cattle are important. Farm holdings of great antiquity are situated on the sandy *Geest* soils. The bogs were reclaimed after the 17th century by removing the peat or by burning the heather and grass and sowing buckwheat, or (later) by deep plowing to mix the peat with the underlying sands. The holdings are chiefly family ones producing rye, oats and potatoes and raising cattle and pigs. Pine plantations are numerous in the north; sheep raising and beekeeping are traditional.

The farmsteads of the *Börde* are clustered in large villages. Wheat and sugar beet are grown in rotation, and beef and dairy cattle are raised. Amid the Weser uplands, with their varied relief, are numerous lowlands on clay and loess, where wheat and sugar beet are grown.

Lower Saxony has important natural resources. Low-grade iron ores are mined in the Salzgitter area and output is about one-third of the Federal Republic's production. There are iron and steel plants at Salzgitter and also at Peine, between Brunswick and Hanover. These plants use Ruhr coal brought by the Mittelland canal. Lignite is mined near Helmstedt, but most of the deposit lies east of the Democratic Republic's border. Petroleum is obtained near Celle and Peine and in the Emsland (*q.v.*) area between Bentheim and Papenburg; the *Land* is one of the chief European producers of crude oil amounting to about 5,000,000 tons annually.

Both Hanover and Brunswick have a diversity of manufacturing and processing industries. One of the largest automobile plants in Europe is at Wolfsburg, about 50 km. (31 mi.) N.E. of Brunswick. These industrial centres, together with the iron and steel plants, owe much to the Mittelland canal opened in the late 1930s.

(R. E. DI.)

LOWESTOFT, a municipal borough, North sea port and resort town in the Lowestoft parliamentary division of Suffolk, Eng., is 44 mi. N.E. of Ipswich and 27 mi. S.E. of Norwich by road. Pop. (1961) 45,687. In 1086 Lowestoft was a hamlet in the demesne of the royal manor of Lothingland. A weekly market on Wednesdays was granted in 1308 to John, earl of Richmond, together with an eight days' fair. In 1442 William de la Pole, earl of Suffolk, received a further grant of the same market and also two yearly fairs. In 1643 Lowestoft supported the royalist cause but Cromwell carried off the chief supporters. For several centuries Lowestoft was in dispute with Yarmouth over the herring fisheries until the matter was finally settled in the house of lords in 1662. In 1665 the Dutch under Adm. Jacob Opdam were defeated off Lowestoft by the English fleet commanded by James, duke of York. Lowestoft china, of soft-paste porcelain, specializing in table and tea wares often bearing Chinese patterns, was made in the town from 1757 to 1802. The old town stands on a declivity (Lowestoft Ness, the most easterly point of Great Britain) to the north of the present harbour, which was constructed by the Norwich and Lowestoft Navigation company in 1831 and considerably extended by Samuel Morton Peto in 1846. Following the improvement of the harbour and the opening of the railway link with Norwich and London in 1847 Lowestoft developed rapidly as a port and coastal resort. The population increased from 4,671 in 1831 to 21,905 in 1885 when it was granted borough status. There are good sands as well as a fine esplanade and two piers; South pier has a pavilion. Oulton Broad within the borough boundary provides yachting, motorboating and a swimming pool. The parish church of St. Margaret dates from the 15th century.

The outer and inner harbours have quays for the important herring and trawl industry, and for general trade. On the south bank of the inner harbour six construction slips for vessels up to 300 ft. in length were added to the shipbuilding facilities of the port. Other industries include canning and food preservation, and the manufacture of television sets, marine radios, electrical apparatus, motor coaches and footwear.

LOWIE, ROBERT HARRY (1883–1957), U.S. anthropologist, a leading figure in the development of cultural anthropology, was born June 12, 1883, in Vienna, and was brought to New York at the age of ten. He graduated from the College of the City of New York at 18 and, while teaching elementary school for three years, studied under Franz Boas at Columbia university, where he received his Ph.D. in anthropology in 1908. From then until 1921 he was affiliated with the American Museum of Natural History in New York and undertook many of his major field trips to the Plains tribes, *inter alia* to the northern Shoshone, Assiniboin, Blackfoot and Crow. From 1921 to 1950 he was professor of anthropology at the University of California in Berkeley, serving as chairman of the department for 14 years. His honours and duties included: editorship of the *American Anthropologist* (1924–33); presidency of the American Folklore society (1916–17), the American Ethnological society (1920–21) and the American Anthropological association (1935); and election to the National Academy of Sciences (1931). Awards were the Viking medal (1947) and the Huxley medal (1948).

Lowie's most original ethnographic contributions are contained in about 18 monographs on American Indians. Of these his studies on the Crow Indians engaged his most enduring interest and became classic. Later in life he turned to South American ethnography and then to the German culture in which he had been steeped in his youth. Although strongly empirical by conviction, he made distinguished theoretical contributions to the fields of kinship and social organization and folklore and religion. In his younger years he had a strong philosophical bent and wrote widely for liberal, intellectual journals. He died on Sept. 21, 1957, in Berkeley, Calif.

His outstanding books are *Culture and Ethnology* (1917), *Primitive Society* (1920), *Primitive Religion* (1924), *Origin of the State* (1927), *Crow Indians* (1935), *The History of Ethnological Theory* (1937), *Social Organization* (1948), *Toward Understanding Germany* (1954), and, published posthumously, *R. H. Lowie, Ethnologist: a Personal Record* (1959), and *Selected Papers in Anthropology* edited by Cora Du Bois (1960).

See P. Radin, "R. H. Lowie," *American Anthropologist*, vol. 60 (1958). (C. D. B.)

LOWIN, JOHN (1576–1653), English actor, the son of a carpenter and a colleague of Shakespeare, was baptized on Dec. 9, 1576. A goldsmith's apprentice for eight years, he joined Worcester's men as an actor in 1602. By 1603 he was a member of the King's company. He is known to have specialized in the roles of comic soldiers as well as downright villains. He created Bosola in Webster's *The Duchess of Malfi*. Shakespeare is said to have coached him in the part of Henry VIII. Lowin was also remembered for his Falstaff and the Jonsonian parts of Morose (*Epi-*

coene), Volpone and Mammon (*The Alchemist*). After the death of John Heminge, Lowin became, with Joseph Taylor, co-manager of the King's company. As such he received payments for the company's appearances in court performances. He also acquired shares as a housekeeper in the Globe and Blackfriars theatres. At the outbreak of the English Civil War, after the theatres' closing, Lowin became an innkeeper at Brentford. He was buried on Aug. 24, 1653. (A. M. N.)

LOW SUNDAY, first Sunday after Easter. It is called in Latin *Dominica in albis* (*depositis*), "Sunday in white garments (laid aside)," in allusion to the fact that those who were baptized on Easter have put aside their white robes.

See also CHURCH YEAR.

LOW-TEMPERATURE PHYSICS (CRYOGENICS) is that branch of physics which is concerned with the measurement and the interpretation of natural phenomena at low temperatures. This definition cuts across the classification of physics according to the kind of system under investigation; *e.g.*, one speaks of low-temperature nuclear physics, low-temperature solid state physics, etc.

Strictly speaking any measurement below room temperature falls into one of these categories, but it has become customary to restrict the term low-temperature physics (often called cryogenics, although this word more correctly refers to the production of low temperatures) to physical research carried out at temperatures at or below the boiling point of oxygen; *i.e.*, at temperatures below about 90° K. All temperatures in this article will be given on the absolute scale in degrees Kelvin (° K.). The reader is reminded that on this scale the absolute zero of temperature is at 0° K., corresponding to −459.7° F., or −273.2° C. (*See* THERMOMETRY.)

Basic Phenomena.—The discovery of techniques for reaching and sustaining very low temperatures opened a new frontier in the study of matter.

Since heat is created by the random motion of molecules (*see* HEAT), the elimination of it involves bringing matter as close to a static and ordered condition as nature permits. In the close-to-absolute-zero state, the opportunity for new investigation is comparable to the one that was opened when the content of the bulb used in cathode-ray experiments was brought close to a perfect vacuum.

At extremely low temperatures, the electric, magnetic and thermal properties of most substances are found to be greatly altered. Among the phenomena sometimes encountered perhaps the most striking are superfluidity and superconductivity. Some metals, when cooled below a characteristic critical temperature, are perfect conductors of electricity; a current induced in them will continue indefinitely without being maintained. Liquid helium, below a certain temperature, can flow without apparent viscosity through channels a few millionths of an inch in width.

Energy Levels and Order.—Some basic theories commonly accepted up to the turn of the 20th century were casualties of low-temperature physics. The most striking example is the classical law of P. L. Dulong and A. T. Petit, predicting that the specific heat of solids should remain constant at all temperatures. It is indeed reasonably constant at high temperatures. However, it decreases with lowering temperature and finally vanishes in the limit of the absolute zero of temperature. The article QUANTUM MECHANICS describes this more fully and discusses how first A. Einstein and subsequently P. J. W. Debye drew up quantum models to explain this unexpected low-temperature behaviour.

These models form part of the modern view that the microscopic components of any physical system can have only certain discrete amounts of energy; *i.e.*, they can occupy only certain definite energy levels. This means that at the absolute zero, where a system in such a theory contains the smallest possible amount of energy, its components should all either occupy the single lowest energy level available to them, or at least, if this is not permitted by the Pauli exclusion principle, they should occupy the fewest possible and lowest possible levels. In terms of quantum mechanics the degree of disorder of a system is related to the number of energy levels occupied by the system's components in excess of the allowed minimum. According to this, therefore, the absolute zero of temperature is the point at which a system achieves its state of highest order. This is equivalent to the statement of the third law of thermodynamics (*q.v.*) that the entropy of any system vanishes at absolute zero, since the entropy is a measure of the disorder of a system. The rise in temperature of a system above the absolute zero is equivalent to its gradual disordering as its microscopic components occupy an increasing number of energy levels above the lowest possible ones. The manner in which this occurs depends uniquely on the values of these energy levels, which in turn are determined by the detailed nature and behaviour of the individual components of the system in question. Thus the importance of cryogenic research arises from the fact that experimental observation of the low-temperature characteristics of a system furnishes vital clues to its spectrum of energy levels, an understanding of which forms part of a theoretical analysis of the system.

A system will become disordered when the thermal energy available to its components becomes comparable to the spacing between their energy levels. This thermal energy is equal to kT, where T is the absolute temperature and k, Boltzmann's constant, is about 10^{-4} electron volt (ev) per degree. The spacing between the levels, however, depends, as was just mentioned, on the characteristics of the system and will thus be different for different systems. Thus what is a low temperature for one system may be a high temperature for another; *e.g.*, in the absence of an external magnetic field the spacing between the levels of a system of nuclear magnetic dipoles is of the order of 10^{-7} ev, that between the levels of a system of ionic magnetic dipoles at least 10^{-5} ev. As a result, the thermal energy available at about 0.01° K. (10^{-6} ev) is high enough to distribute nuclear dipoles almost equally among the available levels, but is barely sufficient to excite a few ionic dipoles. This means that for the former system 0.01° K. is a high temperature, while for the latter it is a low one.

Experimental Details.—When it is desired to measure the properties of a substance at a certain temperature it is necessary to place this substance in good thermal contact with a reservoir at the desired temperature. The simplest and most convenient kind of reservoir is of course a bath of liquid, and indeed low-temperature measurements are carried out as much as possible by this means, using the liquefied form of one of the substances listed in Table I.

In liquefaction, the cooling of the gas to its boiling point occurs by two methods, used singly or in combination. After a gas has been compressed isothermally, it can be cooled either by adiabatic expansion, in which the gas pushes against a piston while it is thermally isolated, or by Joule-Thomson (isenthalpic) expansion, in which the gas expands through a throttle valve into a low-pressure space. The volume of gas cooled a small amount by either of these processes then precools the next batch of incoming, compressed gas in a counterflow heat exchanger, so that the next expansion begins at a slightly lower temperature and cools a little further. This process is repeated until the boiling point is finally reached. A thermodynamic discussion of the two expansion processes can be found in THERMODYNAMICS; detailed descriptions of various liquefiers are given by J. G. Daunt and S. C. Collins in their contributions to vol. xiv of the *Encyclopedia of Physics* (see *Bibliography*).

For experimental purposes the liquid which has been obtained is transferred into a so-called Dewar vessel, a double-walled, silvered glass (or highly polished metal) flask, with an evacuated space between the walls, very similar except for size to the conventional Thermos bottle. Liquid air, oxygen, nitrogen and even hydrogen can be kept in such a vessel without further thermal protection for several hours; liquid helium has such a low specific

TABLE I.—*The Substances Commonly Used as Liquid Baths in Low-Temperature Research*

Substance	Boiling point (° K.)	Melting point (° K.)
Air	86	49
Nitrogen	78	63
Hydrogen	20	14
Helium	4.2	—

heat that it can be kept for any length of time only if the Dewar flask is in turn surrounded by a similar, larger flask containing liquid nitrogen or air.

If provisions are made to seal the flask containing the liquid hermetically; *e.g.*, by means of a metal cap and neoprene O-ring gaskets, the pressure over the liquid can be reduced with large vacuum pumps, resulting in a decrease of the temperature of the liquid, down to the freezing point of all the substances listed in Table I except helium. Temperatures between the freezing point of one substance and the melting point of the next lower one can be obtained with apparatus in which the flow of heat in and out of the sample under investigation can be controlled and varied. Helium, as will be discussed in some detail in a later section of this article, does not freeze at all under any pressure less than about 25 atm., so that in principle the liquid could be pumped down to arbitrarily low temperatures. However, the vapour pressure of the liquid becomes so low at about 1° K. that this temperature represents approximately the lower limit which can be achieved by this means.

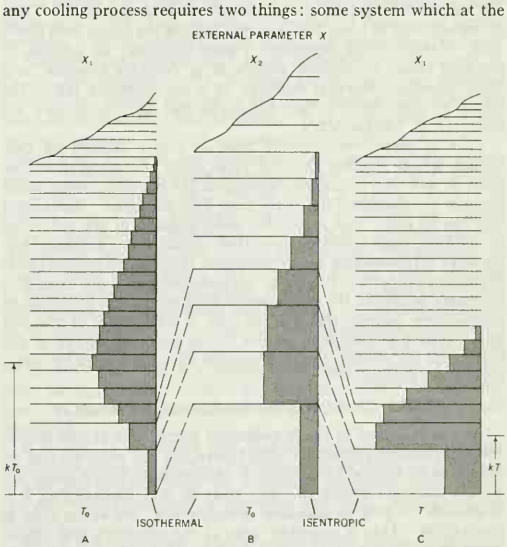
Thus it is seen that various liquids, under atmospheric or reduced pressure, provide readily available experimental temperatures down to about 1° K. Although the bulk of low-temperature research is being carried out in this range, we have mentioned that for certain systems 1° K. is actually a rather high temperature, so that it is a matter of considerable physical interest to cool them further. In order to understand how this can be done it is well to return to the considerations of the state of order of a system.

The Principle of Cooling.—Consider an arbitrary system in equilibrium at some temperature T such that the thermal energy is large enough to excite most of the system's components into energy levels above the ground state. The distribution of the components among the different energy levels depends on the product of two factors, one the exponent of the ratio of the energy of a level to kT, the other an increasing function of this energy. This means that the level at which the energy is most nearly equal to kT will be most heavily populated, with a gradually lessening number of components occupying the levels of higher and lower energy on either side, as illustrated in fig. 1(A). If now there exists some external variable, such as the volume or the magnetic field, by means of which the spacing of the energy levels can be varied, then a change of this variable such as to increase the spacing of the levels will result in a redistribution of the components of the systems among fewer levels, as shown in fig. 1(B). Hence the order of the system has been increased. If this process has occurred while the system was in thermal equilibrium with some external bath at a fixed temperature, this means thermodynamically that the entropy of the system has been decreased isothermally. As discussed in THERMODYNAMICS, a system can change its entropy only by absorbing or releasing an amount of heat. Thus if the system is now isolated from its surroundings so that it cannot absorb any heat, and the external variable is then returned to its original value, the spacing of the energy levels is again what it was in fig. 1(A), but the entropy or the degree of order is still that in fig. 1(B), since the entropy has not changed in the second part of the process. Hence the system has been returned to the original external conditions with a lower degree of disorder, which means that the temperature of the system has been decreased.

This two-step operation is basic to all physical cooling processes. For a system consisting of a given number of gas molecules, the external parameter affecting the spacing of the energy levels is the volume in which the system is contained. Isothermal compression of the gas lowers its entropy, and its subsequent expansion to its original volume under conditions such that its entropy remains constant will leave the gas at a lower temperature than the initial one. For a variety of reasons, it is often both more convenient and more efficient to expand a gas under conditions such that its entropy changes by a small amount during the second step, as in Joule-Thomson expansion. However, the final state of the gas is always one of lower entropy than its initial value. In general, any cooling process involves the change of some external variable, first one way and then back to its original value, in such a way that the spacing of the energy levels is first increased and then returned to its initial configuration. All this is done so that the final degree of order of the system is higher, which corresponds to a lower temperature.

Adiabatic Demagnetization.—In the case of the isothermal compression and adiabatic expansion of a gas, the ordering of the molecules is due to their taking up increasingly regular positions and to the fact that there is less room for movement. But the disorder of microscopic particles can be due not only to their random location, but also to varying orientation of certain directional quantities, such as the electric or magnetic dipoles which may be associated with the particles. Consider, for example, a crystal of a paramagnetic salt in which associated with each molecule there is a magnetic dipole. Although the spatial disorder of the molecules has to all intents and purposes disappeared at 1° K., the orientation of the magnetic dipoles in the absence of an external magnetic field is still completely random. This is so because the spacing between the finite number of energy levels associated with the possible directions of the dipoles is so small compared with the thermal energy that all these levels are essentially equally populated. This situation, however, can be changed by applying an external magnetic field of 5–10,000 oersted, which will increase the spacing of the energy levels so much that most particles will occupy the lowest one. In terms of direction this simply means that the external magnetic field has aligned the majority of the magnetic dipoles parallel to itself. This corresponds to a high degree of order. If the salt is thermally isolated and the external field is then removed, the energy levels return to their original spacing without a change in the degree of order, which corresponds to a very low temperature for the system of dipoles. If good thermal contact exists between this and the salt as a whole, the salt will thus achieve a temperature which, depending on experimental details and the kind of paramagnetic salt used, can lie anywhere between 0.0015° and about 0.3° K. This method of cooling, called adiabatic demagnetization, was independently suggested by Debye and W. F. Giauque.

Limits of Low-Temperature Research.—We have seen that any cooling process requires two things: some system which at the



FROM F. SIMON ET AL., "LOW TEMPERATURE PHYSICS," LONDON (1952)

FIG. 1.—SCHEMATIC REPRESENTATION OF COOLING PROCESS. HORIZONTAL LINES REPRESENT VALUES OF ENERGY THAT COMPONENTS OF SYSTEM MAY HAVE. THE LOWEST LINE CORRESPONDING TO LOWEST ALLOWED ENERGY LEVELS. EXTERNAL PARAMETER X IS CHANGED FROM VALUE X_1 TO X_2 ISOTHERMALLY, AND BACK TO ORIGINAL VALUE X ISENTROPICALLY, REDUCING TEMPERATURE FROM T_0 TO T. VALUES OF CORRESPONDING THERMAL ENERGIES ARE SHOWN BY LENGTH OF VERTICAL ARROWS

initial temperature is still in a high degree of disorder, and some external variable by means of which the spacing of the energy levels of that system can be increased. At the lowest temperatures reached by adiabatic demagnetization of a paramagnetic salt with its system of ionic magnetic dipoles, there is still the system of nuclear magnetic dipoles which even at 0.01° K. are quite randomly oriented. Furthermore, this system is affected in the same manner as the ionic dipole system by the application of an external magnetic field, so that in principle the adiabatic demagnetization of a system of nuclear dipoles can be used to achieve much lower temperatures, estimated to be of the order of 0.00001° K. or even lower. In spite of considerable technical difficulties much progress is being made in this field, especially as nuclei whose magnetic dipoles are ordered in this fashion can be used for much fundamental research; *e.g.*, research on the degree of symmetry of the physical universe.

Inevitably the question of even lower temperatures arises, and the answer is clearly that if at a temperature reached by nuclear demagnetization there is still some as yet unsuspected system with much disorder, *i.e.*, high entropy, and in addition if this system can be ordered by means of some external variable, then even lower temperatures could be achieved. The reason for trying to achieve them would be to discover this as yet unknown system, as it is always true that much can be found out about a system from studies of that range of temperature in which it changes from great disorder to a high degree of order. If, on the other hand, there is no system which is still disordered at nuclear demagnetization temperatures, then not only would it be impossible to achieve lower temperatures, but it would be quite pointless to try, as nothing further could be found out about any system or set of systems once a perfect degree of order had been achieved.

The Measurement of Temperature.—The thermometers used at low temperatures are in principle the same as those used in any other range: they contain or consist of some substance of which one readily measurable parameter varies with temperature in a systematic and reproducible fashion. At room temperature such a device is the mercury thermometer, in which the length of the column of mercury varies linearly with temperature. Thermometers used at lower temperatures include the liquid bath itself, with its temperature-dependent vapour pressure; an amount of gas kept either at constant volume or at constant pressure; and thermocouples, electrical resistors or a paramagnetic salt. The details of these devices, their accuracies and their limitations, are discussed in THERMOMETRY.

Each of these thermometers must of course initially be calibrated, which requires that for each range of temperature one must at one time or another determine the absolute temperature of some thermometric substance from first principles. Sometimes this can be done from a detailed understanding of the substance in question, from which one can then calculate the absolute temperature corresponding to any measured value of the temperature-dependent property. If such an understanding does not exist, it is necessary to invoke the fundamental thermodynamic definition of temperature, namely, that it is the ratio of the amount of heat put into a system at that temperature to the resulting change in the entropy of the system, and to determine the temperature by measuring these changes.

AREAS OF LOW-TEMPERATURE RESEARCH

As was indicated in the introductory paragraphs of this article, low-temperature physics includes theoretical and experimental research on all natural phenomena at temperatures below about 90° K. It therefore covers so many areas of investigation that it is impossible to give an adequate description of the entire field in this article. This is especially true as the relevance and importance of much low-temperature work can be understood only in terms of an over-all description of behaviour at all temperatures. The following, therefore, constitutes only a brief and inadequate summary of the principal areas of low-temperature physics. Technical but still general background information can be found in the reviews by D. K. C. MacDonald, P. G. Klemens, P. H. Keesom and J. van den Handel in the *Encyclopedia of Physics* (see *Bibliography*), and these articles in turn contain the references needed for a thorough study.

Low-Temperature Specific Heats.—The specific heat of any substance is, by definition, the temperature times the derivative of entropy with respect to the temperature. For a single system, therefore, the specific heat will be appreciable only in that region of temperature in which the entropy changes; *i.e.*, in that range in which the system changes its degree of disorder. Most substances contain several such systems, and their specific heat is the sum of the specific heats of the individual systems. In order to separate the individual contributions it is necessary to extend specific-heat measurements to sufficiently low temperatures so that one or more of the systems reaches a state of order and thus an essentially vanishing specific heat. For example, the specific heat of a metallic conductor consists of two parts, one due to the metal lattice and one due to the conduction electrons. Although at normal temperatures the former is much larger than the latter, it becomes quite small at temperatures of the order of 10° K. This makes it possible to obtain the electronic specific heat of a metal.

Electronic Transport Phenomena.—In a metal at room temperature, the current- and heat-carrying motion of the electrons is impeded by the vibration of the lattice even in a perfect crystal. As is indicated by the decrease of the lattice specific heat, the spacing of the vibrational energy levels of the lattice is such that at temperatures of the order of 10° K. a considerable degree of order is attained. At such low temperatures, therefore, the scattering of the electrons by the lattice is much decreased, and both the electric and thermal resistivities are due mostly to the presence of lattice imperfections, impurities and strains. Low-temperature measurements of these resistivities make possible the separate evaluation of these various contributions, and have shown the great effect which crystal defects have on the characteristics of a metal and, for that matter, of any solid. Such investigations, together with specific-heat measurements, are among the most important in the continuing attempt to reach a satisfactory understanding of the solid state.

Magnetic Phenomena.—At various times in the preceding material we have spoken of systems of magnetic dipoles associated with microscopic particles. It is these which determine the magnetic behaviour of a substance. The low-temperature study of magnetism concentrates on two aspects of the characteristics of a magnetic dipole system. There are, in the first place, extensive investigations in which the direction of these dipoles becomes ordered when the thermal energy becomes small compared to the spacing of their directional energy levels. This spacing, in the absence of any external fields, depends on the strength and the kind of interaction of these dipoles with the electric and magnetic fields created by the surrounding microscopic particles. The determination of the temperature at which the system changes from complete disorder (even distribution of the dipoles over all available levels) to some degree of order (preferential occupation of a few of these levels) thus yields information about the strength of these interactions. Depending on the kind of interaction there are different ways in which this directional ordering can occur. In addition to the kind of ordering of the dipoles into a single direction which gives rise to ferromagnetism and occurs at the temperature called the Curie point, after its discoverer, the dipoles can line up in more complicated patterns to give rise to antiferromagnetism, as predicted by L. Néel, or ferrimagnetism, as discovered by J. L. Snoek, E. J. W. Verwey and others.

It is, of course, also possible to change the degree of order of the magnetic dipoles by means of an externally applied magnetic field. Once this field is again removed the dipole system finds itself at a temperature different from that of the surrounding medium. It will then tend to return to the temperature of the surroundings by exchanging with the latter sufficient energy to re-establish a suitable degree of disorder. This process is called relaxation. The time necessary for complete relaxation clearly depends again on the interaction of the dipole system with its surrounding, and this interaction will in turn be affected by the degree of order of the various systems which make up the surrounding.

Much useful information not only about the dipole system but also about the neighbouring systems can thus be obtained from a study of magnitude and the temperature dependence of these relaxation times.

In addition to the many areas of physical research in which the use of low temperatures forms only a part of a general investigation and analysis of a basic phenomenon, there exist two fields of study unique to cryogenics: the behaviour of liquid helium and the phenomenon of superconductivity. A detailed description of these two is, therefore, particularly germane to this article.

The Behaviour of Liquid Helium.—When H. Kamerlingh Onnes achieved the liquefaction of helium in 1908, he did not expect this element to have much intrinsic interest, and was mainly concerned with the extension of the experimentally available temperature range to lower values. It soon became apparent, however, that liquid helium was not only very useful to cool other substances, but had itself such unusual and unexpected properties as to warrant extensive and detailed investigation. In fact, these investigations, carried out for almost 20 years exclusively at Leiden, and later in cryogenic laboratories in many other countries, uncovered behaviour so unlike that of any other substance that a full theoretical understanding is still lacking. This behaviour and its possible explanations will be discussed in terms of three aspects: the fluidity of helium under moderate pressures down to absolute zero; the existence of a phase transition to a second liquid phase; and the highly anomalous transport characteristics of this phase.

The Fluidity of Helium at 0° K.—Fig. 2 shows the phase diagram of helium, which is quite different from that of a normal substance. At atmospheric pressure the latter is in the gaseous phase at sufficiently high temperatures, condenses into a liquid upon cooling and finally freezes into a solid at some rather low temperature. This is, of course, to be expected from the concept of the relation between the temperature and the degree of disorder of a substance, from which one would conclude that with decreasing temperature, the molecules of a substance would acquire increasing order in space. The phase diagram of helium, however, shows that for pressures below about 25 atm. helium remains liquid down to the absolute zero. In fact, the horizontal melting-pressure curve shows, by application of the Clausius-Clapeyron equation (*see* THERMODYNAMICS), that at sufficiently low temperatures the entropy and therefore the degree of order of the liquid is the same as that of the solid phase.

Clearly this cannot be an order in space, which is precluded by the high mobility of the molecules even in a normal liquid. Instead there must occur, in liquid helium, an ordering of velocities, a possibility which follows from and is in this case actually dictated by the fundamental principles of quantum mechanics (*q.v.*). According to this modern view of the physical universe, the velocity and the position of any particle are of equal importance, and our instinctive emphasis on position is really only due to the fact that spatial ordering is more common and easier to visualize than ordering of velocities. The basic Heisenberg uncertainty principle of quantum mechanics goes one step further in stating that it is impossible to determine simultaneously the position and the velocity of a particle with arbitrary precision, and that the more accurately we measure the one, the more uncertain we become about the other. This means, therefore, that the close definition of the position of molecules upon freezing is accompanied by an uncertainty about their velocity; *i.e.*, the more narrowly a molecule is confined to a certain location, the greater the magnitude of the velocity with which it oscillates about this point. Another way of saying this is that any attempt to minimize the potential energy of a particle, by placing it in the most favourable position with respect to other bodies which either repel or attract it, is accompanied by an increase in the kinetic energy of the particle, which is the greater the more the particle is localized.

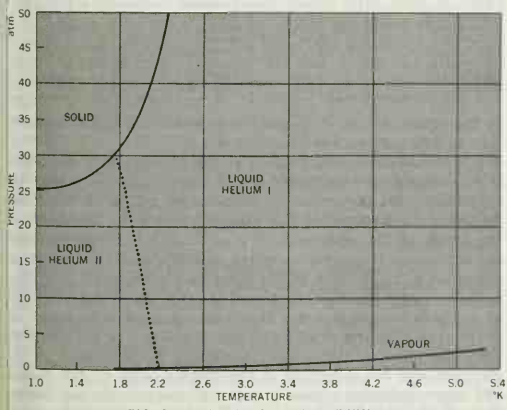


FIG. 2.—PHASE DIAGRAM OF HELIUM

This means that at absolute zero a substance still has some potential and kinetic energy, adding up to what is called the zero-point energy. This is in sharp contrast to the classical view that at absolute zero a substance has lost all energy by having all its particles immobile in the position of minimum potential.

The increase in the particle's kinetic energy due to localization can easily be shown to be inversely proportional to the mass of the particle. With a helium atom, therefore, this energy is unusually large, while at the same time the weak forces existing between helium atoms render quite small the decrease in potential energy gained by having an atom in its most favourable position. It is thus energetically not favourable to localize the helium atoms, and thereby to create order in space; instead a lower total energy can be obtained by minimizing the kinetic energy, which is equivalent to reducing and hence ordering the velocity, at the cost of a small increase in potential energy.

The Phase Transition (λ *point.*)—When liquid helium is cooled under its own vapour pressure, it undergoes a transition from one liquid phase into another at about 2.18° K. These phases are designated by Roman numerals, and one speaks, respectively, of liquid helium I and liquid helium II, the latter denoting the phase existing at lower temperatures. Several of the characteristic variables of the liquid undergo an abrupt change at this transition; in particular its specific heat has a discontinuity, as shown in fig. 3. The resemblance of the shape of this curve to a reversed Greek letter lambda has led to the designation of the transition point as the λ point. The dotted line in fig. 2 is called the λ line and indicates the different pressures and temperatures at which phases I and II are in equilibrium with one another. The highly unusual behaviour of liquid helium II will be discussed presently.

Certain features of the λ transition led F. London (1935) to suggest that it is a so-called order-disorder transition, similar to the Curie point of ferromagnetic substances. Between the normal boiling point and the λ point the ordering which occurs in liquid helium is much like that occurring in any liquid with decreasing temperature: the molecules are distributed over fewer and fewer of the energy levels corresponding to different velocities. At all these temperatures, however, the distribution is such that only an infinitesimal number of the molecules occupy the lowest or ground state. Below a certain quite sharply defined temperature, however, a finite number of the molecules are "condensed" into the ground state, corresponding to the lowest permitted velocities.

It is well to remember that this so-called zero-point velocity is not zero, since the partial localization of the atoms by the walls of the box in which they are contained precludes, according to the uncertainty principle, a vanishing and hence sharply defined velocity.

Below this transition, therefore, the liquid can be considered as consisting of two entirely intermixed components, one comprising all the atoms still distributed over the higher energy levels, and the other consisting of the atoms in the ground state. The former component is qualitatively similar to any liquid, and is therefore in this phenomenological view called the normal component.

The second component, however, should exhibit very astonishing features, since by inverting the uncertainty principle argument just used to show that the ground state velocity is finite, it is clear that the position of these atoms in the ground state is only defined by the walls containing the liquid as a whole. In a way, therefore, these ground-state atoms must be considered as being everywhere in the container at once, and hence should be able to move throughout the container without any friction. Because of this, this component is called the superfluid one. As the temperature decreases from the transition point an increasing number of atoms are condensed into the ground state and hence the superfluid component comprises an increasing fraction of the liquid as a whole, until at the absolute zero the entire liquid is superfluid.

London's phenomenological model of the λ transition received much support with the discovery, isolation and investigation of a rare isotope of helium of mass 3. The condensation of many atoms into the ground state is possible only if these atoms follow Bose-Einstein statistics, and such a process is called Bose-Einstein condensation. The atoms of the prevalent isotope of helium, with mass 4, do follow such statistics, but the atoms of He^3 follow Fermi-Dirac statistics for which, according to the Pauli exclusion principle, any energy level can only be occupied by a single particle. Thus, according to London, He^3 should not have a λ transition, although it too should remain liquid down to the absolute zero since the arguments for this fluidity are independent of statistics.

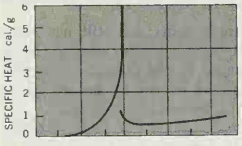


FIG. 3.—THE SPECIFIC HEAT OF LIQUID HELIUM UNDER ITS VAPOUR PRESSURE AS A FUNCTION OF TEMPERATURE

Indeed it has been found experimentally that down to the lowest temperatures at which it has been investigated (about 0.29° K.) He^3 does remain liquid but does not change into a superfluid phase.

At sufficiently low temperatures there begins to occur instead spontaneous alignment of the atomic magnetic dipoles.

These highly qualitative arguments of course do not constitute an explanation for the behaviour of liquid helium but at best indicate a possible mechanism for the λ transition and the peculiarities of helium II. In particular it must be remembered that the division of this liquid into two components is highly artificial, as of course it is not possible to label any one atom as normal and some other as superfluid. The only distinction between them is that one carries a quantum of energy which the other does not. Any interaction between such atoms results in the transfer of this quantum from the one to the other, with a resulting exchange of identity with respect to being normal or superfluid. In fact, a most fruitful systematic approach to a theory of liquid helium from first principles is that of L. Landau, who considers these freely interchangeable quanta of energy (generally called elementary excitations) separately as an independent system superimposed on a sea of particles all in the ground state.

The Characteristics of Helium II.—The principal features of liquid helium II are its ability to flow through narrow slits and capillaries without apparent viscosity, its almost unlimited thermal conductivity and its formation of thin films by means of which it flows over the rims of beakers, etc., to the lowest attainable level. Qualitatively, at least, the mechanism for most of these effects can be deduced from the two-component model described above. The nonviscous flow through narrow apertures is a consequence of the frictionless flow of the superfluid component. This also explains the film flow. The anomalously high ability to conduct heat arises from the fact that at any given temperature the liquid can be thought of as containing a certain fraction of superfluid which decreases with increasing temperature. If some heat is introduced into the liquid at one place, the fraction of superfluid there will decrease, with a corresponding increase in the number of normal atoms. Equilibrium will be re-established by an internal convection process in which superfluid atoms will travel toward the hot spot, and normal atoms away from it. As this counterflow occurs without viscosity due to the nature of the superfluid, it is all but impossible to establish a thermal gradient in liquid helium II. A spectacular demonstration of this is the fact that whereas liquid helium I in a Dewar vessel boils violently, the liquid becomes completely quiescent as soon as the λ point is passed. This is because the boiling in a normal liquid is due to bubbles created at local hot spots, and these do not exist in liquid helium II.

Full descriptions and illustrations of the fascinating and often amusing behaviour of liquid helium II can be found in the first two books listed in the bibliography.

The Phenomenon of Superconductivity.—One of the first experimental uses to which Kamerlingh Onnes put his newly acquired liquid helium was the investigation of metallic conductivity at low temperatures. While measuring the electric resistance of mercury he found, in 1911, that this variable at first decreased gradually with decreasing temperature, as expected, but that at about 4° K. the resistance fell very abruptly to a very low value. All attempts to measure this resistance failed, and he concluded that below this transition point mercury was what came to be called a superconductor with vanishing electric resistance.

Extensive experimental work since that time in many different laboratories has established that 22 metallic elements and a large number of intermetallic compounds become superconductive at temperatures ranging from about 17° K. down to about 0.1° K. The superconductive elements and their transition temperatures are listed in Table II. There is some reason to believe that at temperatures below 0.1° K. five more elements become superconducting, namely molybdenum, tungsten, ytterbium, scandium and protactinium.

While there is no room here for a detailed description of the characteristics of a superconductor, it is possible to discuss briefly the three major experimental discoveries which ultimately led to an understanding and theoretical analysis of the phenomenon.

Destruction of Superconductivity by a Magnetic Field.—A few years after the initial discovery of superconductivity, Kamerlingh Onnes and co-workers found out that the superconducting properties of a substance below its transition temperature could be destroyed by the application of an external magnetic field. Detailed investigation showed that this so-called threshold field increased from a zero value at the transition temperature to a maximum at the absolute zero, varying in this range approximately as the square of the difference between the transition temperature and the temperature of measurement.

TABLE II.—*The Superconducting Elements and Their Transition Temperatures* (T_c)

Element	T_c(° K.)	Element	T_c(° K.)
Aluminum	1.197	Tin	3.729
Titanium	0.387	Lanthanum	5.4
Vanadium	4.89	Hafnium	0.37(?)
Zinc	0.905	Tantalum	4.38
Gallium	1.103	Rhenium	1.699
Zirconium	0.546	Osmium	0.71
Niobium	8.70	Mercury	4.173
Technetium	11.2	Tellurium	2.392
Ruthenium	0.47	Lead	7.2
Cadmium	0.560	Thorium	1.37
Indium	3.396	Uranium	0.8

It was realized several years later that this property made possible a thermodynamic treatment of superconductivity with the assumption that the transition from the normal to the superconductive state is reversible, but without any further knowledge of the details of the superconducting mechanism. If one considers the normal and the superconductive state of a metal as two phases which are in equilibrium at any point on the threshold magnetic-field curve, then the free energies of the two phases must be equal at any point on this curve. This makes it possible to relate the difference of the free energies of the two phases to the threshold field, and in turn allows one to express the difference in the entropies and the difference in the specific heats of the normal and superconductive phases in terms of the temperature derivatives of the threshold field, which can be experimentally deter-

mined. The relation for the entropy difference immediately shows that the superconductive entropy is less than the normal one at all finite temperatures below the transition, which means, as expected, that the degree of order of a superconductor is higher than that of the same metal in the normal phase. A further consequence, also experimentally verified, is that the specific heat shows a discontinuity at the transition.

The Meissner Effect.—The application of a simple thermodynamic treatment to superconductivity depends, as was mentioned, on the reversibility of the transition. This condition is not fulfilled for a perfect conductor, as indicated in the following example. Consider a potential superconductor at some temperature above the transition, and in an external magnetic field. When the temperature is lowered below the transition and the magnetic field removed, the sample will be superconductive, and if the transition is indeed reversible it should make no difference which of these steps is taken first. With a perfect conductor, however, it does matter: if the temperature is lowered in the presence of the field, and the field is then removed, Faraday's law of induction, together with the ability of the substance to maintain currents without dissipation, requires that the magnetic induction inside the sample remain at the value which it had when the external field reached the threshold value. If, on the other hand, the field is first removed, and only then the temperature lowered, the magnetic induction inside the sample will be zero.

W. Meissner and R. Ochsenfeld showed in 1933 that in a superconductor the magnetic induction is zero regardless of the path along which the transition has occurred. They concluded that the vanishing of the magnetic induction inside a superconductor (called the Meissner effect) is a basic characteristic. It has, in fact, come to be considered more fundamental than the property of infinite conductivity.

The Meissner effect not only ensures the reversibility of the superconductive transition and thus allows the application of simple thermodynamic treatment, but has also enabled F. and H. London to draw up a set of very successful phenomenological equations governing the electromagnetic characteristics of superconductors.

The Isotope Effect.—Our understanding of superconductivity was further greatly increased when C. Reynolds, B. Serin and coworkers, and E. Maxwell discovered independently in 1950 that the superconductive transition temperature of an element depends on its isotopic mass. As this mass is a property only of the metallic lattice, and the superconductive behaviour obviously involves the conduction electrons, this so-called isotope effect indicates beyond any doubt that the fundamental mechanism responsible for superconductivity involves the interaction between these electrons and the lattice. H. Fröhlich had suggested this possibility in 1950 on theoretical grounds without being aware of the concurrent experiments.

That this interaction should be responsible for superconductivity is in a sense quite remarkable, for it was mentioned earlier that it is just this interaction which in normal metals inhibits conductivity and is responsible for electrical resistance. However, J. Bardeen and co-workers in 1957 were able to show from first principles that under certain conditions and at sufficiently low temperatures this interaction affects the electronic energy levels in such a way as to make energetically favourable a type of condensation into low-lying levels with a resulting ordering of the velocities. The behaviour of these condensed electrons had previously been shown by Bardeen to lead to the basic superconductive characteristics, including the vanishing of the magnetic induction and the perfect conductivity.

See also REFRIGERATION.

BIBLIOGRAPHY.—By far the best nontechnical discussion of low-temperature physics is F. Simon *et al., Low Temperature Physics* (1952). The best starting point for a more detailed study of any of the subjects mentioned in this article is vol. xiv and xv of the *Encyclopedia of Physics* (*Handbuch der Physik*), ed. by S. Fluegge (1956). These volumes contain articles in English on the production of low temperatures, low-temperature transport, thermal and magnetic properties of solids, superconductivity and liquid helium. Each of these articles in turn contains a full list of more detailed references. Of interest also is *Progress in Low Temperature Physics*, 3 vol., ed. by C. J. Gorter (1955–61) which contains up-to-date reviews of current research. (E. A. L.)

LOWTH, ROBERT (1710–1787), English bishop and student of Hebrew poetry, was born at Winchester on Nov. 27, 1710. He was educated at Winchester college, and New college, Oxford, and in 1741 was appointed professor of poetry at Oxford. Lowth was consecrated bishop of St. David's in 1766 and in the same year was translated to Oxford and in 1777 to London. He died at Fulham palace on Nov. 3, 1787.

Lowth's *Lectures on the Sacred Poetry of the Hebrews* (Eng. trans. from Latin, with notes, 1793), his chief work, had a great influence in England and on the continent. Their chief importance lay in the idea of looking at the sacred poetry as poetry, and examining it by the ordinary standards of literary criticism. He described the typical forms of Hebrew poetry as these occur in the Psalms. Lowth defined the principle of parallelism as the fundamental principle in Hebrew poetry, in contrast with the principle of metre which is fundamental in European poetry.

See P. Hall (ed.), *Sermons and Other Remains of Robert Lowth* (1834), with introductory memoir.

LOYALISTS (TORIES), AMERICAN, the names given to colonists who retained their allegiance to Great Britain during the American Revolution. Contemporaries bitterly called them "Tories" but their descendants in Canada and elsewhere and later generations of Americans have referred to them as "Loyalists." According to the most generally accepted estimate, about one third of the North American colonists were Loyalists. Scholars have tried to determine just what classes comprised the Loyalists but have not agreed on any precise classification. Loyalists were not confined to particular groups; they were in every section, every calling and every class of the thirteen colonies. In general, loyalism was strongest among officeholders and others who served the crown or proprietors; Anglican clergymen and their parishioners in the north; Quakers and other conscientious pacifists, such as members of German religious sects; large landholders, particularly in the north; and wealthy merchant groups in New York city, Philadelphia, Baltimore, Charleston and elsewhere whose businesses and property were affected by the war. A considerable proportion of the professional and intellectual talent, mainly physicians, lawyers, teachers and writers, also opposed the revolutionary movements.

Motivations.—Colonial officeholders, usually men of eminence and power, had a vested interest in upholding the authority of the crown. Many had been born in England and lived in the colonies only because of their employment. Upon entering their positions, they had, moreover, taken special oaths of allegiance to the crown, oaths they considered binding. The Anglican clergy had likewise vowed allegiance and obedience to their king; many had been born in Britain, all had been ordained there, and large numbers received part of their incomes from England. Throughout the Revolutionary War most of them preached obedience and submission to authority and they undoubtedly influenced the political attitudes of their parishioners. This was not true in the south, however. There many of the most distinguished Patriots, or Whigs as they called themselves, were adherents of the established church and men chose sides with little reference to their church affiliation. Among Quakers many deplored the measures of the British government but as a matter of religious conviction abstained from violence and resistance and their leaders counseled obedience and respect for authority.

Among men of status and property who resisted change, detested the "vulgar mob," were appalled by the destruction of property and feared an uncertain future of independence, self-interest was the dominant motive in loyalism. But the most commonly shared trait among all Loyalists appeared to be an innate conservatism coupled with a deep devotion to the mother country and the crown. Numerous Loyalists at first urged moderation in the struggle for colonial rights; some sided with Great Britain slowly, others were driven into active loyalism by their radical fellow colonists who denounced as Tories all who would not join them. The Revolutionary War left no place for moderates or those who wished to remain neutral. More than any

other single factor, apparently, the resort to violence by the radicals confirmed the conservatives in their position.

Loyalists were most numerous in the south, New York and Pennsylvania. New York, the most aristocratic of the colonies, was the Loyalist stronghold and contained more of them than any other colony. Two thirds of its land belonged to the Loyalists or the crown. New Jersey, Delaware, Maryland and Virginia had large Loyalist minorities. In North Carolina the Loyalists and Patriots were about equally divided. South Carolina and particularly Georgia contained Loyalist majorities. New England had fewer than any other section.

Loyalist War Efforts.—Even though Loyalists did not rise in a body in support of the British army, as British authorities had hoped they would, some joined the army and others organized guerrilla bands who, with Indian allies, terrorized the frontier from New York to Georgia. New York alone furnished about 23,000 Loyalist fighters, perhaps as many as all the other colonies combined. A few Loyalist units, such as Patrick Ferguson's "American Riflemen," Sir Banastre Tarleton's "Legion," Sir John Johnson's "Loyal Greens," and Walter Butler's "Tory Rangers," fought effectively. The Loyalist fighters aroused a vengeful hatred among the Patriots and when taken in battle were treated as traitors. George Washington detested them, saying as early as March 1776 that "they were even higher and more insulting in their opposition than the regulars." (Lorenzo Sabine, *A Historical Essay on the Loyalists of the American Revolution*, p. 14, The Walden Press, Springfield, Mass., 1957.) When Gen. Charles Cornwallis surrendered at Yorktown, Va., in 1781, Washington would grant no terms to the Loyalists who had fought against him, saying they were guilty of treason and deserved its penalties.

Congress recommended repressive measures against the Loyalists and all states passed severe laws against them, usually forbidding them to hold office, disenfranchising them and confiscating their property or taxing it heavily. Practically every state struck at them with a test act requiring citizens to renounce allegiance to George III and to promise to support the state against the crown. Some Patriots took the position that, as George M. Wrong wrote in *Canada and the American Revolution* (1935), "a Tory is a thing whose head is in England and its body in America and its neck ought to be stretched." Almost everywhere the Loyalists suffered persecution. Beginning in March 1776 when Sir William Howe evacuated Boston for a safer base at Halifax, Nova Scotia, with about 1,000 Loyalists, approximately 100,000 Loyalists fled into exile. (This was between 3% and 4% of the total number of settlers in the colonies, estimated at 2,500,000–3,000,000 during the Revolutionary period.) The majority of those who fled (about 60,000) ultimately went to Canada, where they and their descendants became known as "United Empire Loyalists." The remainder spread to the Bahamas, the West Indies, Florida and England.

Postwar Settlements.—The peace treaty of 1783 brought the Loyalists little comfort, even though it provided that congress would "earnestly recommend" to the states the restitution of Loyalist property and that there should be no further prosecutions of Loyalists or confiscations of their estates. Americans greeted those terms with flurries of protest and state legislatures refused to heed the recommendations of congress. In the first two years after the peace, returning Loyalists were sometimes tarred and feathered, mobbed and even hanged. Finally, by the beginning of the new government under the federal constitution in 1789, many regained their estates, but the confiscation laws were not repealed by the states, and in fact all the laws against the Loyalists were not erased until after the War of 1812. The British, meantime, had used the continued mistreatment of the Loyalists as one excuse for retaining certain military posts on American territory in the old northwest until 1796 in violation of the peace treaty.

Beginning during the war, the British government tried to care for exiled Loyalists by giving them lucrative positions, food, clothing, shelter and new homes in Canada and by compensating them for losses in property and income. At the end of the war, Loyalist officers received pensions at half pay and grants of land according to rank. In July 1783 parliament appointed commissioners, numbering ultimately five, to investigate Loyalist claims and establish schedules for compensation. As late as 1792 the British government was still meeting claims by grants of land. In all, it expended about $30,000,000 in behalf of the Loyalists.

See also references under "Loyalists (Tories), American" in the Index.

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LOYALTY, as a general term, signifies a person's devotion or sentiment of attachment to a particular object, which may be another person or group of persons, an ideal, a duty or a cause. It expresses itself in both thought and action and strives for the identification of the interests of the loyal person with those of the object. Loyalty turns into fanaticism when it becomes wild and unreasoning; and into resignation when it displays the characteristics of reluctant acceptance. A man without loyalty does not exist. It stirs and arouses him, brings meaning, direction and purpose into his life and unifies his activities. At the same time, loyalty has a social function. Only by man's willingness, in co-operation with others, to invest his intellectual and moral resources generously and wholeheartedly in something beyond his own narrow circle has it been possible for communities of various kinds to emerge and continue to exist; among them, family, church and nation. Both man and community are unthinkable without loyalty.

Political loyalty is devotion to, and identification with, a political cause or a political community, its institutions, basic laws, major political ideas and general policy objectives. A cause to which persons are loyal is often considered "lost" by those who do not share the loyalty; in the face of what seemed to others fearful odds, the Irish, Poles and Zionists never wavered in their loyalty to the cause of their national independence, which they ultimately regained. Loyalty to the laws of Athens, which brought him into the world and nurtured and educated him, was the chief motive of Socrates in accepting death at the hands of a regime that he had opposed and ridiculed, rather than fleeing from prison when given the chance to do so.

The nature and content of political loyalty has varied greatly through the ages. In Greek political thought the principle of unity in life tended to preclude the possibility that a variety of important loyalties might lay claim to the individual and alienate him from the polis, the city-state. Aristotle's famous dictum that man is by nature a political animal stated well the conviction that man could realize his aspirations only by active participation in the affairs of the city-state, which was the highest of all communities because it aimed at a more comprehensive good than any other, and at the highest good, the perfection of human development. A man was expected to be loyal to the city-state and no one else.

Occasionally, however, a conflict of loyalties did arise. Loyalty to the vague concept of a Greek commonwealth of nations, standing over and above individual city-states and overriding local loyalties, inspired Athens' rejection of an alliance with Persia. In Sophocles' *Antigone* the heroine counters the ruler's decree forbidding the burial of her brother with a moving appeal to the moral law of Zeus, which, she believes, has more valid claims to her loyalty than the duly constituted government. Plato's *Republic* expressed concern that the enjoyment of family life and private property by the governing guardian class would result in a conflict of loyalties from which the state would emerge second best.

Other people in antiquity also searched for unity through the state. The Romans, extolling the virtue of political duty, proudly professed their loyalty in the saying *civis Romanus sum*, "I am a Roman citizen." In the Hebrew theocratic state, ruled by the agents of Yahweh, the essence of life consisted in serving and preserving the state, which was equivalent with obedience to God.

Christianity rejected the classical principle of unity in life through the state. While the state, as a divine institution, exercised powers originating with God and was therefore entitled to loyalty as long as it functioned within its natural limits, man could never hope to fulfill his spiritual destiny within the framework of a political organization. To achieve this end, man had to turn elsewhere. The dualism of loyalty postulated by Christianity is affirmed in Jesus' famous dictum, "Render unto Caesar the things that are Caesar's and unto God the things that are God's." Man was, as St. Augustine put it, a citizen of two cities, the city of man and the city of God. Political theorists have often given support to this concept of dual loyalty by defending, for example, the right to resist arbitrary or tyrannical governments, especially if the right is claimed in consequence of one's loyalty to God and the moral law. The Nürnberg and Adolf Eichmann trials have shown that absolute loyalty to the state may be demanded only if the state is guided by principles of right and justice.

The efforts of the rulers of the slowly emerging nation-states to enlist nationwide loyalties took place within the framework of feudalism. On the continent of Europe the result was often disappointing. In France, for example, vassals would owe loyalty only to their immediate lords rather than to the king; the latter, therefore, had no direct contact with the lesser vassals, who even retained the right to make war against him.

In England William I, determined to be a true sovereign rather than one feudal lord among many, imposed an oath upon all the important landowners. In 1086 at Salisbury they swore that they would be faithful to him against all other men. This oath, repeated under later monarchs and extended to all people, even the peasants, by Henry II (1176), was a "national act of homage and allegiance."

Allegiance, later defined by Sir William Blackstone as "the tie or *ligamen*, which binds the subject to the King, in return for that protection which the King affords the subject," has become a powerful legal weapon in the hands of governments, especially those of English-speaking peoples, to promote loyalty and to punish disloyalty. Allegiance assisted the integration of the Norman "foreigners" with the English natives; formed the basis of British nationality; played a part in transforming the British empire into the Commonwealth of Nations, a result foreshadowed by the Balfour report of the 1926 imperial conference, according to which Britain and the self-governing dominions were "united by a common allegiance to the Crown"; and has been crucial in the definition of treason, which is a breach of the allegiance owed to the king in person.

In deference to the commonwealth countries, allegiance lost some of its legal significance; under the British Nationality act of 1948 a British subject is a commonwealth citizen. "Allegiance is no longer a source of British nationality but it may be a consequence of it" (O. H. Phillips, *The Constitutional Law of Great Britain and the Commonwealth*, p. 473 [1957]); and since 1949, nations also qualify for membership in the commonwealth when they accept the monarch "as the symbol of the free association of its independent member nations and as such as the Head of the Commonwealth."

Under the influence of nationalism Englishmen developed a second loyalty, one to the kingdom itself as distinguished from allegiance to the king as a person. On occasion, such as in 1399, 1689 and 1936, the conflict between the old allegiance and the new loyalty resulted in the victory of the latter over the former and the king's deposition or abdication. Thus, the new loyalty was certainly an important political factor. Yet, the law, refusing to take comprehensive cognizance of changes affecting the sovereign, continued to recognize allegiance to him rather than the newly discovered loyalty to his realm. Thus, treason has technically never ceased to be a crime against the king, although actually the state rather than the sovereign himself has been involved.

However, in Britain, as elsewhere, prosecution for treason is only one of the weapons to combat disloyalty. Especially in the era of fascist and communist world-wide conspiracies, loyalty investigations have been considered necessary for survival by executive departments and legislatures, in the United States notably by the house un-American activities committee and the internal security subcommittee of the senate judiciary committee.

Penal laws directed against disloyal individuals imperiling security include those dealing with espionage, sabotage, sedition, the advocacy of the overthrow of the government by force and violence (United States Smith act, 1940), and trading with the enemy.

Among measures designed to prevent disloyalty of individuals are oaths of allegiance for such purposes as naturalization and holding public office; detention, as provided by the British Emergency Powers Defence act (1939) and Regulation 18B issued thereunder and by the United States Internal Security act (1950); the denial of passports; and deportation of aliens.

Disloyal organizations are outlawed either by legislation, such as the United States Communist Control act (1954), which keeps the Communist party off the election ballots, or by judicial determination, such as the decision of the German federal constitutional court, which in 1956 declared the Communist party unconstitutional. At times, prohibitive legislation is restricted to reprehensible practices rather than outlawing the organizations themselves; this approach is found in Britain's Public Order act (1936), which makes it an offense to wear publicly uniforms signifying association with political parties.

President Truman's loyalty program (1947) was intended to afford the United States maximum protection against infiltration of disloyal government employees and to protect loyal employees from unfounded accusations. As the standard for the refusal of, or removal from, employment, the existence of reasonable grounds for believing that a person was disloyal was changed in 1951 to reasonable doubt concerning his loyalty. To administer the program, a loyalty review board heard appeals from loyalty boards established in each department. President Eisenhower's program (1953) substituted security for loyalty as the new standard. No person should be employed unless such employment was clearly consistent with the interests of national security. All loyalty boards were abolished, with the head of an agency making the final decision in each case.

Both the U.S. programs, including loyalty oaths, and their counterparts abroad have been criticized on the ground that they deny basic individual rights. Defending the Canadian system, Prime Minister Louis Stephen St. Laurent asserted in a personnel security case in 1951 that the sole question was whether a certain person could or could not be trusted with secret defense material. "Assessment of character may be the only consideration in some instances. That is not a matter of charge, or trial or of proof. It is a matter of judgment."

Similarly, in 1956 a British conference of privy councilors stated that, while some of the measures that the state was driven to take to protect its security were distasteful and alien to tradition, it was right to continue the practice of tilting the balance in favour of greater security for the state rather than in the direction of safeguarding the rights of individuals.

In the effort to secure loyalty, totalitarian systems have accepted Rousseau's recommendations that there should be no independent associations within the state because they are formed at its expense.

By contrast, in democracies a wide variety of such groups is not only tolerated but encouraged because they all, subversives excepted, contribute to the formation of national loyalty—as illustrated by the British party out of power, called "her majesty's loyal opposition." Loyalties to nonnational groups, such as Jehovah's Witnesses, may even be permitted to take precedence over the highest symbol of national loyalty, as evidenced by the U.S. supreme court's opposition to compulsory flag salutes in public schools.

Those who, like the historian Arnold Toynbee, take a dim view of nationalism believe that national loyalties must be ultimately transferred to mankind as a whole. Only then will it be possible to realize not necessarily a new international organization but what the American philosopher Josiah Royce called "the hope of

the great community." *See* also TREASON AND SEDITION.

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(W. FL.)

LOYALTY ISLANDS (ÎLES LOYAUTÉ), a group in the South Pacific ocean belonging to France, about 60 mi. E. of New Caledonia, with a total land area of about 755 sq.mi. Pop. (1956) 10,946. There are three large islands, Uvéa or Uea (the northernmost), Lifu (Lifou) the largest island, with an area of 650 sq.mi., Maré or Nengone, and several small islands. They are coral islands of comparatively recent elevation, and in no place rise more than 250 ft. above sea level.

The Loyalty Islanders are Melanesians; the islands have separate languages, and in Uvéa one tribe uses a Samoan and another a New Hebridean form of speech. The Loyalty group was discovered at the beginning of the 19th century, and Dumont d'Urville laid down the several islands in his chart. Christianity was introduced into Maré by native teachers from Rarotonga and Samoa. Enough of the rocky surface is covered with a thin coating of soil to enable the natives to grow yams, taro and bananas. Fresh water, rising and falling with the tide, is found in caverns in Lifu, and by sinking to sea level a supply may be obtained in any part of the island. Coconuts are the chief product; copra and rubber the chief exports. The Loyalty Islands are political dependencies of New Caledonia.

See PACIFIC ISLANDS: *Administrative Groupings*.

LO-YANG, an ancient city in the lower valley of the Lo Ho, a right bank tributary of the Yellow river, in northern Honan province, China. Pop. (1953) 171,200. Possibly the first true city at the site was built in the 11th century B.C., about 10 mi. E. of the present city. This served as the eastern capital of the Chou dynasty until about 770 B.C., when it became the chief capital, remaining so until 255 B.C. It was the eastern Han dynasty capital from 25 to 221 A.D. The Tu'pa (Toba) removed their capital southward to Lo-yang at the end of the 5th century, and Sui rulers resided there at intervals during the 6th century. Lo-yang was a Buddhist centre during the 6th and 7th centuries. After the 10th century the city declined to a position as a local administrative and trade centre. Thus Lo-yang occupies an important historical niche in Chinese culture and, because of its many ruins, tombs and walls, was for centuries one of the historic tourist centres of China. It was called Honanfu until 1913.

In 1955 a tractor factory was constructed amid the tombs and ruins on the western outskirts of the city. A new steam electric plant and mining machinery plants followed. Hard coal deposits near the city were mined. Cotton, wheat and other staple crops are grown and processed in this region, and the city regained importance as a regional trade centre. Since Lo-yang is on the east-west Lunghai railway, with north-south connections close by, its location is favourable to development. (J. E. SR.)

LOYOLA, SAINT IGNATIUS OF (ÍÑIGO LÓPEZ DE LOYOLA) (1491–1556), founder of the Society of Jesus, was born in the ancestral castle of the Loyolas in the Basque province of Guipúzcoa, Sp., in 1491. His life falls into four periods. The first (1491–1521) covers the years when secular ideals dominated him; the second (1521–24) is the critical period of reorientation; the third (1524–38) comprises the years of his belated studies; and the fourth (1539–56) those during which he founded and governed the Society of Jesus.

Ignatius, the youngest son in a noble and wealthy family, became in 1506 a page in the service of a relative, Juan Velázquez de Cuéllar, treasurer of the kingdom of Castile. In 1517 Ignatius passed as a knight into the service of another relative, Antonio Manrique de Lara, duke of Nájera and viceroy of Navarre, who employed him in military undertakings and on a diplomatic mission. While defending the citadel of Pamplona against the French, Ignatius was hit by a cannonball on May 20, 1521, sustaining a bad fracture of his right leg and damage to his left. This ends the first period, during which he was, on his own admission, "a man given to the vanities of the world, whose chief delight consisted in martial exercises, with a great and vain desire to win renown" (*Autobiography*, 1). Although his morals were far from stainless, Ignatius was in his early years a proud rather than sensual man. He stood just under five feet two inches in height and had in his youth an abundance of hair of a reddish tint. He delighted in music, especially sacred hymns.

The second period of Ignatius' life is perhaps the best known. After treatment at Pamplona, he was transported to Loyola in June 1521. There his condition became so serious that for a time his life was despaired of. When out of danger, he chose to undergo painful surgery to correct blunders made when the bone was first set. The result was a convalescence of many weeks during which he read a life of Christ and a book on the lives of the saints, the only reading matter the castle afforded. He also passed time in recalling tales of martial valour and in thinking of a great lady whom he admired. In the early stages of this enforced reading his attention was centred on the saints. The anonymous version of the lives of the saints he was reading contained prologues to the various lives by a Cistercian monk who conceived the service of God as a holy chivalry. This view of life profoundly moved and attracted Ignatius. After much reflection, he resolved to imitate the holy austerities of the saints in order to do penance for his sins.

In Feb. 1522 Ignatius bade farewell to his family and went to Montserrat, a place of pilgrimage in northeastern Spain. He spent three days in confessing the sins of his whole life, hung his sword and dagger as symbols of his abandoned ambitions near the statue of the Virgin Mary, and, clothed in sackcloth, spent the night of March 24 in prayer. The next day he went to Manresa, a town 30 mi. from Barcelona, to pass the decisive months of his career, from March 25, 1522, to mid-Feb. 1523. He lived as a beggar, ate and drank sparingly, scourged himself and for a time neither combed nor trimmed his hair and did not cut his nails. Daily he attended Mass and spent seven hours in prayer, often in a cave outside Manresa.

The sojourn at Manresa was marked by spiritual trials as well as by joy and interior light. While sitting one day on the banks of Cardoner river, "the eyes of his understanding began to open and, without seeing any vision, he understood and knew many things, as well spiritual things as things of the faith" (*Autobiography*, 30). At Manresa Ignatius sketched the fundamentals of his little book *The Spiritual Exercises*. Until the close of his studies at Paris (1535) he made some additions to it. Thereafter there were only minor changes until Pope Paul III approved it in 1548. *The Spiritual Exercises* is a manual of spiritual

arms, containing a vital and dynamic system of spirituality. During his lifetime Ignatius used it to give spiritual retreats to others, especially to his followers. The booklet is indeed an adaptation of the Gospels for such retreats.

The remainder of the decisive period was devoted to a pilgrimage to Jerusalem. Ignatius left Barcelona in March 1523 and traveling by way of Rome, Venice and Cyprus, reached Jerusalem on Sept. 4. He would have liked to settle permanently there, but the Franciscan custodians of the shrines of the Latin church would not listen to this plan. After visiting Bethany, the Mount of Olives, Bethlehem, the Jordan and Mount of Temptation, Ignatius left Palestine on Oct. 3 and, passing through Cyprus and Venice, reached Barcelona in March 1524.

"After the pilgrim had learned that it was God's will that he should not stay in Jerusalem, he pondered in his heart what he should do and finally decided to study for a time in order to be able to help souls" (*Autobiography*, 50). So Ignatius, who in his *Autobiography* refers to himself as the "pilgrim," describes his decision to acquire as good an education as the circumstances permitted. He probably could have reached the priesthood in a few years. He chose to defer this goal for more than 12 years and to undergo the drudgery of the classroom at an age when most men have long since finished their training. Perhaps his military career had taught him the value of careful preparation. At any rate he was convinced that a well-trained man would accomplish in a short time what one without training would never accomplish.

Ignatius studied at Barcelona for nearly two years. In 1526 he transferred to Alcalá. By this time he had followers, and the little group assumed a distinctive garb. Ignatius fell under suspicion of heresy, was imprisoned and tried. Although found innocent, he left Alcalá for Salamanca. There not only was he imprisoned but his companions were also apprehended. Again he won acquittal but was forbidden to teach until he had finished his studies. This prohibition induced Ignatius to leave his disciples and Spain.

He arrived in Paris on Feb. 2, 1528, and remained there as a student until 1535. He lived on alms and in 1528 and 1529 went to Flanders to beg from Spanish merchants. In 1530 he went to England for the same purpose. In Paris Ignatius soon had another group of disciples whose manner of living caused such a stir that he had to explain himself to the religious authorities. This episode finally convinced him that he must abstain from public religious endeavour until he reached the priesthood.

During his long stay in the French capital, Ignatius won the coveted M.A. of the famous university. He also gathered the companions who were to be cofounders with him of the Society of Jesus, among them Francis Xavier (*q.v.*), Peter Favre, Diego Lainez (*q.v.*) and Alphonsus Salmerón. On Aug. 15, 1534, he led the little band to nearby Montmartre, where they bound themselves by vows of poverty, chastity and obedience, though as yet without the express purpose of founding a religious order.

Early in 1535, before the completion of his theological studies, Ignatius left Paris for reasons of health. He spent more than six months in Spain and then went to Bologna and Venice where he studied privately. On Jan. 8, 1537, his Parisian companions joined him in Venice. All were eager to make the pilgrimage to Jerusalem, but war between Venice and the Turkish empire rendered this impossible. Ignatius and most of his companions were ordained on June 24, 1537. There followed 18 months during which they acquired experience in the ministry while also devoting much time to prayer. During these months, although he did not as yet say Mass, Ignatius had one of the decisive experiences of his life. He related to his companions that on a certain day while in prayer he seemed to see Christ with the cross on his shoulder and beside him the Eternal Father, who said, "I wish you to take this man for your servant," and Jesus took him and said, "My will is that you should serve us." On Christmas day 1538 Ignatius said his first Mass at the Church of St. Mary Major in Rome. This ends the third period of his life, that of his studies, which were far from a formality. Diego Lainez, a clever man, judged that despite handicaps Ignatius had as great diligence as any of his fellow students. He certainly became in the difficult field of ascetical and mystical theology one of the surest of Catholic guides.

The final period of Loyola's life was spent in Rome or its vicinity. In 1539 the companions decided to form a permanent union, adding a vow of obedience to a superior elected by themselves to the vows of poverty, chastity and obedience to the Roman pontiff which they had already taken. In 1540 Pope Paul III approved the plan of the new order. Loyola was the choice of his companions for the office of general.

The Society of Jesus developed rapidly under his hand. When he died there were about 1,000 Jesuits divided into 12 administrative units, called provinces. Three of these were in Italy, a like number in Spain, two in Germany, one in France, one in Portugal and two overseas in India and Brazil. Loyola was, in his last years, much occupied with Germany and India, to which he sent his famous followers Peter Canisius (*q.v.*) and Francis Xavier. He also dispatched missionaries to the Congo and to Ethiopia. In 1546 he secretly received into the society Francis Borgia (*q.v.*), duke of Gandía and viceroy of Catalonia. When knowledge of this became public four years later it created a sensation. Borgia organized the Spanish provinces of the order and became third general.

Loyola left his mark on Rome. He founded the Roman college, embryo of the Gregorian university, and the Germanicum, a seminary for German candidates for the priesthood. He also established a home for fallen women and one for converted Jews.

Although at first Loyola had been somewhat opposed to fixing his companions in colleges as educators of youth, he came in the course of time to recognize the value of the educational apostolate and in his last years was busily engaged in laying the foundations of the system of schools which was to stamp his order as largely a teaching order.

Probably the most important work of his later years was the composition of the *Constitutions* of the Society of Jesus. In them he decreed that his followers were to abandon some of the traditional forms of the religious life, such as chanting the divine office, corporal penances of rule and penitential garb, in favour of greater adaptability and mobility; they also renounced capitular government with its democratic character in favour of a more monarchial regime; and their vows were in general of such a nature that separation from the order was easier than had been usual in similar Catholic groups. The Society of Jesus was to be above all an order of apostles "ready to live in any part of the world where there was hope of God's greater glory and the good of souls." Loyola insisted on long and thorough training of his followers. Convinced that women are better ruled by women than by men, after some hesitation he resolutely excluded a female branch of the order. The special vow of obedience to the pope was called by Loyola "the cause and principal foundation" of his society.

Loyola and his work were much admired during his lifetime. But he also met with opposition in the church and outside it. His innovations in the religious life were criticized and, while Protestant leaders early came to look on him as one of their principal opponents, some Catholics accused him and his followers of being secret Protestants.

As general, Loyola was frequently sick. In Jan. 1551 he became so ill that he begged his associates, though to no purpose, to accept his resignation as superior. Despite his condition he continued to direct the order until his death on July 31, 1556. Since his days at Manresa, Loyola had practised a form of prayer which in his last years appears to have rivaled that of the greatest mystics.

Ignatius Loyola was beatified by Pope Paul V in 1609 and canonized by Pope Gregory XV in 1622; his feast day is July 31. In 1922 he was declared patron of all spiritual retreats by Pope Pius XI. His enemies no less than his friends agree that Ignatius Loyola was a maker of history. Scores of books could be cited in proof of this statement. The spirit of Loyola lives on in the Society of Jesus and in the Jesuit *Constitutions*, which still regulate the lives and aspirations of over 30,000 Jesuits, scattered through most countries of the world. *The Spiritual Exercises* molded 27 canonized saints, three of them, Francis Xavier, Peter

Canisius and Francis Borgia, intimates of Loyola. His achievements and those of his followers form a chapter in the history of the Roman Catholic Church which cannot be neglected by those who desire to understand that institution.

See also JESUS, SOCIETY OF.

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LOZÈRE, a highland *département* of southern France, lies astride the Atlantic-Mediterranean watershed in the Massif Central, and consists of higher, inland portions of the old province of Languedoc (*q.v.*). Area 5,180 sq.km. (2,000 sq.mi.). With only 81,868 inhabitants in 1962, it is the least populous of all the *départements* of France. To the east it is bounded by Ardèche, to the southeast by Gard, to the west by Aveyron and to the north by Cantal and Haute-Loire. The northern and eastern parts consist of high granite plateaus. In the southeast is the Lozère portion of the Cevennes, the heavily dissected, uptilted edge of the Massif Central. Farther north the slablike ridge of Margeride, which separates the Allier drainage from that by westward flowing tributaries of the Garonne system, the Truyère, Lot and Tarn, exceeds 5,000 ft. In the southwest of the *département* the Lot and Tarn cross the almost deserted, high limestone plateaus of the Causses by labyrinthine gorges with precipitous walls. Both the Causse de Sauveterre, between the Lot and the Tarn, and the Causse Méjean south of the Tarn rise well above 3,000 ft.

Infertile soils and the severe, wet climate restrict farming activities on the crystalline highlands, and the highest parts are moorland, with only the beginnings of afforestation. The lower plateaus of Bas Gévaudan, lying west of the Margeride, and the basalt plateaus of Aubrac that cap the older crystalline basis in the extreme west of the *département* offer better prospects for farming. Freed by modern transport from the need to grow all their own food, the farmers concentrate increasingly upon cattle raising. Cultivation of rye and chestnut, once staple features of the diet, is in decline. Potatoes have increased in importance, but most cultivation is concerned with fodder crops. The crystalline plateaus are no longer much visited, as in the past, by transhumant flocks of sheep from the Mediterranean coastlands, but local sheep are the basis of the economy in the Causses, now directed toward the production of sheep's milk for making Roquefort cheese. Apart from some scattered workings of silver-lead and zinc ores, mineral wealth is unimportant and there is little manufacturing. The harnessing of the Truyère for hydroelectric power, however, made possible the post-World War II establishment of electrometallurgy at St. Chély-d'Apcher.

JEAN ROUBIER FROM RAPHO GUILLUMETTE

CHAPEL OF SAINT MICHEL D'AIGUILLE, LE PUY, HAUTE-LOIRE, NEAR LOZÈRE, FRANCE

At Mende, the capital and largest town (pop. [1962] 7,647), a woolen industry survives. Mende is the seat of the bishopric. The old town, dominated by its cathedral, is situated where the Lot enters the Causses. Mende and Florac are the centres of the two *arrondissements* into which the *département* is divided. For the administration of education and of justice the *département* comes under Nimes. (AR. E. S.)

LUANDA (formerly SÃO PAULO DE LUANDA; LOANDA), the chief city and capital of the Portuguese overseas territory of Angola in west Africa, and also the capital of the coastal district of Luanda. The city, founded in 1576 by Paulo Dias de Novaes, is one of the most attractive in west Africa. Its population, which trebled in the 15 years after 1940, was 189,590 in 1955, including 34,250 whites. It lies on the coast about 40 mi. N. of the Kwanza river estuary. The higher part is generally residential and the lower is industrial and commercial. The old fortress of São Miguel looks over Luanda Island beyond the port. Luanda port is the second in Angola after Lobito. It has modern equipment and about 1,000 yd. of wharfage, can accommodate ships of 37 ft. draft and is linked with the hinterland by the Luanda railway. Luanda, once an important centre of the slave trade, has been the administrative centre of Angola since 1627 and is the seat of a Roman Catholic archdiocese. It is also commercially important, with large exports of agricultural and mineral products and with secondary and manufacturing industries. Petroleum was discovered nearby in 1955, and a refinery with an annual throughput of 100,000 tons was built at the north end of Luanda bay. Power is obtained from a hydroelectric plant completed in 1954 at the Mabubas rapids, about 40 mi. N.E. on the Dande river. The Luanda railway extends inland to Quela, about 450 mi. E., and Luanda airport is served by international and local airlines.

LUANDA DISTRICT had a population (1960) of 347,173, including approximately 58,000 whites. Area 13,363 sq.mi. Much of it is low lying, with a humid tropical climate and fertile soil. The principal crops are cotton, sugar cane, palm oil and kernels, oilseeds, cereals, tobacco, coffee and fruits. The waters offshore are rich in fish. At Dande bituminous asphalt and mica are exploited. Administratively, the district consists of the *concelhos* (counties) of Ambriz, Dande, Icolo e Bengo and Quiçama, and the circumscription of Luanda. After Luanda, the chief towns are Ambriz, Caxito, Catete and Muxima. (A. A. G. P.)

LUANG PRABANG, a town and river port in Laos located on the left bank of the Mekong at the confluence of small streams draining from the mountainous borders of south China and North Vietnam, 130 mi. N.N.W. of Vientiane. Traditionally founded by Indian Buddhist missionaries, it is the capital of Luang Prabang province which has an area of 14,363 sq.mi. and a population (1959 est.) of 322,100. The town contains approximately 25,000 persons and, though it was the seat of kings of Luang Prabang and remains the royal capital (*see* LAOS), it is in reality little more than a poor market town trading in fish and forest products. Its buildings are mainly of wood and laid out very openly along unmetaled streets. Most shops are owned by Chinese who are the chief users of the caravan routes northward. The surrounding countryside is peopled largely by subsistence farmers growing poor

crops of *padi* (rough rice) and a little maize (corn). Luang Prabang has a tropical inland location in a mountainous setting and in winter temperatures sometimes drop below 10° C. (50° F.). Rainfall averages only 53 in. annually with a maximum in August. During the dry season, November to March, the skies are clear and the air crisp. (E. H. G. D.)

LUANSHYA, a town in the Western province of Northern Rhodesia, Africa, known as "the garden town of the copper belt," is situated 4,250 ft. above sea level, 21 mi. S.W. of Ndola. Pop. (1956) 51,671. The public township contains residential, business and industrial areas and there is a separate mine township (Roan Antelope). A rail terminus, Luanshya is also connected by macadamized roads to the other copper belt towns and has an airfield; the nearest airport is Ndola. Besides copper mining there are steel, welding and general machine shops, and concrete, furniture and clothing industries. (L. R. B.)

LUBA. The Luba people, or Baluba, are a Bantu group of the southeastern Republic of the Congo. They inhabit a wide area extending from the extreme south of Kivu province through the major part of Katanga province to the southeast of Kasai province. The name Luba applies to a variety of tribes which, although of different origins, speak closely related languages, exhibit many common cultural traits and participate in a common political history founded on the beginnings (16th century) and breakdown (17th century onward) of the Luba empires. The population (1960s) amounts to more than 1,500,000. Three main subdivisions may be recognized: the Baluba-Shankaji of Katanga, the Baluba-Bambo of Kasai (both patrilineal and viripatrilocal and speaking respectively Kiluba and Ciluba) and the Baluba-Hemba of northern Katanga and southern Kivu, who are either matrilineal or bilineal, practice virilocal marriage and speak Kiluba. All are historically, linguistically and culturally linked with other Congo peoples, such as the Benalulua, the Bakwaluntu, the Benakanyok and the Basonge. The Shankaji branch is also connected with the early founders of the Lunda dynasty. Luba tribes are also mixed with other groups of miscellaneous origin. Finally, since the 17th century there has been an ever-growing expansion of Luba-Bambo in Kasai province.

The Luba are savanna and forest dwellers; they practise hunting, food gathering and agriculture (manioc, maize) and keep small livestock; they fish the Congo and its main tributaries intensively. High marriage payments (bridewealth) are common. Polygyny, leviratic marriage and sororate exist, but not cross-cousin marriage; parallel and cross-cousins are called by the same terms as brothers and sisters. Luba are subdivided into large dispersed clans and localized lineages; the latter form exogamous units and may be linked by an elaborate system of political and ritual status. In the 16th and early 17th centuries most of the Luba were ruled by a paramount chief (*mulopwe*), although smaller independent chiefdoms already existed. The breakdown of the empire resulted in the development either of smaller chiefdoms or of small autonomous local lineage groups.

Luba practise circumcision and women's initiation; they have associations for hunting, magic and medicine. They have a strong belief in a supreme being and worship ancestors and natural spirits. Literature, including epic cycles, is well developed. The Shankaji and Hemba are renowned wood-carvers, especially of anthropomorphic figures, ceremonial axes and headrests.

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LUBBOCK, seat of Lubbock county, is the industrial, financial and commercial hub of the south plains area of western Texas, U.S., about 100 mi. S. of Amarillo. The first settlers were ranchers who arrived in the late 1870s. The town, laid out in 1891, when Lubbock county was created out of Bexar territory and named for Tom S. Lubbock, a Confederate soldier, was incorporated in 1909, and adopted a mayor-commission-manager form of government in 1917.

Although Lubbock has a diversified economy, regional agriculture (cotton, grain sorghums, Sudan grass, wheat and vegetables) supported by irrigation from underground water is its base. The south plains produce almost one-fifth of the nation's cotton and Lubbock is one of the world's leading inland cotton markets and cottonseed-oil centres. Other major industries include poultry and dairy products, feed mills, cattle feeding, irrigation pipes and oil. The city is also the regional centre for government offices and medical care.

Cultural institutions include Texas Technological college (1923), Lubbock Christian Junior college, the West Texas museum and two public libraries. The annual Panhandle South plains fair, a large coliseum, a number of city parks, Mackenzie State park (548 ac., with its "prairie dog town") and Buffalo lakes provide recreational facilities.

After World War II, Lubbock witnessed a rapid growth with its population increasing from 31,895 in 1940 to 128,691 in 1960. Population (1960) of the standard metropolitan statistical area (Lubbock county) was 156,271. For comparative population figures *see* table in TEXAS: *Population.* (E. WE.)

LÜBECK, a city and Baltic port of Germany which after partition of the nation following World War II was in the *Land* (state) of Schleswig-Holstein, Federal Republic of Germany, was formerly a state of the German empire (a Free Hansa City, later the Hansa city of Lübeck). On an inlet of the Baltic on the lower course of the Trave river, the city lies directly west of the boundary between the Federal Republic of Germany and the German Democratic Republic (Mecklenburg). Pop. (1961) 234,643. The city proper lies on an island formed by the Trave and Wakenitz rivers and the Elbe-Lübeck canal; suburbs, which are incorporated in the city and are still often rural in character, lie on the other side of the watercourses and along the Trave river to its mouth. One of these suburbs is the seaside resort of Travemünde. The Trave is navigable and has several harbour basins; the Elbe-Lübeck canal was constructed in 1900. Rail connections include those with Hamburg, Eutin-Kiel and Neustadt-Grossenbrode (rail-ferry to Denmark). A motorway connects Hamburg, Lübeck and Travemünde. In the summer there are regular sea passenger services to Sweden, Denmark and Finland.

Lübeck is West Germany's most important Baltic port, having shipping and trade connections especially with Sweden, Finland and Denmark. The chief imports are ores, coal, timber and cattle, and the exports are salt, iron, coal and chemical products. Well-known Lübeck specialities are associated with the wine trade and the production of marzipan, a confectionery. Industrial installations include blast furnaces, several large shipyards, engineering works and fish-processing plants.

In 1138 Old Lübeck, on the Lower Trave, a Slav precursor to the present city, was destroyed. Count Adolf II of Holstein founded the town on its present site in 1143, when he brought in colonists from western Germany and Flanders. The first settlement was burned down in 1157, and in 1159 was redesigned and built as a city foundation by Henry the Lion, duke of Saxony. This first Baltic town built on the west European pattern quickly flourished because of its excellent geographical position, and about 1200 was already developing into the centre of north European trade between Scandinavia and the Baltic countries, on the one hand, and western Germany, Flanders and England on the other. Most of the younger towns on the Baltic were strongly influenced by Lübeck, not only in their economic and legal systems but also in their style of architecture. In 1226 the town was raised by Emperor Frederick II to the status of free imperial city. Lübeck took up the leading position in the Hanseatic league, the community of towns still forming early in the 14th century; while abroad, Lübeck merchants played a special role in the German commercial settlements in London (the steelyard), Bruges, Bergen and Novgorod. During the middle ages Lübeck was one of the largest and most important towns in central Europe. The decline began in the 15th century as the states of west and north Europe became politically and economically more powerful and independent, and the main volume of European trade shifted more and more to the west. In the years 1530–37 the rash war policy of the demagogue burgomaster Jürgen Wullenwever (1492–1537) to-

ward the Netherlands, Denmark and Sweden led to the collapse of Lübeck's old position as a great power. In the following centuries Lübeck sank to an economic position of the second rank, to that of a mere Baltic port. But as such it has retained considerable importance up to the most recent times in its traffic with Scandinavia, the Baltic states and Russia.

Politically the town continued as a free city within the old German empire, and after a short interval (1811–13) when it was attached to Napoleon's empire, it became a member state of the German confederation, in 1866 of the North German confederation, and in 1871 of the new German empire. Lübeck also kept its status as a *Land* after World War I, indeed right through the period of the Weimar republic, and in the first few years of Hitler's regime. However, by a decree of Hitler's government Lübeck lost its ancient independence in 1937, and was incorporated in the Prussian province of Schleswig-Holstein (from 1946 the *Land* of Schleswig-Holstein).

From the beginning of the 20th century the economic situation of the town was critical, especially following the opening in 1895 of the Kiel canal, which substantially favoured competition from the west in the Baltic area; other factors disturbing to the economy were the political and economic upheavals in the area after 1918. World War II and its consequences aggravated them. An air raid in 1942 destroyed about one-quarter of the inner town and damaged a substantial proportion. After 1945 thousands of refugees flocked into Lübeck from the east and increased the population, which was 150,000 before World War II, by more than a third. The lowering of the "iron curtain," cutting off communication with the east, made Lübeck a border town and deprived it of a large number of its export partners and of its hinterland. The effect on the town's economy was an increasing shift of emphasis from the export trade to industry. For early history, *see* also HANSEATIC LEAGUE.

The inner town, although partially destroyed by the air raid in 1942, retained much of its medieval character. Of the medieval works of architecture, the five main churches are outstanding: the cathedral, St. Mary's, St. Peter's, St. Jacob's and St. Giles' (all 13th–14th centuries); also the monastery church of St. Catherine (14th century) and the Hospital of the Holy Ghost (end of the 13th century). Several of the churches sustained war damage in the air raid but for the most part have been restored. Among the secular buildings are the *Rathaus* (town hall) (13th–16th centuries), the House of the Seaman's Guild, the Schabbelhaus and numerous private houses of special interest, and there are medieval city gates that have been preserved (Holstentor, Burgtor). Three museums (St. Anne's museum, the Behnhaus and Holstentor) contain works of value in art or social history; they include works of the Lübeck artists Bernt Notke, Hermann Rode (both 15th century) and Johann Friedrich Overbeck (1789–1869). In the city archives the charters and deeds of the Hansa are also preserved. The two writers Heinrich and Thomas Mann were of a Lübeck merchant family; Thomas Mann's novel *Buddenbrooks* gives an excellent portrayal of that Lübeck milieu in the 19th century. Another native of the city was the portrait painter and court artist of Charles II and of James II, Sir Godfrey Kneller.

See also references under "Lübeck" in the Index. (A. v. B.)

LUBECKI, KSAWERY DRUCKI (1779–1846), Polish statesman, the restorer of the finances of the "Congress kingdom" under the Russians after the Napoleonic Wars, was born in St. Petersburg on Dec. 28, 1779, of a princely family descended from the ancient Russian ruling house of Rurik. As an officer in the Russian service the prince took part in A. V. Suvorov's Italian campaign of 1799. In 1813–15 he was a member of the provisional government of the duchy of Warsaw, then under Russian occupation. From 1817 to 1821 he led successful negotiations in Berlin and Vienna for the settlement of the Polish foreign debt.

In July 1821 the prince was appointed minister of the treasury of the kingdom of Poland at a time when its finances were in a critical state. He restored public confidence, restraining numerous abuses and efficiently collecting overdue taxes. In three years he balanced the budget, basing it chiefly on indirect taxation. Using budget surpluses for promoting industry, he developed state mines and foundries and helped the growing textile industry. The Land Credit society (1825) and the Bank of Poland (1828) were also his creations. Having secured an independent position in the government as well as the Russian emperor's confidence, he steadfastly defended Poland's autonomy, though he disregarded the constitutional freedoms and opposed revolutionary trends. After the national insurrection of Nov. 29, 1830, he tried to maintain the movement within legal limits; then went to St. Petersburg to negotiate with the emperor Nicholas I. His mission failed, and Lubecki remained a passive witness of the Polish defeat. He spent the rest of his life in St. Petersburg, where in 1832 he was appointed a member of the state council. He died there on May 23, 1846. Lubecki's correspondence was published by S. Smolka, four volumes (1909).

See S. Smolka, *Polityka Lubeckiego przed powstaniem listopadowem* (1907). (S. Ki.)

LUBLIN, a town in eastern Poland and capital of Lublin *województwo* (voivodship), is located 105 mi. S.E. of Warsaw on the Bystrzyca, at the intersection of important routes from Cracow and Warsaw to the U.S.S.R. Pop. (1960) 180,700. The trade settlement, which existed in the 10th century, flourished and acquired town rights in 1317. Because of its location on the borders of the Polish and Lithuanian lands it became a meeting place for joint congresses, and in 1569 the Act of Union between the two countries was signed there. In 1795 it passed to Austria after the third partition of Poland. Between 1809 and 1815 it was incorporated in the Warsaw kingdom, and from 1815 was included in the Polish kingdom, dependent on Russia. Following the re-emergence of independent Poland in 1918, the first independent Polish government was proclaimed in Lublin. After World War II it was the provisional seat of the Polish Committee of National Liberation and later of the temporary government.

Industries include meat, tobacco and sugar factories, a large hop-drying plant, flour mills and breweries. Agricultural implements and, since World War II, automobiles are also manufactured. Lublin is the cultural centre of eastern Poland, containing five higher educational establishments, two theatres, three museums, a philharmonic hall and a theatre for operettas. Despite damage sustained during World War II, Gothic and other buildings have survived, including the Castle chapel (with fine 15th-century murals), many fine churches (including a 16th-century cathedral), three town gates and many houses and palaces of former Polish nobles. One of the town's museums, in the suburb of Majdanek, is situated on the site of the former concentration camp established by the Nazis in 1941. The Majdanek camp, second largest after Oswiecim (*q.v.*), was one of the most notorious extermination camps. It has not been possible to establish the total number of persons murdered, since the Germans burned the bodies in furnaces and before retreating destroyed their records, but about 820,000 pairs of boots and shoes were found in the camp. The number of Majdanek victims was estimated during the Nürnberg trials at 1,500,000.

LUBLIN *województwo* borders (east) the U.S.S.R. along the Bug river and (west) the Vistula. Area 9,584 sq.mi. Pop. (1960) 1,799,900. It comprises highlands in the south and plains to the north. The excellent soils of the highlands provide for an agricultural economy where wheat is mostly grown, as well as sugar beets, hemp and hops (more than 60% of Poland's total production) and tobacco. Farming is also the main occupation of the inhabitants of the plain, though the soils there are poorer, and the crops are mainly rye and potatoes. The agricultural character of the region is evident in the high percentage of cultivated land (more than 70%). The voivodship is also important for the breeding of cattle, pigs, sheep and horses. Industry is poorly developed because of the scarcity of mines and raw materials. Good facilities are available for food processing; there are metal industries and large cement works at Rejowiec and Chelm. After World War II metal industries were developed in Lublin, Swidnik, Krasnik and Poniatowa. During the region's most prosperous period in the 16th century, many buildings were erected in the style known as Lublin Renaissance. The finest are found in the old city of Zamosc (in the northeast of the voivodship), which was

erected by the Zamoyski family on a uniform plan and is well preserved; and Kazimierz, a favourite spot for artists on the Vistula.

Only about one-fifth of the population is urban. The most important towns include (pop. 1960): Chelm (31,000), Zamosc (28,000), Biala Podlaska (20,000), Pulawy (13,400), Swidnik (12,700), Hrubieszow (12,300), Krasnik (12,100), Miedzyrzec Podlaski (11,000), Luków (11,000) and Krasnystaw (11,000).

(T. K. W.)

LUBRICATION concerns itself with the reduction of frictional resistance between two contacting surfaces forced to slide over one another. As secondary objectives lubrication tends to minimize wear and prevent corrosion. Lubrication is accomplished by inserting a thin film of lubricant between the sliding surfaces; thus lower fluid friction is substituted for the higher dry, metal friction. Any material placed between the surfaces to lessen friction is a lubricant. (*See* FRICTION.)

In a machine civilization, lubrication is vitally important. Friction wastes energy. It has been estimated that over 30% of the energy generated is consumed in friction; *i.e.*, heat. Lubrication was probably first practised when primitive man noted the eased skidding that resulted, because of sap lubrication, when the bark was removed from the trunk. From this crude start to the operation of delicate instruments on a man-made satellite, man's most persistent problem has been the reduction of friction and wear. Only in the 20th century, however, did he begin to understand the mechanism of friction and lubrication.

As man continued to analyze the phenomena, the art of lubrication gradually evolved into an exact science. Not long ago the task of lubricating the crude machines of industry was just a messy chore. A low-rated employee equipped with little more than an oilcan would irregularly proceed to oil all bearings with often only a single oil. Mass production, higher speeds, larger machines, long space flights—all these have changed the chore into a scientifically engineered phase of preventive maintenance. Better lubricants, special additives and automatic dispensing systems are among improvements that are receiving continuous attention.

Dispensing.—The best lubricant is useless until it is applied properly to the bearing, or gear, or guideway needing it. Where points to be lubricated are few and frequency of application is not critical, manual methods are sufficient. Modern machines, however, contain many bearings, precision-built to operate under severe conditions. The lubricant must, therefore, be applied with regularity, according to a precisely controlled plan: it is essential to get the right lubricant to the right place at the right time. Consequently, application by use of mechanical means is common procedure.

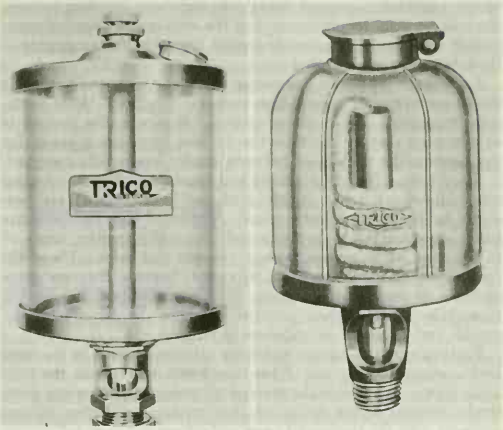
Many varieties and types of dispensing devices are available, ranging from simple units that lubricate a single bearing to fully automatic central systems capable of lubricating all the machines in a plant.

The oilcan, though providing unreliable, inefficient and irregular lubrication is proper in some cases. Rough units such as chains, hoists and farm machinery are appropriate for oilcan lubrication. Where the oil fed to the bearing should be partly controlled, drop feed, wick feed, bottle oilers and ring oiling are used (fig. 1). Bath and splash methods are effective in heavy, slow machinery.

For positive, adjustable, reliable lubrication, mechanical force feed systems (fig. 2) are best. Oil fog lubrication is one of the latest techniques being developed to transmit the lubricant to the surface needing lubrication.

History.—The major portion of industrial lubricants are derived from crude petroleum. The history of lubrication, therefore, closely parallels the growth of the petroleum industry. Actually petroleum is not a new discovery. Ancient Assyrians and Egyptians, and later Greeks and Romans, all used petroleum for lighting and embalming.

American Indians used petroleum medicinally. The colonists, however, when discovering it while drilling for salt, considered it a nuisance and poured it away as waste. In 1859 the Drake well in Pennsylvania was drilled to 69 ft. and produced 25 bbl. of crude oil daily; in 1901 the Lucas gusher, drilled in the Spindletop field, emitted up to 100,000 bbl. daily, and signaled the abundant availability of petroleum and its products. After this time petroleum rose to become mankind's major source of lubricants. Thus, the internal-combustion engine, the automobile, the airplane, the diesel train and the turbojet were all made possible by the use of petroleum, both as a fuel and as a lubricant. It also became possible to design production machinery for larger capacity and higher speed because improved lubricants could be modified to satisfy more severe operation conditions.



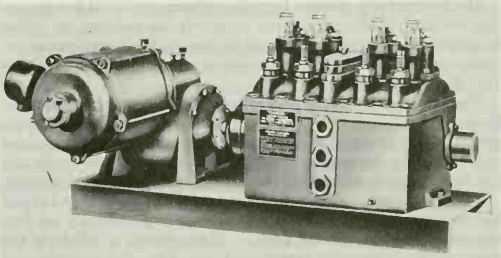
BY COURTESY OF TRICO FUSE MANUFACTURING CO., INC.

FIG. 1.—SEMIAUTOMATIC LUBRICANT DISPENSERS: LEFT, GRAVITY FEED OILER; RIGHT, WICK FEED OILER

Lubricants.—If the function of reducing resistance between surfaces sliding over one another is to be performed satisfactorily for a reasonable length of time, the lubricant must possess particular properties. Thus, a lubricant must be a versatile, multifunctioned product. It must reduce wear as well as friction; it must also carry the heat away, prevent corrosion, disperse contaminants, inhibit foam formation and remain intact under severe requirements. In addition it must flow through the bearing easily in order to perform all its functions well.

Lubricants may be grouped into five convenient categories. These are (1) petroleum or mineral oils; (2) fixed or animal oils; (3) synthetic lubricants; (4) solid lubricants; and (5) greases.

Petroleum Lubricants.—Petroleum lubricants are produced from crude oil, a complex mixture of hydrogen, carbon and oxygen plus traces of nitrogen and sulfur. Clay, water, chemical elements, resins and mineral salts are also often present in the crude oil. Obviously then, refining becomes necessary. Distillation, known as fractionation, is the key step in the refining process. In order to convert the crude into the finished lubricant many other steps are performed. Dewaxing, filtering, solvent refining to remove as-



BY COURTESY OF MANZEL DIVISION, HOUDAILLE INDUSTRIES, INC.

FIG. 2.—MULTIPLE-FEED AUTOMATIC MECHANICAL LUBRICATION SYSTEM

phalts, cracking to convert heavy into light oils, blending to meet the many special requirements, and the addition of chemical compounds to enhance, improve or impart desirable characteristics to the lubricant stock are other steps.

Each of the crude oils originating in the earth's petroleum fields differs somewhat in composition from every other. Many variations in refining are therefore needed. However, the process is so advanced that by the time the finished lubricant is ready for the bearing, the distinction between crudes has mostly vanished.

Fixed Oils.—These are animal and vegetable extracts. Animal oils (tallow, neat's-foot, whale, lard, cod-liver, *degras*) are produced by heating the fatty tissue. Vegetable oils, on the other hand, are extracted by pressing and chemically treating seeds of castor, rape, olive, cotton, peanut, coconut and palm. These oils can seldom be used directly as lubricants because they are quite unstable at ordinary operating temperatures, oxidizing into a varnishlike sludge. Their principal use is in the manufacture of greases and as agents or additives in mineral oils.

Fatty oils contain oxygen and fatty acids in addition to the basic hydrocarbon constituents. When mixed with mineral oils, the fatty acids appear to activate the mineral oil molecules into more effectively oriented layers, an action that results in a higher oiliness property with the tendency to wet and adhere to the metal surface even under high pressure.

Oiliness is particularly important in thin-film lubrication where it helps to prevent direct metal-to-metal contact and so reduces friction and wear.

Synthetic Lubricants.—Although costlier, synthetic oils have found extensive use in the second half of the 20th century. Better stability at higher temperatures and an improved viscosity index (the higher this index the smaller the change in viscosity with temperature) at ordinary temperatures are the principal reasons. Furthermore when many of these synthetic oils undergo thermal decomposition, the resulting products are fluids quite similar to the original product or, otherwise, are volatile materials that evaporate without depositing gummy residues.

Five general types of synthetic lubricants and lubricant agents are in common use. These are the polyalkylene glycols, the silicones, the polymer oils, the organic chlorine compounds and the diesters. Of these the polyalkylene glycols are probably most used because of their inherently wide temperature tolerance, their low solvent action on rubber and their high resistance to sludge formation. A widespread application exists in this group—from 400° to 500° F. temperatures in industrial kiln cars to low temperatures in liquefied hydrocarbon gas pumps. An interesting experience illustrating the unusual antiwear property of glycols is illustrated by their use on highly loaded gears. In a controlled test, gears lubricated with a mineral oil pitted severely in six months while similar gears lubricated with a glycol lubricant showed only traces of wear after a full year of operation.

The silicones also possess good thermal stability and general chemical inertness. The silicones are primarily alkyl polymethyls and polymethyl phenyl siloxanes. Use over the 10° to 500° F. temperature range is common. They are more critical, however, than mineral oils with respect to metal combinations. On the other hand, they inhibit foaming almost magically.

The polymer oils, derived from the polymerization of low molecular weight paraffins, are used primarily as carriers of active lubricating ingredients. They are so used extensively because of their very clean burn-off properties at temperatures as high as 750° F.

The chlorine lubricants or Aroclors are not good lubricants by themselves but are most effective additives as extreme pressure agents. The esters of dicarboxylic acids, the fifth group, serve well in various demanding applications. To date their major use has been in high-quality instrument oils and specialized greases.

Solid Lubricants.—The solid lubricants are of mineral and chemical compound origin. Graphite, talc, soapstone and mica are representative of the mineral group. Molybdenum disulfide is the most important chemical compound type. The solid lubricants are good for temperatures at which liquids become impractical. The direct application of solid lubricants is, in general, quite difficult. They are therefore usually suspended in volatile, liquid carriers that flash off at elevated temperatures, leaving a thin deposit of the solid lubricant.

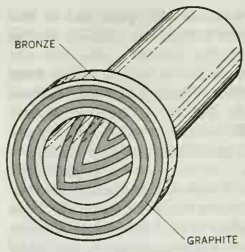


FIG. 3.—GRAPHITE LUBRICANT PRESSED IN BRONZE BEARING

Natural graphite, a black, lustrous mineral, is usually used in the dry form. Sometimes a binder is mixed in to form a paste that is pressed in grooves or layers in bronze and babbitt-bearing sleeves (*see* fig. 3). Colloidal graphite is a soft, greasy substance, almost chemically pure. It is much easier to "carry" in this small particle size and proves itself a good lubricant in the high-temperature range.

The soft molybdenum disulfide is extracted from a natural ore. The favoured solid lubricant over a wide temperature range, it has been used successfully in liquid nitrogen valve systems at temperatures as low as −300° F. Its use has been reported at 1,600° F. in a vacuum and at 2,400° F. in argon atmospheres. In normal atmospheres it is stable up to 750° F. The National Aeronautics and Space administration (NASA) claims the most effective molybdenum disulfide (molykote) surface to be one that is obtained when a bearing is smeared with the molykote suspended in a fluid, baked at around 650° F., and finally buffed to a high finish.

Certain metallic dispersions can also be considered solid lubricants. Finely powdered lead and indium have been dispersed in oil and other vehicles with interesting lubricating results. Thin metallic platings of copper, indium and aluminum have also been tried with some success. In addition several chemical coatings, deposited as reaction products, have been found to possess lubricating properties.

Greases.—Grease is a plastic solid, a mixture of saponified fat in a liquid lubricant. Plastic solids (see *Theory,* below) do not flow at ordinary temperatures. Officially the American Society for Testing Materials (A.S.T.M.) defines greases more broadly, "Lubricating Grease: A solid to semisolid product of dispersion of a thickening agent in a liquid lubricant. Other ingredients imparting special properties may be included." (American Society for Testing Materials, *Standard Definitions of Terms Relating to Petroleum,* 1959.) Greases vary extensively both in composition and in physical properties.

Many different soap bases—calcium, lithium, sodium, barium, silica—are used in combination with various petroleum oils, as well as with some of the synthetic lubricants.

In general, greases are inferior wherever liquid lubricants can be used. Greases suffer greater power losses because of the thickening soap. For the same reason greases are used where a liquid lubricant cannot be constantly supplied and where lubricant leaks or spattering may be objectionable or even detrimental to the product, such as on food or cloth. Also in rough, heavy machinery, where boundary conditions are likely to exist, grease lubrication is preferred. Comparative advantages of grease and oil are shown in Table I.

The lubricating power of greases depends on both the liquid and soap constituents. The soap base acting as a sponge absorbs the oil to release it to the bearing during operation by squeeze action. On the other hand, the soap molecules are adsorbed into the metal

TABLE I.—*Comparative Advantages of Grease and Oil in Bearings*

Advantages of Grease	Advantages of Oil
1. Maintenance may be reduced; no oil level to maintain; regreasing is infrequent.	1. Oil is easier to drain and refill. This is important if lubricating intervals are close together.
2. Proper grease quantity is easily confined in housing. Simplifies design of bearing enclosure.	2. Use of oil makes it easier to control the correct amount of lubricant.
3. Freedom from leakage is important in food, textile and chemical industries.	3. Same lubricant may be used on other types of bearings on the same machine.
4. Improves efficiency of labyrinth enclosures, gives better bearing protection.	4. If bearing must operate under high temperatures, conditions favour oil.

Adapted from J. J. O'Connor, "Bearings and Lubrication," *Power* (Dec. 1951).

to hold the rubbing surfaces separated and thus lubricated. Probably where bearing clearances are comparatively large the liquid constituent is more important, while at smaller clearances the molecular soap layers provide the lubrication.

Greases may be divided into five groups: (1) the water-resistant; (2) the water-soluble; (3) the multipurpose; (4) the synthetic; and (5) the special purpose greases.

(1) Calcium forms the base of the water-resistant group. Lube oil and a small amount of stabilizing water are the other constituents. In general these water-resistant greases are satisfactory up to about 200° F. as a maximum. Above this temperature the water will boil off, which allows the oil to separate and "bleed" off, leaving the sticky, gummy soap.

When not stabilized with water the grease may work at slightly higher temperatures. Aluminum oleate or palmitate is also used as the base.

(2) The water-soluble greases contain a sodium hydroxide base. Since these greases offer very little resistance to water-washing, they cannot be used where water or steam is present. However, because of the absence of water they may be used at temperatures up to 300° F.

(3) The multipurpose members contain either a barium or a lithium base. Both bases make the grease reasonably water resistant—better than sodium but not quite as good as the calcium greases. In continuous service the multipurpose greases may be used up to about 350° or 400° F. The need for this group arises, of course, from the desire to have a single grease serve many purposes, a good example being automobile servicing.

(4) The synthetic greases are the latest development in the industry. Some contain standard soaps in synthetic oils, while others are mixtures of synthetic thickeners (bases) in petroleum oils.

The silicones, on the other hand, are greases in which both the base and the oil are synthetic. The synthetic greases are made in water-soluble and water-resistant forms. As a result they may be used over a wide temperature range. In addition the synthetics can be used in contact with natural or other rubbers because they are quite inert to these materials.

(5) In the attempt to obtain some especially desirable characteristic two or more soap bases are used to produce the special purpose greases.

In some cases additives, like extreme pressure agents, are used to gain the special property.

Additives.—Chemical compounds are added to lubricants to improve certain properties or impart new ones. Some additives affect the lubricant chemically, others physically. Most compounds are interdependent, complementing and supplementing each other. In some cases additives affect each other adversely. As a result, additive compounding is a most complex problem. This complexity, in turn, adds much value to procedures developed and facts learned; the latest information is, therefore, seldom published or otherwise publicly expounded.

Better-known addition agents include oxidation inhibitors, detergents, dispersants, anticorrosives, foam inhibitors, antiwear agents, oiliness compounds, pour point depressors and viscosity index improvers (see *Viscosity* below). Many different classes of organic compounds, metallo organics and soaps in various proportions are used. Each lubricant producer has his own formulas and compounding techniques. Compounds containing sulfur and phosphorus, amines, phenols and naphthenates, silicone and methacrylate polymers, soaps of calcium, barium, cobalt and strontium are all typical additives.

A special group of additives are contained in boundary range lubricants. When speed is too low, high loads exist, or excessive temperatures reduce viscosity, the oil film is difficult to maintain; thus metal-to-metal contact occurs. Satisfactory lubricants are expected to remain in at least molecular thickness under these conditions. Proper additives appear to bring this about by either adsorption or reaction. In either case a layer of lower shear strength is "bonded" to the metal, providing at least minimum lubrication.

The additives of polar structure, such as lard oil, are identified as extreme pressure (EP) agents. In turn, the product itself is called an EP lubricant.

Viscosity.—The internal friction between molecules of a fluid—liquid or gas—is, in general, viscosity. The viscosity of a lubricant is of vital importance. The friction developed in a bearing in which the rubbing surfaces are separated by a fluid film depends directly upon the viscosity of the fluid. Viscosity also impedes the flow through the bearing.

When two surfaces, moving with a velocity v relative to each other, are separated by a fluid film, the velocity of film layers is as shown in fig. 4. The velocity of the layer in contact with the fixed surface is zero; that of the layer in contact with the moving layer is v. The velocity in between varies linearly.

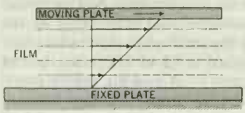


FIG. 4.—STREAMLINE FLOW OF FLUID BETWEEN TWO PLATES. VELOCITIES ARE PROPORTIONAL TO DISTANCE FROM FIXED PLATE

A pull (force) must be applied to the upper plate if it is to move. Shear between successive layers of the film results from the pull. Sir Isaac Newton established in 1668 the mathematical relationship describing the shearing stress. He wrote

$$S_r = \frac{F}{A} = \mu \frac{v}{h}$$

where F is force in pounds, A is area of the film, v is velocity of upper plate in feet per second, and h is the film thickness in inches. In turn (*see* fig. 5) the viscosity becomes algebraically

$$\mu = \frac{Fh}{Av}$$

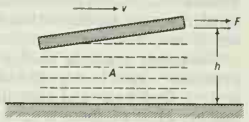


FIG. 5.—PLATE MOVING ON OIL FILM

A unit of viscosity is thus the viscosity which requires one unit force to move one unit surface at unit velocity when one unit length away from the fixed surface. A unit viscosity in the metric system is called a poise in honour of J. L. M. Poiseuille who investigated extensively the flow of liquids in capillaries in the 1840s. Because of the size of a poise a smaller unit, one-hundredth the size, called a centipoise is customarily used. It so happens, and quite conveniently, that the viscosity of water at 68.4° F. is one centipoise. In the English system a unit of viscosity is measured in pound-seconds per square inch. It is called a reyn in honour of Sir Osborne Reynolds, father of hydrodynamic lubrication.

Obviously the measurement of viscosity—viscometry—is quite essential. Literally hundreds of kinds of viscometers have been built and used. The most popular is the capillary tube type, which uses the principle first recognized by Poiseuille. The viscosity is obtained indirectly by measuring the pressure needed to force the liquid through the small tube, the tube dimensions and the rate of flow. An example of such an instrument, depending upon gravity as the driving force, is the A.S.T.M. modified Ostwald viscometer.

Another type of viscometer is based on Newton's viscosity law, the measurement of the force needed to pull one surface past another with a liquid between them. The rotational viscometer, in which torque is the measured quantity, is probably the best known Newton type.

Great skill is required to manipulate the above mentioned instruments. Because of this fact and the delicacy of such instruments, industry has found them unsuited for use outside the laboratory. More rugged devices, simpler in operation, have been standardized for general use. The time taken by a given volume of oil to flow through a standard orifice is measured in seconds and recorded as an arbitrary expression of viscosity. Of such efflux viscometers, the Saybolt is popular in America, the Redwood in Britain and the Engler in Germany.

Viscosity of fluids varies greatly with temperature. Because of the difficulty of mathematical expression, charts are used to present this variation. A special logarithmic ordinate scale makes the viscosity-temperature plot a straight line.

While the viscosity of liquids decreases as the temperature in-

creases, that of gases increases, curiously enough. Viscosity of a gas is determined with viscometers very similar to those already described. The viscosity of some better known fluids, lubricants included, is given in Table II.

Lubricants change viscosity with pressure as well, the viscosity increasing with an increase in pressure. The increase does not, however, become large until very high pressures are reached. At commonly used bearing pressures, therefore, the change is low enough to be negligible and so is not accounted for.

A greatly simplified, but convenient, indication of the change in viscosity within the temperature range common in bearing operation is the viscosity index (VI), which is used extensively by the lubricant industry. The oil having the smallest change in viscosity between 100° and 210° F. is assigned a VI of 100; that having the largest change has a VI of 0 (zero). A new oil, falling somewhere in between, will carry a number proportionately between 0 and 100. Since lubricants being developed in the second half of the 20th century are quite different from those used to establish the VI scale in 1929, it is possible to have a VI larger than 100 or less than 0.

Lubricant Analysis.—Lubricating oils must be tested at every step of their manufacture if the quality of the finished product is to be ascertained. Tests must also be conducted to check and insure the ability of a specific lubricant to meet particular requirements. As already indicated, the most significant test is the viscosity measurement.

TABLE II.—*Viscosity of Some Better-Known Materials*

Material	Viscosity at 70° F. Centipoise
Hooey	1,500
SAE 50 Oil	800
Glycerin	500
SAE 30 Oil	300
SAE 10 Oil	70
Ethylene Glycol	20
Kerosene	2
Water	1
Gasoline	0.4
Air	0.018
Hydrogen	0.009

Other tests regularly used are pour point, specific gravity, ash content, flash point and neutralization. Most of these tests are conducted according to A.S.T.M. procedures. The pour point is the lowest temperature at which an oil just barely flows. For application at reduced temperatures or outside, winter use, this reading is most important. The specific gravity, its weight relative to water, defines its bulkiness and gives some indication of its heavier constituents.

A measure of the amount of metal contained in an oil is obtained in the ash test.

The flash point test determines the lowest temperature to which the lubricant must be raised to evolve enough vapour to ignite when brought in contact with a flame in the presence of air. It is a safety test but it also indicates the presence of contaminants. The neutralization number, milligrams of potassium hydroxide used in neutralizing one gram of oil, is a measure of the corrosive acid or base content. This test also determines the presence of certain additives.

Other tests are conducted to check properties useful in particular applications. The colour test indicates the nature and extent of refining. The carbon residue test determines the hydrocarbon base. The foam test indicates how readily the lubricant mixes with air to form objectionable foam. How easily the lubricant will absorb oxygen is measured in the oxidation test. Rust-preventive characteristics are found in the rust test.

Greases are also similarly examined.. Major tests are penetration, ash content, oxidation stability and evaporation. The penetration of a standard cone classifies greases into grades. It is a kind of viscosity measure. The amount of nonvolatile metallic compound present in the grease is measured in the ash test. Oxidation stability determines resistance to oxidation under storage conditions.

The evaporation test measures the rate at which the grease loses oil. Tests used primarily in manufacture control are the water test, soap test, oil test, alkali test and drop point.

In research and in development of new or improved lubricants, analyses other than control and application tests are essential. Lubricants are here studied by microchemical, instrumental and even radioactive techniques. Microanalysis is the technique that makes use of very small samples, ten milligrams or less. Such microtechniques aid research greatly because large sample quantities can then be made after more favourable materials have been proven.

Fast methods of testing, which instrumental procedures permit, eliminate the tedious, time-consuming process of wet-chemistry. Furthermore, instruments often give more accurate results because much personal error is eliminated. X-ray, absorption, mass and emission spectroscopy are major instrumental devices.

Nuclear fission made available many radioactive isotopes. They can be used as tracers in wear studies. The mechanism of basic lubrication phenomena can also be studied for better understanding.

Theory.—Rheology is the science that deals with the intrinsic flow of materials. When a shearing force is applied, the material assumes a shearing strain. If the shearing stress—force per unit area—is plotted against the rate of shearing strain—strain per unit thickness—the flow phenomenon is graphically defined. Such a chart is shown in fig. 6. The "true" or Newtonian liquid (*see* VISCOSITY: *The Coefficient of Viscosity*) is represented by a straight line starting at the origin. The slope of this line determines the very important property called viscosity. The non-Newtonian fluid starts at the origin also, but is partly, or wholly a nonlinear curve—the viscosity is not constant. In general, real liquids are non-Newtonian; but, if the graph is exactly or very nearly straight over the range of operation, the fluid is assumed Newtonian. When some initial shearing stress must be applied before flow begins, the material is a plastic solid. The general plastic solid will have curved portions while the ideal or Bingham plastic solid is all straight. Greases are usually considered plastic solids. The Pascal fluid is a material, not found in nature, but theoretically interesting, which has zero viscosity; *i.e.*, it intrinsically spreads out indefinitely. Hydraulic fluids are sometimes assumed as such.

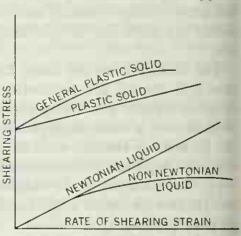


FIG. 6.—RHEOLOGY CHART (*see* TEXT)

All materials used as lubricants, whether gas, liquid or solid, are considered either Newtonian fluids or Bingham plastic solids. *See* also references under "Lubrication" in the Index.

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LUCAN (MARCUS ANNAEUS LUCANUS) (A.D. 39–65), Latin poet who wrote the *Bellum Civile*, better known as the *Pharsalia*, a historical epic more remarkable for rhetoric than poetry though with flashes of poetic fire. Born at Corduba (Cordova), Sp., grandson of the older, and nephew of the younger, Seneca, he was educated at Rome, among his teachers being the Stoic, Cornutus, who also taught the satirist Persius. He was given a quaestorship by Nero, but it was not long before his republican opinions were outraged by Nero's tyrannous conduct, and in the year 65 he was one of the leaders (*paene signifer*, says Suetonius in his life of Lucan) in Piso's conspiracy to assassinate Nero (although Tacitus says that he was also embittered because Nero had forbidden him to give public recitations of his poetry). When the conspiracy was discovered, he was compelled to commit suicide by opening a vein. While he was dying, Tacitus records, "he remembered a poem composed by himself, in which he had told of a wounded soldier dying by the same kind of death. He repeated the lines, and that was his last utterance."

The *Bellum Civile*, his only surviving poem, is an epic of the war between Caesar and Pompey, carried down to the arrival of Caesar in Egypt after the murder of Pompey, until in the tenth book it abruptly stops. Lucan was not a great poet, but he was a great rhetorician and had remarkable political and historical in-

sight for so young a man, though it must be admitted that his hatred of Caesar and his admiration for Pompey are both excessive. The work is naturally imitative of Virgil, his predecessor in Latin epic, but Lucan dismisses the gods from his scene, a wise precaution in a poet dealing with not too distant history.

The narrative is not always clear and is marred by overlong speeches and digressions, particularly on geographical matters, although his interest in geography does not often enable him to make his battles intelligible. He is not as dramatic as Virgil; sometimes, as in the account of Pompey's murder, because the writing is perfunctory and sometimes because he exaggerates or strains after rhetorical effect. Although the style and vocabulary are usually commonplace and the metre is monotonous, the rhetoric is often lifted into real poetry by its energy and fire, like Byron's, and appears at its best in the magnificent funeral speech of Cato on Pompey. Pompey's parting with his wife (in book v) is also very fine; and scattered through the poem are noble sayings and telling comments, expressed with the terse vigour and directness of which the Latin language has such command. As the poem proceeds, the poet's republicanism becomes more and more marked, no doubt because, as Nero's tyranny grew, he began to look back with greater longing to the old Roman republic; yet it is true that he does not make the republicanism of Pompey seem either attractive or effective. It has been said that Cato, who appears very little until after Pompey's death, is the real hero of the epic, and certainly the best of Lucan's own Stoicism appears in the noble courage and endurance of his Cato, in continuing the hopeless struggle after Pompey had failed.

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(An. K.)

LUCANIA, an ancient territorial division of southern Italy, corresponding to most of the modern region of Basilicata (*q.v.*) with much of the province of Salerno and part of that of Cosenza. Its boundaries were, approximately, the Silarus (Sele) river on the northwest, the Bradanus (Bradano) on the northeast and the Crathis (Crati) and Laus (Lao) rivers on the south; Eburum (Eboli) and Volceii (Buccino) beyond the Silarus and Bantia (Banzi) beyond the Bradanus were, however, also included in Lucania. Apart from the east coast and the Silarus valley, the whole of Lucania was occupied by the Lucanian Apennines.

Lucania was so called from the Lucanians (*Lucani*) who conquered it about the middle of the 5th century B.C. Before that it was included under the general name of Oenotria, applied by the Greeks to southernmost Italy. The mountainous interior was occupied by Oenotrians and Chones, while on the coasts on both sides were powerful Greek colonies which doubtless exercised a protectorate over the interior (*see* Magna Graecia). The Lucanians were a southern branch of the Samnite group, who spoke Oscan (*q.v.*). After much intertribal conflict they began to attack the Greek cities, especially Tarentum, which appealed first to Archidamus III of Sparta (killed 338), then to Alexander, king of Epirus (killed 330). In 298 B.C. the Lucanians made alliance with Rome, and Roman influence was extended by the colonies at Venusia (Venosa; 291 B.C.), Paestum (273) and above all Tarentum (272). On the landing of Pyrrhus in Italy (281 B.C.) they were among the first to declare in his favour and found themselves exposed to the resentment of Rome when the departure of Pyrrhus left his allies at the mercy of the Romans. After several campaigns they were reduced to subjection (272 B.C.). They sided with Hannibal during the Second Punic War (216 B.C.), and their territory during several campaigns was ravaged by both armies. The country never recovered from these disasters, and under the Roman government fell into decay, to which the Social War, in which the Lucanians took part with the Samnites against Rome (90 B.C. onward), gave the finishing stroke. For administrative purposes under the Roman empire, Lucania was always united with the district of the Bruttii to the south. The two together constituted the third region of Augustus' reorganized Italy.

The towns on the east coast were Metapontum, a few miles south of the Bradanus; Heraclea (*q.v.*), at the mouth of the Aciris (Agri) river; and Siris, on the river of the same name (mod. Sinni). Close to the southern frontier stood Sybaris, destroyed in 510 B.C., but subsequently replaced by Thurii (*qq.v.*). On the west coast stood Posidonia, known under the Romans as Paestum; below came Elea or Velia, Pyxus, called by the Romans Buxentum (Policastro), and Laus, near the frontier of the province toward Bruttium. Of the towns of the interior the most considerable was Potentia (Potenza). To the north, near the frontier of Apulia, was Bantia; due south from Potentia was Grumentum, and still farther in that direction were Nerulum and Muranum (Morano Calabro). In the upland valley of the Tanager (Tanagro), a tributary of the Silarus, were Atina (Atena Lucana), Forum Popilii (Polla) and Consilinum. The Via Popilia (built 132 B.C.) traversed the district from north to south, entering it at the northwest extremity; the Via Herculia, coming southward from the Via Appia and passing through Potentia and Grumentum, joined the Via Popilia in the southwest of the district; another nameless road followed the east coast.

LUCARIS, CYRIL (Kyrillos Loukaris) (1572–1638), Greek Orthodox bishop and theologian, whose dream was to reform the Orthodox Church on Calvinistic lines, was a native of Crete, where he was born in 1572. In his youth he traveled, studying at Venice and Padua. In Wittenberg and then in Geneva he came under the influence of the Reformed faith as represented by Calvinism. In 1596 the patriarch of Alexandria, Meletios Pigas, sent Lucaris to Poland to lead the Orthodox opposition to the union with Rome, signed in Brest-Litovsk in that year by the Orthodox bishops. For six years Lucaris served as rector of the Orthodox academy in Vilnius. In 1602 he was elected patriarch of Alexandria and in 1620 patriarch of Constantinople.

As patriarch, Lucaris, to further his Calvinizing purpose, sent many young Greek theologians to the universities of Holland, Switzerland and England. It was one of these, Metrophanes Critopoulos, future patriarch of Alexandria, who discovered the *Confession of Orthodox Faith,* written by Lucaris in Latin and published in Geneva in 1629. In its 18 articles Lucaris professed virtually all the major doctrines of Calvinism: predestination, justification by faith alone, acceptance of only two sacraments (instead of seven, as taught by the Eastern Church), rejection of icons, rejection of infallibility of the church, etc. In the Eastern Church the *Confession* started a controversy that culminated in 1672 in the convocation by Dositheos (*q.v.*), patriarch of Jerusalem, of a synod by which the Calvinistic doctrines were condemned. (*See* Jerusalem, Synod of.)

Lucaris was several times temporarily deposed and banished at the instigation of his Orthodox opponents and of the Jesuits, who were his bitterest enemies. Finally, when Sultan Murad was about to set out for the Persian war, the patriarch was accused of a design to stir up the Cossacks, and to avoid trouble during his absence the sultan had him strangled (June 1638). Several Orthodox scholars, beginning with Dositheos, attempted unsuccessfully to prove that Lucaris was not the author of the *Confession,* but the discovery by E. Legrand of the autograph manuscript of the book in Geneva made these attempts hopeless.

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(Al. S.)

LUCAS, EDWARD VERRALL (1868–1938), English journalist, essayist and critic, was born at Eltham, Kent, on June 11, 1868, and after working on a Sussex newspaper studied at University college, London. He read assiduously, joined the *Globe,* a London evening paper, in 1893, and became a versatile and prolific writer. He was a frequent contributor to *Punch* and later a member of its staff, and acted as publisher's reader to the firm of Methuen, becoming chairman of the company in 1924. He edited the *Works of Charles and Mary Lamb* (1903–05), wrote the standard *Life of Lamb* (rev. ed., 1921), produced the first complete edition of the Lambs' *Letters* (1935), and was himself a distin-

guished light essayist. He also edited anthologies (*e.g., The Open Road,* 1899), wrote a popular series of travel books (1905–14), some essaylike novels (*e.g., Over Bemerton's,* 1908), and, in *Reading, Writing and Remembering* (1932), avoided the sentiment which sometimes marred his essays. Lucas was neither a profound nor a scholarly writer, but his work is characterized by its clarity, charm and good taste. He died in London on June 26, 1938.

See A. Lucas, *E. V. Lucas: a Portrait* (1939).

LUCAS VAN LEYDEN (Lucas Hugensz or Jacobsz; known in Italy as Luca d'Olanda) (1494–1533), Dutch painter and engraver, has been described as the greatest of the Dutch artists who laid the foundation of 17th-century Dutch painting. He was probably born at Leiden, where, according to Karel van Mander, he was taught by his father Huygh Jacobsz before entering the studio of Cornelis Engelbrechtsen. According to the same author, he painted at the age of 12 a "Legend of St. Hubert," for which he was paid a dozen florins. He was only 14 when he finished a plate representing Mohammed taking the life of Sergius, the monk. At 15 he produced a series of nine plates for a "Passion," a "Temptation of St. Anthony," and a "Conversion of St. Paul." The list of his engravings in 1510 includes subjects as various as a celebrated "Ecce Homo," "Adam and Eve expelled from Paradise," a herdsman and a milkmaid with three cows and a "Woman with a Dog." According to Albrecht Dürer's diary, Dürer met Lucas at Antwerp and exchanged the Dutchman's prints for his own and drew his portrait (British museum). The effect of this contact with the great German artist is traceable in Lucas' drawings. He is likely to be the "Lucas de Hollandere, scildere," who registered at the Antwerp guild in 1522.

In 1527 he made a tour of the Netherlands, giving dinners to the painters of the guilds of Middleburg, Ghent, Malines and Antwerp. The journey ruined his health; after a long illness he died at Leyden in 1533.

After Dürer, Lucas was the most important engraver of his time. Existing engravings ascribed to him number 172. He also designed a number of woodcuts, and about 20 pictures by him are in public and private collections. Early works are the "Chess Players" in the Berlin museum; the "Beheading of John the Baptist" in the Johnson collection, Philadelphia; the triptych of the "Epiphany" in the Barnes collection, Philadelphia; the triptych of the "Last Supper" in the Aachen museum; "Lot and his Daughters" at the Louvre, Paris; the "Temptation of St. Anthony" in the Brussels gallery; and a remarkable self-portrait in the Herzog-Anton-Ulrich museum, Brunswick. Then follow the paintings in a more fluent style—"St. Jerome" and "The Virgin Enthroned" in Berlin; the "Card Players" at Wilton house; the "Predication" in the Rijksmuseum, Amsterdam, and a portrait in the National gallery.

BY COURTESY OF THE HERZOG-ANTON-ULRICH MUSEUM, BRUNSWICK, GERMANY

"SELF PORTRAIT" ON WOOD PANEL, BY LUCAS VAN LEYDEN

In 1522 he painted the "Virgin and Child With the Magdalen and a Kneeling Donor" (gallery of Munich). His manner was then akin to that of Mabuse. The "Last Judgment" (commissioned in 1526), in the town gallery of Leiden, is composed on the traditional lines yet some of the heads are painted with great delicacy and modeled with exquisite feeling. His last important work was a triptych now at the Hermitage at Leningrad (executed, according to Van Mander, in 1531), representing the "Blind Man of Jericho Healed by Jesus Christ." Here may be observed great finish and warm flesh tints with a gaudy scale of colours.

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LUCCA (ancient Luca), a town and archiepiscopal see of Tuscany, Italy, capital of the province of Lucca, is 21 km. (13 mi.) N.E. of Pisa by road. Pop. (1961) 88,717 (commune). Lying in the fertile valley of the Serchio with the Apuan Alps to the north and west, it is almost surrounded by hills. Lucca's central streets preserve the rectangular Roman plan, and remains of the ancient walls have been found. The Piazza S. Michele is on the site of the ancient forum and the principal market place, Piazza del Mercato, occupies the arena of the amphitheatre; the arena's outer arches are visible in the surrounding buildings and the substructure of the theatre (probably 2nd century A.D.) can be traced in the Piazza delle Grazie. Spacious squares, including the Piazza Napoleone and Piazza S. Martino, provide a striking contrast with the narrow streets. The Guinigi houses, which include a high tower, and the Gothic-style brick Villa Guinigi (1418) are the outstanding medieval buildings. Among many fine 16th-century palaces and later buildings are the early Renaissance Palazzo Pretorio, the podestà's residence (now the civil courts), begun in 1492 and extended in 1588, and the former ducal palace (restored in 1954; now the prefecture), begun by Ammanati in 1578 and frequently altered. World War II damage has been completely repaired and Lucca, enclosed by well-preserved and picturesque bastioned fortifications built between 1504 and 1645, retains its historic atmosphere.

Many of Lucca's numerous churches follow, though with their own local variations, the distinctive style also found in nearby Pisa; often basilican or Romanesque in structure, many have rich Gothic exterior decorations and some have quadrangular campaniles. The cathedral of S. Martino, probably founded in the 6th century, was rebuilt in the decade 1060–70 by Bishop Anselm (later Pope Alexander II); probably only the apse of Anselm's building remains. The imposing campanile was completed in the 13th century, and the Gothic nave (273 ft. by 84 ft.) and transepts (144 ft. long) form a Latin cross and date from the 13th–14th centuries. Guido Bigarelli of Como worked (*c.* 1204) on the rich west front, with its portico of three arches surmounted by three ranges of open galleries and a Romanesque statue of St. Martin on horseback. In the nave, the *Tempietto del Volto Santo,* an octagonal shrine carved in 1482–84 by Matteo Civitali, contains an 11th–12th century wooden crucifix known as Christ's Sacred Countenance (legendarily begun by the disciple Nicodemus and later miraculously conveyed from the Holy Land to Italy). The cathedral contains other works by Civitali (1436–1501), a local sculptor who introduced Florentine styles to Lucca; and the tomb of Ilaria del Carretto (1408) by Jacopo della Quercia. The treasury houses fine goldsmiths' work, including the 14th-century Croce

BY COURTESY OF THE ITALIAN STATE TOURIST OFFICE

THE CATHEDRAL OF S. MARTINO, LUCCA, ITALY

dei Pisani made in Pisa. Other churches include S. Frediano, rebuilt in 1112–47 but retaining traces of an 8th-century structure, and having a nave, two aisles with side chapels, and a fine façade with a much-restored mosaic in the Byzantine style; the Romanesque S. Alessandro, reconstructed in the 12th century; the 12th-century S. Giovanni; S. Michele, with a marble interior and a 12th–13th century façade; Sta. Maria Forisportam, begun in the 13th century; the Gothic S. Francesco, with the tomb of Castruccio Castracani (d. 1328); and S. Romano, rebuilt by Vincenzo Buonamici in the 17th century.

Many paintings are preserved, especially in the Pinacoteca Nazionale, the Palazzo Mansi and the Museo Nazionale di Villa Guinigi. The home of composers Luigi Boccherini (1743–1805) and Giacomo Puccini (1858–1924), Lucca was for long an important musical centre. The public library, the state archives (in the Palazzo Guidiccioni), and the archiepiscopal library and archives contain many old and valuable books and documents.

A road and rail centre, Lucca is the market town of a rich agricultural region which exports high-quality olive oil. Silk has been manufactured since about the end of the 11th century. Other industries include flour milling and the manufacture of tobacco, paper textiles, jute goods and wine. The Serchio is used for water power, and an aqueduct (1823–32) with 459 arches carries the water supply from the Pisan mountains.

Lucca Province (area 684 sq.mi.; pop. [1961] 360,518) contains the fertile Serchio plain in the south, the Apuan Alps in the northwest and in the north the Garfagnana valley, beyond which it reaches the Apennine crest. Principal towns besides Lucca are Viareggio (*q.v.*; a seaside resort), Castelnuovo, Pietrasanta, and Bagni di Lucca, 13 mi. N.N.E. of Lucca, where there are thermal mineral springs. In addition to the growing of olives, vines, fruit and cereals, there is marble quarrying in the Apuan Alps. (A. T. L.)

History.—If the accepted text is right, the Roman historian Livy mentions Luca in a passage referring to the year 218 B.C. (book xxi, ch. 59); but Luca in this text may be a misreading for Luna. The town was situated in Ligurian territory; the Romans probably established a Latin colony there in 180 B.C. (Livy, xl, 43), which became a *municipium* during the Social Wars. A meeting place of roads to Parma, Florence and Rome (Via Clodia), Pisa and Luni, the town seems to have been fairly prosperous in antiquity. After A.D. 476, Lucca came under the rule of Odoacer and then of Theodoric, king of the Ostrogoths; in 553 its Gothic garrison put up a determined resistance against the Byzantines under Narses. Conquered by the Lombards from the Byzantines shortly after 568, Lucca became the residence of one of the three Lombard dukes in Tuscany. After Charlemagne's annexation of the Lombard kingdom (774), counts replaced the dukes, but the population appears to have remained largely Lombard.

Medieval Lucca.—Lucca greatly increased in importance during the 9th and 10th centuries, when its counts became margraves of Tuscany. Moreover, Lucca commanded the Via Francigena, which after the Lombard period was one of the principal roads between Lombardy and Rome and which assumed fresh significance after Otto I's coronation as Holy Roman emperor in 962. Under the margrave Hugh (d. 1001), Lucca's place in the march of Tuscany began to decline. Hugh lavished favours on Florence, which under the house of Canossa replaced Lucca as the capital of Tuscany.

Lucca was drawn into the Investiture conflict (*see* Germany: *History;* Papacy) through its bishop Anselm, who became pope as Alexander II in 1061. Later the imperial party in the town prevailed, and the German king Henry IV rewarded the citizens in 1081 with a charter of liberties, mainly commercial. The commune of Lucca was probably established soon afterward, though consuls were not recorded until 1107 (*see* Commune [Medieval]).

The conquest of the *contado* or countryside and wars with other cities followed the establishment of the commune. The 12th century was marked by recurring wars with Pisa. While Lucca desired free outlet to the sea, Pisa challenged Lucca's command of the Via Francigena. Thus when in 1181 a relatively lasting reconciliation was achieved, it was on the basis of a commercial agreement. The emperor Frederick I Barbarossa had confirmed Lucca's communal liberties in 1162 but took the *contado* away in 1184, restoring only a small part of it in 1186; Lucca, however, recovered it after 1197. About that time, men with the office of *podestà* began to appear, replacing the consuls as the highest magistrates.

War with Pisa broke out again in 1218 and lasted intermittently until 1256; at the same time, Lucca had to face papal and imperial claims in the Garfagnana. The defeat of Pisa by Genoa in the battle of Meloria in 1284 strengthened Lucca's position in Tuscany, where the town was then second only to Florence. Economic prosperity came not only from a flourishing silk industry (Lucca's wool industry being already outstripped by Florence's), but also from a rapidly expanding banking business. It was assisted by the settlement of Lucchese merchants in towns north of the Alps. The formation of guilds was followed, about 1250, by the political organization of the nonnoble population (*popolo*), which by the end of the century had taken control of the town. The statutes of 1308 show the government vested in the *anziani* (elders) and the "captain of the people," legislation being in the hands of the council of the people and the greater council.

During the emperor Henry VII's Italian expedition (1310–13), Guelph Lucca sided with Florence against him, while Pisa remained loyal to its Ghibelline traditions. In 1314, Pisa's new *signore*, Uguccione della Faggiuola, captured Lucca with the help of Lucchese Ghibellines, among them Castruccio Castracani degli Antelminelli (*q.v.*). In 1316, however, Pisa and Lucca rose against Uguccione, and Castruccio was elected captain general of the people and "defender" of Lucca for 6 and then for 12 months—to be re-elected in 1317 for 10 years and in 1320 for life.

As the capital of Castruccio's powerful despotic state, Lucca be-

came once more the leading city of Tuscany. But on Castruccio's death (1328) his state collapsed, and for Lucca there began a long period of troubles. Sold by the emperor Louis IV to Castruccio's uncle, the city was then sold by the German troops who had occupied it to the Genoese Gherardo Spinola. Spinola's rule (1329–31) was followed by that of John, king of Bohemia, who in 1333 sold it to the Rossi of Parma. Acquired in 1335 by Mastino della Scala of Verona, it was sold by him to Florence in 1341; but before the Florentines could take possession, the Pisans captured it in 1342. During the emperor Charles IV's visit to Lucca in Sept. 1368, Giovanni dell'Agnello, then *signore* of Pisa, fell from power, and Lucca finally regained independence, purchasing for 300,000 florins a charter of liberties from Charles in 1369. In 1370 reforms were passed which were codified in the statutes of 1372; the city was divided into *terzieri* (three units), and a gonfalonier of justice was placed at the head of the government of *anziani*.

The last decade of the 14th century was marked, in Tuscany, by the territorial expansion of Milan under Gian Galeazzo Visconti and, at Lucca, by the growing ascendancy of the Guinigi. After Lazzaro Guinigi's assassination in 1400 his brother Paolo was elected *signore* of Lucca with Gian Galeazzo's support. During the 30 years' rule of this rich merchant, Lucca prospered economically but suffered political setbacks. Florence was greatly strengthened by the acquisition of Pisa in 1406, and Lucca soon came under pressure. When in 1425 Florence decided to resist the renewed southward drive of Milan, Paolo remained loyal to Filippo Maria Visconti; and at the end of 1429 Florence declared war on Lucca. Francesco Sforza, formally dismissed from the Milanese service, came to Lucca's assistance, but turned against Paolo Guinigi, whom he sent a prisoner to Milan. Lucca resisted the Florentines successfully from 1430 to 1433, but, when the war flared up again in 1437–38, lost nearly all the *contado* to Florence. In 1441 a 50-year treaty was concluded between the two towns. Lucca recovered nearly all the lost lands and from then onward remained at peace with Florence. The Este family of Modena and the papacy, however, continued to claim Lucca's territory in the Garfagnana.

In the changed conditions of Italy after the French king Charles VIII's invasion (1494), Lucca succeeded in preserving independence from foreign rule. The emperor Charles V confirmed Lucca's privileges in 1522. The Medici restoration in Florence (1530) was considered by the Lucchesi to be a threat to their own independence, as is shown in Francesco Burlamacchi's abortive scheme in 1546 to liberate Pisa and march on Florence.

The Italian political situation contributed to Lucca's economic difficulties. The crisis of the silk industry led in 1532 to a ruthlessly suppressed rising of its workers. More lasting were troubles created by the spread of heretical doctrines: after an initial policy of relative toleration, repressive legislation was introduced in 1545, and persecution drove many people to emigrate. Yet Lucca continued to resist papal interference and refused to admit the papal Inquisition or the Jesuits—not, however, without serious clashes with the ecclesiastical authorities.

During the 16th and 17th centuries, the government became increasingly oligarchical. In 1556, under the gonfalonier Martino Bernardini, foreigners and their descendants were almost completely excluded from public office (*riforma Martiniana*); and after 1628 only families that had been represented in such offices during the past 60 years and were listed in a *Golden Book* were qualified for them. The decline of trade and industry during this period shifted Lucca's economy to agriculture, with the ruling class becoming a landed aristocracy.

17th Century and After.—The long controversy with the Este over the Garfagnana, of which Lucca had retained only a few places, was finally submitted to the Milanese senate, which decided in 1618 against Lucca. Frontier controversies occasionally strained relations also with the Medici grand dukes of Tuscany. New walls, completed in 1645, were meant to protect Lucca against any eventuality.

The French Revolutionary Wars brought the creation of the Cisalpine Gaul Republic bordering on Lucca's territory (1797), so that Lucca had to toe the French line. In Feb. 1799 Gen. J. M. P. Sérurier entered the town and set up a government on the French model. When the French evacuated Lucca in July 1799, the Austrians ruled it until the French returned in July 1800. Under a democratic constitution introduced by Napoleon in Dec. 1801 Lucca recovered some measure of independence. The establishment of the French empire, however, put an end to the republic. In 1805 Napoleon created Felice Baciocchi, husband of his sister Elisa, hereditary prince of Lucca. Despite its disregard for local traditions and its financial disorders, the principate, under the effective rule of Elisa, brought considerable prosperity and reforms in law and administration, welfare and education, while its urbanistic policy changed the aspect of the town.

On the fall of Napoleon, Elisa fled (March 14, 1814). Occupied first by Joachim Murat's Neapolitan army (March–April), Lucca was taken in May 1814 by the Austrians, who occupied it until 1817. The congress of Vienna in June 1815 assigned Lucca, with the ducal title, to the Spanish infanta Maria Luisa, widow of the former King Louis of Etruria. Her son Charles, however, was heir to the Bourbon claims to Parma; and by the treaty of Paris of June 1817 it was agreed that the Bourbons of Lucca should succeed in Parma on the death of the archduchess Marie Louise, Napoleon's consort, in which event Lucca would pass to Tuscany. Maria Luisa restored ecclesiastical properties confiscated during the Napoleonic period, but in other respects continued the work of the principate. On her death in 1824 she was succeeded by her son Charles. The liberal movement was beginning to affect Lucca, and the duke seemed at first to sympathize with it; but after 1840 his policy, under Austrian influence, dispelled such beliefs. Financial difficulties and increasing pressure from the liberals caused him on Oct. 4, 1847, to anticipate Marie Louise's death by ceding his duchy to Tuscany, with whose history that of Lucca is subsequently merged. (N. R.)

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LUCCHESINI, GIROLAMO (1751–1825), Prussian diplomatist, was born at Lucca on May 7, 1751, the eldest son of Marquis Lucchesini. In 1779 he entered the service of Frederick the Great in Berlin. Frederick William II sent him in 1787 to Rome to obtain the papal sanction for the appointment of a coadjutor to the bishop of Mainz, with a view to strengthening the German Fürstenbund.

In 1788 he was sent to Warsaw and brought about a *rapprochement* of Poland with Prussia and a diminution of Russian influence at Warsaw. Frederick William was at that time intriguing with Turkey, then at war with Austria and Russia. Lucchesini was to arouse Polish feeling against Russia and to secure for Prussia the assistance of Poland in the event of war with Austria and Russia. He concluded a Prusso-Polish alliance in March 1790, and in the autumn of that year was sent to Sistova, where the terms of peace between Austria and Turkey were being discussed. Before he returned to Warsaw his treaty was a dead letter and Prussia was contemplating the second partition of Poland. Lucchesini was recalled and employed on the Rhine in liquidating the intervention in the French Revolution.

In 1793 he was appointed ambassador to Vienna with the ostensible object of securing financial assistance for the Rhenish campaign. His anti-Austrian bias made him extremely unpopular with the Austrian court, which began asking for his recall in 1795. The request was granted in 1797.

In 1800 he was sent by Frederick William III on a special mission to Paris. Napoleon, too, sought his recall but eventually (in 1802) accepted him as regular ambassador. He consistently sought friendly relations between France and Prussia but was unsuccessful and was superseded as ambassador just before the outbreak of war between the two countries in 1806. After the Prussian defeat at Jena he tried to negotiate terms of peace, but his first draft was refused by Napoleon and his second by Frederick William.

He was dismissed from the Prussian service and joined the court of Elisa, grand duchess of Tuscany, and after Napoleon's fall devoted himself to writing. He died on Oct. 20, 1825.

He published in 1819 three volumes, *Sulle cause ed effetti della confederazione renana*, at Florence. His memoirs remained in ms. His dispatches were edited by Bailleu in *Preussen und Frankreich* (1887, *Publikationen aus den preussischen Staatsarchiven*).

LUCE, CLARE BOOTHE (1903–), U.S. playwright and public official, was born in New York city, N.Y., April 10, 1903. Privately educated in Garden City and Tarrytown, N.Y., she was associate editor of *Vogue* in 1930; associate editor and managing editor of *Vanity Fair* from 1930 to 1934. After having been divorced from her first husband, George Tuttle Brokaw, in 1929, she married Henry R. Luce (*q.v.*) in 1935. Mrs. Luce wrote a number of plays, including *The Women* (1936) and *Kiss the Boys Goodbye* (1938), satires on two phases of American life; and *Margin for Error* (1939), an anti-Fascist play. She also wrote the books *Stuffed Shirts* (1931) and *Europe in the Spring* (1940). She was Republican congresswoman from Connecticut in the 78th and 79th congresses. In Feb. 1953 Pres. Dwight D. Eisenhower appointed her ambassador to Italy, from which post she resigned in 1956 because of ill-health.

LUCE, HENRY ROBINSON (1898–), U.S. magazine editor and publisher, was born in Tengchow, China, on April 3, 1898, son of Henry Winters Luce, a Presbyterian missionary. He was sent to the United States at 15 to attend Hotchkiss school, graduated from Yale in 1920 and later studied for a year at Oxford. After a brief reporting career on Chicago and Baltimore newspapers, Luce and a Yale classmate Briton Hadden founded the weekly news magazine *Time* in 1923 on an investment of $86,000 and with 12,000 subscribers. Attracting attention by brightness, eccentricities of style, accent on personalities and editorial orderliness, *Time* was an immediate success. Hadden died in 1929.

Heading Time Inc., Luce founded *Fortune*, a monthly magazine of business, in 1930; *Life*, a weekly with its main emphasis on pictures, in 1936; and *Sports Illustrated*, a weekly, in 1954. The newsreel "March of Time" was produced from 1931 to 1953. Time Inc. purchased *Architectural Forum* in 1932, and 20 years later split from it *House & Home*. The gross income of Time Inc. by 1955 was $200,000,000; it was one of the most influential and profitable publishing concerns in the world.

After divorce from his first wife, the former Lila Ross Hotz, Luce married in 1935 Clare Boothe (*see* LUCE, CLARE BOOTHE).

(F. L. MT.)

LUCE, JOHN (1870–1932), British admiral, was born Feb. 4, 1870, in England. In the Battle of the Falkland Islands in World War I, he commanded the light cruiser HMS "Glasgow," which, with the help of another British ship, sank the German cruiser "Leipzig." From 1921 to 1924, he was admiral superintendent of the Malta dockyard. In 1925 he was retired and in 1930–31 he served as high sheriff of Wiltshire. Luce died Sept. 22, 1932.

LUCE, STEPHEN BLEECKER (1827–1917), U.S. naval officer, first president of the Naval War college, was born in Albany, N.Y., March 25, 1827, and became a midshipman in Oct. 1841. As a young officer he became interested in the training of seamen for the navy and for the merchant marine; this interest developed into practical plans and methods for the improvement of naval education in general.

Luce was chosen for duty at the U.S. Naval academy, where he produced an excellent textbook on seamanship. A practical and efficient seagoing officer as well as a teacher of theory, he was a successful commanding officer of fighting ships, during the Civil War, and of training vessels. He is best known for the development of the Naval War college, at Newport, R.I., becoming the first president, Oct. 6, 1884. The U.S. army and many foreign navies afterward copied this idea of higher professional education for officers. When he became a rear admiral in 1886, Luce was succeeded as head of the Naval War college by Alfred Thayer Mahan (*q.v.*), whom he had chosen for the faculty. After his retirement, in 1889, he continued as a special adviser at the college until 1910. He died July 28, 1917. (J. B. HN.)

LUCERA (anc. LUCERIA), a town and episcopal see in the Puglia region of Italy, province of Foggia, 20 km. (12½ mi.) WNW of Foggia by rail, on a lofty plateau projecting west (highest point 823 ft.). Pop. (1961) 27,821 (commune).

The older part of the city is medieval in appearance, with small, narrow streets. The bastioned Swabian-Angevin castle on Monte Albano, on the site of the Roman citadel, dominates the scene. Among the many churches the oldest is S. Francesco (1301); the cathedral, built on the ruins of a mosque in the centre of the city, was restored in Gothic style after 1300. There are also a number of noteworthy 17th- and 18th-century palaces.

Lucera is particularly noted for the manufacture of building materials; there are extensive deposits of clay near the city. Other industries are milling, oil refining, wool and dairy products and furniture manufacture.

An Oscan city on the site was occupied by the Romans in the 4th century B.C.; subsequently it was given the rank of *colonia* and later raised to full citizenship. (For the history of the region in Roman times, *see* APULIA.) The city was destroyed in 663. In the 13th century it was refounded by the Holy Roman emperor Frederick II, who established there Saracen colonists, to whom he granted religious freedom, and built an imposing castle (of which ruins are still standing). Early in the 14th century the Saracens were killed or forcibly converted and the town was repopulated by Christians.

LUCERNE (Ger. LUZERN), capital of the central Swiss canton of the same name, is situated 1,430 ft. (436 m.) above sea level at the point of issue of the Reuss River from the northwestern branch of the Lake of Lucerne (Vierwaldstättersee), 60 mi. (96 km.) SE of Basel and 179 mi. (288 km.) NNW of Milan, Italy, by the St. Gotthard railway. Pop. (1960) 67,433. With its splendid lakeside gardens and promenades, its well-preserved town walls (Musegg), and its nine watchtowers, Lucerne enjoys one of the loveliest settings of any town in Switzerland. It is divided into two parts by the Reuss, which is crossed by five bridges within the town boundaries. Of these, the oldest are two roofed bridges; the zigzag Kapellbrücke (completed 1333), adjoining the still older Wasserturm (water tower) and spanning the Reuss at an angle; and the Spreuerbrücke (1407). Both bridges have decorated panels painted in the early 17th century. The main bridge is the Seebrücke, joining the Bahnhofplatz (Station Square) on the left bank and the Schwanenplatz (Swan Square) on the right bank.

JAMES P. BARRY—PIX FROM PUBLIX

THE 14TH-CENTURY KAPELLBRÜCKE (CHAPEL BRIDGE) SPANNING THE REUSS RIVER, LUCERNE, WITH THE WASSERTURM (WATER TOWER) ON THE LEFT

On the left bank are the railway station (1897), central post office (1888), telephone and telegraph office (1952), municipal theatre (1839), cantonal government building, or Ritter Palace (Rittersche Palast, 1557–64; from 1577 to 1804 a Jesuit college), state archive (1729–31) with its rococo Marian chamber, central library (housing since 1951 the cantonal and municipal libraries, numismatic collection, natural history museum, and Helvetica collection), the St. Francis Xavier (Jesuit) Church (1666–77) with Baroque vestry, the 14th-century Gothic Franciscan church with rococo transepts, the corporation building (1675), new town hall (1913), Richard Wagner Museum (opened 1933), and the modern St. Anthony's Church (1954). On the right bank, the old town, bounded on the north by the 14th-century Musegg wall, is distinguished by picturesque alleys and squares with medieval houses, while the more recent quarters (built since 1850) are strung out loosely along the hillside. Among the many noteworthy buildings are the early 17th-century Rathaus (the old town hall), housing the historical museum, Am Rhyn House (1617), St. Peter's Chapel (1178), the Hofkirche (cathedral and collegiate church of St. Leodegar [1639]) with choristers' houses, a Tuscan cemetery, and two slender towers (1504), and the Mariahilf Church (1676–81). Interesting sights are the Lion Monument, hewn from the sandstone rocks in 1819–21 by Lucas Ahorn from the model by Bertel Thorvaldsen, in memory of the Swiss guards slain while defending the Tuileries in Paris in 1792; the Glacier Garden (Gletschergarten), with excavations of 1872–75 and a large relief map of central Switzerland (1766–85); the comprehensive Swiss transport museum (1959); and the Utenberg folk costume museum.

In addition to various cantonal and municipal institutions of higher education there are the central Swiss transport school, the Swiss Catholic school of sacred music, the central Swiss technical college, and the Swiss schools of bakery and of hotel keeping. Lucerne is also the seat of the supreme cantonal court, a commercial tribunal, a criminal court, juvenile court, and the federal insurance court.

Because of its magnificent surroundings, sunny climate, and easy access by road and rail from all directions, Lucerne has become an important centre of Swiss tourism. Steamer services on the lake connect with various mountain railways and cableways, *e.g.*, to Pilatus, Rigi, Bürgenstock, and the Stanserhorn, and there is a direct narrow-gauge rail connection with the winter sports centre of Engelberg. Tourist facilities and attractions include a casino, bathing beaches, rowing and sailing regattas, horse-racing and show-jumping competitions, an international festival of music, and a traditional pre-Lenten carnival. The town's commercial and industrial activity depends largely on the tourist trade.

Lucerne derived its name from the Benedictine monastery of Luciaria, founded in the 8th century near the site of the Hofkirche and later a cell of Murbach monastery in Alsace. From the nearby fishing village grew a town, whose inhabitants were originally serfs of the monastery. After the opening of the St. Gotthard Pass (*c.* 1220) Lucerne rapidly gained importance. As early as 1252 the citizens drew up the first municipal constitution. In 1291 the monastery and town were purchased by the German king Rudolf I of Habsburg, against the will of the citizens, who were struggling for independence. The political instability under Rudolf's successors led in 1332 to alliance with the three cantons of Uri, Schwyz, and Unterwalden, which had already joined forces in 1291, and after the battle of Sempach (1386) against the Habsburg army the alliance won its freedom and independence. By 1415 the town had acquired almost all the territory belonging to the present canton, either by treaty, armed occupation or purchase. At the Reformation Lucerne assumed the leadership of the Catholic cantons, and was the seat of the papal nuncio from 1581 to 1848. In the peasant revolt of 1653 the Lucerne area was one of the centres of opposition to the aristocratic regimes of the towns, the members of which had acquired wealth and power by mercenary service in foreign armies and pensions granted by foreign princes. In 1798 the patricians were compelled to abdicate under the onslaught of the Napoleonic armies.

Lucerne was for a time the capital of the Helvetian Republic and finally in 1803, by the Act of Mediation, it resumed its original status as an independent canton. In 1814 the aristocratic regime was restored, being replaced between 1831 and 1841 by a Liberal government. Then power was assumed by a Radical-Conservative Catholic faction which pursued a separatist policy directed against the liberal cantons, leading in 1847 to the Sonderbund War and Lucerne's defeat by federal troops. In 1848 Lucerne again entered the Swiss Confederation as a full member and was granted a liberal constitution, which was later replaced by a conservative one. Under the latter system the transition from representative to direct democracy was effected. By the mid-1960s Conservative governments had been in power since 1871, although usually with a small majority.

Lucerne Canton is the third largest canton in the Swiss Confederation. Area 577 sq.mi. (1,494 sq.km.). Pop. (1960) 253,446, mainly German-speaking. It is divided into five administrative districts (Lucerne, Sursee, Hochdorf, Entlebuch, Willisau). Of the total surface area 91% is productive land. The main sources of income are field crops, fruit growing, cattle rearing, industry, and tourism. Industrial products include textiles, machinery, metallurgical goods, paper, wood, tobacco, electrical equipment, stone, glass, and ceramics; there is also shipbuilding and automobile assembly. A busy transit traffic between West Germany and Italy crosses the canton. The highest points are the Brienzer Rothorn (7,720 ft. [2,353 m.]), the Tannhorn (7,296 ft. [2,224 m.]), and Pilatus (6,965 ft. [2,123 m.]).

The Constitution of 1874 defines the canton as a democratic free state within the Swiss Confederation. The legislature (*Grossrat*) consists of 170 members, at least 20 years of age, who are elected by direct male vote for a term of four years. The executive consists of seven members, similarly elected for a term of four years. Its president (the *Schultheiss*) and his deputy (the *Statthalter*) are appointed by the *Grossrat* for a one-year term. Each district is supervised by a government representative (*Regierungsstatthalter*) and has a district court.

LUCERNE: *see* Alfalfa.

LUCERNE, LAKE OF, the name usually given by English-speaking people to the principal lake of central Switzerland. In French it is called the *Lac des Quatre Cantons*, and in German the *Vierwaldstättersee*, the cantons being Lucerne, Unterwalden, Uri and Schwyz. It is named after Lucerne, at the western end, where the Reuss leaves the lake, having entered it near Flüelen at the southeastern end; the Muota flows into the lake at Brunnen (north) and two mountain streams, the Engelberger and the Sarner Aa enter at Buochs (south) and Alpnachstad, respectively. The lake is most beautifully situated between steep limestone mountains, the best known being the Rigi (north) and Pilatus (southwest), and great promontories such as Horw (west), Bürgenstock (south), Meggenhorn (north) and Seelisberg (south) project into its waters, giving the city of Lucerne a romantic setting. The lake occupies the site of converging piedmont glaciers and along its shores moraines dam back its waters.

The area of the lake is about 114 sq.km. (44½ sq.mi.); it is about 39 km. (24 mi.) long, its greatest width only 3 km. (2 mi.) and its greatest depth 702 ft., while the surface of the water is 1,424 ft. above sea level. The lake is composed of four main basins (with two side basins), which represent four glaciated valleys, topographically distinct, and connected only by narrow and tortuous channels. There is, first, the most easterly basin, the lake of Uri, extending from Flüelen (south) to Brunnen (north). At Brunnen the delta of the Muota extends into the lake where it turns west, so that it forms the lake of Gersau, or of Buochs, from the promontory of Seelisberg (east) to that of Bürgenstock (west). Another narrow passage between the two "Noses" (*Nasen*) leads west to the basin of Weggis, between the Rigi (north) and the Bürgenstock promontory (south). This expanse forms the eastern arm of the "Cross of Lucerne," the western arm being the lake of Lucerne, the northern arm the lake of Küssnacht and the southern arm that of Hergiswil, prolonged southwestward by the Alpnach lake, with which it is joined by a narrow channel, spanned by the Acher iron bridge. The lake of Uri provides the most forbidding scenery; at Brunnen the Everlasting league of 1315 was formed while the legendary place of meeting of the

founders of Swiss freedom was the meadow of the Rütli (purchased by the confederation in 1859). The site of William Tell's leap from the boat in which the bailiff Gessler was taking him to prison is marked by the Chapel of Tell (east).

In the lake of Gersau is the village of Gersau (north), an independent republic from 1390 to 1798, and now in Schwyz (1818 onward). In the next basin to the west is Weggis (north), and on the northern shore of the lake is Vitznau, whence a rack railway leads to the top of the Rigi (4½ mi.) while on the southern shore of the lake is Kehrsiten, with an electric railway to the Bürgenstock promontory. Lucerne and Flüelen are connected via Arth-Goldau by the St. Gotthard railway. On the promontory between Lucerne and Küssnacht stands the castle of New Habsburg, while from Küssnacht a motor road leads through the "Hollow Way" (*Hohle Gasse*), the scene of the legendary murder of Gessler by William Tell. The western shore of the southern arm is traversed from Horw to Alpnachtad by the Brünig railway (5½ mi.), which continues toward Sarnen (Obwalden) and the Bernese Oberland, and southwest from Alpnachstad, whence a rack railway leads northwest up Pilatus (2¾ mi.).

Lucerne is a tourist centre of importance, but several settlements serve as lake ports for neighbouring villages (Brunnen for Schwyz, Flüelen for Altdorf, Stansstad for Stans, Alpnachstad for Sarnen). Most of the villages are summer resorts (Gersau also in winter), especially Hertenstein, Weggis, Gersau, Brunnen, Beckenried and Hergiswil, while hotels have been built on eminences, as well as on the Rigi, Pilatus and the Stanserhorn. (A. F. A. M.)

LUCHAIRE, ACHILLE (1846–1908), French historian, whose original work on the Capetians had great value, was born in Paris on Oct. 24, 1846, and died there on Nov. 4, 1908. In 1879 he became a professor at Bordeaux and in 1889 professor of medieval history at the Sorbonne; in 1895 he became a member of the Académie des Sciences Morales et Politiques. The most important of Achille Luchaire's works are *Histoire des institutions monarchiques de la France sous les premiers Capétiens* (1883 and again 1891); *Manuel des institutions françaises: période des Capétiens directs* (1892); *Louis VI le Gros, annales de sa vie et de son règne* (1890); *Étude sur les actes de Louis VII* (1885); *Innocent III* (6 vol., 1904–08); and contributions on the 13th century to E. Lavisse' great history of France.

LU CHIU-YÜAN, better known under his literary name, LU HSIANG-SHAN (1139–1193), Chinese idealist philosopher and rival of his contemporary the Neo-Confucian rationalist Chu Hsi. Lu's doctrine of mind culminated three centuries later in the philosophy of Wang Yang-ming (*q.v.*), whose main tenets show the direct influence of Lu. Together the two philosophers have been called the Idealistic School of Lu-Wang, as opposed to the Realistic School of Ch'eng-Chu, named for Ch'eng I (Ch'eng I-ch'uan) and Chu Hsi. Both schools still attract adherents today.

Lu was born in modern Kiangsi Province, the youngest of six brothers. He was educated partly by his father, held a number of government posts, and taught at the Imperial Academy for several years. The long-standing philosophical differences between Lu and Chu Hsi began with an encounter at Goose Lake Temple in northern Kiangsi in 1175. Lu, as a cosmic monist, held that there is one and only one world, as opposed to Chu's dualist position (for Chu's philosophy, *see* CHU HSI). For Lu, the world is monistic, and all of its phenomena are to be found within one's own mind (*hsin*): "The universe is my mind and my mind is the universe"; *i.e.*, the universe and mind are identical. Lu's central concept is mind, which he conceives: (1) metaphysically as objective, universal, all-comprehending, identified with principle (*li*, the pattern of organization of the universe; *see* CONFUCIANISM: *Neo-Confucianism*), and understandable to each individual mind; and (2) ethically as subjective, identifying it with human nature (*hsing*), which, following the view of Mencius (*q.v.*), Lu held to be originally good. This idealistic position led Lu—in contrast to Chu, whose method of achieving moral excellence was by "constant inquiry and study" (*tao wen hsüeh*)—to propound his own method of "honouring the virtuous nature" (*tsun te hsing*). Hence, the aim of Lu's education (in contrast to Chu's emphasis on studying external things) is to teach man to live in accord with the universal mind and to seek an understanding of the principles lying within himself. The highest knowledge of the Way (*tao*) comes to man from his constant practice of inner reflection and self-culture, which is the best way to develop completely one's original goodness, or to regain it if it has been corrupted and lost by material desires (*wu yü*).

Lu devoted most of his life to teaching and lecturing. He was not a systematic writer, his disinterest being expressed in the statement "The Six Classics will all serve as my commentaries." After his death, his literary works were published under the title of *Hsiang-shan Hsien-sheng Ch'üan-chi* ("Complete Works of Lu Hsiang-shan"). In 1217 he was canonized as Wen-an, and in 1530 a tablet in his honour was placed in the Confucian temple.

See also CHINESE PHILOSOPHY; CONFUCIANISM.

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LUCHOW (LU-CHOU, LU-HSIEN), a river port, road and regional trade centre on the Yangtze river in southwestern Szechwan province, China. Pop. (1953) 289,000. The city is located at the mouth of the T'o Chiang (sometimes Lu river), navigable in its lower course much of the year by native craft. Luchow is an old trade and transport centre, on the Yünnan-North China route, and a distributing centre for salt and sugar, these products being produced at Tzu-liu-ching and Nei-chiang, to the north. (J. E. SR.)

LUCHU ISLANDS: *see* RYŪKYŪ ISLANDS.

LUCIAN, SAINT, OF ANTIOCH (LUCIAN THE MARTYR) (d. 312), Christian theologian and martyr, was born at Samosata (modern Samsat, in southern Turkey). His parents, who were Christians, died when he was 12. In his youth he studied under Macarius of Edessa, and after receiving baptism he adopted a strictly ascetic life. Settling at Antioch he became a presbyter, and is regarded as the founder of the theological school of Antioch. Though he is represented as the connecting link between the heretics Paul of Samosata and Arius (*qq.v.*), he was in good standing at the outbreak of persecution, and the reputation won by his high character and learning was confirmed by his courageous martyrdom.

Lucian was carried to Nicomedia before the emperor Maximinus, and persisting in his faith perished on Jan. 7, 312, under torture and hunger, which he refused to satisfy with food offered to idols. His defense is preserved by Rufinus (ix, 6) and Eusebius (*Church History*, ix, 9). His remains were conveyed to Drepanum in Bithynia, and under Constantine the town was founded anew in his honour and exempted from taxes (A.D. 327). There in 387, on the anniversary of his death, Chrysostom delivered the panegyrical homily from which the facts given above are mainly derived.

Jerome says that Lucian wrote *Libelli de fide* and several letters, but only a short fragment of one epistle remains. The authorship of a confession of faith ascribed to Lucian and put forth at the semi-Arian synod of Antioch (A.D. 341) is uncertain. Lucian's most important literary labour was his edition of the Greek Old Testament corrected by the Hebrew text. From his work derives the text commonly used until modern times, probably for the New Testament as well. St. Lucian's feast day is Jan. 7.

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LUCIAN (*c.* A.D. 125–*c.* 190), a satirist notable for his wit and the elegance of his Greek, was born at Samosata in Syria (now Samsat in Turkey). The only reliable information as to the dates and facts of his life comes from what he himself says in his writings. According to the *Enhypnion* ("Dream"), his parents, who were of limited means, apprenticed him to an uncle who was

a sculptor, but he soon abandoned sculpture for rhetoric. He spent the next few years in Ionia perfecting his Greek, becoming thoroughly familiar with the classical authors, particularly with Homer, Plato and the comic poets, and studying rhetoric. He then adopted the profession of a rhetorician, and in this capacity traveled widely, visiting Greece and Italy, and winning particular success in Gaul. On a visit to Rome, perhaps when about 25 years old, he made the acquaintance of the Academic philosopher whom he praises in his *Nigrinus*. At the age of about 40 he abandoned rhetoric for dialogue; thereafter Athens became his permanent home. When old and infirm he accepted a post in Egypt in the service of the emperor (perhaps Commodus). This post he describes as important, well-paid and involving clerical duties mainly for the courts. He outlived the death of Marcus Aurelius, but the date and circumstances of his death are unknown.

Of the 80 prose works attributed to Lucian about 10, including the *Onos* ("Ass"), are generally regarded as spurious. Rhetorical works such as the *Myias encomion* ("Praise of the Fly") probably belong to his earlier years; despite his unhappy apprenticeship he retained enough interest in art to produce several *ekphraseis (i.e.,* descriptions of works of art). He used many prose forms but is most famous for his dialogues, among the best of which are the *Symposion* ("Banquet"), *Charon, Halieus* ("Fisher"), *Bion Prasis* ("Sale of the Lives"), *Timon* and *Dis kategoroumenos* ("Twice Accused"), and the four collections of minor dialogues, *Hetairikoi dialogoi, Nekrikoi dialogoi, Theon dialogoi* and *Enalioi dialogoi* ("Dialogues of the Courtesans," "Dialogues of the Dead," "Dialogues of the Gods," "Dialogues of the Sea-Gods"). Verse works doubtfully attributed to Lucian are some epigrams and two mock tragedies on gout.

Satire.—Just as Juvenal claims all human activity for his sphere, so too Lucian satirizes every aspect of human behaviour. A favourite topic is man's failure to realize the transiency of greatness and wealth. This Cynic theme permeates the *Charon* (in which Charon and Hermes pile mountain upon mountain to look down upon the vanities of this world), while, in the "Dialogues of the Dead" and elsewhere Menippus the Cynic is made to jibe at kings and grandees, reminding them how much more they have lost by death than he. The *Timon* recounts how Timon, after impoverishing himself by his generosity and becoming a hermit, is restored to wealth, once again to be surrounded by toadies to whom he gives a short shrift. Other human frailties satirized are the folly of bargaining with the gods by sacrifices (*Peri thysion*) or crying over spilt milk when bereaved (*Peri penthous*) or the love of telling or listening to strange tales (*Philopseudes*), while the *Alethes historia* ("True History," which starts by warning the reader that its events are completely untrue and impossible, and describes a voyage that starts on the sea but continues in the skies and includes visits to the belly of a whale and to the Elysian fields) is also directed against human credulity. In the *Nigrinus* Lucian makes an Academic censure the evils of Rome, contrasting the pretentiousness, lack of culture, avarice and will-hunting of Rome with the quiet cultured life of the Athenians.

Lucian in the "Fisher" gives himself the pseudonym *Parrhesiades* (Mr. Frank) and is particularly outspoken against those whom he considers impostors. In the *Alexandros* Lucian attacks Alexander the Paphlagonian and gives his account of the various hoaxes by which Alexander was amassing wealth as a priest of Aesculapius (Asclepius) and a seer; Lucian tells how instead of greeting Alexander by kissing his hand he bit it and how Alexander in revenge plotted unsuccessfully to have him drowned at sea. Another dubbed by Lucian as an impostor was the Cynic Peregrinus who burned himself on a pyre at the Olympic games. The *Peregrinus* is particularly interesting for its reference to the Christians. According to Lucian Peregrinus had once been imprisoned for Christian activities, and while in prison had been enriched by contributions from the Christians, but on his release renounced Christianity. Lucian comments thus on the Christians: "The poor wretches have convinced themselves that they will be completely immortal and live for ever; therefore they despise death and in most cases willingly surrender themselves. Furthermore their first lawgiver has persuaded them that they are brothers of each other once they have renounced the Greek gods and worship that crucified teacher (*sophistes*) and live by his laws. Therefore they despise everything alike and believe in communism of property." In several other places also Lucian castigates credulity in religious matters.

Attitude to Philosophy.—To Lucian the worst charlatans of all were the philosophers who failed to practise what they preached. The "Banquet" gives an amusing account of an imaginary wedding feast given by a patron of the arts. Among the guests are representatives of every philosophical school who all behave outrageously; indeed, when the party is breaking up, they start fighting over delicacies to take home till the scene resembles the fight of the Centaurs and Lapithae. Hypocritical philosophers are also attacked in the "Fisher," in which the founders of the philosophical schools return to life to indict Lucian for writing the "Sale of the Lives" (a lighthearted work in which Zeno, Epicurus and others are auctioned by Hermes in the underworld but fetch next to nothing). Lucian's defense is that he was attacking not the founders of the schools but their present unworthy successors. The philosophers acquit Lucian and call to trial their modern disciples who refuse to have their lives examined till Lucian fishes for them from the Acropolis using a bait of gold and figs. He soon has a fine catch of philosophers who are renounced by the founders of the schools and hurled to their deaths from the Acropolis.

Lucian follows the lead of Xenophanes, Plato and others in complaining about the absurd beliefs concerning the Olympian gods. Thus the discreditable affairs of Zeus with mortal women play a prominent part in the "Dialogues of the Gods." Moreover Lucian seizes on Homer's admission that Zeus is subject to Fate. In *Zeus elenchomenos* ("Zeus Cross-Examined") a Cynic tells Zeus that he is powerless to interfere on earth. In *Zeus Tragodos* ("Zeus Rants") Zeus is panic-stricken because a Stoic is losing an argument on earth with an Epicurean who maintains that the gods neither exist nor exercise providence. Momus ("Blame"), one of the interlocutors, suggests certain defeat for the Stoic because so many evil men prosper and so many good men suffer undeservedly, but Zeus is prevented by Fate from using his thunderbolt against the Epicurean. In the end the Stoic, having failed with every other weapon, is forced to use his fists.

Lucian's interest in philosophy is superficial, and none of his dialogues is really philosophical except perhaps *Anacharsis* ("Gymnastics") and *Hermotimus*, an exposition of the futility of the Stoic discipline. Lucian acknowledges allegiance to no particular school, criticizing the representatives of all philosophies. He has most sympathy with the Epicureans for their insistence that the gods do not interfere on earth; many dialogues lay a Cynic stress on the impermanence of prosperity, partly perhaps because of his literary models, but he parts company with Cynicism when it becomes sensational (*e.g., Peregrinus*) or offends the decencies. His most bitter criticisms are directed against the Stoics particularly for their simultaneous belief in Fate and in divine providence. He does praise two philosophers, Demonax the Cynic, and the Academic of the *Nigrinus*, but presumably for their conduct rather than their theories. His attitude to philosophical studies is best seen in the "Banquet" ch. 34, where, after noting how much worse the philosophers are behaving than the ordinary guests, he comments that he cannot help reflecting that book learning is worthless if it does not improve one's conduct.

Literary Criticism.—Lucian's best work in this field is his treatise on how to write history (*Pos dei historian syngraphein*). He defines the ideal historian as one who is "fearless and incorruptible, independent, a lover of frankness and truth, one who calls a spade a spade, unsparing and unpitying, an impartial judge, benevolent toward both sides, but giving neither more than its due, in his writings a stranger without a city, bowing to no authority and acknowledging no king, not considering what this man or that will think but stating facts as they occurred." There are also admirable remarks on the ideal historical style and amusing descriptions of contemporary historians who ape Thucydides by introducing plagues and funeral orations. Less attractive are the attacks on contemporary rhetoricians. The *Rhetoron didaskalos*

("Teacher of Orators"), containing ironical advice on how to become a successful orator by means of claptrap and impudence, may be directed against Pollux, the lexicographer, while the *Lexiphanes* ("Word-Flaunter") attacks a contemporary who is excessively fond of archaic and recondite vocabulary.

In ch. 33 of the "Twice Accused" (where Lucian is indicted by Rhetoric for deserting her and by Dialogue for taking away his dignity by the introduction of comic elements) Lucian says he has added to dialogue "jest and lampoon and Cynicism and Eupolis and Aristophanes, and lastly Menippus, a truly formidable Dog (*i.e.*, Cynic) who laughed while he bit." If in style Lucian owes much to Plato, he finds ideas for his plots in many writers, particularly Homer, Aristophanes and, no doubt, the lost works of Menippus; but judging from the *Timon*, which is Cynic in tone but influenced by the *Plutus* of Aristophanes, Lucian adapted and blended his literary antecedents in an original way. Menippus may have given Lucian his Cynic viewpoint; Menippean works such as the "Banquet" and the "Sale of Diogenes" may have suggested ideas for the "Banquet" and the "Sale of the Lives"; but, as Lucian in his *Prometheus ei en logois* ("Literary Prometheus") denies any plagiarism on his part, most authorities believe that he did not copy Menippus particularly closely. Moreover the term Menippean satire, as denoting a mixture of prose and verse, can be applied to very few of Lucian's works. Lucian says in the same work that he seeks to be praised not for originality but for perfection and for achieving a harmonious blend of dialogue and comedy, and, strictly speaking, he cannot be called the founder of satirical dialogue in view of the prior claims of Menippus and indeed the satiric elements in Plato (*e.g., Euthydemus*); his merit lies in his initiative in resuscitating and improving the genre used by Menippus, and, as he claims ("Twice Accused" ch. 34), making dialogue more attractive.

Lucian may have known some Latin, but despite some similarities of theme it cannot be proved that he was influenced by Roman satire. Lucian and Varro had a common source available in Menippus. If Juvenal's third satire and the *Nigrinus* both attack the evils of Rome and Juvenal's tenth satire like the *Ploion* ("Ship") deals with the vanity of human wishes, such natural topics for satire may well have been suggested to both writers by their observation of life or by their reading (*e.g.*, of Cynic diatribes) or by both. Tatian and other Christian apologists attack the amours of the gods in much the same way as Lucian, but there is little evidence that they knew Lucian or he them. Because Lucian feels bound to amuse as well as to instruct his audience, his satire usually lacks the ferocity of Juvenal and his touch is even lighter than that of Horace; on such occasions his subjects may have been suggested partly by his reading, and his satire may often apply to the whole classical era as much as to the Antonine age; occasionally he attacks contemporaries such as Peregrinus, the "Teacher of Orators" or the "Ignorant Buyer of Books" with the venom of an Archilochus.

Influence.—Ever since the Renaissance Lucian has had a considerable influence on many European writers including Erasmus, Rabelais and Voltaire, and on artists such as Botticelli, who painted "Calumny" from Lucian's description in *Peri tou me rhadios pisteuein diabole* ("Slander") of a painting by Apelles. The *editio princeps* appeared at Florence in 1496. The English writer who perhaps has most in common with Lucian is Jonathan Swift, who may well have taken ideas for *Gulliver's Travels* from the "True History." Lucian's influence on posterity, his thorough assimilation of the spirit of classical Greece, his novel use of his literary antecedents, his wit, the ease and lucidity of his style (founded on the best Attic models and only in a few minute details aberrant from them) entitle him despite his date to be ranked among the great names in classical literature.

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(M. D. MACL.)

LUCIDOR, LASSE, pseudonym of LARS JOHANNSON (1638–1674), Swedish lyric poet, author of some of the most powerful poems of the baroque period in Swedish literature, was born in Stockholm in 1638. Lasse studied at Greifswald and Leipzig, and spent several years abroad as a wandering scholar and, perhaps, actor. On returning to Sweden, he lived first in Uppsala and, after 1669, in Stockholm, becoming known as a writer of funeral elegies and epithalamiums. His most personal poems are drinking songs and funeral hymns—a typically baroque combination. His models were the German baroque poets, among them Andreas Gryphius, but his best poems surpass theirs in intensity of feeling and power of expression. His most famous song, "Skulle Jag sörja så vore Jag tokot" ("Were I to grieve, then I were a fool"), was written in prison, after an accusation of using disparaging words in a poem to a noble family. He was killed in a tavern brawl in Stockholm, Aug. 13, 1674.

Lucidor's poetry was posthumously published in *Helicons Blomster* (1689). His *Samlade Dikter* were edited by F. Sandwall in a commented edition (1914–30). (CL. FN.)

LUCIFER (d. 370/371), bishop of Cagliari in Sardinia, was a supporter of Athanasius (*q.v.*) and the founder of a small rigorist sect named after him. Nothing is known of his life until after the Arianizing Council of Arles in 353, when he tried to obtain a new and impartial council. At the Council of Milan (355) he refused to sign the condemnation of Athanasius, and was exiled to the east, where he wrote five polemical tracts remarkable more for their violent language against Constantius II than for correctness and wealth of doctrine. His quotations from scripture, however, are of value for the study of the Old Latin text. Of his letters, two survive.

Allowed by Julian's edict to return home, Lucifer declined an invitation to attend the synod of Alexandria (362), and passed through Antioch, where he refused to recognize Meletius as bishop, and consecrated Paulinus, leader of the Eustathian faction, in his stead, thus prolonging the Antiochene schism for many years (*see* MELETIUS, SAINT, of Antioch). Lucifer refused ecclesiastical fellowship with all those who had signed, even under duress, the Arianizing formula of Rimini (359), as he considered them fallen from their clerical dignity through heresy. The short-lived sect which he founded comprised small groups in Spain, Gaul and even Rome.

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(V. C. DE C.)

LUCIFER (Greek *Phosphoros*, "lightbearer"), the morning star; *i.e.*, the planet Venus at dawn. Personified as a male figure bearing a torch, Lucifer has almost no legend, but in poetry is often herald of the dawn. St. Jerome translated as "Lucifer" the metaphorical reference (Hebrew, "shining one") to the fall of the king of Babylon in Isa. xiv, 12. The Church Fathers interpreted the words of Jesus in Luke x, 18, "I saw Satan fall like lightning from heaven," as a reference to this passage in Isaiah, so that "Lucifer" came to be regarded as the name of Satan before his fall. It is so used by Milton in *Paradise Lost*, and the idea underlies the proverbial phrase "as proud as Lucifer."

(H. W. PA.)

LUCILIUS, GAIUS (*c.* 180–*c.* 102 or 101 B.C.), the earliest Latin satirist, of whose writings only fragments remain, was born at Suessa Aurunca, on the Campanian confines of Latium. He was of good family and education, and served under Scipio Aemilianus in the Numantine War in Spain, 134–133 B.C. He was a friend of learned Greeks and well acquainted with Greek manners and thought, was on intimate terms with Scipio and mixed with other great figures of his time. He spent the greater part of his life at Rome but was living at Naples when he died. His career as a writer extended from 131 B.C. to nearly the end of his life. His works were collected in a posthumous edition of 30 books, of which the last five were the earliest in date. In his four earliest

books Lucilius composed in *septenarii* and *senarii*, as well as in hexameters. After his fourth book, he chose the hexameter except for some poems in elegiacs. Of his work about 1,300 complete or partial lines have survived.

Lucilius may be regarded as the inventor of poetical satire, as he was the first to give to the formless Latin *satura* that distinctive character of critical comment on manners, politics and literature which the word "satire" still denotes. Unlike other forms of Latin literature, it owes virtually nothing to Greek. In his style and his choice of subject Lucilius was equally original. He ridiculed the conventional language of epic and tragic poetry and used the style of familiar speech, even to the point of frequently employing Greek, which was then fashionable in educated circles. For his subjects he abandoned the hackneyed ground of Greek and Roman mythology and treated of the politics and wars, the business and pleasure, the scandals and vices of his own day. These he handled, not in Juvenal's spirit, but, like Horace, from the standpoint of a man of the world and the associate of men of affairs. But he differed from Horace in being a thoroughly good hater, and also in a savage outspokenness of attack characteristic of the public life of his age.

Lucilius' unpolished and vigorous poetry was something new. Its topics were various: politics, social life, luxury, marriage, aims in writing, history, literary and dramatic criticism, grammar, rules of spelling, a letter to a friend, a journey. But it was largely self-portraiture, and this is borne out by Horace, whose artistic development in his hexameter writings owed much to Lucilius' work. Lucilius is recorded as saying that he wrote neither for the most ignorant nor for the most learned. Quintilian says that some men of his day preferred Lucilius not only to all other satirists but to all other poets. Certainly the loss of his work, except for fragments, is one of the most grievous in Latin literature.

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LUCINA, "light bringing," an epithet applied to both Diana and Juno (*qq.v.*) but particularly to the latter as protectress of women, especially in childbirth. As a goddess especially of moonlight, and hence controller of the menses, Lucina's functions spread over the entire birth cycle: fertility, conception, pregnancy, nourishment of the fetus, labour and delivery, lactation, etc. On coins Juno Lucina is represented as a matron holding a child and a flower, symbols of fertility. A shrine of Juno Lucina on the Cispius dated from 375 B.C., and the introduction of the cult went back traditionally to Titus Tatius.

See G. Wissowa, *Religion und Kultus*, 2nd ed., p. 183 ff. (1912); S. B. Platner, *Topographical Dictionary of Ancient Rome*, completed and rev. by Thomas Ashby, s.v. "Juno Lucina" (1929). (R. B. Ld.)

LUCIUS, the name of three popes.

SAINT LUCIUS I (d. 254), pope from 253 to 254, succeeded Cornelius in the summer of 253. Exiled at first, he returned to Rome at the accession of Valerian and received a letter of congratulation from St. Cyprian. Cyprian, writing later to Pope Stephen I, referred to Cornelius and Lucius as being in agreement with Cyprian's policies. St. Lucius died in March 254. His feast day is March 4. (F. X. G.)

LUCIUS II (Gherardo Caccianemici) (d. 1145), pope from 1144 to 1145, was born at Bologna, was cardinal and papal chancellor and succeeded Celestine II on March 12, 1144, the year the Romans proclaimed a constitutional republic, rejecting papal civil rule. Lucius made a truce with King Roger II of Sicily and recognized Portugal as a papal fief. He died on Feb. 15, 1145, following an assault on the Campidoglio.

LUCIUS III (Ubaldo Allucingoli of Lucca) (d. 1185), pope from 1181 to 1185, Cistercian monk and cardinal since 1141, was elected on Sept. 1, 1181, as successor to Alexander III. He was unable to remain in Rome with its autonomy-minded republic. Unable also to agree, despite his willingness, over outstanding problems with Frederick I, except for action against the Catharist and other heresies, Lucius died on Nov. 25, 1185, at Verona, before an open break occurred, still hopeful of promoting the Crusade cause.

See H. K. Mann, *The Lives of the Popes in the Middle Ages*, vol. 9–10 (1925). (J. J. Rs.)

LUCKA, EMIL (1877–1941), Austrian author and philosopher born in Vienna on May 11, 1877, came to the forefront of Austrian literature in 1912. His novels and shorter tales are as rich in thought as in invention, their plots being laid either in the Middle Ages, as in *Isolde Weisshand* (1908), *Heiligenrast* (1919), *Der Weltkreis* (1919), *Fredegund* (1924); or in Vienna society, as in *Das Brausen der Berge* (1918); or in the Austrian Alps, as in *Am Sternbrunnen* (1925). In *Die drei Stufen der Erotik* (1913) Lucka gives a representation of the development of love throughout the ages; in *Grenzen der Seele* (1916) he presents the psychology of genius; and in *Urgut der Menschheit* (1924) he discusses the problem of how the primeval myths may be revived to meet the needs of modern civilization. Later works included a biography of Michelangelo (1930); a novel, *Der blutende Berg* (1931); *Die Verwandlung des Menschen* (1934); and *Die grosse Zeit der Niederlande* (1936).

LUCKENWALDE, a town of Germany which after partition of the nation following World War II was in the *Bezirk* (district) of Potsdam, German Democratic Republic. It is located on the Nuthe river, 30 mi. S. of Berlin on the railway linking Berlin with Halle and Leipzig. Pop. (1962 est.) 28,696. The site of Luckenwalde was occupied in the 12th century by a Cistercian monastery, but the place, first recorded in chronicles in 1217, did not become important till the reign of Frederick the Great, though it received a municipal charter in 1442. It belonged to the archbishopric of Magdeburg until it passed to the electorates of Saxony (1648) and Brandenburg (1680). Its cloth and hat manufactories are extensive. Other industries include brewing and the making of metal and paper products, shoes, furniture and screws.

LUCKNOW, a city, district and division of Uttar Pradesh, India. The city, headquarters of the district and division and the seat of the state government, is situated on the Gumti river, a tributary of the Ganges, 303 mi. S.W. of Delhi and 606 mi. N.W. of Calcutta. Pop. (1961) 635,590. The town was administered by a corporation after 1960. There are a number of impressive buildings representing an admixture of European and Indo-Saracenic style all constructed in the late 18th or early 19th century. The best known is the great imambara (a meeting place used mainly by Shi'a Muslims especially during the Muharram ceremonies), built in 1784, a large single-storied edifice of brick and mortar, with one of the largest vaulted halls of its kind, measuring 160 ft. by 53 ft. by 50 ft. The Rumi Darwaza or Turkish gate (1784) has at its western edge a 60-ft. high arch, while the clock tower (1881) west of it is 221 ft. high. Husainabad imambara is a later construction. Shah Nazaf (1824–27), the mausoleum of Nawab Ghazi ud-Din Haider, has an interior decorated with chandeliers, which are illuminated during Muharram. Constantia, now housing La Martinière college, is of a different type, while Chhattar Manzil has a fine dome surmounted with a gilt umbrella. The best preserved monument of the city is the ruined residency built in 1800, and besieged and totally shelled in 1857 during the Indian Mutiny (called by Indians the freedom struggle).

Among modern buildings, the most outstanding are the railway station in Rajasthani style claimed to be one of the most elegant in India, the council house, the new councilor's residence, Lucknow university, Isabella Thoburn college and the stadium. A martyr's memorial on the bank of the Gumti river and facing the residency was added in 1957. Among the many parks and gardens are the Sikandar Bagh, converted in 1953 into the first national botanical garden of India, Banarsi Bagh (an open-air zoological garden), Dilkusha Bagh and Victoria park.

As a noted centre of learning the city has, besides the teaching and residential Lucknow university founded in 1921 and its constituent and associated colleges, a university of Indian music, an institute of Muslim theology and Arabic learning, the Birbal Sahni institute of paleobotany, the central drug research institute, the

. K. institute of sociology and human relations, the government ollege of fine arts and crafts, and a state museum. The city, well onnected by roads, is a central junction of the Northern and Vorth Eastern railways, and lies on the air route between Delhi and Calcutta. As a centre of traditional artistic industry it is well nown for its *chikan* work (fine hand embroidery), *zari* and *amdani* (gold and silver thread work), clay modeling, cotton abrics, perfumes and ivory carving. Its large-scale industries nclude a distillery and a paper mill.

LUCKNOW DISTRICT, an alluvial expanse in the centre of the ndo-Gangetic plain, is traversed by the Gumti and the Sai rivers. rea 977 sq.mi. Pop. (1961) 1,338,882. Its main crops are wheat, ice gram, barley, jowar (sorghum) and bajra (pearl millet); but is better known for its *dasheri* mangoes, the best in Uttar Pradesh, and sweet melons. The other towns in the district are Malihabad, Kakori, Amethi and Gusainganj.

LUCKNOW DIVISION (area 12,037 sq.mi.; pop. [1961] 8,320,-15) consists of the districts of Lucknow, Unnao, Rae Bareli, itapur, Hardoi and Kheri. (B. SI.)

History.—According to Hindu tradition Lucknow was founded y Lakshmana, the brother of Rama of Ajodhya (Ayodhya), the egendary hero of the *Rāmāyana*. It was not until the end of the 2th century that the Muslims entered Oudh (*q.v.*). Local tradions, however, conflict with Muslim accounts and suggest that the Rajput chiefs maintained their power practically intact throughut the Muslim period. Lucknow was captured by Babur in 1528. After Humayun's flight in 1540 to Persia (Iran) it formed part f the dominions of Sher Shah Suri. During Akbar's reign it was ncorporated in the province of Oudh. Its importance really dates rom the accession of Asaf ud-Daula, who succeeded Shuja ud-Daula as nawab of Oudh in 1775. It was Asaf ud-Daula who ransferred the seat of government from Fyzabad to Lucknow. His extravagance became proverbial. He built the famous mambara, the great gate of which was said to be modeled on that f the Turkish Sublime Porte at Constantinople (Istanbul). At Lucknow in 1819 Lord Hastings conferred the title of king pon Ghazi ud-Din Haider. He was succeeded by his son Nasir d-Din Haider in 1827, whose life was wholly given over to pleasre; and the description of Lucknow during his reign in William Knighton's *Private Life of an Eastern King* (1921) is probably not xaggerated. From 1773 to 1856 Lucknow was the headquarters f the British resident in Oudh. From 1843 to 1845 Maj. Gen. ir William Nott was stationed there as special envoy to the king f Oudh. During the Mutiny, on July 1, 1857, Sir Henry Lawence, the chief commissioner in Oudh, retired with the European nhabitants of Lucknow and a small force of loyal sepoys into the esidency. Early in the siege Lawrence was mortally wounded, but he garrison held out against enormous odds until relieved by Sir Henry Havelock and Sir James Outram on Sept. 25. The relieving orce found itself besieged by the rebels until the arrival of Sir Colin Campbell (later Lord Clyde) on Nov. 16. A week later British troops were withdrawn from Lucknow which was not ermanently reoccupied until March 1858. Lucknow remained he capital of a separate administration till 1877 when the post f chief commissioner of Oudh was united with that of lieutenant overnor of the North-Western provinces (later the United Provnces, now Uttar Pradesh).

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(C. C. D.)

LUCRETIA, a Roman lady, wife of Lucius Tarquinius Collatinus, distinguished for her beauty and domestic virtues. According to tradition, having been raped by Sextus Tarquinius, one of the sons of the king Tarquinius Superbus, she informed her father and her husband, and, having exacted an oath of vengeance rom them, stabbed herself to death. Lucius Junius Brutus (*see* BRUTUS) put himself at the head of the people, drove out the Tarquins, and established a republic (traditional date, 509 B.C.).

See Livy, *History of Rome,* i, 57–60.

LUCRETIUS (TITUS LUCRETIUS CARUS) (earlier half of first entury B.C.), Latin poet and philosopher, whose one poem, *De rerum natura* ("On the Nature of Things") renders in hexameters the atomic theory of Epicurus (*q.v.*). Its declared purpose is to free mankind from religious fears by proving that the soul is material and is born and dies with the body, and that, though gods exist, they cannot intervene to help or harm men. Apart from his poem almost nothing is known about him. What little evidence there is, is quite inconclusive. Jerome in his chronicle, for 94 B.C. (so most manuscripts; others 96 or 93 B.C.), states that Titus Lucretius the poet was born in that year; afterward he became mad from a love potion, and having written in lucid intervals some books, which Cicero afterward emended, he killed himself in his 44th year (*i.e.*, 51 or 50 B.C.). Donatus in his "Life" of Virgil notices that Virgil put on the *toga virilis* in his 17th year, on his birthday (*i.e.*, Oct. 15, 54 or 53 B.C., according to whether Virgil was entering or completing his 17th year), and that Lucretius died that same day; but Donatus contradicts himself by stating that the consuls that year were the same as in the year of Virgil's birth (*i.e.*, Crassus and Pompey, consuls in 70 B.C. and again in 55 B.C.). This last date, 55 B.C., seems partly confirmed by a sentence in Cicero's reply to his brother in Feb. 54 B.C. (*Ad Quintum fratrem* 2, 9, 3). The sentence, though variously interpreted or emended, suggests that Lucretius was already dead and also that Cicero may have had something to do with the publication of his poem: "The poems (*poemata*) of Lucretius are as you write in your letter—they have many high lights of genius (*lumina ingeni*), yet also much artistry (*ars*). But more when you come." The coincidence noticed by Donatus, of Lucretius dying on the day that Virgil came of age, looks like the neat invention of literary history. Again, though Lucretius clearly died before finally revising his poem, it is surprising to find no other reference to the remarkable circumstances of his life and death alleged by Jerome. They may belong to a late story put about by Christian polemic developed perhaps from an ignorant or wishful misunderstanding of *docti furor arduus Lucreti* (Statius, *Silvae,* 2, 7, 76). Excepting the single mention in Cicero, the only contemporary who names Lucretius is Nepos (*Atticus* 12, 4) in the phrase "after the death of Lucretius and Catullus," and the only contemporary whom Lucretius names is the Memmius to whom he dedicates his poem, probably C. Memmius (son-in-law of Sulla, praetor of 58 B.C., patron of Catullus and Cinna) for whose friendship Lucretius "hopes" (i, 140).

Theme of "De Rerum Natura."—*De rerum natura* translates the title of the chief work of Epicurus, *Peri Physeos,* as also of the didactic epic of Empedocles (*q.v.*), of whom Lucretius speaks with admiration only less than that with which he praises his master Epicurus (*cf.* i, 731 ff. with iii, 14 ff.). The poem is the fullest statement extant of the physical theory of Epicurus, but it also alludes to his ethical and logical doctrines. The argument in outline is as follows.

1. No thing is created out of nothing and no thing can be reduced to nothing. The universe is infinite: an infinite extent of empty space (or void) and an infinite number of irreducible particles of matter (or atoms), there being a finite number of different kinds of atoms, but an infinite number of atoms of each kind. Atoms differ only in shape, size and weight. They are absolutely hard, changeless, everlasting, the limit of physical division. They are made up of inseparable "minimal parts" or units, which are the limit of mathematical division. Bigger atoms have more such parts; but there is a limit to the size of atoms, and even the biggest are minute. Atoms of all kinds move always at an equal and constant velocity many times greater than the velocity of light (ii, 161 ff.). All atoms would move everlastingly downward in infinite space, and never collide to form atomic systems unless they swerved at times a minimal degree from the vertical. To these indeterminate swerves is due the creation of an infinite plurality of worlds, and also free will. All things that exist or happen consist ultimately only of matter and void: they are systems of moving atoms, separated by greater or smaller intervals of void, which cohere more or less according to the shapes of the constituent atoms. All systems are divisible and therefore perishable (except the gods). Only systems of atoms have "secondary" properties: colour, taste, heat, smell, or sensation. All change is explainable in

terms of addition, subtraction or rearrangement of changeless atoms.

2. The soul is made of atoms exceedingly fine, and has two connected parts: the *anima* distributed throughout the body, which is the cause of sensation, and the *animus* in the breast (not the head), the central consciousness where thinking, willing, and the emotions of joy and fear occur. The soul is born, grows, and dies with the body. At death it escapes, like "smoke," into the air and disintegrates more quickly than even the body.

3. The gods exist, but neither made nor manipulate the world. They themselves are creatures of the atomic process, systems of exceedingly fine atoms, human in shape, yet by some principle of existence everlasting. They live remote, in between worlds, unconcerned with human affairs, examples to men of the ideal life of perfect happiness (absence of mental fear and bodily pain). Their excellent being is perceived at times by some sort of intuition of the mind.

4. We know by sense perception; and argue by reason, correctly if according to certain rules (the *Canonica*). The senses are infallible. Reason however can make false inferences. We see objects because they discharge from their surface representative films which strike the eye. Similarly hearing, smelling, etc., are explained by atomic discharges striking the appropriate sense organ. Separate atoms are in principle imperceptible because they have no dischargeable parts. The senses perceive the existence of matter; reason infers that it exists in the form of atoms, and also that void, untouchable and so imperceptible, exists to explain the perceived movement of matter.

5. We know from feelings of pleasure or pain what we should do or not do. Our aim should be so to conduct our lives that we get, on balance, the maximum of pleasure and the minimum of pain.

Structure of the Poem.—Lucretius distributes his argument into six books, beginning each with a highly finished exordium. Books i and ii establish the main principles of the atomic universe, refuting rival theories of Heraclitus, Empedocles and Anaxagoras (*qq.v.*), and covertly attacking the Stoics. Book iii demonstrates the atomic structure and mortality of the soul, and ends with a triumphant sermon on the theme: "death is nothing to us" (iii, 830). Book iv describes the mechanics of sense perception and thought and certain bodily functions, ending with a violent condemnation of sexual love. Book v describes the creation and working of this world and the celestial bodies, the evolution of life and human society. Book vi explains remarkable phenomena of the earth and sky, in particular thunder and lightning. It ends with a description of the plague at Athens, a sombre picture of death contrasting with that of spring and birth in the invocation to Venus with which the poem opens.

Use and Adaptation of the Latin Language.—The problem of Lucretius was to render the bald and abstract prose of the Greek Epicurus into Latin, and into hexameters, at a time when Latin as yet had no philosophic vocabulary. He had to find scanning equivalents for Greek terms as well as synonyms for the sake of poetic variety. He succeeded admirably in spite of repeated complaints about "the poverty of our native speech" (i, 136 ff.). He applied common words to a technical use. So he used *concilium*, "assembly of people" for a "system of atoms," and *primordia*, "first-weavings" for the "atoms" which make up the texture of things. When necessary he invented words, *e.g.*, *clinamen* for the "swerve," usually on the pattern of the Greek originals. In poetic diction and style his debt to the older Latin poets, especially Ennius, is apparent (i, 117; iii, 1025). He freely used alliteration and assonance, solemn and often metrically convenient archaic forms, and old constructions. He formed with almost Greek facility expressive compound adjectives of a sort rejected by Augustan taste, *e.g.*, "the light-sleeping hearts of dogs" (v, 864), "forest-breaking winds" (i, 275). He imitated or echoed Homer, Aeschylus, Euripides, Callimachus, Thucydides and Hippocrates. His hexameters can be said to stand halfway between those of Ennius who introduced the metre into Latin, and Virgil who perfected it. An ear familiar with Virgil will notice some incoherence of rhythm due to words ending with the end of the second foot, to spondaic words occupying the fourth foot, or to words of one or more than three syllables concluding the verse, as well as harsh elisions and examples of unusual prosody. The influence of Lucretius on Virgil is pervasive and unmistakable, especially in the Georgics, the next masterpiece of didactic poetry in Latin and it is in evident allusion to the author of *De rerum natura* that Virgil wrote *Felix qui potuit rerum cognoscere causas* ("Happy is the man who can read the causes of things") (*Georgics* ii, 490).

Poetical Power and Moral Fervour.—Lucretius wrote his poem with the conviction of a proselytizing convert. Epicurus to him was a saviour "god" (v, 8 ff.), greater than the mythical benefactors of mankind, Ceres, Liber or the Stoic hero Hercules. But Epicureanism seemed bitter to the "gross" of men (i, 945). So Lucretius was offering the medicine cup of beneficial wormwood, edged with the deceptive honey of poetry. His poem opens with an invocation to Venus, mother of Aeneas, mistress of Mars, the only divinity in the Pantheon competent to grant his prayer for beauty for his words and peace for the Roman world, the natural symbol of pleasure and of the creative moment in the atomic process. The argumentative runs of the poem read less "pleasantly," but are relieved by finished passages of a higher strain, more impressive in their poetical power than almost any other ancient poetry. Even in his more cobbled verses interest is sustained by his evident will to convince, and by the energy, propriety and perspicuity of his language. The style ranges from classic economy (*e.g.*, v, 1188–1193) to the persuasive redundancies of the enthusiastic lecturer. His mind is visual. His eye notices the curious particularity of nature. The argument by analogy prescribed by the *Canonica* (that hypotheses of reason must agree with, or not contradict, sense perception) gives him his opportunity as a poet. He regularly follows an abstract exposition by a concrete picture. The constant motion of imperceptible atoms within an apparently still object he illustrates by the distant view of grazing sheep, which appear as a "white stationary gleam on a green hillside" (*stare videntur et in campis consistere fulgor.* ii, 332).

He speaks to mankind as well as to the "sons of Aeneas" in austere compassion for the ignorant, unhappy human race. His moral fervour expresses itself in gratitude to Epicurus and in hatred of the seers (*vates* i, 102) of the Greco-Roman world who inculcate religious fears (*religiones*) by threats of eternal punishment after death, of the Etruscan soothsayers (*haruspices*, vi, 381) with their lore of thunder and lightning, of the false philosophers—Stoics with their belief in divine providence, or Platonists and Pythagoreans who teach the transmigration of immortal souls. The first appearance of *religio* in the poem is as a monster which thrusts its fearful head from the augural quarters of the sky (i, 62 ff.). Epicurus, not intimidated by theological myths or by thunder and lightning, had ranged beyond the "flaming ramparts of the world" through the infinite universe, broken into the citadel of nature, and brought back in triumph the knowledge of what can and what cannot be, of that "deep-set boundary stone" which divides the separate properties of things, the real from the not-real. "So religion is crushed beneath our feet and his victory lifts us to the skies" (i, 78 ff.).

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LUCULLUS, LUCIUS LICINIUS (*c.* 117–58/56 B.C.), a Roman general who fought Mithradates VI Eupator of Pontus from 74 to 66, and from whose high standard of living on his return to Rome the word "Lucullan" derives. He was a protégé of Sulla, serving in the east as quaestor in 87 and proquaestor from 86 to 80. He was aedile in 79 and praetor in 78, when Sulla died, having entrusted Lucullus with the publication of his memoirs and made him guardian of his son.

Consul in 74 when Bithynia, bequeathed by King Nicomedes IV to Rome, was invaded by Mithradates, he intrigued to secure the

nilitary command against him and was appointed governor of Cilicia and later, in addition, of Asia. At the head of five legions (two of which, the "Valeriani" or "Fimbriani," had murdered their irst commander L. Valerius Flaccus in 85) he drove Mithradates rom Cyzicus in winter 74/73, defeated him at Cabira in 72, and except that Mithradates was still at large (in Armenia, whose king Tigranes was his son-in-law) the war seemed over by 70, when he senate appointed a commission of ten to join Lucullus in drawng up a charter for the new province of Bithynia-Pontus. But business circles in Rome turned against him because their profits were cut by the reforms he effected in winter 71/70 on behalf of he provincials, who were staggering under overdue interest on npaid instalments of the heavy indemnity imposed on them by Sulla; and, in the east, Tigranes, having rejected the Roman proposal that he should surrender Mithradates by treachery, had oined Mithradates as an active ally. Lucullus attacked Armenia, lefeating Tigranes and capturing his capital Tigranocerta in 69. He planned further aggression still, but he handled men badly ind, despite good military leadership, small casualties and extensive loot, his troops mutinied twice in 68 and again, encouraged by Lucullus' brother-in-law P. Clodius, in spring 67 at Nisibis. Finally in 66, Mithradates having recovered much of his territory, Lucullus (who had already been ineffectively superseded in Bithynia by Manius Acilius Glabrio, consul of 67) was instructed by a bill of the tribune Manilius to hand over his command to Pompey.

At Rome his triumph was conceded but delayed until 63. After that, an immensely wealthy man, he lived in great extravagance, occasionally intervening in politics as a disgruntled nd spineless optimate, more seriously occupied with cultural purnuits. He died between 58 and 56 B.C.

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(J. P. V. D. B.)

LUCUS FERONIAE, the name of a small Faliscan town of which there are remains on the right bank of the Tiber, near Corano, 35 km. (22 mi.) N. of Rome, Italy. Its name derives from the grove, and later temple, of the ancient Latin divinity Feronia, which was its principal monument. The long controversy as to its location was resolved by the discovery in 1952 of inscriptions naming the site and by the subsequent excavation of the centre of the ancient town. Already a substantial market in the 6th century B.C. (Livy), it was sacked by Hannibal in 211. Veterans were settled there, possibly by Sulla and certainly by Augustus, under whom it took the title of Colonia Julia Felix Lucus Feroniae. Its history under the empire is one of steady decline. The latest dedication recorded by the early 1960s was to the emperor Gallienus in A.D. 266, and by 305–306 many of the public buildings had fallen into ruin.

The principal surviving remains are those of the late republican forum, with a flanking portico containing shops and offices; a basilica of Vitruvian plan, with an annexed shrine containing a rich series of Julio-Claudian dedications and incorporating the city treasury; a small republican temple; the Augustan aqueduct; a fountain and public latrines. The uncleared sites of the temple of Feronia, the baths, theatre and amphitheatre were discovered from air photographs.

See R. Bartoccini in *Atti del VII Congresso Internazionale di Archeologia Classica, 1958,* ed. by G. Susini, 3 vol. (1961). (J. B. W.-P.)

LUCY, SAINT, a martyr at Syracuse in Sicily, probably during Diocletian's persecutions, whose veneration is attested by a 6th/5th-century inscription found at Syracuse. Her legend, which is historically worthless, relates how she was martyred for refusing to marry because she had taken a vow of virginity. It closely resembles that of St. Agnes and other virgin martyrs, and was widely diffused: the English St. Aldhelm (d. 709) used it in his *De laudibus virginitatis* and *De laudibus virginum.* St. Lucy is named in the canon of the Roman Mass, and her feast day is Dec. 13. Probably because of her name (*lux,* "light") she is invoked by those with eye trouble, and is sometimes represented in art with a dish containing her eyes which were said to have been torn out by her persecutors. There was much popular devotion to St. Lucy and she was well known in folklore; for example, the saying "Lucy-light, shortest day, longest night."

See H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints,* rev. and supplemented, vol. iv, pp. 548–549 (1956). (D. AR.)

LUCY, SIR HENRY (1845–1924), British journalist, was born at Crosby, near Liverpool, on Dec. 5, 1845. Educated in Liverpool, he began life in a Liverpool merchant's office, but soon became a reporter for a Shrewsbury periodical. In 1870 he joined the staff of the *Pall Mall Gazette* (London) and in 1873 became parliamentary reporter to the *Daily News,* with which paper he had a long connection in various capacities. In 1881 he also joined the staff of *Punch* and won a great reputation as the contributor of its parliamentary sketch signed "Toby, M.P." He was knighted in 1909 and retired from parliamentary work in 1916. He published his autobiography, *Sixty Years in the Wilderness,* in 1909, and *The Diary of a Journalist* in 1920. He died on Feb. 20, 1924.

LUCY, RICHARD DE (d. 1179), chief justiciar of England under Henry II, came from Lucé near Domfront in western Normandy, and probably entered royal service under Henry I. He is recorded as a supporter of Stephen from about the year 1140, succeeding Geoffrey de Mandeville as justiciar and sheriff of Essex (1143). Henry II made him and Robert de Beaumont, 2nd earl of Leicester, chief justiciars jointly (*c.* 1155), and after Leicester's death in 1168 Lucy held the office alone. As one of the king's chief councilors, he must be given part of the credit for the important legislation of the period, and during the struggle with Becket he was singled out by the king's enemies as a principal author of the Constitutions of Clarendon (1164). His role in holding together those loyal to the king in the great revolt of 1173–74 was crucial. In 1179 he resigned his office and entered the religious life at Lesnes abbey, Erith, Kent, founded by himself in 1178 in penance for his part in the events leading to Becket's death. He had been excommunicated by Becket in 1166 and again in 1169, and the archbishop's murder had been in part provoked by his refusal to lift the sentences he had passed upon his enemies. Richard de Lucy died at Lesnes on July 14, 1179.

See J. Boussard, *Le gouvernement d'Henri II Plantagenet* (1956).
(G. W. S. B.)

LUCY, SIR THOMAS (1532–1600), English Warwickshire squire, traditionally associated with the youth of Shakespeare, was born on April 24, 1532, the son of William Lucy of Charlecote, near Stratford-upon-Avon. As a boy he is said to have been under the tutorship of John Foxe, the martyrologist, from whom he learned the Puritan principles which distinguish his adult life. He was married at 16 to Joyce Acton, sole heiress to her father Thomas Acton of Sutton, Worcestershire. With her fortune he was able to rebuild the family house, beginning probably soon after his father's death in 1551. He was knighted in 1565, and sat in two parliaments as knight of the shire for Warwick. He was a justice of the queen's peace, a commissioner for musters at the time of the Armada, a commissioner for recusancy, and a member of Burleigh's council for the marches of Wales. After his part in the arrest and execution of Edward Arden in 1583 he became widely respected and feared as a recusant hunter. He died suddenly at Charlecote on July 7, 1600.

In 1709 Nicholas Rowe, in the preface to his edition of Shakespeare, told the story that Shakespeare had been concerned, in his youth, in stealing a deer from Charlecote park, and had been prosecuted by Lucy. In revenge, Shakespeare had written a ballad on Lucy, and the trouble which resulted compelled him to leave Stratford for London. Critics have disputed the truth and the details of this story ever since, but 20th-century opinion tends to regard it as largely legendary, with a possible kernel of truth. Shakespeare is also supposed to have caricatured Lucy in his portrait of Justice Shallow, who appears in *2 Henry IV* and again in *The Merry Wives of Windsor.* Amid all the controversy on this question there are only four certain facts: *The Merry Wives* was written about 14 years after the alleged deer stealing; there

is a reference in that play to the white luces "that do become an old coat well"; Shallow's threat to make a Star Chamber case of a poaching incident; and the general mockery of justices of the peace. In the opinion of most 20th-century critics this is insufficient evidence to substantiate the claim that Shakespeare intended Shallow to be a recognizable portrait of Lucy.

BIBLIOGRAPHY.—The fullest account of Lucy is in A. Fairfax-Lucy, *Charlecote and the Lucys* (1958). *See* also C. C. Stopes, *Shakespeare's Warwickshire Contemporaries,* 2nd ed. (1907); E. K. Chambers, *William Shakespeare,* vol. i, pp. 18–22 (1930); J. L. Hotson, *Shakespeare versus Shallow* (1931). (B. R. M.)

LUDDITES, the name given to organized bands of English rioters for the destruction of machinery, who first appeared in Nottingham and the neighbouring districts toward the end of 1811. The "Ludds" or Luddites were generally masked, and operated at night. Their leader, real or imaginary, was known as "King Ludd" from a probably mythical "Ned Ludd." Great distress had been caused by the dismissal of handicraftsmen in the areas in which textile machinery was introduced; and even those handicraftsmen who did not lose their employment suffered considerable worsening of conditions owing to competition. There had been previous machine-breaking disturbances in the 18th century, but they were less contagious than the Luddite disturbances. The riots began with the destruction of stocking and lace frames, and, continuing through the winter and the following spring, spread into Yorkshire, Lancashire, Derbyshire and Leicestershire. The riots were directed not merely against reductions of wages but also against the poor quality goods (especially stockings) produced by the new machines. The rioters were sometimes supported by local public opinion, and they abstained from bloodshed or violence against living beings, until in 1812 a band of them was shot down by soldiers at the request of a threatened employer, Horsfall, who was afterward murdered. They were met by severe repressive legislation, introduced by Lord Liverpool's government. A notable feature of the opposition to the legislation was Lord Byron's speech in the house of lords. The organization was temporarily broken up by a mass trial at York in 1813, which resulted in many hangings and transportations. Among the victims was probably the real "King Ludd," for the elaborate organization suddenly collapsed. In 1816 similar rioting was resumed, caused by the depression that followed the peace of 1815 and was aggravated by one of the worst of recorded harvests. In that year, although the centre of the rioting was again in Nottingham, it extended over almost the whole kingdom. The rioters were also thoroughly organized. While part of the band destroyed the machinery, sentinels were posted to give warning of the approach of the military. Vigorous repressive measures, and, especially, reviving prosperity, brought the movement to an end. It has been commemorated in fiction, notably in Charlotte Brontë's novel *Shirley* (1849). *Ben o'Bills* by D. F. E. Sykes (1898) is a "novel" in which is concealed much genuine history written from a Luddite point of view. (A. BRI.)

LUDENDORFF, ERICH (1865–1937), German general who was mainly responsible for military policy and strategy in the latter years of World War I, was born at Kruszewnia near Posen (Poznan) in Prussian Poland on April 9, 1865, of an impoverished landowning family. This background and his father's bankruptcy had a permanent influence on the son who, throughout his life, remained an austere figure without a spark of humour.

Ludendorff entered the army through the cadet corps, became an infantry officer and, from 1894 onward, served almost continuously on the general staff. From 1908 to 1912 he was head of the deployment section and thus responsible for the detailed planning for the invasion of France and Belgium. He appears to have had no thoughts outside his work, his only relaxation being short periods of travel in pursuit of military knowledge: he once remarked that, apart from strictly military literature, he had never read a serious book in his life.

From 1912 to 1914 Ludendorff commanded an infantry brigade; but on mobilization in July 1914 he was posted to headquarters, 2nd army, as quartermaster general. The German plan of operations in the west when World War I broke out hinged on the speedy capture of the Belgian fortress of Liège; and Ludendorff, who was familiar with every detail of the arrangements, was attached as liaison officer with the commander of the force which was to effect the capture. He personally led the body of troops which seems to have surprised the garrison by infiltration. The fortress and all the outlying forts of Liège were captured in 48 hours with very small losses.

Because of the threat of a large-scale Russian invasion of East Prussia, the elderly Gen. Paul von Hindenburg was recalled from retirement to take command of the 8th army in the east, and Ludendorff was appointed as his chief of staff. The chief of staff of a German army had two loyalties: on the one hand to his commander, on the other to the chief of the general staff at supreme headquarters. This resulted in the chief of staff's possessing power and authority to a degree unknown in other armies. Not infrequently the nominal commander became a figurehead and the chief of staff the commander in all but name. This system determined the partnership of Hindenburg and Ludendorff.

By a series of lightning moves, Hindenburg and Ludendorff won two great victories over the Russians (Aug.–Sept. 1914); but they were not decisive and did no more than stabilize the eastern front for the time being. Thus Hindenburg and Ludendorff remained in charge of a vastly expanded eastern front until the end of Aug. 1916. By that time the policy of Erich von Falkenhayn (the chief of the general staff) had become discredited, and the emperor William II then appointed Hindenburg (with Ludendorff as his first quartermaster general) to assume supreme military control. Ludendorff's first task was to secure some improvement on the western front, where German failure to capture Verdun, together with heavy losses both there and on the Somme front, had created a dangerous situation. This was eased in March 1917 by withdrawal to the "Hindenburg line."

Ludendorff now became increasingly involved in political matters. Though he never advocated military dictatorship he constantly reiterated his desire for a "strong policy," by which he meant government by civilians who would acquiesce to the measures he and Hindenburg considered necessary (the fall of Theobald von Bethmann Hollweg and the appointment of Georg Michaelis as chancellor were largely contrived by Ludendorff). It was here that Ludendorff's limited outlook became apparent. During the early operations on the eastern front he had proved himself a fine campaign strategist, but the broader strategy of supreme control was beyond him, as were the problems of finance, industry, social changes and foreign policy in which he interfered. He did much to formulate the terms of the treaties of Brest-Litovsk and of Bucharest and the German plans for a puppet kingdom of Poland; he was also a strong advocate of unrestricted submarine warfare.

The collapse of Russia at the end of 1917 enabled the high command to transfer troops from the eastern to the western front. Ludendorff judged that the time was ripe for an all-out effort, and elaborate preparations were made for an offensive in the early spring of 1918. The front selected was that held by the numerically weak British 5th army; the objective being the important communications centre of Amiens. The offensive opened on March 21, 1918, and met with considerable initial success, but by the first days of April its impetus had flagged and Amiens was never reached. This offensive was followed by others—at Lys (April 9), Chemin-des-Dames (May 27), Metz (June 9) and Reims (July 15). By the end of July the German armies had shot their bolt: Ludendorff's final bid for victory had failed and the Allied armies were themselves about to begin the final and decisive offensive of the war. After the collapse of Turkey and Bulgaria, Ludendorff fell into extreme despondency and on Sept. 29 peremptorily demanded that the imperial government should at once conclude an armistice and sue for peace. However, he recovered sufficiently to oppose violently the new government of Prince Max of Baden, who had the strength to dismiss him on Oct. 26.

On the signing of the Armistice (Nov. 1918), Ludendorff fled to Sweden, where he wrote his war memoirs. He returned to Germany in the spring of 1919 and became the leader of a reactionary political movement and the apostle of a "Nordic" religion, con-

centrating on the fight against Freemasons, Jesuits, Jews and Marxists. He backed Hitler in his unsuccessful Munich *Putsch* of Nov. 8, 1923: only his past services saved him from the consequences. In May 1924 he entered the *Reichstag* as a National Socialist; and in 1925 he stood, unsuccessfully, for president of the *Reich*. Later Hitler and Ludendorff became bitter enemies. Ludendorff died at Tutzing on Dec. 20, 1937. His publications were *Meine Kriegserinnerungen* (1919; Eng. trans., *My War Memoirs, 1914–1918*, 1919); *Kriegführung und Politik* (1922); and *Mein militärischer Werdegang* (1933).

See H. Delbrück, *Ludendorffs Selbstporträt*, 10th ed. (1922); W. Görlitz, *The German General Staff: Its History and Structure*, Eng. trans. (1953). (C. N. B.)

LÜDENSCHEID, a town of Germany which after partition of the nation following World War II was located in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. It lies in the wooded Sauerland at the watershed of the Lenne and Volme rivers, 19 mi. S.E. of Hagen at an altitude of 495 m. (1,624 ft.). Pop. (1961) 58,239. The main business street, the Wilhelmstrasse, joins several other streets at the city centre, while at the centre of the old town is the Church of the Saviour with a tower dating from 1072. There is a modern hospital, a park and recreational facilities. Lüdenscheid is an industrial centre and manufactures aluminum, plastics and synthetics, light metal products and rolled and semi-finished goods.

A Frankish settlement in the 9th century and chartered in the mid-13th century, Lüdenscheid became during the middle ages a centre of the iron industry, and was a member of the Hanseatic league. In the 17th century it passed with Cleves-Mark to Brandenburg; during the French occupation of 1806–15 it belonged to the grand duchy of Berg. In 1723 the town was destroyed by fire. (R. A. Kr.)

LÜDERITZ (formerly Angra Pequena), a lighterage port in South West Africa, 419 nautical miles N.N.W. of Cape Town, S.Af., by sea. Pop. (1960) 3,604. Entry is forbidden to large areas (*Sperrgebiet*) of the Namib desert hinterland because diamonds are present. Rainfall is about 0.6 in. annually and the town depends on condensed sea water. A railway links Lüderitz with the main South West African system at Seeheim (197 mi. E.) and a single road crosses the restricted area to Aus (83 mi. E.). Lüderitz is a health and holiday resort. Rock lobsters and fish meal are processed; other industries are seaweed milling, sealing, guano recovery and boatbuilding. Bartolomeu Dias de Novaes (*q.v.*) erected a cross (replaced by a replica) on a rocky promontory nearby in 1486. He named the bay Angra Pequena. In 1883 the German merchant Franz Adolf Lüderitz established a trading post there. Diamonds were discovered in 1908 but after a period of development mining activities were transferred to richer fields near the mouth of the Orange river. The town was renamed Lüderitz in 1921. (P. D. du P.)

LUDFORD, NICHOLAS (*c.* 1485–*c.* 1557), one of the most important English composers of the early Tudor period. Though mentioned in Thomas Morley's list of English authors consulted in the preparation of his famous *Plain and Easy Introduction to Practical Music* (1597), Ludford otherwise went unnoticed until the 20th century. Very little is known of his life. He was admitted to the Fraternity of St. Nicholas, the guild of parish clerks of the city of London, in 1521, and was identified as a verger in the dissolution certificate of the collegiate church of St. Stephen's, Westminster, in 1547; he was still receiving a pension in 1555–56. Eleven of his Masses have survived complete. These comprise a set of seven daily Lady Masses, complete with Propers, unique in English music, and four large-scale festal Masses; there is also a fine Magnificat that is musically related to his Mass *Benedicta*.

Bibliography.—Hugh Baillie, "Nicholas Ludford (*c.* 1485–*c.* 1557)," in *The Musical Quarterly*, xliv (1958); J. D. Bergsagel, "An Introduction to Ludford," in *Musica Disciplina*, xiv (1960); *The Collected Works of Nicholas Ludford*, ed. by J. D. Bergsagel (1963–). (Jo. D. B.)

LUDHIANA, a city and district of the Jullundur division in Punjab, India. The city, which is 194 mi. N. of Delhi by rail, is situated on the old bank of the Sutlej river, 8 mi. S. of the present river bed. Pop. (1961) 244,032. The city was founded in 1480 by two members of the Lodi dynasty (then ruling in Delhi) from whom it derives its name. It stands on the Grand Trunk road, and commands a strategic crossing over the Sutlej. The railway line divides the city into two parts. To the north is the old town with a network of narrow alleys along which the houses are huddled together. Chaura Bazaar is the chief shopping centre. Industry is concentrated in Millerganj and in the newly developed areas. The residential areas (civil lines, Model town, Gurdev Nagar and Modelgram) lie to the south. The five arts and science colleges (two for women) and the colleges of agriculture, medicine, engineering and teachers' training are all affiliated with Panjab university. There is a U.S. Presbyterian mission which runs the medical college and a hospital.

Ludhiana is an important railway junction on the Northern railway, connected with Amritsar and Delhi by the main line, and with Ferozepur and Hissar by branch lines. The city is one of the largest manufacturing centres of hosiery goods in India, employing 7,000 workers, and the old fort is occupied by the government hosiery institute. The manufactures are chiefly exported to Ceylon, Burma, Nepal, Indonesia, east Africa and Iraq. The production of cotton textiles, bicycle spare parts, hosiery and sewing machines are the other main industries. The town is also an important wholesale trade centre.

Ludhiana District (area 1,324 sq.mi.; pop. [1961] 1,022,519) is a flat alluvial plain with a strip of flood plain along the Sutlej river. Average annual rainfall is 24.41 in. Agriculturally it is one of the most productive districts of Punjab with about 80% of the total area under cultivation, of which more than 40% is irrigated by the Sirhind canal and wells. Wheat, maize (corn), peanuts, millet, sugar cane and cotton are the principal crops. Jagraon (pop. [1961] 29,617), Samrala (5,439), Khanna (24,416) and Raikot (11,239) are the municipal towns and centres of local trade. (O. P. B.)

LUDLOW, EDMUND (*c.* 1617–1692), English parliamentarian general, whose memoirs set out his republican views, was the son of Sir Henry Ludlow of Maiden Bradley, Wiltshire. He went to Trinity college, Oxford, and was admitted to the Inner Temple in 1638. When the English Civil War broke out, he engaged as a volunteer in the life guard of Lord Essex and served through successive campaigns until 1646, when he was elected member of parliament for Wiltshire and attached himself to the republican party. He was one of the chief promoters of Thomas Pride's purge in 1648, was one of the king's judges and signed the warrant for his execution. In February he joined the council of state.

In Jan. 1651 Ludlow was sent to Ireland as second-in-command to Henry Ireton and as one of the commissioners for civil government. Ireton, the deputy of Ireland, died on Nov. 26, 1651, and Ludlow then held the chief command and had practically completed the conquest of Ireland when he resigned his authority to Charles Fleetwood in Oct. 1652. On returning to England in Oct. 1655 he was arrested, as he refused to acknowledge Oliver Cromwell's authority as protector, but he was allowed to retire to Essex. Ludlow sat in Richard Cromwell's parliament of 1659, but opposed the continuance of the protectorate. He was a member of the restored Rump parliament and of its council of state. In July 1659 he was sent to Ireland as a commander in chief but returned to England in October and, after a brief visit to Ireland at the end of the year, was impeached. Ludlow, having vainly sought to oppose the Restoration, surrendered to the speaker on June 20, but, finding that his life was not assured, although he was not named for capital punishment, he escaped to Switzerland, where he lived at Vevey. He came back to England in 1689 but was forced to return to Vevey, where he died in 1692.

See E. Ludlow, *Memoirs*, ed. by C. H. Firth (1894).

LUDLOW, a market town and municipal borough of Shropshire, Eng., stands on a hill on the left bank of the Teme below its confluence with the Corve, near the Herefordshire border. It is 28 mi. S. of Shrewsbury by road and 24 mi. N. of Hereford. Pop. (1961) 6,796.

The castle, occupying a commanding position, was probably begun in 1085 by Roger de Lacy, with modifications up till the

16th century; it fell into ruins during the 18th century. The Norman keep, the late-Norman circular chapel, the Decorated Gothic state rooms and the Mortimer and Pendover towers are interesting features. John Milton's masque *Comus* was first performed in the great hall (1634) and Samuel Butler, when steward of the castle (1661–62), is thought to have written the first part of *Hudibras* in the room over the 14th-century gateway. Ludlow was laid out on the grid pattern in the 12th century, after the castle was built. Its position ensured it an important place in the military and commercial life of the middle ages. In the 13th century it was fortified with an encircling wall. It was at that time a borough by prescription, having received its first charter in 1189. The burgesses owed most of their privileges to their allegiance to the house of York, the castle having passed in 1425 to Richard, nephew of Edmund Mortimer, who was created duke of York in 1426. In 1461 his son was crowned King Edward IV, the castle became royal property and the town received a royal charter. Thanks to its strong position, Ludlow was the last Shropshire fortress to yield to the parliamentary forces in 1646. The confirmation of early charters in 1665 continued in force until the Municipal Corporations Reform act of 1835. The Council of the Marches held its court at Ludlow castle from the reign of Henry VII until 1689.

The greater portion of the old town wall, together with one of the original seven gates, still remains. The town has many fine half-timbered buildings and several Georgian houses. The parish church of St. Lawrence is of great size with a lofty central tower and some 14th- and 15th-century glass; the ashes of A. E. Housman, the poet, are buried in the churchyard. The grammar school, founded by the Palmers' guild in the 13th century, moved to its present 15th-century building in 1533, since when it has had many additions. There is a county high school for girls (1910). The Butter Cross, an 18th-century building now a museum, and the guildhall (rebuilt 1768) belong to the corporation. The Roman Catholic church is in oriental style. The medieval Ludford bridge over the Teme has been declared an ancient monument. Ludlow is now a thriving market town, a noted centre for sales of Hereford cattle, and a business, social and tourist centre. There are several industries connected with agriculture and light engineering works have been introduced since World War II.

LUDMILA, SAINT (d. 921), wife of Borivoj, the first of the Czech princes to adopt Christianity in 874, and grandmother of St. Wenceslas, was born at Psovka, near Melnik. Her relationship with her daughter-in-law Drahomira, mother of Wenceslas, turned into a feud that ended with Ludmila's murder on Drahomira's instigation in 921. Ludmila was known as a pious woman, who had brought up Wenceslas in the faith, and oral tradition soon surrounded her with a martyr's halo. Only a short time elapsed before the first legends arose: a "prologue on St. Ludmila" in Church Slavonic, one of the oldest works to have arisen independently on Bohemian territory, and a Latin life based on it. The best-known legend is the Latin life of both Wenceslas and Ludmila written by the monk Christian in the 10th century. Ludmila's feast day is Sept. 16.

See J. Pekar, *Die Wenzels- und Ludmilalegenden* (1906).

LUDWIG, EMIL (1881–1948), German writer, the author of a number of effective and popular biographies, was born in Breslau (now Wroclaw, Pol.) on Jan. 25, 1881. His father was a Jewish doctor who changed his name from Cohn to Ludwig. Emil Ludwig studied law at the University of Breslau, but soon devoted himself to writing, mainly plays and verse. During World War I he worked for a Berlin paper as foreign correspondent, at the same time writing novels, sketches and more plays. He then began to develop his talent for "humanizing" historical biography in a series of books in which the main emphasis was laid on the psychological motive. His style was vivid, even flamboyant, and his works achieved international popularity, being widely translated, although they won more favour with the general public than with historians. Clever, stimulating and controversial, with considerable psychological insight, his books lack both historical method and historical manner. His works include biographies of Goethe (1920 and 1923; Eng. partial trans. 1928), Bismarck (1913, expanded 1926; Eng. trans. 1927), Napoleon (1925; Eng. trans. 1926), the emperor William II (1926; Eng. trans. 1927) and Lincoln (1930; Eng. trans. 1930). Ludwig died on Sept. 17, 1948, near Ascona, Switz.

See N. Hansen, *Der Fall Emil Ludwig* (1930); W. Mommsen, *"Legitime" und "illegitime" Geschichtsscheibung* (1930).

LUDWIG, KARL FRIEDRICH WILHELM (1816–1895), German physiologist, one of the founders of 19th-century German physiology and teacher of many notable physiologists, was born at Witzenhausen, near Cassel, on Dec. 29, 1816. He studied at Erlangen and at Marburg, where he taught anatomy and physiology until 1849. He then became professor at Zürich, Switz. Subsequently he went to Vienna and later organized the newly created chair of physiology at Leipzig, 1865–95. He died in Leipzig on April 23, 1895.

Ludwig was ingenious in devising instrumentation for the study of physiological processes. To be especially mentioned are his adaptation of the Thomas Young kymograph for recording arterial blood pressure and respiration and the floating writing point on the mercury manometer introduced by J. L. M. Poiseuille.

His researches comprised a variety of fields. All modern theories of urine and lymph formation stemmed from his original communication on urine secretion (1844). He devised the first blood gas pump and the first instrument for determining the velocity of blood flow in the larger arteries (*Stromuhr*). With Élie de Cyon he discovered the depressor nerve (1866) and with Baxt the accelerator nerves to the heart. He studied the effect of certain drugs on the heart with Oswald Schmiedeberg and Sir Thomas Lauder Brunton, localized the vasomotor centre in the medulla and studied capillary blood pressure. With Wooldridge he studied certain phases of the coagulation of the blood and with H. P. Bowditch discovered the all-or-none law (*q.v.*) of cardiac muscle and the indefatigability of nerve.

Ludwig was the first to demonstrate that human digestive glands might be under the influence of secretory nerves, when he demonstrated that the chorda tympani nerve had such an effect on the submaxillary and sublingual glands. He also demonstrated that stimulation of the nervi erigentes caused a vasodilation.

See the biography by Walter J. Meek in the *Gamma Alpha Record*, vol. xxiii, no. 2, pp. 31–43 (May 1933). (F. L. A.)

LUDWIG, OTTO (1813–1865), German writer remembered for his realistic stories, which contributed to the development of the *Novelle*, was born at Eisfeld, Thuringia, on Feb. 12, 1813. Showing an early aptitude for both literature and music, he was sent to Leipzig in 1839 to study music under Mendelssohn. Later he changed to literary studies, in particular dramatic theory, his principal interest from 1844 to 1849, when he lived in Meissen. His last years were spent in Dresden, where he died on Feb. 25, 1865. His work is *Heimatkunst* (regional art) at its best; he coined the expression *"Poetischer Realismus,"* later used to describe the writing of several of his contemporaries. An admirer of Shakespeare but a sharp critic of Schiller, Ludwig strove to create dramas embodying his theories. *Der Erbförster* (1850), an attempt to depict the psychology and environment of the middle class, owes much to the Schillerian tragedy, despite Ludwig's efforts to avoid this effect. His other plays are forgotten, but his graphic stories of Thuringian life are still read, *e.g., Die Heiterethei* (1854), the humorous tale of a village love affair, and the psychological masterpiece *Zwischen Himmel und Erde* (1855; Eng. trans., *Between Heaven and Earth*, 1928), in which a tragic conflict between two brothers is played out against the background of the slaters' trade. Ludwig's collected works were published by A. Stern and E. Schmidt (6 vol., 1891); unfinished critical edition by P. Merker (6 vol., 1912–22).

For biographies, studies and other editions *see* W. Kosch, *Literatur-Lexikon*, vol. ii (1953), pp. 1587–88. (L. H. C. T.)

LUDWIGSBURG, a town of Germany which after partition of the nation following World War II was located in the *Land* (state) of Baden-Württemberg, Federal Republic of Germany. It lies on the Neckar, 14 km. (9 mi.) N. of Stuttgart by road. Pop. (1961) 73,512. The town is celebrated for its many baroque buildings, chief of which is the former royal palace, the largest

baroque castle in Germany, set in a well-laid-out park. It contains 452 rooms, including the gallery of the ancestors of the Württemberg dynasty, a portrait gallery, a chapel, a theatre and the burial vault of the rulers of Württemberg. In the knights' hall the monthly Ludwigsburg castle concerts take place. An annual garden show, "Flowers and Baroque," with a fairy-tale garden, is held in the park. Ludwigsburg is on the Stuttgart-Frankfurt railway; another line runs to Karlsruhe. Machines, iron and wire goods, bird cages, organs and pianos, brewing machines and textiles are manufactured and the town has an important savings bank for house building. From 1758 to 1824 the town produced the famous Ludwigsburg porcelain. Founded at the beginning of the 18th century by Duke Eberhard Ludwig of Württemberg, Ludwigsburg was enlarged by Duke Karl Eugen.

LUDWIGSHAFEN, a city and river port of southwest Germany, after partition of the nation following World War II in the *Land* (state) of Rhineland-Palatinate, Federal Republic of Germany, is an industrial and commercial centre and the gateway of the wine-growing region. Pop. (1961) 165,761. On the Rhine, facing Mannheim, it was established early in the 17th century as a bridgehead on the left bank of the river. It was named by Louis I, king of Bavaria, in 1843 but was not made a town until the 1850s. The city is noted for its large chemical industry, established there in the mid-1860s, which produces aniline dyes, fertilizer, alkali and other products; there are also manufactures of metal, glass and pharmaceutical machinery. Trade in iron, coal and agricultural products was fostered by the opening of the harbour in 1897, and the town is an important railway junction.

The city was severely bombed during World War II. After the war, athletic events in the new Southwest stadium (capacity 85,000) attracted international participation and interest, and tourist services were important to the economy.

The pilgrimage church of Maria Himmelfahrt (1774–77) is in the Oggersheim district, where Schiller lived after fleeing from Stuttgart.

LUEGER, KARL (1844–1910), co-founder of the Christian Social party of Austria and burgomaster or mayor of Vienna, was born in Vienna on Oct. 24, 1844, the son of a caretaker at the Polytechnic institute. He received a careful upbringing at the Theresianum, studied law in Vienna and early became interested in social problems. Elected to the Vienna municipal council in 1875 and to the Austrian parliament in 1885, he won popularity by concerning himself with the petty questions of the day and by zealously exposing cases of corruption. Though he was not himself an anti-Semite and regarded German nationalism with skeptical antipathy, he did not scruple to exploit the prevalent anti-Semitic and nationalistic currents in Vienna for his own demagogic purposes. He had no part in the constitution of the Christian Social union (1887), but was one of the founders of the Christian Social party, which emerged in 1889. The most effective champion of this party, he won for it more than two-thirds of the seats on the Vienna municipal council in 1895; but because of Lueger's reputation as an agitator the Austrian prime minister, Graf Badeni, advised the emperor Francis Joseph not to confirm his appointment as mayor. In the spring of 1897, however, the emperor finally yielded to the pressure of public opinion and confirmed Lueger's appointment. As mayor, Lueger proved better than his reputation: he reorganized the gas supply and the tramway system, developed parks and gardens in the city and rebuilt schools and hospitals. Moreover, the introduction of universal suffrage (1905–06) was largely due to his efforts; and he played a decisive part in launching the Christian Social party's plan for the federalization of the empire as a means of solving the problem of the nationalities from 1905 onward. His energies, however, were sapped by a rapidly worsening illness, and he died on March 10, 1910.

See K. Skalnik, *Dr. Karl Lueger: der Mann zwischen den Zeiten* (1954). (K. O. v. A.)

LUFFA (Loofah), the name given to the fruit of the sponge gourd (*Luffa cylindrica*), a herbaceous plant of the family Cucurbitaceae (*q.v.*). *See* also Gourd.

LUGANO (Ger. Lauis), the largest town in Ticino canton, Switz., is situated on the shore of the Lake of Lugano, 200 km. (124 mi.) from Lucerne and 83 km. (51½ mi.) from Milan, Italy, by rail. It is the seat of a bishop with jurisdiction over the Italian-speaking parts of Switzerland. Pop. (1960) 19,758, almost all Italian speaking. To the south is Monte San Salvatore (2,992 ft.), to the east, Monte Brè (3,061 ft.), and to the southeast (across the lake), Monte Generoso (5,584 ft.); the first two are accessible by funiculars and the last-named by steamer to Capolago and from there by cogwheel railway.

Though politically Swiss from 1512, Lugano is Italian in appearance and character. The cathedral of San Lorenzo in part dates to before the 15th century. The church of Santa Maria degli Angioli, built about 1499 and until 1848 occupied by Franciscans, contains several frescoes by Bernardino Luini. One of the greatest private art collections in Europe is in the Villa Favorita in Castagnola. Situated on the St. Gotthard railway line, which is connected to the quays by funicular railway, Lugano is much frequented by tourists. They are the city's most important source of revenue, but there is some industry including chocolate and machine manufacturing. During the struggle of 1848–66 to expel the Austrians from Lombardy, Lugano served as headquarters for Mazzini. Books and tracts intended for distribution in Italy were produced there and at Capolago, beyond the reach of the Austrian police. (P. Bi.)

LUGANO, LAKE OF (Italian Lago di Lugano; anc. Lacus Ceresius), lies partly in Italy and partly in Switzerland, between Lake Maggiore and Lake Como. The great promontory of San Salvatore (2,992 ft.) nearly cuts off the western arm from the main lake. The area is 50½ sq.km. (19½ sq.mi.), of which about 46 sq.km. (18 sq.mi.) are in the Swiss canton of Ticino, formed in 1803 out of the conquests made by the Swiss from the Milanese in 1512. The remainder of the area is in the Lombardy region of Italy, to which also belongs the small enclave of Campione, almost opposite the town of Lugano, Switz. The lake lies among the outer spurs of the Alps that divide the Ticino basin from that of the Adda, where the calcareous strata have been disturbed by the intrusion of porphyry and other igneous rocks. It is fed by numerous torrents issuing from short glens in the surrounding mountains, and is drained by the Tresa, an unimportant stream flowing into Lake Maggiore. The greatest length of the lake is about 22 mi., the greatest width 2 mi. and the greatest depth 945 ft.; the surface is 889 ft. above sea level.

Between Melide, Switz., south of the town of Lugano, and Bissone, on the eastern shore, the lake is so shallow that a great stone dam has been built across it for the St. Gotthard railway line and the road. The chief town is Lugano, at the northern end, which by the St. Gotthard line is 19 mi. from Bellinzona, Switz., and 9 mi. from Capolago, the station at the southeastern extremity of the lake which is only 8 mi. by rail from

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SAN SALVATORE PROMONTORY, LOCATED IN SWITZERLAND, AS SEEN FROM ACROSS LAKE LUGANO ON THE SWISS BANK

Como. In Italy, at the lake's southwestern extremity, a railway leads southwest from Porto Ceresio to Varese (9 mi.). Porlezza, at the east end of the lake, is 8 mi. by rail from Menaggio on Lake Como, while Ponte Tresa, at the western end, is about 13 mi. by electric railway from Luino on Lake Maggiore. The first steamer was placed on the lake in 1848.

LUGANSK (formerly VOROSHILOVGRAD), *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., was formed in 1938 and covers an area of 10,309 sq.mi. in the extreme east of the Ukraine. The Severny (Northern) Donets cuts across the *oblast* from W.N.W. to E.S.E. North of the river is open, rolling steppe, with dry interfluves between the valleys of the Krasnaya, Aidar and Derkul, tributaries of the Northern Donets. South of the Northern Donets are the low hills of the Donets ridge (Donetski Kryazh), originally forest-steppe, but, like the northern part, now almost wholly under the plow.

Lugansk *oblast* covers the eastern half of the industrialized Donbass or Donets Basin (*q.v.*). Population in 1959 was 2,452,172, a very high proportion (79.3%) of which was urban and lived in 24 towns and 118 urban districts, the largest being the administrative centre of Lugansk (*q.v.;* 274,520), Kadiyevka (180,205), Kommunarsk (97,561, formerly Voroshilovsk), Krasny Luch (93,764) and Sverdlovsk (62,155) (to be distinguished from Sverdlovsk in the Ural mountains). The *oblast's* economy is overwhelmingly dominated by the great industrial area, especially its coal mining, which is the basis for much of the industrial output. There is large-scale iron and steel production, with associated heavy engineering and chemical industries. Many of the pits and factories had to be entirely rebuilt after World War II, when the Donbass was occupied by the Germans, and thus have modern equipment. Agriculture is well developed and is largely concerned with grain production, especially wheat and barley. Maize (corn), for human and animal consumption, and sunflowers are also important. There is much market gardening around the towns. (R. A. F.)

LUGANSK (VOROSHILOVGRAD, 1935–58), a town and *oblast,* centre of the Ukrainian Soviet Socialist Republic, U.S.S.R., stands on the Lugan river at its confluence with the Olkhovaya 420 mi. E.S.E. of Kiev. Pop. (1959) 274,520. The town dates from 1795 when a state iron foundry was established there to supply ordnance to the Black sea fleet. Lugansk grew with the development of the Donbass or Donets Basin (*q.v.*) in the 1890s and industrialization was accelerated in the 1930s. It had 20,000 inhabitants in 1895, and its present population makes it one of the largest cities of the Donbass. The major branch of its industry is heavy engineering. The former gigantic steam locomotive works, which in 1941 produced almost half the engines in the U.S.S.R., now makes diesel locomotives. Steel tubes, coal-mining equipment, tractor spares and enamelware are also made. Lugansk has a relatively small iron and steel works, most of the steel coming from other Donbass towns. It has pedagogic, agricultural and machine-building institutes and many technical schools, Ukrainian and Russian theatres, a concert hall and two museums. In World War II the town was occupied by the Germans.
(R. A. F.)

LUGARD, FREDERICK JOHN DEALTRY LUGARD, 1ST BARON (1858–1945), British colonial administrator mainly associated with the development of Nigeria. He was the eldest son of the Rev. F. G. Lugard, a senior chaplain at Madras, and was born at Fort St. George, Madras, on Jan. 22, 1858. He was commissioned in the East Norfolk regiment in 1878, after only two months at the Royal Military college, Sandhurst, and joined his regiment in India. He served in the latter stages of the Afghan War (1878–80); seconded to the military transport service, he saw further fighting in the Sudan campaign (1884–85) and in Burma (1886–87) and was awarded the Distinguished Service order in 1887. While on leave from the army in May 1888 he took command of an expedition organized by British settlers in Nyasaland against Arab slave traders on Lake Nyasa and was severely wounded.

Lugard was engaged in 1889 by the Imperial British East Africa company, which had been granted a charter authorizing it to develop British influence in east Africa, and in their service explored the Sabaki river region and drew up a plan under which fugitive slaves might work to earn money and so purchase their freedom. The company sent Lugard to Uganda in 1890 where he secured British predominance and, after severe fighting, put an end to the civil disturbances caused by the rivalry of the "French" (Roman Catholic) and "British" (Anglican) factions. While administering Uganda he traveled through, and mapped, large areas of the country. Returning to England in 1892, Lugard strongly opposed the contemplated abandonment of Uganda by Great Britain.

In 1894 Lugard was dispatched by the Royal Niger company to the region of Borgu, which the French government was eager to acquire. Reaching Borgu before a rival French expedition which had started before him, he secured treaties with the chiefs acknowledging the sovereignty of the company. After an expedition to Lake Ngami (1896–97) he was recalled in 1897 and sent back to west Africa to organize a local force for the protection of British interests against the French and in August raised the West African Frontier force of African soldiers led by British officers.

The differences with France were settled and after the Royal Niger company had surrendered its charter Lugard was appointed high commissioner and commander in chief of the protectorate of northern Nigeria (1900). Little of the country was under effective control but a successful campaign (mainly to put a stop to slave raiding) against the emir of Kano and the sultan of Sokoto in 1903 facilitated the effective extension of British administration. Owing to the shortage of British staff, Lugard introduced the system of indirect rule, the chiefs and officials of the native states administering their areas under the supervision of British residents. (*See* NIGERIA: *History*).

Resigning his office in Sept. 1906 Lugard was appointed governor of Hong Kong in April 1907; the present University of Hong Kong owes much to his initiative. He was appointed governor of both northern and southern Nigeria in 1912, with instructions to amalgamate the two administrations. This became effective on Jan. 1, 1914, and Lugard was given the title of governor general. He guided the affairs of Nigeria throughout World War I, retiring in 1919. From 1923 to 1936 he was a member of the Permanent Mandates commission of the League of Nations.

Lugard published *The Rise of Our East African Empire* (1893), which was partly autobiographical, and also wrote various valuable reports on Nigeria. His most important publication was *The Dual Mandate* (1922), a book dealing with the duties of European powers in tropical Africa. Throughout his career in Nigeria Lugard sought to ameliorate the conditions of the African people and to eliminate slavery and the slave trade.

In 1902 he married Flora Louisa Shaw who had been a distinguished writer on colonial subjects for the *Times* (London). He was knighted in 1901, was made a privy councilor in 1920 and was created a baron in 1928. He died at Abinger, Surrey, on April 11, 1945.

See Margery Perham, *Lugard, the Years of Adventure, 1858–1898* (1956), and *Lugard, the Years of Authority, 1898–1945* (1960).
(A. C. Bs.)

LUGBARA (LOGBARA), a Sudanic-speaking people numbering about 244,000 in the 1960s. About three-quarters of them live in the West Nile district of northwestern Uganda (*q.v.*) and the remainder in the adjoining area of the Republic of the Congo. They are closely related to the Madi (*q.v.*).

Lugbara are settled agriculturalists, growing millet as the traditional staple, and much cassava and tobacco; they provide many labour migrants who work as share croppers for Ganda (*q.v.*) landowners in southern Uganda. They lack centralized political authority and what formal authority exists is exercised by rainmakers and the heads of large family groups based upon small patrilineal lineages. There are government-appointed chiefs set over large areas. The majority of Lugbara still practise ancestor worship and they believe in a creator-god, Adroa.

The Lugbara were one of the tribes of the Lado enclave, and were administered as part of the Congo Free State (later the Belgian Congo) from 1900 to 1908; then by the Sudan government until 1913 when they became part of Uganda. They are one

of the tribes least affected by modern changes among the peoples of Uganda, with a strong sense of their own identity in contrast to their Bantu-speaking neighbours to the south. *See* also AFRICA: *Ethnography (Anthropology)*: *East Africa.*

See J. F. M. Middleton, *Lugbara Religion* (1960); J. P. Crazzolara, *Study of the Logbara (Ma'di) Language, Grammar and Vocabulary* (1960). (J. F. M. M.)

LUGDUNUM (LUGUDUNUM), a Celtic place name, possibly meaning "fort (or hill) of the god Lugos (Lug)," used by the Romans of at least four towns in or near ancient Gaul. The most important was situated at the confluence of the Rhône and Saône rivers, now Lyons (*q.v.*, for its history), and gave its name to the province of Gallia Lugdunensis. The other towns of that name are the following:

LUGDUNUM BATAVORUM, a town of the Germanic Batavi, though presumably of Celtic origin. It is commonly identified with the modern Leiden (*q.v.*) in the Netherlands, but alternative sites have been suggested on the coast near either The Hague or Katwijk.

LUGDUNUM CLAVATUM, the oldest Latin name for the modern French town of Laon (*q.v.*). By the 7th century *Lugdunum* had become *Laudunum*, hence *Laon.*

LUGDUNUM CONVENARUM, also known as CONVENAE (St. Bertrand de Comminges, Haute-Garonne, France). After the death of Sertorius (72 B.C.) surviving supporters of his were deported across the Pyrenees by Pompey and were settled there (*convenae*, "refugees"). The town flourished under the Roman empire. Herod Antipas and Herodias were exiled there by the emperor Caligula (A.D. 39). Guntram, king of Burgundy, sacked Convenae in 585 and it remained deserted until *c.* 1120, when a cathedral was built there by Bertrand de L'Isle, bishop of Comminges, after whom the present village is named.

See R. Lizop, *Les Convenae et les Consoranni* (1931).

LUGEON, MAURICE (1870–1953), French geologist, a brilliant pioneer in the development of modern Alpine geology, was born at Poissy near Paris on July 10, 1870. He moved with his parents to Lausanne, Switz., in 1876 and graduated at the university in 1893 where he later became extraordinary professor of geology and physical geography in 1898 and ordinary professor eight years later. Lugeon was closely connected with Hans Schardt's tectonic discovery of the far-traveled nature of the rocks of the Prealps that extend from Lake Geneva to Lake Thun and subsequently played the leading part in developing the tectonic ideas thus liberated and in providing a comprehensive interpretation of the Alps as a whole. In *Les grandes nappes de recouvrement des Alpes du Chablais et de la Suisse* (1901) he developed his great synthesis showing that from the Arve to Salzburg the north front of the Alpine chain is composed of large superimposed nappes. His tectonic interpretations were extended by him to regions outside the main Alpine province, notably to the Carpathians, Sicily and Morocco. Lugeon won international renown as a consultant on dam sites and published authoritative memoirs in this field: *Étude géologique sur le projet de barrage du Haut-Rhône français à Génissiat* (1912) and *Barrages et géologie* (1933). He died in Lausanne on Oct. 23, 1953. (C. E. T.)

LUGGAGE. The first piece of luggage was probably the crudely dressed pelt in which primitive man wrapped his few possessions. As man learned to use sinews, simple laced bags were evolved. Then plaiting with reeds permitted more variety of form, including rectangular baskets. Chests of wood followed; they were first dug out, later joined. Egyptian and Greek chests, some used as traveling coffers, were often beautifully painted on gesso; many were covered with leather, which overlapped the juncture of lid and body to prevent ingress of water, and strengthened with flat bands of iron. The large medieval coffer (the earliest recorded use of "trunk" is in 1462), often called a standard, usually took the form of a rectangular box with a hemihexagonal vaulted lid; it was made of thick planks of wood covered with oxhide and banded with iron in both directions. It generally had two locks and two or more handles and its weight was considerable. The lighter form of coffer with arched lid was seldom used before the 17th century. Instead of iron bands, iron or brass corner plates gave protection, and the leather was secured with iron or brass nails often worked into attractive patterns; often deer hide, retaining the hair, was used. More readily portable medieval luggage bore such expressive names as gardeviance, clothesacke and mail; none survive but they were probably essentially bags.

There was no great change until the 19th century, when there appeared trunks and cases of solid cattle hide up to $\frac{3}{8}$ in. thick. The leather trunks were later replaced by lighter and cheaper "cabin" trunks; these, made at first of compressed cane and then of compressed flax fibre, were covered with painted or proofed flax canvas and strengthened with bentwood hoops, later imitated in cheaper jute canvas and bent plywood. Toward the end of the 19th century many trunks—some, like the Saratoga, with trays and compartments—were made of deal covered with waste leather, painted canvas and even printed tinplate. This type was succeeded by the lighter steamer trunks of sheets of plywood covered by painted and varnished vulcanized fibre. The first wardrobe trunks also appeared at the end of the 19th century. These stood upright, some 40 in. high, one half being fitted with bars and hangers, the other with drawers.

Early bags used as luggage were made largely of leather but also of canvas and were fastened with drawcords, rods and padlocks, or iron frames. In the middle of the 19th century, when heavy leather portmanteaus were still in vogue, there appeared a series of lightweight bags made of split hide (and occasionally of crocodile or morocco leather) hung from a light mild-steel frame provided with locks and other fittings: the Gladstone, Hartington and Rosebery bags were familiar before World War II, as were kit, brief and square bags. In the third quarter of the 19th century split hide was also used, with a foundation of strawboard, for the rigid form of suitcase that lingered on to the 1940s. Shortly after 1918 the zip (slide) fastener was applied to hand luggage, revolutionizing style and design. Zip bags are now made in leather and various fabrics. In the 1920s came the soft-top case, usually covered with cotton coated with a nitrated cellulose and misnamed leather cloth; this piece was essentially a preformed cover to whose perimeter was applied a stiffening board strengthened with wire frames.

After World War II greatly increased traveling, particularly by private automobile and on airplanes that restricted the weight of luggage carried free, and the necessity of handling one's own luggage encouraged the design of lightweight but robust luggage. For this type, plywood has been used; it is bent by heat or built up over molds and covered with leather, canvas or coated fabrics, the tougher polyvinyl chloride having replaced the earlier nitrated cellulose materials. The usual cotton fabric base has been experimentally replaced by fabrics woven from plastic yarns and glass fibre. Molded forms have been employed; they were made at first of light metal alloys, later of sheets of cellulose acetate laminated with woven fabrics, and then of a "dough" of polyester resin and glass fibre: none was light, cheap or attractive, and all called for costly plant and tools. A cheaper case was made from a "dough" of polyester resin mixed with wood fibre, sometimes with a small percentage of glass fibre. These molded shells were light and inexpensive but had to be covered with coated fabrics, polyvinyl chloride sheets or leather, thus losing many of the advantages of mechanical molding. The first molded forms that dispensed with coverings were made of polypropylene as injection moldings, but the high cost of the hollow molds could be recovered only from large-scale production. This method was rendered obsolete, however, by the introduction of sheet materials that were first softened by heat and then pulled over formers by the vacuum-forming process. The material most widely used in this process in the 1960s was acrylonitrile butadiene styrene. *See* also BAG. (J. W. WA.)

LUGO, a town in northwestern Spain, capital of a province of the same name. It is situated on the Miño river 95 km. (59 mi.) S.E. of La Coruña by road. It is a commercial centre with important fairs and markets, and has slaughterhouses and meat-chilling plants. Pop. (1960) 58,264 (mun.). The Roman walls of the ancient Lucus Augusti remain. Houses built of granite and

slate, with *soportales* (porticoes) as a protection against the rain, predominate. There is a splendid Romanesque cathedral and San Francisco is a fine Gothic church. The town was attacked by the Normans during the middle ages. During the Peninsular War it was occupied by French troops after the withdrawal of Sir John Moore's army.

LUGO PROVINCE, one of the four comprising the region of Galicia, is bordered by the Bay of Biscay in the north, Asturias and León in the east, Orense on the south and by Pontevedra and La Coruña on the west. Area 9,803 sq.km. (3,785 sq.mi.). Pop. (1960) 479,530. The main roads are Madrid-La Coruña and Santander-Oviedo-La Coruña, and the chief rail routes are Palencia-La Coruña and Monforte de Lemos-Vigo. The province came into existence in 1833. Besides the capital, its most important cities are Mondoñedo (episcopal see), Monforte de Lemos and Vivero.

The coast line extends for 97 km. (60 mi.) from the *ría* (inlet) of Ribadeo in the east to that of Barquero in the west. It is steep and has many *rías;* the ports engage in fishing and the coasting trade. The Cantabrian mountains, with Peña Rubia (6,073 ft.), extend into the province. The Sierra de Meira divides the waters of the Sil river from the Eo. There are two hydrographic systems: the Cantabrian (Navia and Eo rivers) and Atlantic (Eume, Ulla, Miño and Sil). There are many medicinal springs. The principal sources of wealth in the province are agriculture and fishing, which together employ 80% of the population. Lugo is the main Spanish producer of rye and potatoes, but cattle and pig breeding are more important. (M. B. F.)

LUGOJ, a town and administrative centre of Lugoj district of Timişoara *regiunea* (region) in the Banat, Rum. Pop. (1960 est.) 31,670. The town lies on the banks of the Timiş river and is a rail and road centre. It is first mentioned in 1369, though a settlement there is said to date from the 13th century. Lugoj is the seat of Orthodox and Uniate bishoprics and has several old churches.

Industries include the manufacture of silk, textiles, bricks and tiles, wine and leather goods, and food processing. Lugoj was formerly divided, with a Rumanian town on the south bank and a German town on the north bank, reflecting the strong medieval German influence.

LU HSÜN (LUSIN; pseudonym of CHOU SHU-JEN) (1881–1936), Chinese writer, scholar, teacher and translator, was born of gentry stock at Shao-hsing, Chekiang. The imprisonment of his grandfather and the death of his father reduced the family circumstances when he was still a child and embittered his outlook. He matriculated at the School of Railways and Mines, Kiangnan Military academy, Nanking, and later studied western medicine, philosophy and literature in Japan on a government scholarship, returning home an ardent anti-Manchu revolutionary and a moderate cultural protectionist. In 1912 he joined the republican ministry of education, moved to Peking and devoted his leisure time to antiquarian pursuits. At the urging of friends associated with the nascent literary movement, he wrote the short story "A Madman's Diary" (1918), a pungent satire on the dark, animal forces of traditional, Confucian-oriented society. *The True Story of Ah Q* (1921) is his representative work. A mixture of humour and pathos, it is a repudiation of the old order and a classic portrayal of the national psychology. Other stories in *Call to Arms* (1923), the work that brought him national prominence, the volume *Hesitation* (1926) and the various symbolic prose-poems, reminiscences and retold classical tales all reveal a modern sensibility informed by a sardonic humour and biting satire. Although Lu Hsün is better known abroad for his works of fiction, the prose essay is more characteristic of his genius. Forced by political circumstances to flee Peking in 1926, he eventually found sanctuary in the Shanghai International settlement, where, alienated from the right and courted by the left, he turned increasingly to direct prose expression. His *Outline History of Chinese Fiction* and companion compilations of classical fiction remain standard works. Translations, largely from the Russian, also occupy a large place in his complete works. Independent, antimaterialistic and antiauthoritarian, and imbued with a profound sense of moral justice, Lu Hsün nevertheless was adopted posthumously as the exemplar of socialist realism by the Chinese Communist movement.

CHOU TSO-JEN (1885–), eminent literary figure known for the casual, sophisticated essay, and CHOU CHIEN-JEN (1889–), scientist, teacher, politician and Communist governor of Chekiang province, are brothers of Lu Hsün. (W. R. Sz.)

LUHYA, a cluster of Bantu-speaking tribes in western Kenya, often known as Bantu Kavirondo; they numbered about 654,000 in the 1960s and in most parts of their country the population density is extremely high. They are agriculturalists, and provide labour migrants who are found in all parts of east Africa.

The main tribes include the Logoli, Vugusu, Nyala, Isukha, Marama, Idakho, Tiriki and Nyore. All lack traditional chieftainship, being organized into more or less politically autonomous patrilineal lineages, each associated with a stretch of land. With land shortage there has been considerable tribal interspersal. In the centre of the country are the Wanga (Hanga), the only people of Kenya with a traditional kingship. The king or chief of Wanga when the British came in the 1890s was Mumia, who sought paramountcy over the neighbouring tribes. The British supported his attempts, recognizing him as paramount until the late 1920s; but by the time he died in 1952 Wanga supremacy had dwindled. After that time, however, Luhya unity came to the fore as a political aim, with the realization of their cultural and linguistic identity as distinct from that of the neighbouring Nilotic Luo and Nilo-Hamitic Nandi, Kipsigis and Masai. *See* also KAVIRONDO; KENYA; AFRICA: *Ethnography (Anthropology); East Africa.*

See G. Wagner, *The Bantu of North Kavirondo,* 2 vol. (1949, 1956). (J. F. M. M.)

LUINI (LUVINI), **BERNARDINO** (fl. 1512–1532), Lombard painter, is best known for his religious frescoes. Although his fame has long been considerable, exceedingly little is known of his life, even Giorgio Vasari giving the minimum information. The earliest surviving painting certainly his work is a fresco of the "Madonna and Child" at the Cistercian monastery of Chiaravalle, near Milan. A contemporary record states that this was painted in 1512 by "B. Luino." This is also the earliest certain evidence of the painter's existence, statements concerning his birth and apprenticeship which are sometimes given as fact being derived from sources too late to be reliable. An altarpiece of the "Madonna and Child With Saints," now in the Musée Jacquemart-André, Paris, bears the inscription "Bernardin (us) Mediolanensis faciebat MDVII" and may be an early work of Luini, but the omission of the surname in the signature precludes certainty. An altarpiece of the "Lamentation Over the Dead Christ" in the church of Sta. Maria della Passione at Milan is likewise frequently, but not universally, considered an early work of Luini, but it has no signature or documentation to support it.

Between 1512 and his death in 1532 a number of paintings are signed or otherwise reliably attributed, and still others can be ascribed to Luini with confidence on the strength of resemblance to the first group. Of these numerous works, the most important among those with religious subjects are the series of paintings in the churches of S. Giorgio al Palazzo and S. Maurizio at Milan, the frescoes in the church of Sta. Maria dei Miracoli at Saronno, the two Adorations "of the Magi" and "of the Shepherds" in Como cathedral, the huge fresco of the "Crucifixion" in the church of Sta. Maria degli Angeli at Lugano and the altarpieces at San Magno, Legnano, and in the Di Rovasenda collection at Turin (from Mendrisio). Of Luini's fewer paintings of secular subjects, the most important are two series of frescoes, subsequently detached and dispersed. One of these came from the Villa Pelucca, near Monza. It consists of various mythological subjects and also some from the Old Testament. Most of the pieces are now in the Brera, Milan. The second, from Casa Rabia, Milan, is divided between the state museums, Berlin and the National Gallery of Art at Washington, D.C. The subjects are the stories of Europa and of Cephalus and Procris. Luini's work is represented in other galleries in Europe and the United States and in Canada.

The art of Luini in its entirety fits naturally into the Lombard tradition of the second half of the 15th century and the opening

years of the 16th, as exemplified by Vincenzo Foppa, Bernardino Butinone, Bernardino Zenale, Borgognone, Bramantino and Andrea Solari. To many scholars, however, one of the main points of interest is its relation to that of Leonardo da Vinci. The periods of the latter's second residence in Milan were 1506–07 and 1508–13 and while it is certain that his work was known to Luini, no evidence of personal contact is forthcoming. Although Luini, on at least one occasion, incorporated a design of Leonardo's into a painting ("Holy Family" in the Ambrosiana, Milan, from Leonardo's cartoon now at the Royal Academy, London), he showed in general greater independence with regard to the great Florentine than did most of his Milanese contemporaries. The excellence of his craftsmanship and the unstudied sweetness of his pictures were the qualities which endeared him to John Ruskin and to the later 19th century.

See Angela Ottino della Chiesa, *Bernardino Luini* (1956).

(C. H. M. G.)

LUÍS I (1838–1889), king of Portugal from 1861 to 1889, was born in Lisbon on Oct. 31, 1838, the second son of Maria II and Ferdinand of Saxe-Coburg. He was destined for the navy but the unexpected death on Nov. 11, 1861, of his brother Pedro V placed him on the throne instead. He married Maria Pia of Savoy in 1862. The reign began inauspiciously, with public disturbances and a financial crisis later aggravated by the suspension of remittances from Brazil which the Paraguayan War provoked. The overthrow of Isabella II of Spain (1868) led to agitation in favour of an Iberian union under Luis but he disavowed the idea. The king was criticized for the exercise of unconstitutional powers in attempting to control political turmoil. Republican agitation increased and republicans ran for national office in the elections of 1879. The Camões quadricentennial celebration (1880), promoted by the Freemasons, played into republican hands. In 1881 republicans aroused public opinion against the proposed treaty with Great Britain over Mozambique and India. Despite the agitation, railroads were built at home and in Africa, and the disputes with Britain over Bolama and Lourenço Marques were settled favourably by arbitration. Less satisfactory treaties were signed with France and Germany over African boundaries. Literature flourished during the reign. The king himself was artistically talented. He translated Shakespeare and works from the French. When he died in Cascais on Oct. 19, 1889, he left political problems that were to be the undoing of his successor. (M. Ca.)

LUITPOLD (1821–1912), prince regent of Bavaria from 1886, was born on March 12, 1821, in Würzburg, the third son of King Louis I. By his marriage (1844) to Augusta, daughter of Leopold II of Tuscany, he had three sons and one daughter. He followed the customary military career and commanded a division in the Seven Weeks' War against Prussia (1866). On Jan. 18, 1871, he was present at the proclamation of the German empire at Versailles. Against his will he took over the regency of Bavaria in June 1886, when his nephew King Louis II was found unfit to rule; and after Louis II's tragic death a few days later he remained regent for his younger nephew Otto, who was completely insane. Luitpold's consciously patriarchal form of government soon succeeded in overcoming his people's initial mistrust. The cabinet of Johann von Lutz (prime minister since 1880) was left in office till 1890 despite its tactless handling of the royal tragedy; and Bavaria was governed strictly in accordance with liberal principles. In 1890, however, Luitpold secured a better relationship with the Roman Catholic Church, and this was further consolidated while Friedrich von Crailsheim was prime minister (1890–1903). In his dealings with the German imperial government Luitpold maintained an attitude of strict loyalty: he refrained from pursuing an actively federalist policy and did nothing to make his influence felt in foreign affairs, even though the emperor William II's methods caused him anxiety. The reform of the electoral law (1906), combined with the introduction of ministerial responsibility to parliament, made Bavaria the most democratically governed country of Germany and, in some points, even went beyond the republican Weimar constitution of 1919.

The 26 years of the regency, which lasted till Luitpold's death, were regarded as Bavaria's golden age, particularly in matters of culture. Luitpold himself was on terms of personal friendship with many artists (*e.g.*, Franz von Lenbach and Wilhelm Kaulbach); and though the prince regent's civil list was meagre by comparison with a king's, he spent large sums from his privy purse for the benefit of artists. He had the Künstlerhaus built as a meeting place and exhibition building, and under his rule Munich became a centre of European culture. Luitpold died in Munich on Dec. 12, 1912, and was deeply mourned. His eldest son became king as Louis III in 1913.

See F. Endres, *Prinzregent Luitpold* . . . (1916). (K. O. v. A.)

LUKE, SAINT, "the beloved physician," a companion of St. Paul (*q.v.*), the traditional author of the third Gospel and the Acts of the Apostles, the most literary of New Testament writers (*see* ACTS OF THE APOSTLES; LUKE, GOSPEL ACCORDING TO SAINT). His gentile origin is indicated by the name Loukas, a short form for the Latin Lucius or Lucanus (like Silas, Acts xv, 40, for Silvanus, I Thess. 1, 1). Possibly he was the son of a freedman of some Roman family. The Anti-Marcionite Prologue (prefixed to Luke's Gospel in some manuscripts of the Vulgate and dating perhaps from the late 2nd century), Eusebius of Caesarea and Jerome refer to him as a Syrian from Antioch. This probably means that he lived there and first met Paul there. Luke's connection with the early Antiochene church is abundantly illustrated by the detailed information he supplies in Acts (xi, 19 ff.; xiii, 1 ff.; xiv, 26–xv, 35) concerning the origin and growth of that community. Nothing is known of the time or circumstances of his conversion; if the reading of the Bezan codex in Acts xi, 28 is correct, "When we were assembled," this personal reference would indicate that Luke was an early member of the Antiochene community.

Paul calls Luke "the beloved physician" (Col. iv, 14), who undoubtedly attended the physically afflicted Apostle (II Cor. xii, 7; Gal. iv, 13–15). It can no longer be held, as it once was, that Lucan vocabulary proves that the author was a physician; however, later studies, showing that many of Luke's words formerly regarded as distinctively medical are to be found not only in medical writers but also in Josephus, Plutarch, Lucian and the Septuagint, have not done away with all the evidence. Some passages of the Marcan source that mention diseases when modified by Luke reveal the terminology and interest of a professional physician (Luke iv, 38; v, 12; viii, 44). While not proving that their author was a physician, these passages nevertheless support the tradition.

Luke accompanied Paul on his second missionary journey. The "we-sections" of Acts (*see* ACTS OF THE APOSTLES) recount how Luke joined Paul at Troas (*c.* A.D. 50) and passed over to Macedonia with him (Acts xvi, 11–12). Luke most likely remained at Philippi until the end of Paul's third mission (Passover, A.D. 58), when he joined him again as the latter set out for Troas on his return to Jerusalem (Acts xx, 5–xxi, 18). Finally, Luke accompanied Paul from Caesarea to Rome (Acts xxvii, 1–xxviii, 16). Writing from his Roman captivity, Paul refers to Luke as a "fellow worker" (Philem. 24; *see* Col. iv, 14) and faithful companion to the end (II Tim. iv, 11). Origen was the first to identify Luke with the "brother who is famous among all the churches for his preaching of the gospel" (II Cor. viii, 18). He seems to be the only non-Macedonian (as demanded by II Cor. ix, 2–4) of Paul's entourage eligible at the time for such identification (*see* Acts xx, 4).

A tradition that can be traced back to Irenaeus (*c.* 185) regards Luke as the author of the third Gospel. This attribution was probably also known to Justin in the middle of the 2nd century. The Muratorian canon (*c.* 190; *see* BIBLE: *Canon and Text: Canon of the New Testament*) ascribes both the third Gospel and Acts to Luke. The Lucan authorship of both books is generally (though not universally) accepted by modern scholars.

Luke belonged to cultivated Hellenistic circles, where he learned to write with ease good, idiomatic Greek. His writings betray an acquaintance with the historical method of his day, and the "Semitisms" that shine through his Greek style reveal a deep contact with the Greek Old Testament. In fact, his imitation of the style of the latter is at times surprising. He was a perceptive, sensitive writer with a knack for telling a story and depicting

a scene, and his Gospel has been described as "the most beautiful book" ever written. His two books constitute the earliest history of the Christian church.

The Anti-Marcionite Prologue records that Luke wrote his Gospel in Greece, was not married and died in Boeotia (or Bithynia?) at the age of 84. But further details about his life come from either later traditions or legends; *e.g.*, that he was martyred, that he was one of the Seventy (Luke x, 1), that he was the unnamed disciple of Emmaus (Luke xxiv, 13–35), that he was a painter.

Luke is the patron of physicians and artists; in the Roman martyrology his feast day is Oct. 18. His symbol is an ox, the sacrificial animal, because his Gospel begins with the story of Zechariah, the priest, the father of John the Baptist.

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LUKE, GOSPEL ACCORDING TO SAINT, the third Gospel of the New Testament. It is the first volume of a longer work which the author addressed to the same patron, Theophilus; another New Testament book, the Acts of the Apostles (*q.v.*), is the additional volume.

Sources.—As the third of the three Synoptic Gospels the Gospel of Luke is closely related to Matthew and Mark; like Matthew it is based on the Marcan narrative and it also uses Matthew's Saying-Source Q (*see* MARK, GOSPEL ACCORDING TO SAINT; GOSPELS). In addition to these, Luke employs at least one other source which contained traditions unknown to Matthew and Mark, thereby preserving in his Gospel the following unique materials:

Luke i, 1–80:	promise of the Baptist's birth, annunciation, visitation, "Magnificat," birth of the Baptist, "Benedictus"
ii, 1–52:	nativity of Jesus, circumcision and presentation in the Temple, Jesus at 12 years
iii, 10–14:	John's sociological teaching
iv, 16–30:	first preaching in Nazareth
v, 1–11:	Peter's draught of fishes
vi, 24–26:	woes to the wealthy
vii, 11–17:	the widow's son at Nain
vii, 36–50:	the woman who was a sinner (41–43: parable of the two debtors)
viii, 1–3:	the ministering women
ix, 51–56:	the unhospitable Samaritans
x, 1, 17–20:	sending and return of the Seventy
x, 29–37:	parable of the good Samaritan
x, 38–42:	Martha and Mary
xi, 5–13:	parable of the friend at midnight
xi, 27–28:	the blessedness of Christ's mother
xii, 13–21:	parable of the rich fool
xii, 47–48:	parable of punishment and responsibility
xiii, 1–9:	call to repentance and parable of the fig tree
xiii, 10–17:	Sabbath healing of the bent woman
xiii, 31–33:	Jesus and Herod (leaving Galilee)
xiv, 1–6:	Sabbath healing of the man with dropsy
xiv, 7–14:	discourse at the banquet
xiv, 28–32:	parables of the architect and the king
xv, 8–32:	parables of the lost coin, and the prodigal son
xvi, 1–31:	parables of the unjust steward, and Dives and Lazarus
xvii, 7–10:	parable of the servant's wages
xvii, 11–19:	healing of the ten lepers
xvii, 20–21:	on the coming of the Kingdom
xviii, 1–14:	parables of the unjust judge, and the Pharisee and the publican
xix, 1–10:	Zacchaeus
xxii, 15–38:	special account of the Lord's Supper, and last words to the disciples
xxiii, 27–32:	words on the road to Calvary
xxiii, 39–43:	the two crucified criminals
xxiv, 13–35:	the road to Emmaus
xxiv, 36–49:	the appearance in Jerusalem
xxiv, 50–53:	the Ascension

The character of the source for this special Lucan material is debated. But whether there was actually a Proto-Lucan Gospel, or only a number of written "collections" (of parables, infancy narratives, resurrection accounts), the peculiarities of arrangement and outline of the present Gospel certainly are the work of its author, who impressed his own literary skill and theological insight upon the various sources used by him.

Style and Technique of Composition.—Luke is a writer of distinctive qualities of mind and style. Though he shares with other New Testament writings the vernacular flavour of 1st-century Greek, his language is more literary than that of his sources. He repeatedly improves Mark's wording, and also avoids foreign words, whether Latin or Aramaic, used by his sources.

Luke connects single narratives much more smoothly than does either Mark or Matthew; he sometimes localizes two scenes in the same setting (*e.g.*, v, 29–32 and 33–38), often establishes a temporal sequence and frequently employs connecting participle constructions. But Luke also realizes that a monotonous sequence of single stories would result in a rather unconvincing picture of Jesus' life. He therefore makes single incidents appear as illustrations of the whole of a continuous history; this purpose is served by the frequent introductory phrase "(and) it came to pass (when). . ." (Authorized Version), often connected with a date.

For purposes of division or connection he formulates summary statements (i, 80, etc.), a specifically Lucan device also employed in Acts (*e.g.*, ii, 42–47). Significant for Luke as a historian is his attempt to relate the history of Jesus to world history (i, 5; ii, 1–3; iii, 1–2; xxiii, 6–7).

A characteristic of the Gospel is Luke's intermittent use of sources in the following way (Q = synoptic Saying-Source; S = special Lucan sources; minor deviations are not mentioned):

Luke i, 5–ii, 52:	S
iii, 1–iv, 30:	synthesized from Mark, Q and S
iv, 31–vi, 19:	Mark (insertions from S)
vi, 20–viii, 3:	Q (insertions from S)
viii, 4–ix, 50:	Mark
ix, 51–xiii, 30:	Q (insertions from S)
xiii, 31–xviii, 14:	S (insertions from Q)
xviii, 15–xxiv, 11:	Mark (insertions from Q and S)
xxiv, 13–53:	S

Thus, introduction (birth narrative) and conclusion (Resurrection appearances) are taken from special sources, whereas the body of the Gospel (iii, 1–xxiv, 11) retains the Marcan structure. But a large central section, the "travel narrative" (ix, 51–xviii, 14), is composed almost entirely on the basis of Q and S, without any use of Mark. Luke, however, adds and omits, rearranges and reinterprets the source material whenever necessary to express his own theological evaluation of Jesus' history.

Luke's View of History.—Luke, who in the manner of a Greek historian introduces his Gospel with a preface (i, 1–4), is the first to conceive of the life of Jesus as a revelation pertaining to a former period of an ongoing history. Thereby the early Christian twofold eschatological scheme of "this age and the age to come," within which Mark had understood the Jesus event as the eschatological turning point of the two ages, is replaced in Luke by a tripartite view of history in which the time of Jesus is the centre rather than the end. Luke's Gospel presents Jesus' life as this centre of history in its relation to the preceding period, the time of the Law and the Prophets, and to the following period, the time of the church, in the following way:

Luke i, 5–iv, 13:	the end of the prophetic era as preparation for the revelation
iv, 14–xxii, 2:	the revelation in Jesus' ministry as the centre of time
xxii, 3–xxiv, 53:	the beginning of the time of the church in Jesus' Passion and Resurrection

The beginning of the central period is marked by the departure of Satan after the temptation (iv, 13). The Baptist still belongs to the former period of the Prophets (xvi, 16), preaching only the "baptism of repentance" (iii, 3), but not the coming of the Kingdom (as in Matt. iii, 2). His imprisonment is told before Jesus' appearance, and he is not mentioned at Jesus' baptism (compare Luke iii, 21 with Mark i, 9).

The end of Jesus' ministry does not look forward to the end of the world and time (as in Mark xiii), but to the next period of history, the time of the church, which actually begins with the return of Satan at the beginning of the Passion of Jesus (Luke

xxii, 3). It will be a time of temptation and suffering, as it is prefigured in Jesus' Passion, but it remains part of the ongoing history, and Luke repeatedly warns against mistaking events of this history as signs of the end—neither Jesus' Passion (xvii, 20–25), nor his Resurrection (Acts i, 4–11), nor the fall of Jerusalem (compare Luke xxi, 20–24 with Mark xiii, 14–20).

As a result the Gospel of Luke rightly can be understood as containing the proper conclusion of the Old Testament in its first chapters, whereas the last chapters have their direct continuation in the Acts of the Apostles (compare Luke xxiv, 49–53 with Acts i, 4–11 and ii, 1–31). The life of Jesus itself, as the time without Satan and without temptation, is the period of revelation and the sacred centre of history.

Geographical Scheme.—Corresponding to this historical structure of the Gospel is a certain geographical scheme used as a meaningful device of theological characterization.

1. The end of the prophetic period is closely connected with the sacred places of the Jewish people: Jerusalem (ii, 22, 41), Bethlehem (ii, 4, 11), the Jordan (iii, 3; iv, 1), the wilderness (iii, 2; iv, 2).

2. Jesus' ministry as the central period of history is limited to Jewish districts, Galilee and Judaea (*see* especially xxiii, 5), which Jesus never leaves during his ministry, neither for Samaria (xx, 51–56) nor for the surrounding gentile country (compare Luke ix, 18 with Mark viii, 27). He also avoids the sacred places of the prophetic period, except in the Temple ministry, and even on this occasion Luke does not say that Jesus entered the city of Jerusalem itself (compare Luke xix, 45 with Mark xi, 11, 12).

3. The beginning of the church era, however, is closely connected with Jerusalem, the place of Jesus' Passion and death (*see* xiii, 33). In contradiction to Mark and Matthew, Luke presents no Resurrection appearance in Galilee but only in and around Jerusalem (xxiv, 13 ff., 33, 36 ff.; compare Luke xxiv, 6 with Mark xvi, 7). There also the disciples witness the Ascension (xxiv, 50–53) and there they are to wait for the sending of the Spirit (xxiv, 49; Acts i, 4). Thus Jerusalem, the Holy City and centre of prophecy, also becomes the birthplace of the church.

Similarly, Luke's geographical details have special significance. He bypasses the Sea of Galilee as the centre of Jesus' early ministry and preaching (Luke viii, 4 omits the "sea" when reproducing Mark iv, 1), for example, and refers to it as a "lake" (of Gennesaret) where messianic epiphanies occur (Luke v, 1–11; viii, 22–25). In a similar way, "the mountain" is omitted in the temptation (iv, 5; compare Matt. iv, 8) and in the Lucan parallel to the Sermon on the Mount (Luke vi, 12–17; compare Matt. v, 1), and exclusively designates the place of revelations and prayer (vi, 12, etc.).

Obviously such a reconstruction of the locality often is in contradiction to traditional information, and sometimes is geographically quite improbable. But Luke looks upon Palestine as the "Holy Country" of Jesus' sacred history, and, therefore, the primary significance of the locality is theological.

Jesus' Ministry as the Centre of Time.—This is portrayed by Luke in three phases:

Luke iv, 14–ix, 50:	wandering in Galilee and Judaea
ix, 51–xix, 27:	traveling through Galilee and Judaea to Jerusalem
xix, 28–xxii, 2:	the Temple ministry

In the first phase Jesus is wandering about like an itinerant Christian missionary, driven by the Holy Spirit (iv, 14; compare Acts xiii, 2 and *passim*). Jesus' works—no longer understood as the manifestation of the eschatological battle with Satan (*see* MARK, GOSPEL ACCORDING TO SAINT)—are attestations of his divine authorization (*see* Acts ii, 22). They always precede the discourses, in which Jesus sets forth the novelty of the "Christian way" as distinguished from that of the Pharisees and the Baptist (v, 30–39, etc.). The main purpose of this section is to assemble the witnesses. To the rejection at home (iv, 16–30) corresponds the call of foreigners (v, 1–11, 27–28; vi, 12–16), and the substitution for Jesus' family of all those who "hear the word of God and do it" (viii, 19–21). But the disciples who recognize Jesus as the "Christ of God" (ix, 20) witness the messianic epiphanies (viii, 22–25; ix, 28–36), receive the authority of healing and preaching (ix, 1–2) and are introduced to the necessity of suffering (ix, 22–27).

In the second phase the location (Galilee and Judaea) and the general structure of Jesus' ministry ("acting and preaching") are retained; this section also begins with a "rejection" (ix, 51–56; compare iv, 16–30). But there are several new elements. Jesus is now traveling to a certain goal—Jerusalem (ix, 51, etc.). He repeatedly turns to his disciples with special instruction, especially discourses about the time of the church, whereas to "those outside" Jesus speaks only in parables (*e.g.*, xii, 13–21; compare xii, 1–12 and 22 ff.). Halfhearted followers are rebuked, especially by Jesus' demand to give up wealth, and any missionary emphasis is completely absent. Jesus is now the Messiah who decidedly travels toward his destination; who consciously faces the necessity of his suffering as the fulfillment of prophecy (xviii, 31 as compared with Mark x, 33); who is already watched by those who will kill him, the Pharisees and lawyers, who are always nearby, offended by his behaviour and discussing his authority (xi, 25–37, etc.).

In the last phase the centre of Jesus' activity is the Temple, into which he enters upon arrival from Jericho, and the Mount of Olives. Preaching in the Temple, he is surrounded by three groups: (1) the people with their meaningless appreciation; (2) the leaders of Jerusalem who try to find an opportunity to destroy him; (3) the disciples who learn to distinguish between the historical event of the fall of Jerusalem and the eschatological events that bring time and history to a definite end (xxi, 5–36; compare Mark xiii, 1–37).

The Temple ministry as an exemplary description of the situation of a Christian missionary concludes the time of revelation. The Passion and Crucifixion of Jesus portray the typical death of a martyr, but according to Luke they do not have a special meaning for salvation. It is the opening chapter of the history of the church—a period without the presence of Jesus, but under the guidance of the Holy Spirit.

Literary History.—The author of the third Gospel (and of Acts) was, according to the tradition, Luke the physician and associate of Paul (Philem. 24; Col. iv, 14; *see* LUKE, SAINT). This tradition encounters major difficulties in Acts, since the contradictions between Acts' narratives about Paul and Paul's own letters should not have arisen if the author had actually been Paul's assistant (*see* ACTS OF THE APOSTLES). In any case, the Gospel was written by a man who knew about Jesus only through traditions of the church and written sources. Whether he was a Jewish Hellenist or a gentile by birth, his Greek style and vocabulary were as educated as that of such Greek writers as Xenophon, and he lived in a time for which not only the life of Jesus but also the "apostolic age" belonged to past history. Since the Gospel of Mark is also used, and the prophecy in Luke xxi apparently reflects the actual fulfillment in the year A.D. 70, the last two decades of the 1st century A.D. are probably the best date; some scholars even prefer the beginning of the 2nd century A.D., since neither the Gospel nor Acts was used before II Clement, Justin and the heretic Marcion.

About the place of writing, nothing can be said with certainty. If Luke's geographical picture of Palestine is really incorrect, it is more likely that he wrote in Asia Minor or Greece than in Syria. Nor is anything known about Theophilus, to whom both Gospel and Acts are addressed. *See* also BIBLE.

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(1958); A. Wikenhauser, *New Testament Introduction* (1958). (H. H. Ko.)

LULEÅ, a city and seaport of Sweden, seat of a Lutheran bishop and capital of the *län* (county) of Norrbotten, is located at the mouth of the Luleälv where it enters the Gulf of Bothnia, 724 km. (450 mi.) N.N.E. of Stockholm. Pop. (1960) 30,488. Buildings of interest include the Gammelstad church (*c.* 1400), the cathedral (1894) and the provincial museum. Luleå is linked by rail with Stockholm, Narvik, Nor., and Tornio, Fin., and by air with Stockholm and Kiruna. The principal industries include ironworks, shipbuilding, engineering and wood pulp. The port, ice-bound in winter, exports chiefly iron, iron ore, timber and pulp and imports coal, oil and gasoline. Founded in 1621 by Gustavus Adolphus 7 mi. farther up the river, Luleå was moved to its present site in 1649. It was almost entirely destroyed by fire in 1887.

LULEÄLV (Lule River), in northern Sweden, flows south-east from the Norwegian frontier to the Gulf of Bothnia at Luleå. Total length 450 km. (279 mi.). There are two main headstreams, the Stora Luleälv and Lilla Luleälv; Sareks National park in the interfluve rises to 6,857 ft. at Sarektjåkko. The headstreams have numerous lakes, some of which are dammed to increase storage for hydroelectricity production. The river has several high falls. Porjus is one of the chief power stations, supplying the nearby iron mines and railway and feeding power south via Harsprånget. Luleå (*q.v.*), with its outport, Svartöstaden, is the main port and handles iron-ore exports in summer. (A. C. O'D.)

LULL (Lully), **RAMON** (Raymond): *see* Llull, Ramon.

LULLY, JEAN BAPTISTE (Giovanni Battista Lulli) (1632–1687), French court and operatic composer. Born in Florence of Italian parents on Nov. 28, 1632, he changed his name to its French form when he became a naturalized Frenchman. His early history is obscure but it is probable that he was taken to France by the duke of Guise. He entered the service of Mme de Montpensier and became a member of her string band, but was dismissed for having composed some scurrilous verses and music. He joined the court band of Louis XIV in 1652 as a violinist and soon became composer of dance music to the king and leader of the newly formed *Petit Violons*. In 1658 he began to compose music for the court ballets and from 1662 to 1671 he collaborated with Molière in such works as *Les Fâcheux, Le Mariage forcé, La Princesse d'Élide* and *Le Bourgeois Gentilhomme*. From 1672 until the time of his death he worked with the librettist Philippe Quinault. The subjects of the works produced by this partnership vary from the classical *Atys* (1676) and *Isis* (1677) to the heroic *Roland* (1685) and the pastoral *Le Temple de la Paix* (1685). Lully died in Paris on March 22, 1687, from blood poisoning resulting from a wound in his foot caused by his long conducting stick.

A man of insatiable ambition, his rise from violinist in Louis XIV's court band was meteoric and was accomplished by brazen and merciless intrigue. By 1662 he had gained complete control of the court music by the following royal appointments: *Brevet de la charge de Composition de la Musique de la chambre du Roi* in 1661 and *La charge de Maître de Musique de la Famille royale* in 1662. He then acquired from Abbé Perrin and Robert Cambert their patents of operatic production, and by 1674 no opera could be performed anywhere in France without Lully's permission. In 1681 he received his *lettres de nationalisation* and his *lettres de noblesse*. He also became one of the *secrétaires du roi*, a privilege usually held only by the French aristocracy.

At the outset of his career Lully's operatic style was similar to that of the Italian masters P. F. Cavalli and L. Rossi. He quickly assimilated the contemporary French idiom, however, and then created a new and original style of writing that was widely imitated in Europe. In his ballets he introduced new dances such as the minuet and made use of a higher proportion of quicker ones such as the *bourrée*, gavotte and *gigue;* he also introduced women dancers to the stage. The texts in both ballets and operas were French.

He established the form of the French overture and abandoned the *recitativo secco* style. This last he replaced by an accompanied recitative of great rhythmic freedom with careful word setting, and declamation. This led to a lessening of the demarcation between the recitative and the aria, so that French opera acquired much more continuity. The arias themselves, however, retain many Italian characteristics. Each is written in a particular style and mood: *chanson à couplets, air-complainte* (*arioso*) and *air déclamé*. His operas frequently end with a chaconne movement, and in this he was followed by both Rameau and Gluck.

Among Lully's other works are several sacred compositions, including the famous *Miserere* and 17 motets; dances for various instruments; suites for trumpets and strings, a form that became very popular in England during the Restoration; and the *Suites de Symphonies et Trios*. (C. A. L.)

LUMBAGO, a sprain of the back, characterized by pain, muscle spasm and limited motion. *See* Spine, Diseases and Disabilities of.

LUMBERING, a broad term that designates the production and marketing of lumber and certain other forest products. Lumbering production generally is understood to include harvesting (logging) the raw material and converting it into marketable forms.

About two-thirds of the annual world lumbering output consists of fuel wood, pulpwood, pit props and similar items. The other one-third is comprised of saw logs, plywood, railroad ties and similar sawed products; it is to this second group that the term lumber, or timber in Britain, is applied.

The annual world production of sawed wood (*i.e.,* lumber) is estimated to be about 140,000,000,000 bd.ft. The leading lumber-producing countries, and the approximate percentages of world production they account for, are: U.S.S.R. 32%, United States 24%, Japan 8%, Canada 5%, Sweden 2½%, Finland 2½%, West Germany 2%, France 2%, Norway 2%, Brazil 2%, Austria 1½% and Australia 1%. Other producers of significant amounts of lumber are Poland, Czechoslovakia, Rumania, East Germany, Yugoslavia, New Zealand, Italy, Spain, the United Kingdom, Indonesia, Mexico and the Philippines. About 80% of the world's lumber is produced from softwood (coniferous) species while 20% is derived from hardwoods (broad-leaved deciduous species).

This article discusses (1) the general methods of lumbering and (2) the lumbering industries in the major producing regions and countries. Information about the propagation, management and conservation of forests is included in Forests and Forestry. Supplemental information about production will be found in the separate articles on the producing countries (*e.g.,* Canada) or their political subdivisions (*e.g.,* British Columbia). Other articles related to lumbering are Cooperage; Naval Stores; Paper Manufacture; Paperboard; Plywood; Timber; Turpentine.

Logging.—The methods of felling trees and converting them into logs are generally the same in all forested regions. First the tree is undercut with an ax or a power saw on the side of the fall. A two-man crosscut saw or a power saw is employed opposite the undercut. Where the ground is flat, the men cut from the ground; but where the ground is rough or sloping and irregular, or where the trunk of the tree is heavily buttressed, the undercutting and sawing are done from a platform or springboard.

After felling, branches are trimmed off and the tree is sawed or bucked into logs of a length convenient for handling. After bucking, the logs are dragged or skidded to concentration points, usually with either power skidders or tractors and log arches. Where steel cables are employed over valleys and canyons, the method is called high-lead skidding. Other methods are overhead skidding (the logs are hoisted up over the brush and ground for some distance) and ground-line skidding, which is the dragging of the log over the ground by means of a cable. In Scandinavian countries horses and motor trucks are frequently used for transporting the logs to rivers, where they are subsequently floated to the mills. In Burma the elephant is used; in many tropical forests manual labour is often the only means of hauling the felled log to the nearest roadway.

In the U.S. northwest a spar tree is frequently employed in the skidding operations. This tree is selected for its height and favour-

able location with regard to the surrounding trees to be felled. A man known as a high-climber ascends the tree, aided by climbing spurs affixed to his shoes and a rope around the tree. He is equipped with a saw and an ax, and as he ascends he cuts off interfering branches until he reaches the desired height, which is usually about 175 to 200 ft. and about 30 to 50 ft. from the treetop. Then he saws off the top, waits until the swaying caused by the top's rebound has stopped and descends. The rigger next ascends, carrying equipment for rigging. Finally the spar is rigged at the top with cable and pulleys and a loading boom is affixed about 20 ft. above the ground. A cable with grab hooks on the end is carried to the log to be skidded and then, by means of a steam or electric skidder, the log is dragged within reach of the loading boom, which raises the log off the ground and loads it on a nearby truck or railroad car or stacks it for future loading. When the logs reach the mill centres they are stored in log ponds, which usually cover a number of acres. They are kept there until ready for manufacture. The ponds facilitate sorting and cleaning and also prevent the deterioration that would occur if the logs were left on the ground for any appreciable length of time.

Sawmill Operations.—Sawmills vary widely in size. The largest plants, employing several thousand persons, and the smallest, operated by fewer than a dozen men, often coexist in the same region. Large-scale operations offer no decisive competitive advantage; moreover, the small capital investment required (about $10,000 in the U.S. for the average rotary sawmill) facilitates entry into the business. A group of farmers living in a wooded area may operate a sawmill part time.

In the U.S. the number of small mills grew rapidly early in the 20th century as lumber prices increased and second-growth timber became available in all parts of the nation. In 1900 large and medium-sized mills (*i.e.*, with an annual output of at least 10,000,000 bd.ft.) accounted for most of the U.S. production. By 1960 small mills produced nearly two-thirds of the total.

Most modern sawmills employ the same general type of machinery and somewhat similar plant layouts. Band saws of varying types such as single-cut, double-cut, vertical and horizontal band resaws and gang saws are common in the larger mills. Many labour-saving devices are employed. Various types of conveyers and other machinery permit the log to enter the mill and pass out as manufactured lumber with little handling or moving by hand. The modern methods of lumber manufacture are so intricate and so efficient as a rule that the term sawmill has been supplanted in some measure by that of forest-products manufacturing plant.

The following method of lumber manufacturing is prevalent, with variations to fit certain local requirements. The logs enter the head mill from the pond over an inclined chute or log slip. They are transported by an endless spiked conveyer known as a jack ladder or bull chain. As logs ascend the slip they are sprayed with water to remove grit and dirt that might dull the saws. Hydraulic log debarkers are installed at larger mills to strip the logs of bark prior to sawing. Sawmill refuse (slabs, edgings and trimmings) free of bark can then be utilized for making fibreboard and the like. From the slip the jack ladder carries the log under a large circular saw known as the deck saw, which is used if the log is to be shortened; otherwise the log is "kicked" off onto the log deck by steam-driven steel arms. From the log deck the log rolls onto the log carriage. A steam or air nigger (mechanically operated steel arms) helps to place the log in the proper position. The carriage is a long, flat platform that is made to travel back and forth rapidly on a track, keeping the log against a band or head saw that squares it and reduces it into flitches or cants. The log is turned from time to time on the carriage by means of the nigger. If the log is to be used as a timber, it is squared and edged and passed immediately to the rear of the mill, where the timber dock is usually located. If the log is to be converted into lumber, the flitches or cants enter the remanufacturing plant directly behind the head mill, where they pass to the gang saws and edgers and then to the trimmers.

Several types of headsaws (main saws) may be used. Large circular saws are common in small and medium-sized mills but band saws are preferred in large establishments. A band saw consists of a continuous band of steel with teeth on both edges; the band moves at extremely high speed around two large broad-rimmed wheels. One wheel, a type of heavy cast-iron flywheel, commonly is mounted under the floor and the other is mounted above the sawing area. Large band saws measure about 50 ft. long and 15 in. wide. The teeth on large double-cut band saws must be sharpened after the saw has been used for about four hours. When the saw becomes dull, it is hoisted to the saw filing room, where the teeth are first swaged (*i.e.*, square, sharp corners are put on the worn points of the teeth) and shaped to the proper angle and width, and then sharpened by automatic filers. Some North American and many European sawmills use gang saws, which consist of as many as 40 parallel saws arranged in a movable sash mounted in a heavy iron frame. The logs are first slabbed into square cants by a circular or band headrig. The cants, either singly or in groups, are then passed through the gang saw and in a single trip are converted to lumber of the desired thickness. Gang saws produce a large volume of smoothly sawed lumber with less labour than required with other types of saws. The main disadvantage of the gang saw is that the log cannot be turned, nor can the thickness of the cut be varied.

A system of rollers carries the boards from the headrig to the edger, where bark, wane and uneven edges are removed and wide boards are cut to standard widths. Several circular saws, one fixed and one movable, perform this function. The boards are next carried sideways to the trimmer. Here a battery of spinning saws suspended 24 in. apart over the conveyer are operated by a trimmer man to remove decay, cracks, jagged edges or other defects. As the operator manipulates a keyboard of levers, the saws drop alone or in combinations to trim the boards in a manner that produces the maximum amount of good lumber of uniform standard length and with square ends. (*See* also SAWMILL; WOODWORKING MACHINERY.)

Grading.—The trimmed boards then travel down a ramp to the greenchain, a waist-high conveyer, to be sorted by species, thickness, length, weight, width and grade. The greenchain is situated either in a shed with open sides or in a separate building. Workmen standing at either side of the head of the greenchain mark each board with a coloured pencil. The sorted lumber is piled in bunks or bins. When a bin is filled, an overhead crane or a straddle truck lifts the entire stack and carries it to the yard for storing or to the kiln for drying.

Lumber is graded on the basis of the number, location and type of knots and other defects, and according to intended use. Thus, in the U.S., shop grades are designated for manufacture into sash, doors and other woodwork. Common grades 1, 2, 3, 4 and 5 are general utility lumber suitable for such uses as roofing and framing, while the select grades of A, B, C and D may be used when paint or other finishes will be applied.

Grading practices conform to rules adopted by regional trade associations and in some countries these are enforced by a system of inspection. At one time each mill followed its own rules. The confusion caused by the differences in sizes, grades and specifications led to attempts to simplify and standardize grades. In the U.S. lumbermen in the Great Lakes area achieved considerable success in the standardization of grading and their standards were later adopted in other regions; in the 1920s the so-called American Lumber Standards were adopted to serve as a guide for rules formulated regionally for each major species.

In its modern concept the term lumber is restricted to include only those products of the saw not further manufactured other than by being sawed, resawed, passed lengthwise through a standard planing machine, crosscut to specific lengths and matched. Lumber includes deals, battens, boards, planks, structural timbers, scantlings, sawed crossties, flooring and dimension and pattern stocks, all measured in board feet, cubic feet, cubic metres and standards (1 Petersburg standard = 165 cu.ft. or 1,980 bd.ft.).

In North America lumber is classified as boards, dimension or timbers, depending on thickness. Boards are less than 2 in. thick. All boards are thinner than their nominal thickness. A 1-in. board, for example, is dressed to a minimum thickness of 25/32 in. The same is true for the thickness of dimension lumber, which is 2 in.

or more but less than 5 in. thick. Two-inch dimension lumber may be dressed to 1½ in. A piece of 2 by 4 dimension, therefore, may measure 1½ in. by 3½ in. Joists, planks and other structural sizes are classified as dimension. Timbers are 5 in. or more in thickness and width. The retail selling price of lumber is reckoned on the basis of 1,000 bd.ft. A board foot, the unit of measure used by the U.S. lumber industry, represents a volume of lumber 1 in. thick and 12 in. in width and length (424 bd.ft. = 1 cu.m.; 1,980 bd.ft. = 1 standard; 12 bd.ft. = 1 cu.ft.). Some items such as molding are sold by the lineal foot, while plywood and fibreboard are sold by the square foot.

Drying.—If wood is used in construction without being dried properly it will shrink or swell and has a tendency to warp or split. Dry lumber retains relatively stable dimensions and in addition is stronger, substantially lighter in weight and less vulnerable to decay than moist lumber.

The most common method of drying lumber is that of air seasoning; *i.e.*, piling lumber outdoors to dry. The lumber is stacked in courses or layers on foundation piers so that each surface receives maximum exposure to air currents. Narrow strips of boards, called stickers, are laid crosswise over each layer and spaces are left between the boards to allow the air to circulate. The tall piles are sloped and roofed to protect the lumber and permit water drainage. After 6 to 18 months the seasoned lumber is removed from the yard, graded again, finished, then stored until shipped.

To accelerate the drying process and permit greater control of temperature and humidity, lumber is kiln-dried. The result, aside from reducing the drying time to about one week, compared with an average of one year for air seasoning, is a better product. In practice the two methods are used together; to reduce costs, green lumber may be air seasoned before being kiln-dried.

A dry kiln is a shedlike building in which temperature, humidity and ventilation are automatically maintained at levels that vary according to the size, species and moisture content of the lumber being dried. Proper stacking and circulation of air insure uniform drying. Forced ventilation by fans has replaced natural drafts in the kilns. Heat is provided by coiled tubing filled with steam from boilers fired by sawdust, bark and other mill refuse. The optimum temperature and other conditions for the various stages of the drying process are known for each species and size of wood. Samples are cut from the wood at intervals as it is kilned and are tested in order to check quality and moisture content.

A development called vapour seasoning reduces the drying time to about 7 to 12 hours. Green or partially seasoned wood is placed in a vacuum chamber and subjected to high temperatures that cause the moisture in the wood to vapourize rapidly.

Kiln-drying, together with motorized log transportation and heated log storage ponds at sawmill plants, has practically made the lumber industry independent of the weather in cold climates. The various operations involved in lumbering, from cutting the trees to marketing the finished product, can now be conducted on a year-round basis. Early-day lumberjacks in the United States harvested trees in the winter logging season, when the logs could be hauled by sleigh to the banks of the nearest frozen stream. During the driving season in the spring, the rivers, swollen by water from melting snow, carried the logs down to the sawmills, where they were stored in log ponds. The sawing season began in April and lasted until the log ponds froze or until there was no more piling room in the yard. The green (moisture-laden) lumber was piled up to dry or season in the open air. Many months later the seasoned lumber would be ready for market. Altogether, about two years elapsed from stump to market. In some areas of the world, notably in the Scandinavian countries and Finland, and to some extent in North America, lumbering is still conducted by the season, with sleigh hauling in winter, spring drives and summer sawing. Nevertheless, in all lumber-producing regions the practice of kiln-drying has proved advantageous in reducing the storage period and the risk of deterioration in quality, and in permitting more accurate control of the moisture content.

The Finishing Process.—Dried rough lumber is further processed in a planing mill, where sharp knives revolving at high speed shave the lumber and give it a silky, smooth surface. A planer and matcher, the basic unit in a planing mill, surfaces the two sides and two edges of each piece of lumber. Various profile attachments and cutterheads shape the lumber into window sash, furniture components and materials for countless other uses. Molding is turned out by special molding machines. Assorted devices, including horizontal and vertical resaws, are installed as adjuncts either to the sawmill or planing mill, or both, to salvage usable material from slabs, miscuts and large pieces cut off by the trimmers and edgers, or to produce shiplap, flooring, siding, etc.

United States.—About one-third of the United States is forested, and 489,000,000 ac. are accessible and capable of growing commercially valuable timber. Another 297,000,000 ac. are classified as noncommercial. More than 132,000,000,000 bd.ft. of wood are harvested annually for all purposes, an amount that is balanced by new growth. The rapidly growing southern forests account for more than half the total production; however, Oregon, Washington and California are the top producing states, followed by Alabama, Mississippi, Texas, Arkansas, North Carolina, Louisiana and Georgia. The principal southern stands are made up of pines, cypress and white cedar mixed with hardwoods. The central region, embracing the middle Mississippi and Ohio river valleys and part of New England, yields oak, hickory, ash, elm, walnut, beech, maple and other hardwoods. In the northern forest, from Maine to Minnesota, white, red and jack pines, spruce and hemlock softwoods and maple, birch, aspen and other hardwoods predominate. West of the eastern slopes of the Rockies is the major source of softwood sawtimber, including ponderosa, sugar, white and lodgepole pines, Douglas fir, western larch, Sitka and Engelmann spruce, white fir, red cedar and California redwood.

The production of lumber in the U.S. totals about 31,500,000,000 bd.ft. annually, of which about 85% is from softwoods and 15% from hardwoods. The major softwoods are Douglas fir and Southern yellow pine, which account respectively for about 37% and 22% of the lumber manufactured from conifers. Other leading softwood lumber species are ponderosa pine, white fir, hemlock and redwood. By far the most important hardwoods for lumber are the oaks, which account for about 70% of the production in that category. Other major hardwoods used for lumber are yellow poplar, maple, sweet gum (red and sap), tupelo and black gum, beech, elm, birch, cottonwood and ash.

During the North American pioneer era wood was abundant, cheap and indispensable. Houses, barns, town halls, schools, churches, stores, saloons and virtually all other conceivable structures—including sidewalks and streets—were made of wood. Goods sold in the market were packed in wooden barrels, casks, kegs, boxes and crates. Wood was the principal fuel.

Large-scale lumbering began in Maine during the colonial era. As the population grew and settlers penetrated inland, the lumber industry expanded and moved steadily westward. Before 1850 the industry was centred in New York and Pennsylvania. During the next half century the pine forests of the lake states (Michigan, Wisconsin and Minnesota) were felled by the double-bitted axes and crosscut saws of the woodsmen as they laboured to fulfill the tremendous demand for lumber from the newly settled treeless prairies and plains. About 1895 a market was developed for southern longleaf and shortleaf yellow pine, until then virtually untouched. After 1900 the industry pushed rapidly to the Pacific northwest. By the 1960s lumber was produced from coast to coast and from border to border. About 57,000 companies operated 46,000 sawmills, 1,150 pulp, paper and paperboard plants, 300 plywood and veneer mills and 200 cooperage mills; these mills, which employed approximately 1,600,000 persons, produced 30% of the world's lumber and more than 40% of the world output of other forest products, excluding fuelwood.

U.S. production of lumber in the early 1960s totaled about the same as in the 1890s but was three times greater than shortly after the Civil War. Per capita consumption in the 1960s, however, was less than half the 1890s amount and only about two-thirds the post-Civil War amount. Per capita consumption figures for selected years were: 1859, 262 bd.ft.; 1899, 456; 1907, 509 (all-time high); 1919, 324; 1929, 268; 1949, 225; early 1960s, about 200.

Canada.—Lumbering is one of Canada's major industries.

More than one-third of the country is covered with forests, of which 450,000 sq.mi. with more than 250,000,000,000 bd.ft. of sawtimber are productive and accessible. But the nature of the terrain precludes easy access to much of the forested area.

A wide variety of commercial trees thrive in Canada. The mainly pulpwood species—spruce, balsam fir, jack pine and aspen—are concentrated in a broad belt reaching from Manitoba to Newfoundland. These species, along with white and Norway pine, white cedar and tamarack, also border the Great Lakes. The mild, humid Pacific northwest is the realm of giant conifers, including western hemlock, Sitka and Engelmann spruce, Douglas fir, white pine, larch and cedar. In the drier inland regions and towards the north, ponderosa and lodgepole pines are more numerous.

Newfoundland and the maritime provinces are literally dotted with sawmills, large and small. The manufacture of forest products began there in the 18th century and subsequently became the major local industry. Numerous excellent streams can carry logs from almost every part of the interior.

The province of Quebec is 61% forested, while only 3.6% is used as farmland. The annual production of logs in Quebec is about 12,000,000,000 bd.ft., much of which is pulpwood.

In British Columbia, where half the population depends on forest industries for its livelihood, the annual production of lumber is about 5,000,000,000 bd.ft., which is about four times the lumber production in Quebec. Logs cut from giant trees along the fiord-indented coast are dumped into the tidewater, assembled into rafts or enclosed in booms, and towed to large coastal sawmills, particularly in Vancouver, where ship and rail transportation and a labour supply are available.

In northern Ontario roughly 100,000,000 ac. of forest contain an estimated 40,000,000,000 bd.ft. of softwood sawtimber. However, the hundreds of small sawmills there produce less than 1,000,000,000 bd.ft. of lumber annually. Pulpwood production, once insignificant, has outdistanced lumbering in Ontario and continues to increase in relative economic importance. Huge pulp and paper mills are located in Ontario at Kenora, Fort Frances, Fort William, Port Arthur and Sault Ste. Marie.

The modern trend in Canadian logging is to build sawmills in the forest so as to be near the source of raw material. It is difficult, however, to generalize concerning logging methods in Canada. In many areas logging is fully mechanized. On the other hand, horses are far from obsolete. In portions of eastern Canada conventional methods utilizing horses, sleighs and streams are the rule. In difficult terrain horses prove better adapted and/or cheaper, particularly in small operations.

In mountainous terrain where logging is difficult, many ingenious logging methods have been tried. In high-lead (*i.e.*, high-line) logging, logs are brought down steep slopes, across deep ravines and over swamps at breakneck speed on overhead wire cables. The logs are then hauled to sawmills or are dumped into navigable streams or bays to continue their journey by water. Cable skidding is a preferred method in pulpwood operations where clear-cutting (*i.e.*, total clearance of timber) predominates. The trees are removed in long, narrow corridors extending outward from the landing; the logs are dragged by cable down skidding trails, which join together in herringbone fashion.

The Canadian sawmill industry is characterized by great variations in the size of plants, in techniques and in equipment. There are large, modern plants equipped with hydraulic riderless carriages, double-cut band mills, double edgers, automatic drop-saw trimmers, dry kilns, complete finishing and remanufacturing facilities, and mechanized systems for handling materials, including automatic stackers and unstackers. Year-round operations are made possible by storing debarked logs in a stockpile and transferring them as needed during the winter to a "hot pond" (a log pond heated with steam or electricity to prevent the water from freezing). Hammer hogs and chippers convert sawmill residue into fuel and chips, thus eliminating the refuse burner in which leftovers from the sawmilling process are burned to get rid of them. Most Canadian mills are small, are operated with conventional equipment, including circular and gang saws, and are geared to a six- or seven-month sawing season. In the relatively smaller timber of eastern Canada the emphasis is on production of wood chips for pulp and paper mills. Some British Columbian mills ship rough lumber to be seasoned and finished at larger centres, or exported to the United States. In general, modern developments in both log and lumber handling stress mobility; *e.g.*, shovel loaders and fork-lift tractors greatly increase the speed and efficiency of woods and yard operations.

More than 90% of Canada's forest land is government-owned. Most of the forested area has been reserved as crown lands controlled by the dominion government. The land is divided into so-called "timber limits"; stumpage rights to the limits are leased to private companies. In times when forests were considered inexhaustible, the policy was to dispose of cutover land to agricultural settlers. Later, forest reserves were established and cutting was regulated with a view to perpetual production.

U.S.S.R.—Forests occupy more than a third of Russia's land area, or roughly 2,600,000,000 acres. It has been estimated that one-third of the world's total reserves of standing timber grow in the coniferous belt, or taiga zone, between the northern tundra and the steppes. The main commercial species are larch, pine and spruce, along with the hardwoods birch and aspen.

Until the 1940s logging practices in the U.S.S.R. were fairly backward. After World War II, beginning with the fourth five-year plan (1946–1950), the high priority given to developing more efficient methods resulted in a transition from seasonal work with horses and human brawn to well-organized mechanized operations with a permanent labour force. This advance was accomplished by applying mechanized techniques observed in the United States and Canada, and by independent research. One of the more significant innovations was the introduction of the concept that the forest should provide the power required for logging. Inferior species of trees and logging waste came to be utilized as fuel either in the form of gas or as electricity generated in wood-consuming power plants. Mobile equipment, such as trucks, tractors and narrow-gauge railroad locomotives, is powered by fuel wood, electricity or petroleum. Electric chain saws are commonly used in felling trees; cable skidders, log loaders and other machinery for handling logs are powered by electricity generated by portable power plants or relayed from nearby power stations.

In Soviet lumbering, logs usually are skidded in tree lengths. Entire trees may be brought to the landings; in this method the work of removing branches, bucking into logs and disposing of slash (debris) is transferred from the stump to the landing, or to larger assembly and processing centres. Various ground, high-lead and overhead cable skidding techniques are employed as alternatives to tractor skidding. A simplified, single-truss cable crane was introduced in 1957. Much emphasis has been given to proper layout of skidways and to organizing the once-haphazard logging operations into logical units with the work performed on an assembly line basis. In some units large increases in productivity were reported; in others satisfactory organization was reached only by trial and error and the goal of eliminating waste generally was not reached. Over half the logs are floated down rivers to manufacturing centres. Archangel, at the mouth of the Dvina river, has long been a sawmilling centre. Sawmills are widely dispersed, with new mills in the virgin timber of the north and east.

Europe.—On the European continent, which was once heavily forested, lumber was abundant and cheap for centuries. As population increased, wood was used freely for heating homes and in such industrial processes as smelting and brick- and glassmaking. As forest lands became depleted they were converted to agriculture. In modern times the forests along the upper Rhine supplied the relatively treeless Netherlands. The enterprising Dutch eventually imported square timbers, resawed them and sold lumber throughout Europe. France, England and later Germany were the principal consumers; eventually the English market was supplied largely from Canada. At one time, great quantities of lumber from Prussia and Poland were assembled in the ports of Danzig, Riga, Memel and St. Petersburg and shipped to western Europe.

Lumbering in Sweden expanded rapidly after 1850, especially in those sectors of the Norrland region convenient to rivers, ports and the superb forests. Swedish timber exports reached a peak in

1903. After World War I the Swedish sawmilling industry developed highly efficient techniques with the triple objective of reducing labour costs through mechanization, converting sawmill waste into usable by-products and improving product quality. By the 1960s lumbering was conducted on a large scale. Logging methods tended to be traditional because of the long, cold winters, the availability of water transportation and the fact that the labour supply was drawn from rural areas. Swedish forest workers alternated between farm and woods employment.

Finland also has excellent coniferous forests and lumbering is also a major industry there. Up to 88% of the output is exported. Lumber and allied forest products are the mainstay of foreign trade for both Finland and Sweden; considerable quantities of pine and spruce (European redwood and European whitewood) and birch plywood are exported annually.

Extensive forests remain in central and eastern Europe, but lumbering is rather poorly developed. Manual and horse-powered practices are typical, mechanized operations appearing only occasionally; however, considerable progress was being made in building access roads and extending lumbering activities to new areas.

Nowhere are forests more valued than in Germany, France, Switzerland and the rest of western Europe. Meticulous forest management and careful milling result in a maximum yield from the limited area of commercial forests. Most countries in Europe, as well as those in the rest of the world, were striving in the 1960's for self-sufficiency in forest products by expanding their logging activities and utilizing secondary species of trees. Europeans were applying technical knowledge to make maximum use of the raw material harvested. For example, lumber was treated with chemicals to protect it against decay, insects and fungi. Preservative treatment also permits the use of fast-growing species of tropical or semitropical trees whose wood is of inferior quality.

Africa.—Africa's equatorial forest consists of a dense 3,000-mile belt reaching from Sierra Leone on the west coast to the great east African lakes. This forest contains large quantities of timber (the exact amount is unknown) and a profusion of species. Some 120,000,000 ha. (1 hectare = 2.471 ac.), or over half the surface, in the Congo region is forested. Trees grow rapidly in Africa because of the warm, humid climate. Commercial logging began early in the 20th century but progress was slow. The demand for tropical woods is limited and the few commercially valuable trees are found in mixed stands; logging and transportation costs are high. The two main exports were mahogany and okoume.

In Nigeria and Ghana, obeche, agba, iroko and sapele woods, among others, are harvested. The forests generally are community-owned, with private companies leasing stumpage rights. Trees are felled by hand ax but crawler tractors, bulldozers and diesel-powered loaders and trucks are used to bring the logs out of the forest. In Nigeria logs are hauled to the river and towed in rafts to sawmills or to peeler plants for making plywood and veneer. Since Ghana has no suitable river, logs are hauled entirely by truck or rail. The mills are equipped with conveyer systems, band saw headrigs and wood-burning steam plants; modern plywood mills have been built.

Outside the central zone, Africa lacks great forest areas, although the semiarid grasslands and plateaus support forest growth of local economic importance. In Sudan the government introduced sawmills and mechanized logging machinery in 1955, but production is on a very small and local scale. Fires periodically burn over portions of the forest, which then revert to grassland or to the growing of inferior species of trees. Parts of Uganda, Kenya, Tanganyika, Angola and Southern Rhodesia also are forested, and considerable logging is done there.

Asia.—China is deficient in timber, although sizable tracts remain untouched in the remote, rugged regions. Access roads have been built into these reserves, particularly in Manchuria and the southeastern and western interior. Massive reforestation and flood control projects are underway. Apparently because of the enormous labour force available, mechanized techniques have not been introduced. The poplar tree occupies an important place in the Chinese economy; it is widely planted and finds many uses.

The teakwood of India and Burma is a prime building material and is in wide demand. Logging is done by traditional hand methods with buffalo and oxen except on mountainous terrain, where the elephant is used. Some mechanized logging was introduced after the elephant herds became depleted. The innovation of greenfelling permitted easier milling and better seasoning. With this method teak trees are killed by girdling them and letting them stand for three years to dry before logging. Green teakwood logs are too heavy to float; consequently, like hardwoods, they must be transported by animals, rail or truck. Occasionally, heavy logs are buoyed with bamboo floats.

The Indochina countries, particularly Thailand, and Malaysia and the Philippines, are covered with extensive forests. Malaysia, for example, with an area as large as England, is nearly 75% forested. Only a very small fraction of the timber resources are at present commercially exploited. Teak is the most valuable wood, followed by several species of pine. Most of the timber is of low average quality for which it is difficult to find a market. Nevertheless, it is increasingly being recognized that the forests of these countries are a potentially valuable resource. Various technical assistance and economic development programs are introducing silvicultural practices and more efficient methods of harvesting and utilizing the forests of these far eastern regions. Malaysia in particular has a progressive forest policy and, although overshadowed by rubber and tin, forest products is one of the most important industries in Malaysia.

The Ganges delta region in East Pakistan has 2,000 sq.mi. of forests with many huge trees. The elephant is the preferred source of transport but is being replaced by machines. The main commercial tree is the sundri, which is ideal for shipbuilding and for use as utility poles. The gewa, a softwood species, is valued as a raw material for paper pulp and fibreboard. The lumber industry, however, is relatively undeveloped; one reason is that tigers and crocodiles are a constant hazard to woodsmen.

Turkey launched a program to increase production from its forests and thus reduce lumber imports. North American techniques and equipment were being introduced.

Australia and New Zealand.—The natural forests of Australia are mostly hardwoods of mixed species with many worthless scrub trees. The area of commercial timber is very small but extensive forests have been planted with fast-growing exotic softwoods, and timber from these forests, together with the native eucalypti, which are widely used, and other native trees were expected to reduce Australia's dependence on imported softwoods. To keep pace with the growth of this lumbering industry, logging and milling methods were modernized and in some of the larger sawmills mechanization is comparable to that of North America.

New Zealand's forest industry expanded after World War II and a surplus of forest products was exported. Drawing on European experience, manufacturers treated lumber with preservatives to make maximum use of the lumbering harvest. Moderately dense hardwoods, including beech and tawa, are used in light construction, while native softwoods are used for laminated products.

South and Central America.—Much of South America is covered with forest, only a small fraction of which is accessible commercial timber. In many areas lumbering is conducted on a small scale with relatively crude methods. Large areas are still undeveloped. In Brazil nearly half the land area is forested. The Amazon basin and the rain forests of the Atlantic slopes contain 362,000,000 ha. of tropical hardwoods and 8,800,000 ha. of Paraná pine. The latter is the most important softwood species in South America. In contrast to the commercial hardwoods, Paraná pine grows in dense stands and is relatively easy to harvest. Consequently, the pine industry is well-developed and a large surplus is exported to Argentina, Uruguay, the United Kingdom and South Africa. Logging and milling equipment compare with that of the southern pine areas in the United States, but formidable problems of transportation and seasoning exist.

The Orinoco river basin ranks second to the Amazon area as the most important forest region in South America. Logging in the Orinoco is generally confined to sectors near the river or its tributaries. About 85% of British Guiana is forested, mainly with tropical rain forest trees. A significant lumber industry has de-

veloped there. Paramaribo, the capital city and principal seaport of Surinam, has 16 sawmills, in addition to facilities for making plywood, crates, flooring, furniture and other wood products.

Bolivia, Chile, Colombia and Paraguay also have extensive forests, all of which are largely undeveloped.

In Central America Nicaragua has dense forests but its forest industry, located principally near population centres, is small. Some fine mahogany is harvested in Honduras and in the Dominican Republic. Tropical forests generally are logged only for special timber of the largest sizes; some loggers seek only mahogany. To utilize the hundreds of other species requires road and railroad building, costly mechanical equipment and a market.

See also references under "Lumbering" in the Index.

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(F. W. Ko.)

LUMBINI, the grove, located near the village of Paderia in southern Nepal, in which, according to Buddhist legend, Gautama Buddha (*q.v.*) was born. There are two references to the name in the Pali scriptures, the first in the narrative poem prefixed to the Nalaka Sutta in the Sutta Nipata, where it is related how the gods rejoicing in the sky inform the sage Asita that "the Bodhisattva, the incomparable jewel, has been born for weal and happiness in the world of men, in a village of the Sakyas, in the Lumbini country." The other reference is in the Kathavatthu, one of the latest works in the canon. The detailed story of the birth as known to Pali Buddhism first occurs in the introduction to the commentary on the Jataka. This account says that Queen Mahamaya (of the Sakya people), when her time was come, desired to go to her parents' home at Devadaha. On the way she stopped in the Lumbini grove, her pains came upon her and there the future Buddha was born. The earliest canonical accounts of the birth are not in the Pali canon but in the Sanskrit scriptures of two other schools, the Mahavastu (ii, 18) and the Lalitavistara (ch. 7). Neither of these works can be put earlier than the 3rd or 4th century A.D., but the discovery of an inscription of Asoka makes it probable that the whole legend was established at least as early as the 3rd century B.C. The inscription, found in 1896, a few miles within the border of Nepal and several miles east of the site of Kapilavatthu (Kapilavastu), the city of Buddha's family, records that "Piyadasi [*i.e.*, Asoka], after he had been consecrated 20 years, came in person and worshipped, because here was born Buddha Sakyamuni. . . ." This makes the date 249 B.C., according to the accepted chronology of Asoka's reign. There is a shrine at the place, now increasingly a site of pilgrimage for modern Buddhists. The shrine contains a bas-relief representing the birth of the Buddha. The legends with their fabulous details are not historical documents, but the archaeological evidence which has accumulated increases the probability that they originated in a historical event.

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(E. J. T.; Ce. H. H.)

LUMHOLTZ, CARL SOFUS (1851–1922), Norwegian explorer and naturalist, was born on April 23, 1851, at Faberg in Gudbrandsdal. After graduating in theology at the University of Oslo, he was sent by the university to Australia (1880–84) and subsequently traveled extensively in Mexico, where he made three expeditions. During World War I he went to India and in 1915–17 visited Borneo. He made extensive collections of zoological material and also of anthropological data and added new information concerning the Tarahumare Indians of Sierra Madre (descendants of the Aztecs) and the language and customs of the Dyaks. He died at Saranac Lake, N.Y., on May 5, 1922. His books include *Blandt Mexicos Indianere* (1902–03; English trans., 1903), *New Trails in Mexico* (1912), and *Through Central Borneo* (1920).

(Ed. He.)

LUMINESCENCE, a process by which some materials emit light when they are relatively cool. Familiar examples of luminescence output are the light emissions from: electronically excited gases in neon lamps and lightning; tiny inorganic crystals used as coatings in luminescent watch dials, television and radar kinescopes, fluorescent lamps, and X-ray fluoroscope screens; and certain organic materials undergoing oxidation in fireflies and glowworms. Because they luminesce at room temperature, such materials emit what is sometimes loosely called cold light.

Following are the main sections and divisions of this article:

I. Introduction
  1. Incandescence and Luminescence
  2. Pigment Action and Luminescence
II. Early History
  1. The Bolognian Stone of Cascariolo
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  3. Phosphorescence
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III. Luminescence Excitation
  1. Bioluminescence and Chemiluminescence
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  5. Efficiency and Luminance

I. INTRODUCTION

The process of luminescence is started by exciting the material, usually with ultraviolet radiation, X rays, electrons, alpha particles, electric fields, or energy liberated during some chemical reactions. Suitable materials convert one or more of these invisible input energies to light.

Few luminescent materials are efficient enough for practical use. The efficient ones are custom-made to convert a particular input energy to light of a particular colour and intensity. The colour is determined by the material, while the intensity depends on the material and the input energy.

Luminescence is an electronic process that functions most efficiently on a localized, subatomic scale. On that scale, input energy is absorbed by an atom that becomes excited internally, without moving and becoming agitated as a whole. The absorbed energy forces the atom's electrons into an unstable arrangement. When the atom reverts to its original condition it ejects the absorbed energy as light.

1. Incandescence and Luminescence.—Incandescence is a process by which materials emit light when they are hot; input of heat agitates the atoms and they collide. Some of the collisions

excite the atoms to emit thermal radiation. Every material emits thermal radiation of colour and intensity that are determined chiefly by its temperature. At room temperature the radiation is chiefly in the invisible far-infrared region of the spectrum. As temperature rises, the radiation shifts toward the visible region, and its intensity increases until the material is obviously incandescent; that is, until there is an appreciable amount of visible light in the thermal radiation. Familiar examples of incandescence occur in burning coal and wood, and in the hot tungsten filaments in conventional lamp bulbs.

The mechanism of incandescence is detrimental to luminescence, because atomic collisions dissipate the input energy that is temporarily localized in the excited atom in luminescence. Therefore, luminescent materials are efficient sources of light when cool, but not when hot.

2. Pigment Action and Luminescence.—Pigments and dyes produce colour effects by selectively reflecting light, without emitting appreciable radiation in excess of their thermal radiation. A red pigment, for example, reflects red light and absorbs the remainder of incident daylight. The energy of the absorbed light is converted to a negligible amount of heat. A suitable luminescent material, however, produces colour effects by absorbing some of the daylight and emitting light of a different colour than that which was absorbed. Some luminescent materials also exhibit pigment action. They can, for example, selectively reflect red light and, by luminescence, convert the energy of absorbed blue and green light to additional emitted red light. Such materials are used for vivid colour effects in outdoor advertising, where some of the input excitation energy comes from the ultraviolet content of daylight. Certain organic luminescent materials transmit or reflect white light and convert ultraviolet to additional blue or blue-white light. They are used in detergents and coatings to enhance the appearance of white fabrics in sunlight.

The colours of pigments and dyes are subtractive, because they arise from selectively absorbed and reflected incident light. When blue and yellow pigments are mixed and viewed under white light, each pigment selectively absorbs some of the incident light and the residual reflected light appears green.

The colours of the light emitted by luminescing materials are additive, because the materials generate the light. When blue-emitting and yellow-emitting luminescent materials are mixed, as in monochrome television kinescope screens, the resultant blue-plus-yellow light appears white (*see* COLOUR; LIGHT).

II. EARLY HISTORY

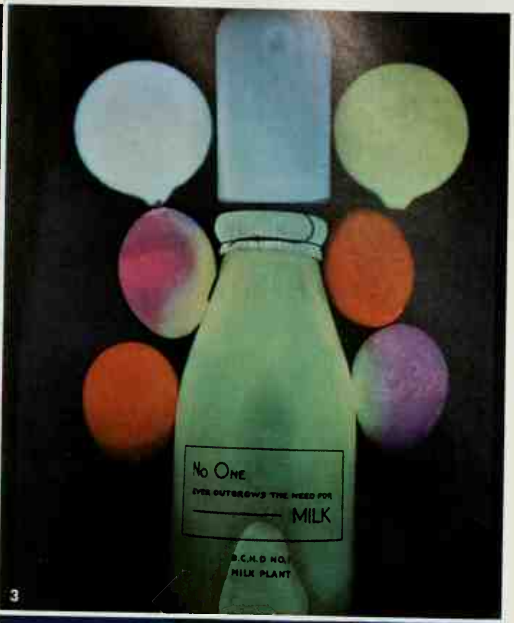
1. The Bolognian Stone of Cascariolo.—According to available records, the first significant inquiry into luminescence began with the synthesis of a new material, not with study of the naturally available fireflies, glowworms, luminous sea bacteria and decaying organic matter, lightning, aurorae, or luminescent minerals. The inquiry was started (*c.* 1603) by an Italian cobbler-alchemist, Vincenzo Cascariolo. He found on Monte Paderno, near Bologna, some unusually dense, silvery white stones. They were pieces of the mineral barite (heavy spar) which is chiefly barium sulfate. In typical alchemical fashion, Cascariolo pulverized the stones and heated the powder in contact with coal. He was seeking to convert the stones to precious metals or gems, or to the fabled philosopher's stone that was believed to be able to transmute baser metals to gold. When he cooled the heated powder, it was a dull-coloured porous cake by daylight, but showed a purple-blue glow at night. The weak glow kindled hopes of magic properties, particularly when it was recognized that the material was energized by the "golden light of the sun." (Sol, the sun, was the alchemical symbol for gold.) The material was named *lapis solaris,* or "sun stone," and attempts were made to use it to produce gold. Despite its failure to function as the philosopher's stone, it gained fame for its property of glowing at night after exposure to daylight. News of the material was transmitted to Galileo who gave samples to Gulio Cesare Lagalla of the Collegio Romano in Rome. Lagalla was the first to write of the *lapis solaris* in *De phaenomenis in orbe lunae* (1612).

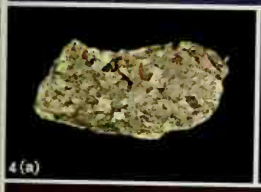
2. Phosphorus and Phosphors.—Many names were proposed for Cascariolo's new material, including *lapis lunaris, lapis illuminabilis, lapis lucifer, luna terrestris,* and *spongia solis.* The first monograph on the Bolognian stone, by Fortunio Liceti (1640), bore the Greek title *Litheosphorus,* or "stony phosphorus." Thereafter, the word phosphorus ("light bearer") increased in popularity as a designation for Cascariolo's material and others that glowed in the dark. The term also was applied to the chemical element phosphorus after it was extracted from urine by Hennig Brand (1669). It was natural to call the new element a phosphorus because it glowed in the dark when it was moist. It is not excited by daylight; instead, its luminescence is energized by chemical oxidation that ceases when the oxygen is removed or the phosphorus (*q.v.*) is consumed. The original Bolognian phosphorus, on the other hand, luminesces best without chemical change, and it continues to luminesce indefinitely in a vacuum. Modern usage restricts the term phosphorus to the chemical element, as applied by Johann Sigismund Elsholz (1677), while the term phosphor is used for the many fine-crystal luminescent materials that have been made since the original Bolognian stone.

3. Phosphorescence.—This term was used to describe the persistent emission of early phosphors after they were excited by daylight. The apparent porous structure of the material led to the postulate that phosphorescence involved a simple spongelike absorption of light, followed by gradual release of that light in the dark. This notion was discredited (1652) when Nicolas Zucchi showed that the colour emitted during phosphorescence was the same whether the phosphor was excited by white light or by light of several other colours. The implication is that phosphors generate rather than store light. This correct interpretation was not obvious, however, in an age when some people associated light with the human soul or considered light to be a fifth element in addition to earth, air, fire, and water.

4. Fluorescence and Luminescence.—The news of the Bolognian phosphor spread, and a German Jesuit, Athanasius Kircher, studied that phosphor and other luminous materials. In his book *Ars magna lucis et umbrae* (1646) he called attention to the peculiar appearance of an aqueous extract of a wood called lignum nephriticum. This solution had been described (1565) as having an unusually intense blue colour by the Spanish physician Nicolás Monardes who recommended the liquid for treatment of kidney ailments. Kircher and, later, Francesco Maria Grimaldi of Italy, and Robert Boyle and Isaac Newton of England, reported that the tincture appeared blue by "reflected" white light, and yellow by the light that was transmitted through the liquid. All of these investigators referred to the blue light as being reflected; the concept of luminescence eluded them. It was not until 1852, after studies of the mineral fluorspar (*see* FLUORITE) and solutions of lignum nephriticum, quinine sulfate, and chlorophyll, by the French mineralogist René Just Haüy, the English astronomer John Frederick William Herschel, and the Scottish physicist David Brewster, that the blue light of lignum nephriticum was identified as a luminescence emission by the English mathematician-physicist George Gabriel Stokes. Stokes used prisms and optical filters that were opaque to each others' light to demonstrate that incident light of one narrow spectral region (such as blue) was absorbed in certain clear solids and solutions, and instantaneously produced emitted light in another spectral region (such as yellow) that was not present in the incident light.

For this luminescence, which apparently ceased when the incident light was shut off, Stokes proposed "to coin a term and call it fluorescence, from fluor-spar, as the analogous term opalescence is derived from the name of a mineral." The term fluorescence was thenceforth loosely applied to short-lived luminescence; also, to light emission during excitation, irrespective of duration after the excitation was stopped. These indiscriminate usages made the term fluorescence ambiguous. Phosphorescence should be used for persistent luminescence in general. Fluorescence should be used only for certain liniting cases of short-duration phosphorescence, as from an isolated, nonmetastable, excited atom. A typical persistence of fluorescence is 10 millimicroseconds (10^{-8} sec.) for emission of visible light. The general term luminescence, of Latin origin, including both fluorescence and phosphorescence, was first





BY COURTESY OF (1–3, 5) R. W. WOOD, (4, 6, 7) ULTRA-VIOLET PRODUCTS, INC.

1. Photoluminescence in a glass tank containing water. Very dilute solutions of the luminescent dyes fluorescein and rhodamine are dropped into the tank, forming graceful vortex rings and whorls as they descend. 1(a) shows the glass dropper above the tank, a second dropper at the left having been removed before a flashbulb was set off directly above the tank. Light from the flashbulb excited the luminescent dyes. 2. Red photoluminescence emission of a chemical substance in the Harderian gland of a rat under "black light" (ultraviolet radiation). At left is a normal rat with Harderian gland exposed by displacement of the eyeball. Rat at right received a diet deficient in pantothenic acid. In this rat the porphyrins excreted by the Harderian gland have migrated to the nose through the naso-lachrymal duct. These studies were made by H. J. Figge of the University of Maryland as part of a search for carcinogenic agents. 3. Photoluminescence, under ultraviolet radiation, of a bottle of milk surmounted by a smaller bottle of evaporated milk. On the right is a circular disk of butter and on the left one of margarine. The four ovals are hen's eggs which luminesce with a scarlet colour due to the presence of a luminescent material with which they became coated during their passage through the oviduct. 4. A specimen of the mineral scheelite, from Tulare county, Calif., photographed (a) in daylight and (b) under ultraviolet radiation in the dark. 5. Specimens of photoluminescent materials. The blue-emitting crystals on the left are fluorspar from which the name fluorescence was derived. 6. A specimen of the mineral willemite with a centre strip of calcite under ultraviolet radiation. The non-luminescent portions are chiefly franklinite. Specimen from Franklin, N.J. 7. Another specimen of scheelite from Lucin, Utah, photographed under ultraviolet radiation in the dark

LUMINESCENCE

PHOTOGRAPHS, ANDREAS FEININGER, "LIFE," © 1945 TIME INC.

EXCITATION OF LUMINESCENT MATERIALS

Top: Luminescent minerals and synthetic microcrystalline phosphors under (left) white light and (right) ultraviolet radiation in a dark room. Most useful phosphors simply reflect white light, but absorb ultraviolet rays and generate light with a colour that is determined by the composition of the phosphor. Phosphor crystals in the centre row of vials are zinc-cadmium sulfides with 0.01% silver activator. As the proportion of cadmium is changed from zero to 100%, the luminescent colour changes from blue to red. The phosphors in the trays below are zinc-beryllium silicates with manganese activator. As the proportions of beryllium and manganese are increased, the luminescent colour changes from green to red. Duration of phosphorescence (afterglow) also varies with composition

Centre: Patches of synthetic microcrystalline phosphors on a plate in an evacuated cathode-ray tube under (left) white light and (right) under a beam of 12,000 volt electrons from an electron gun. The electron beam was deflected from patch to patch on the outer circle by manually rotating a bar magnet near the neck of the tube. When the magnet was removed, the beam struck the centre patch

Bottom: Left, separate pigments or dyes that selectively reflect blue and yellow light from incident white light provide a mixture that reflects green light. Right, separate phosphors that emit blue and yellow light under ultraviolet irradiation, in a dark room, provide a mixture that emits white light

introduced by the German physicist Eilhard Wiedemann (1888) for "all those phenomena of light which are not caused solely by a rise in temperature."

Originally, luminescence was associated with the production of visible light. When it became known that luminescence can also produce such invisible radiation as ultraviolet and infrared, the term was correspondingly broadened. Luminescence is used here in the broad sense, recognizing that there are other detectors of radiation than the human eye.

III. LUMINESCENCE EXCITATION

From Cascariolo's time on, many materials were subjected to different treatments and exposures to find new means for making them luminesce. Iacopo Bartolomeo Beccari, professor of physics, medicine, and chemistry at Bologna, reported (1744, 1747) that glowworms, certain marine life, rotten wood, and the flesh of some birds and mammals emit light spontaneously during putrefaction and chemical change, whereas the phosphori require excitation by grinding, heat, light, or exposure to air. Beccari gave a scrambled catalogue of luminescence classified according to the means of excitation.

In modern terminology, a distinctive prefix is used to indicate the means of excitation; for example, bioluminescence (as in glowworms), chemiluminescence (as in rotting wood), triboluminescence (as in grinding a phosphor), and photoluminescence (as in exciting a phosphor with light).

1. Bioluminescence and Chemiluminescence.—The light from glowworms and fireflies is referred to in the Chinese *Shih Ching*, or "Book of Odes," in the period 1200–1000 B.C. Aristotle (384–322 B.C.) wrote of light from decaying fish, and fostered the concept of cold light by mentioning in his *De colŏribus:* "some things though they are not in their nature fire nor any species of fire, yet seem to produce light." Francis Bacon described his experiments on decaying wood that luminesced (posthumous publication in 1627). Alexander Humboldt showed (1799) that rotting wood ceased luminescing when placed in nitrogen or carbon dioxide, and resumed luminescing in oxygen or air. Humboldt also showed that a live jellyfish could be electrically stimulated to bioluminesce.

All these luminescences of naturally occurring organic matter are essentially chemiluminescence, wherein the excitation energy is supplied by excited molecules, molecular fragments, or electron transfers that occur during chemical reactions. These reactions usually involve oxidation, as does the chemiluminescence of the element phosphorus. Bioluminescence is chemiluminescence in living things.

In the plant kingdom, bioluminescent bacteria and fungi emit light continuously, whereas the more complex organisms of the animal kingdom can control their emission of light. Some animals regulate the emission of light by controlling the influx of air that provides the oxygen for reaction with organic fluids that are synthesized in the animal. Glowworms and fireflies thus glow periodically to attract mates during courtship. According to Thomas Bartholin, Carolus Vintimillia (*c.* 1647) first called attention to the significance of this intense, periodic, green-yellow glow. The rare "railroad worm" of South America emits red light from a spot on its head, and green-yellow light from rows of spots along each side. It is a beetle larva, about two inches long. Its glow can be stimulated mechanically and electrically, as can the bioluminescences of other animals. The greenish-yellow sidelights glow when the larva is shaken, and the red headlight glows when air is blown on it. (*See* also BIOLUMINESCENCE; FIREFLY; GLOWWORM.)

2. Triboluminescence.—The emission of light upon the scratching or breaking of cakes or crystals of sugar was mentioned by Bacon in *Advancement of Learning* (1605). It was called triboluminescence although the name is inappropriate because the prefix *tribo* means "to rub" (Greek). Numerous organic and inorganic materials luminesce when scratched, broken, or ground, and the phenomenon is allied to the blue glow observable when some adhesive tapes are unrolled in the dark. The surfaces that are mechanically separated have unequal electric charges and discharge through the intervening space. The blue glow seen on unrolling adhesive tape is that of atmospheric nitrogen excited by the discharge, and the glows seen on breaking crystalline materials are from the air and from the material excited by the discharge. They are mechanically produced electroluminescences.

3. Thermoluminescence.—This name, another misnomer, was used to denote light emission from crystals on being warmed. Boyle observed such emission from a diamond (1663), and Elsholz saw similar effects in fluorspar (*c.* 1676). The effects caused confusion, because they seemed to indicate that heat alone could excite a luminescent material. More than two centuries of experimenting elapsed before it was realized that heat simply accelerated emission of light by materials already excited by other means, such as exposure to ultraviolet radiation or electric discharges. This phenomenon is heat-stimulated (thermostimulated) phosphorescence.

4. Photoluminescence.—Monardes saw a strange light emitted from his tincture of lignum nephriticum (1565) without appreciating its significance. The realization that a material could be photoexcited to produce light was delayed until Cascariolo's discovery (1603). Nearly two centuries then went by before such invisible radiation as ultraviolet and infrared became known. Johann Wolfgang von Goethe reported in *Farbenlehre* (1810) that he and Thomas Johann Seebeck in 1792 observed light emission when a Bolognian phosphor was held in the invisible region just beyond the violet rays from a prism. (Later, phosphors gave the first indications of other important invisible radiations.)

Positive identification of ultraviolet rays was made by Johann Wilhelm Ritter (1801). He tested phosphors under ultraviolet, and under the infrared rays that were discovered at about the same time. Ultraviolet excited phosphors very well, but he and Seebeck found that infrared decreased the intensity of emission during phosphorescence. This quenching of phosphorescence was later found to be specific for certain phosphors and certain wavelengths. Photoquenching converts stored excitation energy into heat instead of light. With some other phosphors, and selected wavelengths of infrared, the intensity of phosphorescence emission is increased. This stimulation by photons (photostimulation) is similar to that produced by heat, but the mechanisms differ.

5. Stokes' Law.—In about 1852 Stokes showed that the wavelength of the emitted light was always equal to or longer than that of the exciting light. This relationship is called Stokes' law. It was disputed for several decades, but it is valid for most photoluminescences, except those rare instances when thermal energy contributes slighty to the input excitation energy, and when very intense photon irradiation, such as with laser beams, produces multiple excitation or frequency multiplication (*see* LASER; MASER).

6. Electroluminescence.—In 1672, Otto von Guericke, mayor of Magdeburg, Ger., saw light from a ball of sulfur that he rubbed in the dark, and he likened the effect to that seen when sugar is ground. He also noticed roaring and crackling sounds from the ball that he had electrified by rubbing. He thus took a major step toward Benjamin Franklin's identification (1752) of the electric discharge as responsible for energizing the luminescence displayed during lightning. Lightning and Guericke's luminescence both arise from electric discharges through a gas, and both are electroluminescence. Electroluminescence is luminescence in any material that is excited by electrons. It is common to use electric fields to accelerate electrons and make them energetic enough to excite luminescent materials. The electric field may be constant or alternating, and the electrons may originate outside or inside the material.

The first reported electroluminescence in an evacuated vessel is attributed to Jean Picard, a French astronomer and priest, who (1675) noticed a glow above the mercury in his barometer as he carried it into a dark room. The glow ceased when the mercury was still, and appeared when the mercury was moving downward, but not upward, in the glass tube. Johann Bernoulli, a Swiss mathematician, reported (1700) that an evacuated clean glass phial containing some clean mercury glowed while it was shaken. The effect is due to electric discharges from the glass when the mercury is moved rapidly away and leaves an excess of electrons on the

newly exposed glass surface. The charging effect was demonstrated by a Berlin physician, Christian Friedrich Ludolff (1745), by movements of silk threads he suspended near the moving surface of the mercury next to the glass wall of the tube. Francis Hauksbee, a self-educated English scientist, obtained light (1705–11) by electric discharges from many materials (including glass, oyster shells, wool, and flint) that were electrified by rubbing or fracturing in a partial vacuum.

Further studies led the English physicist, John Canton (1768), to observe that phosphors could be excited by electric sparks. As the means for achieving higher voltages and stronger electric discharges in rarefied gases were improved, there was increasing interest in practical application of electroluminescence. One of the earliest demonstrations of an electric discharge lamp was by J. P. Gassiot at a meeting of the Royal Society, London (1860). Gassiot's lamp utilized a high-voltage discharge through carbon dioxide at low pressure to give "a brilliant white light." Gaseous-discharge lamps were further developed by Daniel McFarlan Moore of the U.S., and by Georges Claude of France, in the period 1890–1900. The modern fluorescent lamp appeared in the latter part of the 1930s. It combines electroluminescence and photoluminescense in that accelerated electrons excite mercury gas atoms that emit ultraviolet radiation which in turn excites a phosphor coating that emits light (*see* LIGHTING).

7. Cathodoluminescence.—This term is a partial misnomer, because in this process accelerated electrons are used to excite a luminescent material, and so cathodoluminescence is a subclass of electroluminescence.

In 1858, Julius Plücker discovered that invisible rays were emitted from the cathode of an evacuated electric-discharge vessel, and that these rays could be deflected by a magnet, as evidenced by the movement of a spot of light emitted from the glass wall of the vessel where the rays impinged. Further experiments, especially by A. E. Becquerel, Gassiot, J. W. Hittorf, E. Goldstein, Wiedemann, P. E. Lecoq de Boisbaudran, William Crookes, and P. E. A. Lenard, established that the rays could produce bright luminescence emission from many phosphors, including some naturally occurring minerals. Goldstein discovered (1876) that the rays could be electrostatically deflected, and named them cathode rays (German, *Kathodenstrahlen*). Not until 1897 were cathode rays shown to be electrically charged particles by J. J. Thomson, who called them corpuscles. The name electron (*q.v.*), first suggested (1881) by G. Johnstone Stoney for the unit of electric charge, was not generally adopted until after 1900. Investigators bombarded thousands of materials with cathode rays, and obtained striking displays of cathodoluminescence in platinocyanides, uranium salts, diamonds, rubies, and other solid materials.

The first practical device using cathode rays to excite phosphors was the oscilloscope tube invented by Karl Ferdinand Braun (1897). The moving spot of light on the screen of this electron-beam tube made it possible to observe electric and magnetic fluctuations that are too rapid to follow mechanically. Starting in the 1920s the Braun tube was provided with means for modulating the intensity of the electron beam, and with efficient cathodoluminescent phosphors. The cathode-ray tube has since become the kinescope (image-reproducer tube) of television and radar (*qq.v.*). Cathodoluminescent phosphors in the viewing screens of electron microscopes also transform patterns of electron-beam intensity into visible images (*see* MICROSCOPE: *The Electron Microscope*).

8. Ionoluminescence; Anodoluminescence.—Goldstein discovered rays from anodes, first called canal rays, in 1886. Later identified as positive ions, they also produce luminescence, but are less effective than electrons. Ionoluminescence is an appropriate term to use for luminescence excited by ions, either negative or positive, but the terms anodoluminescence and radioluminescence have sometimes been used as synonyms.

9. Radioluminescence.—After cathode rays, anode rays, and X rays had been discovered (1858–95), Antoine Henri Becquerel of France wondered whether some penetrating invisible radiations might be emitted along with the light from phosphorescing materials. In 1896, he excited some luminescent materials with daylight and then placed them on a photographic plate wrapped in black paper. When the plate was developed, he found that one of the materials, a uranyl potassium sulfate, had darkened the plate. When he repeated the experiment, without previous exposure of the material to sunlight, he got the same result.

His experiments led to the discovery of radioactivity (*q.v.*); that is, penetrating rays spontaneously emitted from atomic nuclei in uranium, radium, thorium, and other radioactive substances. These rays were found to excite phosphors and the phenomenon was called radioluminescence. The term is ambiguous because the rays include electrons (beta rays), ions (alpha particles), and photons (gamma rays). The so-called radioluminescence was put to use by mixing a phosphor and radioactive material in a paint vehicle to make self-luminous dial markings for watches and other instruments. The scintillations produced by alpha particles bombarding phosphor crystals may be seen in the dark by looking at radioluminescent dial markings through a strong magnifying glass. The separate flashes of light show that the excitation is by particles (*see* NUCLEAR INSTRUMENTS: *Scintillation Counters*).

The aurorae are radioluminescence on a large scale. Here, the radioactive source is the sun, which ejects such particles as electrons and protons during violent fluctuations of its nuclear reactions. As these particles approach they are deflected by the earth's magnetic field (which is strongest near the poles) and some of them are concentrated in high-lying belts surrounding the earth. Interactions of particles with each other and the upper atmosphere produce the spectacular luminescent displays of the aurora polaris (*q.v.*).

10. Roentgenoluminescence.—This luminescence, excited by X rays, was discovered (1895) in Würzburg, Ger., by Wilhelm Conrad Röntgen, a physicist. He wrapped a cathode-ray tube with opaque black paper and noticed that some nearby barium platinocyanide crystals emitted light when he operated the tube. He then found that invisible rays came from the glass wall of the tube where it was struck by the accelerated electrons. These newfound radiations, called roentgen rays or X rays, were not deflected by electric or magnetic fields, and were much more penetrating than any previously known. They were later identified as being radiation that is the same as light, but of much shorter wavelength.

Many phosphors are roentgenoluminescent; some are used to make X-ray fluoroscope screens and intensifier screens for displaying the intensity patterns of X rays that have traversed optically opaque bodies. X rays are produced by fluorescence involving the innermost electrons of atoms; thus roentgenoluminescence is the second in a two-stage luminescence (*see* RADIOLOGY).

IV. LUMINESCENT MATERIALS AND PHOSPHOR CHEMISTRY

The Bolognian phosphor, a barium sulfide, was used to make pictures that glowed dimly in the dark, and in moist air it decomposed and evolved malodorous hydrogen sulfide. Despite these shortcomings, its recipe was so highly prized that it was kept semi-secret for nearly a century. The first calcium sulfide phosphor was made (1700) by Friedrich Hoffmann, a court physician in Prussia. He used Cascariolo's technique, heating gypsum ($CaSO_4$) with coal to make a brighter phosphor. A better technique for making a calcium sulfide phosphor was devised (1768) by John Canton, who heated ground oyster shells with sulfur. Canton's phosphor glowed brighter than the Bolognian phosphor, but both were difficult to reproduce, and both decomposed obnoxiously in humid air. The first stable sulfide phosphor, a zinc sulfide, was prepared (1866) by the French mineralogist, Theodor Sidot, who heated zinc oxide in a stream of hydrogen sulfide.

1. Sulfide-Type Phosphors; Activators; Fluxes.—The difficulty of reproducing phosphors led to the suspicion that impurities might be important constituents. In 1870 there appeared the first commercial phosphor, called Balmain's paint, and in 1879 a German patent on "Leuchtfarben" was issued. Balmain's paint was a calcium sulfide in which was incorporated about 0.01% of a compound of bismuth. In 1886 the French chemist A. V. L. Verneuil showed that a pure calcium sulfide was nonluminescent, but after heating with a trace of a compound of bismuth it gave the violet emission of Balmain's paint. Verneuil thus established the

need for a small amount of activator (*e.g.*, bismuth) in the host crystal (*e.g.*, calcium sulfide). In retrospect, Cascariolo's heavy spar ($BaSO_4$) and Canton's oyster shells ($CaCO_3$) apparently contained about the right proportion of bismuth to provide the activator in their phosphors. Sidot's green-emitting zinc sulfide phosphor had a few thousandths of one percent of copper impurity that functioned as the activator.

The best sulfide phosphors were made with about 2% of certain salts in the mixture during heating. Sodium chloride was particularly effective as an additive in making zinc sulfide:copper phosphors, as were several other alkali halides. Almost none of the alkali halide was incorporated in the final phosphor. The beneficial action of these salts led to their being called fluxes, as in welding where certain salts facilitate high-temperature bonding of metals (*see* FLUX).

2. Oxide-Type Phosphors; Poisons.—After the discovery of activators, the search for new phosphors continued with more attention given to minor ingredients. Among the minerals, bright red emission was obtained from excited specimens of ruby (aluminum oxide with chromium activator), green from willemite (zinc silicate with manganese activator), and blue from scheelite (calcium tungstate, which requires no activator impurity). These materials were then made synthetically with higher efficiencies of luminescence than those of the best naturally occurring specimens.

The higher efficiencies were achieved by eliminating unessential ingredients, and intimate mixing, combining, and crystallizing at optimum temperature and time (usually about 1,000° C for an hour). Great care had to be taken to avoid inclusion of such undesirable impurities as iron and nickel. The efficiency-reducing impurities became known as poisons or killers, and some phosphors were found to be hypersensitive to certain poisons, but relatively insensitive to others. Fluxes, which were essential in making efficient, sulfide-type phosphors, were found to be unessential, and even poisonlike, in making oxide-type phosphors.

3. Centres; Intensifier Activators; Originative Activators; Coactivators.—Attempts to explain the roles of activators led to the concept of distinct atoms (or groups of atoms), that Lenard (1890) called centres, in which luminescence takes place. The host crystal was viewed as a medium in which separated activator atoms were suspended and, with their neighbouring host-crystal atoms, provided discrete centres which, when excited, emitted light. As a corollary, poisons were viewed as foreign atoms that incapacitate nearby centres. The optimum proportion of activator was found to be about 0.001–1% of the weight of the host crystal, indicating that centres packed too densely poison each other.

In phosphors that require no added activator, such as pure calcium tungstate and zinc silicate, the luminescent centres may be identified with distinct groups of atoms, such as the octahedral tungstate (WO_6) group in $CaWO_4$ and the tetrahedral silicate (SiO_4) group in Zn_2SiO_4 (*see* SCHEELITE; WILLEMITE).

When about 0.2% of titania (TiO_2) is incorporated in pure Zn_2SiO_4, or in some other pure silicates, the violet emission is greatly increased. A titanium atom apparently increases the luminescent capability of nearby SiO_4 centres, presumably by altering the symmetry of the centres. Impurities that increase latent host-crystal luminescence are called intensifier activators.

When about 0.2% of manganese oxide (MnO) is incorporated in pure Zn_2SiO_4, the violet emission is replaced by a strong green emission. Here, manganese atoms replace some of the zinc atoms to form new, luminescent MnO_4 centres (and the SiO_4 centres become inactive). Impurities that produce luminescence not ascribable to the pure host crystal are called originative activators.

Another type of activator action was traced to fluxes. Pure zinc sulfide (ZnS) crystallized with 0.01% of a copper salt and 1% of NaCl flux produces a phosphor with a strong green emission. It was found that trace amounts of chloride ions (Cl^-) were incorporated in the ZnS host crystal where they facilitated the incorporation of the copper activator ions (Cu^+) and compensated the electrical charge of Cu^+ Impurities (*e.g.*, Cl^-) that facilitate the formation of luminescent centres associated with another impurity (*e.g.*, Cu^+) are called coactivators.

Identification of centres, activators, and poisons is a formidable challenge in many phosphors because of the minute proportions involved. In a very pure ZnS, for example, as little as 0.0000001% (10^{-7}%) of copper activator gives a readily discernible green emission. In the same phosphor, as little as 0.00001% of iron or nickel poison discernibly decreases efficiency. Organic luminescent materials also exhibit sensitivity to impurities. The green emission long attributed to pure anthracene (*q.v.*) was found to be due to traces of naphthacene. Pure anthracene has a blue emission from its host-crystal centres, which consist of the planar anthracene molecule $C_6H_4:(CH)_2:C_6H_4$. When a trace of naphthacene is incorporated, the naphthacene molecule $C_6H_4:(CH)_2:(CH)_2:C_6H_4$ functions as an originative activator.

A shorthand designation of phosphors denotes the crystal class and chemical composition of the host crystal, the activator, the proportion of activator (usually in percent by weight of the host crystal), auxiliary impurities, the temperature and time of crystallization, and other essential data. On this basis, some phosphors and their congeners are shown in Table I.

TABLE I.—*Typical Oxide-Type and Sulfide-Type Phosphors*

Phosphor	Emission	
	Colour	Persistence
rhombohedral-Zn_2SiO_4:Mn(0.3%), 1,200° C., 60 min., slow cool	green	short
β-Zn_2SiO_4:Mn(0.3%), 1,600° C., 10 min., quench cool	yellow	short
cubic-ZnS:Cu(0.003%):[Cl], 950° C., 10 min., slow cool	green-blue	long
hexagonal-ZnS:Cu(0.003%):[Cl], 1,250° C., 10 min., slow cool	green	very long

The examples in the table show that the structure of the host crystal can greatly influence luminescence. Zn_2SiO_4:Mn, for example, can be changed from the yellow-emitting form to the structurally different green-emitting form without changing its chemical composition. In these phosphors, the luminescent MnO_4 centres are significantly influenced by structural rearrangements of the surrounding host-crystal atoms.

Phosphors are frequently symbolized in still shorter form, such as rbhdl.-Zn_2SiO_4:Mn, hex.-ZnS:Cu:[Cl], and tetr.-$CaWO_4$. Each such short-form designation represents a family of phosphors, whose members differ in luminescence with differences in the unspecified proportions and ionization states of ingredients and the conditions of preparation. Hundreds of thousands of different phosphors have been synthesized and studied, and a few dozen are in practical use.

4. Gases; Liquids; Crystals; Photons.—Studies of luminescence were extended to rarefied matter after the invention of the vacuum pump by Von Guericke (*c.* 1650). From studies of rarefied gases, it was determined that every kind of atom (*q.v.*), when alone, will luminesce. When the light that such atoms emit is passed through a prism or spectroscope sharp lines are seen in some parts of the spectrum. Each kind of atom (there are more than 100 different kinds; *see* ELEMENTS, CHEMICAL) exhibits characteristic locations and intensities of spectral lines. These have been interpreted in terms of quantum theory (*see* QUANTUM MECHANICS).

According to quantum theory, an isolated atom or ion can exist indefinitely in an unexcited state (called the ground state) or it can be excited and exist for short periods in one or another of various discrete excited states. In other words, a given kind of atom can exist briefly in one of several separate and distinct states of higher energy, but not in intermediate states. Each state has an energy level that corresponds to a different configuration of the electrons in the atom. When the excited atom drops from a higher to a lower energy level, the difference in energy between the two sharply defined levels is radiated as a discrete bit (quantum) of light that is called a photon.

A lone excited atom loses its excess energy by radiation, in the absence of collisions with other atoms. An excited atom in a molecule, however, can dissipate excess energy by converting it to increased agitation of all the atoms that are bound together in the molecule. Spectroscopic analysis of light from luminescing molecules shows that the energy levels of the constituent atoms

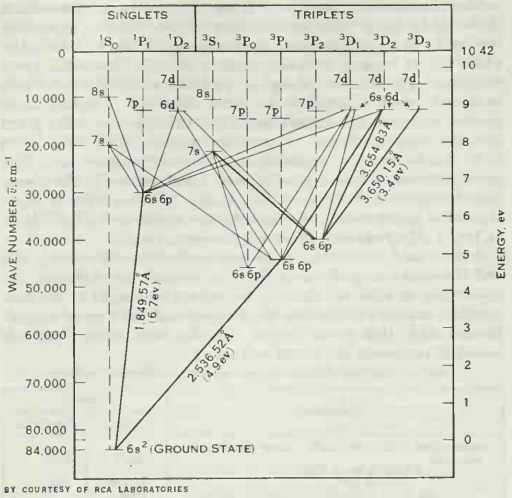


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FIG. 1.—PART OF THE ENERGY-LEVEL DIAGRAM FOR AN ISOLATED (FREE) ATOM OF MERCURY (Hg)

are altered and proliferated into many additional closely spaced levels due to vibrations and rotations of the atomic ensemble. A multiatom ensemble generally has lower efficiency of luminescence than an isolated atom because the assemblage can convert excitation energy into atomic motion, which in condensed matter is thermal agitation (heat).

The probability of dissipating input energy as heat is enormously increased on going from an isolated atom to one bound to myriads of others in an elemental liquid or solid. Most elemental liquids and solids, therefore, are nonluminescent. Mercury is an efficient luminescent gas, but is a nonluminescent liquid. There are some nonelemental liquids, however, that have relatively high luminescence efficiencies. In benzene C_6H_6 (which luminesces as a gas, a liquid, and a solid), the hexagonal benzene molecule is the luminescent centre that emits ultraviolet radiation in all three physical states. As in many other organic substances, the strength of bonding between atoms in each molecule is much greater than that between molecules, and the molecules function as distinct centres. Crystals are generally the most advantageous hosts, because their ordered structures provide stable arrangements of atoms around centres, and permit relatively efficient ingress and internal transport of input energy, and emission of photons.

V. LUMINESCENCE PHYSICS

1. Energy and Spectra; Excitation; Energy Levels; Black Light.—The basic mechanism in luminescence is conceptually simple. Input energy is absorbed by an isolated atom or centre that becomes excited and then emits a photon when it returns to the unexcited state. According to quantum mechanics, the energy E of the photon is related to the frequency and wavelength of the emitted light by

$$E = h\nu \ (\equiv hc/\lambda) \qquad (1)$$

where $h = 4.141 \times 10^{-15}$ electron-volt second (Planck's elementary action constant in ev sec.); ν is the frequency of the light in cycles per second (= sec.$^{-1}$); $c = 2.998 \times 10^{18}$ angstroms per second (velocity of light in a vacuum, in Å sec.$^{-1}$); λ is the diffraction wavelength of the light, in Å. (Note: 1 electron volt = 1.6×10^{-12} erg = 3.8×10^{-20} calorie, and 1 angstrom = 10^{-8} centimetre = 10^{-4} micron.) The average person can see light that has photon energies ranging from about 1.8 ev (deep red, near 6,900 Å) to 3.1 ev (deep violet, near 4,000 Å).

Excitation of luminescent materials may be accomplished by photons or charged particles (electrons, ions) with energies equal to or greater than the energies of the photons to be emitted. There is no known upper limit to the energies of primary particles capable of exciting luminescence. Very high-energy particles that exceed the velocity of light in materials lose energy and produce a glow called Cerenkov radiation. This effect is not a true luminescence, because the spectral quality depends chiefly on the excess high energy, not on the nature of the material (*see* CERENKOV RADIATION). The primary-particle energies used for luminescence excitation generally range from about 3.4 ev, for photons in the near ultraviolet, to billions (U.S. usage: 1 billion = 10^9) of electron volts, for energetic particles produced in accelerators such as cyclotrons and synchrotrons (*see* ACCELERATORS, PARTICLE). Under certain conditions, luminescence may be produced by applying quanta of much lower energy, as is described later in connection with solid-state electroluminescence.

Some phosphors, such as blue-emitting hex.-ZnS:Ag:[Cl], may be excited by electrons with energies ranging from about 6 ev to more than 10,000,000 ev. This phosphor is used in television kinescopes, where it is excited by beams of electrons wherein each electron has an energy of about 25,000 ev. The colour of the light emitted is nearly independent of the energy of the particle used for excitation. The energies of the photons emitted are determined chiefly by the composition and structure of the luminescent material.

The detailed mechanism in luminescence is complex, because an atom consists of a nucleus and from 1 to more than 100 electrons. These subatomic particles have intricate interactions, and an atom can exist in only certain overall energy states wherein its electrons exist in many different substates. As an example, a few of the energy levels of an isolated atom of mercury (Hg) are shown in fig. 1.

Each energy level corresponds to a particular overall state (or configuration) of the mercury nucleus and its surrounding 80 electrons. The excited-state energy levels above ground state are those in which the two outermost electrons of the mercury atom have been put into abnormal configurations. By bombarding a mercury atom with an electron having somewhat more than 6.7 ev of energy, for example, the two outermost electrons originally in the $6s^2$ singlet configuration may be excited into the 6s6p singlet configuration (*see* SPECTROSCOPY). When the excited atom returns to the ground state, the excess 6.7 ev is radiated as an ultraviolet photon with a wavelength of 1,850 Å. If, however, more than 10.42 ev of energy were to be absorbed, then one of the electrons would be ejected from the atom, producing a positive ion (Hg^+).

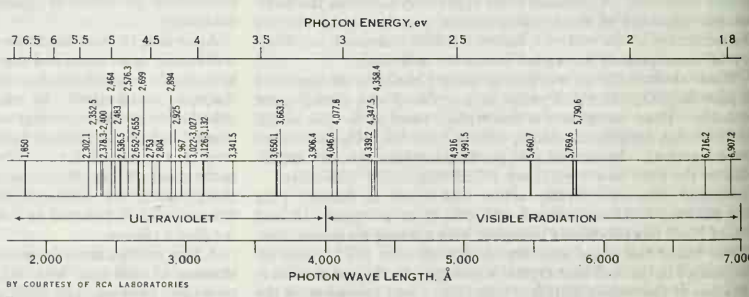

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FIG. 2.—SOME OF THE PRINCIPAL LINES IN THE ARC EMISSION SPECTRUM OF MERCURY (Hg). THE LINES ARE DISTINCT AT A PRESSURE OF 10^{-3} CM. (OF Hg) BUT GENERALLY BROADEN AND BECOME DIFFUSE BANDS AT 10^{4} CM. ALSO, THE MEAN RADIATED-POWER DISTRIBUTION SHIFTS TOWARD LONGER WAVE LENGTHS WITH INCREASING PRESSURE

Luminescence transitions in a mercury atom occur in the region between ground state, at zero ev, and ionization threshold, at 10.42 ev. Within that span there are many excited-state levels that may be achieved by excitation from ground state, by multiple-stage excitation from a lower-lying excited state, or by emission transitions from higher-lying levels. Not all interlevel transitions occur, however, and those that do have unequal probabilities. Some of the permitted transitions are shown in fig. 1, with corresponding spectral locations shown in fig. 2.

The 2,537-Å emission is particularly strong when rarefied mercury gas at about 10^{-5} atmosphere pressure is bombarded by about 100-ev electrons. Under these conditions at room temperature, about 60% of the input electron energy is converted to the 2,537-Å radiation used to excite phosphors in fluorescent lamps (the phosphors, in turn, convert the invisible 2,537-Å radiation to visible light). As indicated in fig. 2, the spectral quality of luminescence emission from mercury gas varies with pressure.

At high pressures, the high frequency of collision with other atoms de-excites, or further excites the already excited atoms. When mercury-vapour lamps are operated at about 8 atmospheres pressure, the 3,650-Å emission transition is prominent. Such lamps are used, with suitable filters, to provide invisible near-ultraviolet radiation.

Ultraviolet radiation is commonly called black light. Ultraviolet lamps are used to excite photoluminescence for decorative and theatrical effects. The lamps also are used in prospecting for luminescent minerals; in disclosing otherwise invisible luminescent markings for laundries, flaw detection, and criminological investigations; in detecting diseased tissues in agriculture and surgery; and in disclosing flow and seepage paths of luminescent fluids. Natural teeth luminesce with a pale blue glow under ultraviolet irradiation.

2. Time Aspects; Growth and Decay; Trapping; Stimulation; Quenching.—The first observations of the persistence of luminescence after cessation of excitation were made visually. A century and a half elapsed before it was found that the visual process itself is persistent, and was eventually found to persist for about 0.1 sec. Luminescences that persisted longer than 0.1 sec. were the first to be observed, and were called phosphorescence. When Stokes (1852) identified a luminescence that had an imperceptibly short persistence, he called it fluorescence, and contended it was distinct from phosphorescence. A. E. Becquerel (1854) disputed Stokes, and devised a mechanical-optical device, called a phosphoroscope, to detect phosphorescences as short as 0.0001 sec. Since 1897, cathode-ray oscilloscopes have been used to show duration of phosphorescence down to 10^{-9} sec. At present, fluorescence is recognized as a limiting case of phosphorescence. Fluorescence is spontaneous luminescence as may be exhibited by a simple, isolated, excited atom.

A *spontaneous* transition, with emission of a photon, is usual for an excited luminescent atom returning to the unexcited state. In an assemblage of excited atoms, individual spontaneous transitions occur independently; thus the usual light output from luminescent materials is incoherent because the photons are not generated in unison.

It is sometimes possible to induce an assemblage of atoms or ions to make mostly *stimulated* transitions. Here, the return to the unexcited state is stimulated (triggered) by input radiation with the same frequency as that of the luminescence emission. The concept of stimulated transitions was introduced by Albert Einstein (1917) who calculated the probability of an induced radiative transition from the excited state. Stimulated transitions are used in lasers and masers to produce intense beams of coherent monochromatic light. The beams are generated by luminescent materials in an optical cavity in which standing waves are produced by first raising more than half of the line-emitting atoms (ions) to the excited state, and then stimulating their de-excitation with input radiation that has the same wavelength as the luminescence photons.

The duration of fluorescence is a fundamental quantity related to the energy, or frequency, of the spontaneously emitted photon. For an allowed radiative transition of an excited, isolated atom, the natural fluorescence lifetime in the excited state is

$$\tau_f = \tfrac{1}{2}\pi\Delta\nu \text{ sec.} \tag{2}$$

where $\Delta\nu$ is the frequency width of the emission line, measured at half the peak intensity. Equation (2) is derivable from equations (1) and (5). Classically, for emitted photons of frequency ν_0,

$$\Delta\nu = 3.93 \times 10^{-23}\nu_0^2 \text{ sec.}^{-1} \tag{3}$$

from which the energy width of the emission line is

$$\Delta E = h(\Delta\nu) = 1.66 \times 10^{-37}\nu_0^2 \text{ ev} \tag{4}$$

and, according to the uncertainty principle for complementary energy and time, the minimum value of τ_f is

$$\tau_f \approx h/2\pi\Delta E \text{ sec.} \tag{5}$$

Equations (1), (4), and (5) indicate for emission of optical photons with a wavelength of 6000 Å that $\nu_0 = 5 \times 10^{14}$ sec.$^{-1}$, $\Delta E \approx 4 \times 10^{-8}$ ev, and fluorescence duration $\tau_f \approx 1.6 \times 10^{-8}$ sec. For emission of X-ray photons, with wavelengths less than 1 Å, line widths as large as 3 ev have been observed, and the corresponding fluorescence duration from equation (5) is $\tau_f \approx 2 \times 10^{-16}$ sec. (A more precise expression for $\Delta\nu$, which does not greatly change the indicated value of τ_f for optical photons, is given by quantum theory as

$$\Delta\nu = 32\pi^3\nu_0^3|\mu|^2/3hc^3 \text{ sec.}^{-1}$$

where μ is the quantum-mechanical matrix element of the dipole moment. For photons of wavelength 6000 Å, μ would have a value of about 6×10^{-18} electrostatic units [esu] to correspond to the classical expression given in equation [3].)

If there be a number N^* of excited, isolated atoms (centres) at time τ, then the intensity of spontaneous luminescence emission from the N^* atoms is

$$L = -dN^*/dt = aN^* \tag{6}$$

meaning that the number of photons emitted at time t is equal to a rate constant times the number of excited atoms existing at time t. Integration of equation (6) gives

$$-\log_\epsilon L = -\log_\epsilon N^* = at + [\text{constant}] \tag{7}$$

and, when $t = 0$ (instant of cessation of excitation) and $N^* = N_0{}^*$, the [constant] $= -\log_\epsilon N_0{}^*$. The rate constant a is equal to the reciprocal of the lifetime τ of the excited state,

$$a = \tau^{-1} \tag{8}$$

and τ is the time taken by the assemblage of excited atoms to decrease (decay) in emission intensity to $L_0\epsilon^{-1}$ ($= 0.368L_0$) when L_0 is the intensity of emission at $t = 0$. On this basis, equation (7) becomes

$$L = L_0\epsilon^{-at} = L_0\epsilon^{-t/\tau} \tag{9}$$

Equation (9) represents a simple exponential decay of emission intensity with time, and is identical in form with the familiar equation for the decay of radioactivity.

When a luminescent material exhibits a simple exponential decay of emission intensity after excitation, it exhibits also an exponential growth of emission intensity during excitation. During excitation

$$L = dN^*/dt = I(N_0 - N^*) - aN^* \tag{10}$$

where I is the intensity of excitation applied to the initial N_0 unexcited centres, and continued. Rearrangement, integration, solving for the integration constant at $t = 0$, and substitution lead from equation (10) to

$$L = aIN_0(1 - \epsilon^{-(a+I)t})/(a + I) \tag{11}$$

At low excitation intensities, the time required for the emission intensity to increase and become substantially constant is approximately τ ($= a^{-1}$), and the emission intensity L is determined chiefly by the excitation intensity I. At excitation intensities higher than the value of I required to excite all of the N_0 centres in a time τ, the time required for the emission intensity to become

constant is shorter than τ and is inversely proportional to I. In this saturated condition, the emission intensity is determined chiefly by $N_0 a$ ($\equiv N_0/\tau$).

If the excited atoms (centres) come in contact with other atoms during their excited-state lifetimes τ, some of the N^* atoms can become de-excited by radiationless transitions. Their potential photoemission energy is then converted to heat. Under such conditions, which obtain in dense gases, liquids, and solids, the effective excited-state lifetime τ_e includes the temperature-insensitive radiative decay rate a, and a temperature-sensitive nonradiative decay rate a', such that

$$\tau_e = (a + a')^{-1} = (a + \nu_c \epsilon^{-\Delta E^*/kT})^{-1} \qquad (12)$$

where ν_c is the number of collisions per second suffered by the excited centres, ΔE^* is the activation energy that must be imparted to the excited centre to cause it to transfer its excitation energy into heat energy, $k = 8.62 \times 10^{-5}$ ev degree^{-1} (Boltzmann's constant), and T is the temperature of the luminescent material, in degrees Kelvin (° K). Substituting τ_e for τ in equation (9) gives

$$L = L_0 \epsilon^{-(a + \nu_c \epsilon^{-\Delta E^*/kT})t} \qquad (13)$$

which is representative of the actual exponential decays of many dense luminescent materials.

In a crystal, the collision frequency ν_c is approximately the same as the highest vibration frequency of the atoms. A typical value of ν_c is about 10^{12} sec.$^{-1}$, and so an excited centre with lifetime as short as 10^{-8} sec. has about 10,000 thermal-agitation collisions during this period. Under these conditions the activation energy ΔE^* should exceed about $30kT$ to yield a high probability that the excited centre will emit a luminescence photon. At room temperature (nearly 300° K) the value of kT is about 0.025 ev, and $30kT$ is about 0.75 ev. Lower values of ΔE^* require lower operating temperatures for efficient luminescence.

It is possible to decrease observed decay time of luminescence to periods shorter than τ, or even τ_f ($\approx 10^{-8}$ sec.), by either decreasing ΔE^* or by increasing T. Both expedients decrease the efficiency of luminescence. The value of ΔE^* in a phosphor may be decreased by increasing the proportion of activator beyond its optimum, or by incorporating poison-type impurities.

Decay times longer than 10^{-8} sec. can be obtained by using semiallowed radiative transitions in isolated atoms, or by using suitable neighbouring atoms to alter the excited-state lifetimes of certain atoms or centres in a liquid or solid. Examples of the influence of the host crystal on the lifetime of the excited state of manganese centres in several phosphors are given in Table II. All of the listed phosphors have exponential decays of phosphorescence emission.

The data in Table II provide clear evidence of the potency of atomic interactions in altering excited-state lifetimes and energy levels of luminescence centres in solids. Advantage is taken of atomic interactions to make phosphors and other electronically active solids with specific characteristics for practical uses. For this purpose, inorganic solids are usually more versatile than organic solids.

Inorganic solids permit broad use of combinations of atoms without requiring carbon in the combination; provide the most degrees of freedom in using ionic, covalent, and intermediate

TABLE II.—*Effective Excited-State Lifetimes τ_e of Some Phosphors With About 0.3%, by Weight, of Manganese Activator*

Host crystal	Activator*	τ_e(sec.)	Emission colour
tetr.-ZnF_2	$Mn^{(2+)}$	0.1	orange
rhombl.-$CdSO_4$	"	0.05	orange
rhombl.-$MgSO_4$	"	0.03	red
rhombl.-$Zn_3(PO_4)_2$	"	0.02	red
? -$CdSiO_3$	"	0.019	orange
? -$Zn_2B_2O_5$	"	0.018	yellow
? -$Cd_2B_2O_5$	"	0.015	red-orange
rbhdl.-Zn_2SiO_4	"	0.013	green
rbhdl.-Zn_2GeO_4	"	0.0105	green-yellow
cub.-$ZnAl_2O_4$	"	0.0055	blue-green
cub.-$ZnGa_2O_4$	"	0.0043	green-blue
hex.-ZnS	"	0.0004	orange

*The parentheses $^{(2+)}$ indicate that there are variable proportions of ionic and covalent bonding of the manganese ion to its neighbouring atoms (F, O and S) in the different host crystals

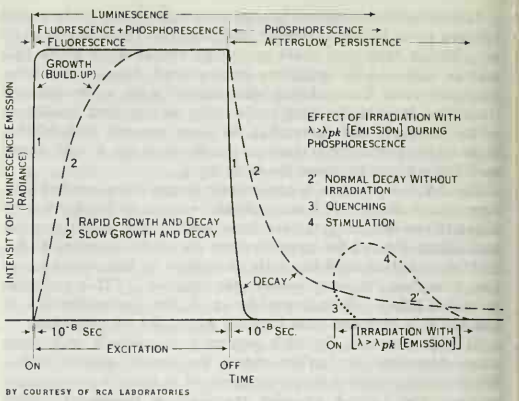

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FIG. 3.—DIAGRAMMATIC REPRESENTATION OF THE DYNAMICS (GROWTH AND DECAY) AND TERMINOLOGY OF LUMINESCENCE EMISSION

types of interatomic bonding; and provide the greatest range of bonding energies, as shown by the high melting points of many inorganic solids.

Trapping is another prominent mechanism for extending the duration of phosphorescence. In many solids this mechanism proceeds as follows: (1) excitation energy ejects an electron from a luminescent centre in a host crystal; (2) the excited electron is trapped in an imperfection elsewhere in the crystal; (3) additional energy, usually heat or infrared radiation, must then be imparted to release the electron from the trap; and finally (4) the electron returns to the centre to be captured and make a radiative transition to the ground state in the usual manner. By inserting a trapping step between the excitation and emission steps, it is possible to prolong phosphorescence for days and even years. Trapping was responsible for the long afterglow of the Bolognian phosphor, and what was mistakenly called thermoluminescence.

The trapping mechanism in solids has its counterpart in the metastable excited states of isolated atoms in gases. A metastable state, such as the 6s6p, $^3P_0$ state of mercury shown in the centre of fig. 1, is one from which the excited atom cannot go directly to a configuration with lower energy. Instead, additional energy must be supplied to excite the atom into a higher energy level, such as the 7s, $^3S_1$ level, from which a radiative transition can occur. The additional energy can be supplied by collision with other atoms, or by photons. If collision energy be used, the release of stored energy in metastable states is strongly temperature-dependent and follows a relation of the type

$$N^* = -dN_m^*/dt = N_m^* \nu_c \epsilon^{-\Delta E^*/kT} \qquad (14)$$

where N^* is the number of atoms elevated from the metastable state to a given excited state from which radiative transitions can be made, N_m^* is the number of atoms in the given metastable state, ν_c is the frequency of collisions (proportional to $T^{1/2}$ in gas), and ΔE^* is the energy difference between the N^* radiative level and the N_m^* metastable level. Under these conditions, in the absence of retrapping in the metastable state, equation (14) leads to a phosphorescence emission that has a temperature and time dependence according to

$$L = L_0 \epsilon^{-\nu_c t \epsilon^{-\Delta E^*/kT}} \qquad (15)$$

Equation (15) represents the rate-determining process for the simplest case of transitions between one discrete trapping level and one discrete radiative level. In crystals, however, there are usually many trapping levels with different values of ΔE^*. The contributions of different numbers of traps with different depths require that equation (15) be expanded to a series of terms, with different values of L_0 and ΔE^*. For a hypothetical uniform trap distribution, that is, an equal number N_t^* of traps of all

depths

$$L = N_t^* kT(1 - \epsilon^{-\nu_e t})/t \qquad (16)$$

which reduces to a hyperbolic relationship

$$L = N_t^* kT/t \qquad (17)$$

when $\nu_e t$ is much larger than unity. Many sulfide-type phosphors at room temperature have emissions that decrease approximately as the reciprocal of the time after excitation is stopped. The exact relationship cannot be exhibited because then the total light output, called the light sum, would integrate to infinity.

A summary of luminescence growth and decay, with corresponding terminology is given in fig. 3. The slow-decay curve 2 is typical of phosphors, such as hex.-ZnS:Cu:[Cl], that have traps that are about 0.5 ev deep; that is, $\Delta E^* \approx 0.5$ ev. Room temperature suffices to release trapped electrons and give phosphorescence emission that can be seen for many hours by the dark-adapted eye. Integration of the decay curve, and comparison with the volume of excited phosphor, gives light sums as high as 10^{18} photons (traps) per cubic centimetre.

The identity of the traps is obscure in most phosphors, but in cub.-Sr(S:Se):Sm:Eu:[$SrSO_4$:CaF_2] the samarium (Sm) has been identified as providing the traps, while the europium (Eu) provides the luminescence centres; the ingredients indicated in brackets are fluxes. In this sulfoselenide phosphor, which is distantly related to the Bolognian phosphor: (1) 3 ev of excitation energy (*e.g.*, a photon of blue light) ejects an electron from a Eu^{2+} centre, which becomes Eu^{3+}; (2) the excited electron is captured by an Sm^{3+} trap, which becomes Sm^{2+}; (3) 1 ev of heat or infrared stimulation energy releases the electron from the Sm^{2+}, which reverts to Sm^{3+}; (4) the electron is recaptured by an Eu^{3+}, which becomes an excited Eu^{2+}; and (5) the excited Eu^{2+} centre makes a radiative transition to the ground state, emitting a photon with an energy of 2.2 ev (yellow light). The cub.-Sr(S:Se):Sm:Eu:[flux] phosphor is able to store trapped electrons for many months, even at room temperature, because its trap depth is very large relative to the heat energy (kT) of the solid. This phosphor has been used in devices for viewing scenes at night by reflected infrared radiation from an infrared lamp. Deep-trap phosphors can be used, also, for storage and later read-out of information.

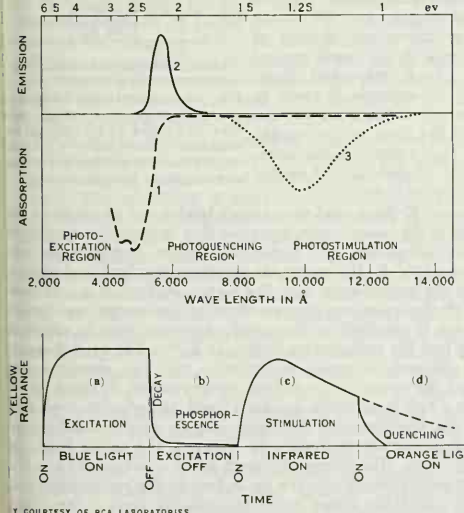

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FIG. 4.—ABOVE: SPECTRAL DISTRIBUTIONS OF EXCITATION, QUENCHING AND STIMULATION FOR A CUB.-Sr(S:Se):Sm:Eu:[$SrSO_4$:CaF_2] PHOSPHOR. BELOW: DYNAMICS OF GROWTH AND DECAY OF THE ABOVE PHOSPHOR DURING AND AFTER (a) EXCITATION, (b) DECAY, (c) STIMULATION AND (d) QUENCHING

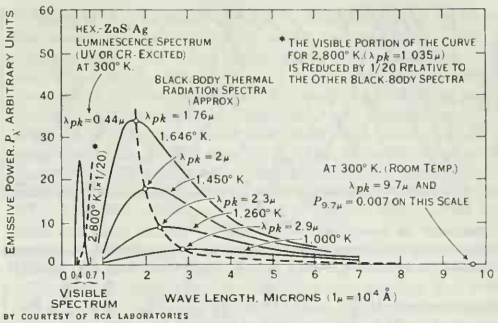

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FIG. 5.—THE ROOM-TEMPERATURE LUMINESCENCE EMISSION SPECTRUM OF A TYPICAL PHOSPHOR [HEX.-ZnS:Ag(0.01S), 1,250° C.], AND THE THERMAL RADIATION SPECTRA OF A BLACK BODY AT VARIOUS TEMPERATURES

By varying the intensity of excitation, the relative height of the luminescence spectrum may be varied from zero to values much higher than the indicated black-body spectra. The black-body spectra are drawn to scale relative to each other

Some of the spectral and dynamic aspects of the luminescence of a cub.-Sr(S:Se):Sm:Eu:[flux] phosphor are given in fig. 4. The photostimulation curve (c), representing accelerated release of trapped electrons by infrared irradiation, has its counterpart in a thermostimulation curve, wherein the accelerated release is accomplished by heating the excited phosphor. When such a phosphor is excited at a low temperature and later heated, the curve of thermostimulated emission as a function of time of heating is called a glow curve.

Light sums may be obtained by integration of photostimulation curves or thermostimulation curves. The conventional phosphorescence of a trap-type phosphor at room temperature is a thermostimulated phosphorescence.

As shown in fig. 3 and 4, stimulation which leads to luminescence has its opposite in quenching, which converts stored excitation energy to heat. Quenching may be accomplished by having poison-type impurities in a phosphor, and then ejecting electrons so vigorously from traps that the electrons go far afield and encounter the poison sites. Incorporation of a trace of iron in hex.-ZnS:Cu:[Cl], for example, transforms the normal stimulation effect of broad-band infrared radiation into a rapid quenching of phosphorescence emission.

3. Emission Spectra of Phosphors; Cascading; Sensitization.—The sharp lines of emission from isolated atoms, as shown in fig. 2, become broadened when the excited atoms collide with other atoms. In a luminescent gas, broadening increases with temperature and density of the gas. In liquids and solids the alteration of energy levels is so pronounced that most phosphor emission spectra are bands instead of lines at room temperature. Notable exceptions are the intense line emissions of rbhdl.-Al_2O_3:Cr^{3+} and cub.-CaF_2:Dy^{2+}, used in lasers, and the strongly cathodoluminescent cub.-Y_2O_3:Eu^{3+} and cub.-YVO_4:Eu^{3+}. The luminescence emission band of a hex.-ZnS:Ag:[Cl] phosphor is contrasted in fig. 5 with the bands of thermal radiation obtained from matter at several different temperatures. Luminescence emission is photon emission in excess of thermal radiation.

In contrast with thermal radiation, the intensity of luminescence emission generally decreases with increasing temperature, and the spectrum of emission is usually a narrow band of wavelengths whose shape and spectral location are relatively insensitive to changes in temperature. As shown in fig. 6, the emission spectrum of zinc sulfide crystals may be shifted gradually from blue (curve 1) to red (curve 8) by substituting increasing proportions of cadmium for zinc. This is typical of several other phosphor families in which the emission colour can be made to order by suitable choice of ingredients and conditions of preparation.

In kinescopes for black-and-white television, for example, the luminescent screen is a mixture of microcrystals of a blue-emitting

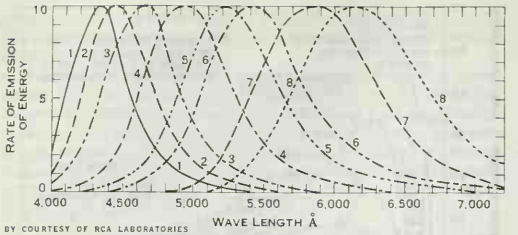
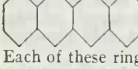
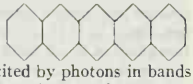


FIG. 6.—SPECTRAL-DISTRIBUTION CURVES OF THE EMISSIONS OF SELECTED MEMBERS OF PHOSPHOR FAMILY (Zn:Cd)S:Ag(0.01). [NaCl(2)], 1,200° C.

Curve		1	2	3	4	5	6	7	8
Mole proportions	ZnS	10	9.5	9	8	7	6	5	4
	CdS	..	0.5	1	2	3	4	5	6
Peak output excited by	6-kv. CR*	415	170	161	147	143	124	64	55
	3,650-Å UV*	217	148	114	109	110	99	60	47

*CR = cathode rays; UV = ultraviolet radiation

phosphor and a yellow-emitting phosphor. The blue-emitting phosphor is the one shown as curve 1 in fig. 6, while the yellow-emitting phosphor has a composition and emission spectrum between curves 6 and 7 in the same figure. Kinescopes for colour television have a blue-emitting hex.-ZnS:Ag:[Cl] phosphor, a green-emitting hex.-(Zn:Cd)S:Ag:[Cl] phosphor, and a red-emitting hex.-(Zn:Cd)S:Ag:[Cl] (or cub.-YVO_4:Eu^{3+}) phosphor, with the red emitter having the higher proportion of cadmium in the sulfide. Inner coatings for white-emitting fluorescent lamps may be made of a blue-emitting monocl.-$MgWO_4$ phosphor mixed with a yellow-emitting rbhdl.-$(Zn:Be)_2SiO_4$:Mn phosphor, or of a single white-emitting phosphor, hex.-$Ca_5(PO_4)_3Cl$:Sb:Mn, wherein the Sb centres emit blue light and the Mn centres emit yellow light.

Another example of a family of luminescent materials is the sequence of aromatic organic substances: benzene , naphthalene , anthracene , naphthacene  and pentacene 

Each of these ring-chain molecules is excited by photons in bands of wavelengths just below a certain demarcation wavelength, and emits photons in bands of wavelengths just above the given wavelength. The approximate demarcation wavelengths for this family are: benzene 2,700 Å, naphthalene 3,100 Å, anthracene 3,800 Å, naphthacene 4,700 Å, and pentacene above 6,000 Å. Luminescence wavelength increases progressively with increasing length of the molecule, just as the optimum wavelength of a dipole antenna increases with increasing length of the antenna. Such an orderly unidimensional correlation is not observed in inorganic phosphors, whose centres generally involve a relatively small number of atoms bound in a multidimensional complex of host-crystal atoms.

It is possible to use luminescent materials in cascade, such that photons emitted by one material can be used to excite another. In the preceding sequence the emission from benzene could excite naphthalene, whose emission could excite anthracene, and so forth.

Cascade luminescence is used in certain radar kinescopes that have composite luminescent screens made of a coating of a yellow-emitting hex.-(Zn:Cd)S:Cu:[Cl] phosphor covered with a coating of a blue-emitting hex.-ZnS:Ag:[Cl] phosphor. Electrons in the cathode-ray beam excite the blue-emitting phosphor whose photons excite the yellow-emitting phosphor. The final phosphor has traps that provide long persistence of emission to retain the radar image for later observation. Direct excitation of the final phosphor by the cathode rays is unfavourable, because the highly energetic electrons in the beam locally heat the material and empty the traps too rapidly. Cascade luminescence also may be accomplished in a single phosphor by having two or more kinds of centres, such that the emission band of one centre overlaps the excitation band of another kind of centre.

Another type of cooperative interaction, called sensitization, can occur between different kinds of centres in a given host crystal. As an example, rbhdl.-$CaCO_3$:Mn emits orange light under excitation by cathode rays, but is not excited by 2,537-Å ultraviolet radiation, whereas the same orange light is emitted by rbhdl.-$CaCO_3$:Pb:Mn under the 2,537-Å irradiation. A mechanical mixture of the host crystals with the two activators incorporated separately gives no emission under ultraviolet, showing that cascade luminescence is not involved. In the host crystal with both activators, the lead centres introduce a new excitation band into the host crystal and transfer absorbed energy to the manganese centres by an energy-exchange interaction that does not involve photon emission. A similar sensitization occurs in gases. For example, thallium gas alone is not excited by 2,537-Å photons, but when a little mercury gas is added, the mercury atoms are excited by the photons and transfer their excitation energy to the thallium atoms on collision. In this indirect fashion, the thallium atoms are excited and emit their characteristic spectrum.

4. Solid-State Energy-Level Diagrams; Solid-State Electroluminescence.—The numerous emission lines of isolated atoms, as exemplified in fig. 2, contrast sharply with the single emission bands of centres in many crystalline phosphors, as exemplified in fig. 6. Luminescence band emission in solids, therefore, requires description in terms of energy-level diagrams that differ considerably from the discrete-level diagram shown in fig. 1. Several kinds of diagrams have been evolved, and some have been found useful for general qualitative descriptions.

One type of solid-state energy-level diagram, shown in fig. 7, is adapted from the conventional diagram used to describe luminescence of an isolated diatomic molecule. As applied to a centre, the potential energy E_p of the centre is plotted as a function of the average distance $\bar{x}$ between the atoms, where $\bar{x}_0$ is the average interatomic spacing of the unexcited centre, and $\bar{x}^*$ is the average interatomic spacing of the centre in its lowest excited state. In a tetrahedral MnO_4 centre, for example, $\bar{x}$ would be the average distance between the central Mn atom and an oxygen atom at a corner of the tetrahedron. Higher allowed excited states are not shown.

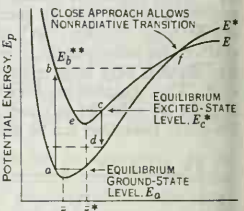


FIG. 7.—GENERALIZED ENERGY-LEVEL DIAGRAM OF A TYPICAL ACTIVATOR CENTRE AS A FUNCTION OF AVERAGED INTERATOMIC CONFIGURATION FOR THE GROUND STATE AND ONE (LOWEST) EXCITED STATE

At zero° K the ground-state energy level would be nearly at the bottom of the lowest curve, corresponding to minimum amplitude of atomic vibration. At a higher temperature, such as room temperature, 300° K, the centre has considerable vibrational energy, and so the ground-state level lies higher, such as at a. If now, a bit of excitation energy approximating the energy represented by $b - a$ is absorbed by the centre, the centre may be raised in energy into the excited-state level near E_b^{**}. The excited centre has a different electronic configuration than the unexcited centre, and the atoms of the excited centre readjust in about 10^{-12} sec. to a new equilibrium spacing $\bar{x}^*$ and excited-state level E_c^*. After the readjustment, the atoms may be arranged differently, with disproportionate changes in distances and angles from the central atom. The energy difference $b - c$, corresponding to the atomic readjustment, is given up as heat to the surrounding host crystal. With the centre in the excited-state level c, the length of time before there occurs a spontaneous radiative transition from c to d depends on the nature of the centre and its host-crystal environment, as indicated in Table II. After the centre has emitted the energy $c - d$ as a photon of light, the electronic configuration has changed back to that of the unexcited centre,

and the atoms readjust in about 10^{-12} sec. to original spacing $\bar{x}_0$, and ground-state level E_a, giving up energy $d - a$ as heat.

The radiative transition is practically independent of temperature, but the probability of a nonradiative transition to the ground state via $c \rightarrow f \rightarrow a$ increases exponentially with temperature, as discussed in connection with equation (13). The energy difference $f - c$ is equal to ΔE^* in equation (13). The observed decrease of luminescence efficiency with increasing temperature corresponds to a raising of the excited-state level c so that there is an increasing amplitude of interatomic vibration. When the highly agitated centre attains level f, the localized potential energy of the excited centre is converted to energy of atomic agitation that is dissipated into the surrounding host crystal.

If, at a given temperature, the energy $f - c$ is much less than $30kT$, then the centre quickly dissipates excitation energy by converting it to heat. When activator centres are located too near each other in a host crystal, they interact to reduce each others' energy $f - c$, thereby poisoning each other. A poison-impurity atom has a similar effect on a nearby activator centre. The diagram also indicates that a luminescent centre that is efficiently radiative at low temperatures becomes increasingly nonradiative, and dissipative, as the temperature is raised. There are very few phosphors available for efficient operation at temperatures above about 400° C. An outstanding exception is a boron nitride phosphor that luminesces even when heated above 1,100° C. In general, phosphors should be used at the lowest temperatures possible, with the exception of some trap-type phosphors that should be used at temperatures high enough to eject excited electrons from the traps. Trapping corresponds to ionizing the centre and having the ejected electron caught in a remote potential well, of the type shown as the excited-state curve in fig. 7, except that radiative transitions do not occur in the trap.

Only one excited state is required to describe a single emission band. The apparent absence of higher excited states for radiative transitions is made plausible by assuming that such states correspond to ionization in the solid, or that only nonradiative transitions occur from other higher states below the ionization level. The width of the emission band, which can be of the order of an electron volt, is describable in terms of radiative transitions occurring from any point on the excited-state curve below line c to any point directly below on the ground-state curve. Additional band-broadening can be produced by differences of environment in the ensemble of centres in a given host crystal. Such differences may arise from fluctuations in thermal agitation, which alter level c, and from random distributions and perturbations of centres and other imperfections, including impurities, and displaced and omitted host-crystal atoms.

Fig. 8 depicts the energy levels of a luminescence centre as a function of distance along a row of atoms in the crystal. This type of diagram indicates that the host-crystal energy levels are bands. The broadening of energy levels into bands is produced by interaction of electrons of all of the atoms in the crystal. There are about 10^{23} atoms per cubic centimetre in a crystal, and the Pauli exclusion principle permits only two electrons (of opposite spin) to occupy the same energy level in a given system (*see* QUANTUM MECHANICS: *Electron Spin*). Each pair of electrons, therefore, must occupy a different energy level. Unlike the previous diagram, fig. 8 is drawn for a specific $\bar{x}$, and so one should imagine that the spacings and potential barriers between the atoms change with every energy change of the centre.

According to fig. 8 the activator atom I_C: (1) lowers the potential barriers between the neighbouring host-crystal atoms; (2) introduces an additional ground-state level E_I, occupied by an electron, into the forbidden zone of host-crystal energy; and (3) introduces one or more unoccupied excited-state levels E_I^* whose lateral extensions are short and thus localize excitation energy. The excitation transition $E_I \rightarrow E_{I_1}^{**}$ corresponds to $a \rightarrow b$ in fig. 7, and the radiative transition $E_{I_1}^{**} \rightarrow E_I^*$ corresponds to $c \rightarrow d$. As drawn, this process is highly localized, and the spontaneous decay of emission is exponential with time, as represented by equation (9), in the absence of competing processes.

When excitation energy is large, an electron can be raised into the ionization continuum, here called the conduction band E_C^*, where it moves away from the centre and out into the host crystal. The freed electron may be trapped by a remote imperfection from which it must be released by supplying additional energy. An electron so released can then return to an ionized centre, drop down to a radiative excited-state level, and make a radiative transition to the ground-state level. This ionization process may start with direct raising of a host-crystal electron in the normally filled band E_H up into the normally unoccupied conduction band E_C^*. The electron vacancy, called a positive hole, in the filled band can then wander through the host crystal, by an electron-exchange process until it encounters the unexcited activator centre I_C. At that point, an electron from the filled level E_I of the activator can drop down to neutralize the positive hole. The activator atom is then in an ionized state and is ready to capture the excited electron in the conduction band. When trapping is involved, phosphors may exhibit chiefly so-called power-law decays of emission intensity, as are indicated in equations (15) through (17), or they may exhibit initial exponential decays that trail off into power-law-decay tails. The spectral character of the emission is substantially constant during decay time, even when there is a mixture of exponential and power-law decays. As is to be expected from fig. 8, electronic conduction occurs during luminescence of trap-type phosphors, whereas little or no electronic conduction is observed when the decay is a simple exponential function of time, and is independent of temperature (equation [9] and fig. 7).

There are many mechanisms of excitation, because there are many ways of absorbing and transferring energy. In photoluminescence, for example, excitation and emission may both occur in a given centre, or they may occur in separate sites with energy-transfer between the sites. Specifically, a single 3.4-ev ultraviolet photon may pass without loss of energy through a crystal until it is completely absorbed by a luminescent centre, which then emits one 2-ev photon of light. On the other hand, X-ray photons (and high-energy particles in general) excite atoms indiscriminately. The bulk of the energy of a high-energy particle is imparted bitwise to the numerically preponderant host-crystal atoms. Energy transfer from site of absorption to luminescent centre can occur through mobile electrons, positive holes, and excitons (paired electrons and positive holes). In cathodoluminescence, a single 25,000-ev cathode-ray electron yields energy stepwise and indirectly excites about 1,200 centres along its path in a phosphor crystal. Each excited centre then emits one photon of visible light (1.7- to 3.1-ev photons).

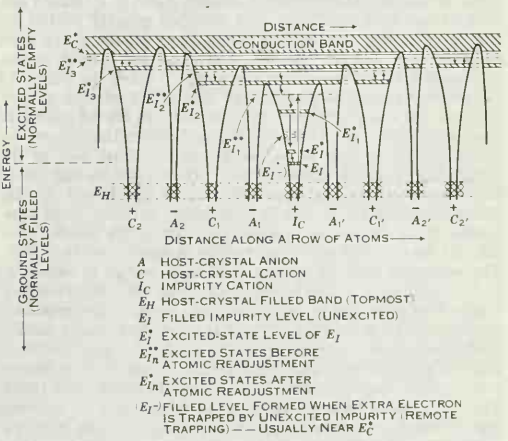


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FIG. 8.—GENERALIZED ENERGY-LEVEL DIAGRAM OF A PHOSPHOR LUMINESCENT CENTRE AS A FUNCTION OF DISTANCE ALONG A ROW OF ATOMS PASSING THROUGH THE CENTRE

In another method of excitation, an alternating electric field is applied to special phosphor microcrystals embedded in a thin insulating layer of glass or organic material between two electrodes. A suitable phosphor for this purpose is hex.-ZnS:Cu:[I], which is made with a very high proportion of copper activator, and with careful incorporation of the iodine coactivator. Intense luminescence emission may be obtained by applying several hundred volts, at several thousand cycles per second, across a 0.01-cm.-thick layer of hex.-ZnS:Cu:[I] microcrystals in castor oil. Such solid-state electroluminescence has afforded sustained luminances higher than 1,000 millilamberts.

An analogous electroluminescence phenomenon occurs in gases on application of high-frequency, alternating electric fields. Rarefied mercury gas, for example, luminesces visibly when subjected to millimetre waves of electromagnetic radiation. At first glance, this seems to violate the law of conservation of energy, because low-energy photons produce high-energy photons. Energy is conserved, however, because many low-energy photons must be absorbed to produce one high-energy photon. The process can start, when the electric field is applied, by accelerating electrons and ions in the gas, such as the charged particles produced by cosmic rays, or by electrification contact of gas atoms with the walls of the container. Some of the accelerated particles will have their directions reversed by collisions with mercury atoms, so that on reversal of the electric field an accelerated-and-reversed particle is further accelerated, and so on until the energy of the particle is enough to excite or ionize a mercury atom.

Solid-state electroluminescence also may be produced by injecting electrons and positive holes (extracting electrons) into a crystal from electrodes connected to a direct-current source. Referring to fig. 8, electrons may be injected into the conduction band E_C^*, and positive holes into the normally filled band E_H. The electrons and positive holes can recombine across the entire width of the forbidden band $E_C^* - E_H$ to produce recombination or they can recombine through a luminescence centre to produce radiation characteristic of the host crystal, with $h\nu \simeq E_C^* - E_H$, radiation characteristic of the centre. Radiations resulting from recombination-transitions, across the forbidden band in centres, have been observed in crystals of elemental germanium and silicon, and in crystals of such compounds as silicon carbide, gallium arsenide, and cadmium sulfide. Another variation of electroluminescence occurs at the surfaces of oxidized electrodes (particularly aluminum electrodes) during electrolysis. This phenomenon, called galvanoluminescence, was observed by F. Braun (1898).

5. Efficiency and Luminance.—Efficiency of luminescence, on both a quantum and energy basis, can approach 100% for resonance excitation and radiation of isolated atoms in a rarefied gas. Under these ideal conditions, each absorbed primary photon excites an atom that then emits a luminescence photon of the same energy as the primary photon. The input and output quanta are nearly identical in number and energy. When the energy of the primary particle is greater than that of the emitted photon, however, the energy efficiency is decreased. In the off-resonance condition, there is less effective coupling between the primary excitant and the system to be excited, and at least part of the energy difference is dissipated as heat. Heat losses are aggravated in condensed luminescent materials, such as liquids and crystals. When phosphors are excited by high-energy particles, as in kinescopes, X-ray fluoroscope screens, and scintillation-counter crystals, the energy efficiency of the process is usually less than 20%. The remaining 80% or more of the input energy is wasted as heat. Solid-state electroluminescence, and the electroluminescences of gases excited by radio-frequency waves, is also relatively inefficient, with more than 90% of the absorbed energy usually dissipated as heat. In a gas excited by millimetre-wave radiation, much of the small-quantum input energy is converted to atomic motion when the accelerated charged particles collide with atoms. There is a major technical challenge in the problem of attaining high efficiency of luminescence when the energy of the input excitation quanta differs greatly from the energy of the quanta of emitted radiation.

The emission intensities of luminescent materials are limited chiefly by the excitation intensity and by the numerical density and excited-state lifetime of the radiative centres. Intensities of visible emission greater than 10^7 millilamberts have been obtained from certain phosphors under short pulses of cathode rays. A luminance of 10^7 millilamberts corresponds to the emission of more than 10^{20} photons per square centimetre per second. Under sustained excitation, however, the average luminance of cathodoluminescent materials may not exceed about 10^5 millilamberts without unduly heating the material and decreasing its efficiency and output. For comparison purposes, the luminance of fresh snow in full sunlight is about 10^4 millilamberts, an intensity that is painful to see. The intensities of luminescent materials after excitation are determined by their decay characteristics and light sums under the operating conditions.

It is likely that the intensity of phosphorescence emission first observed by Cascariolo was less than 0.001 millilambert an hour or more after excitation. From that feeble beginning came such commonplaces as television kinescopes with luminances of about 100 millilamberts, fluorescent lamps with luminances exceeding 3,000 millilamberts, and lasers with pulsed outputs that exceed the 10^6 candlepower/in.^{2} of the sun.

The many practical uses of luminescence continue to increase. From the scientific standpoint, luminescence is uniquely useful as an instantaneous detector of invisible energetic particles, and as an ultrasensitive indicator of changes of composition, structure, and atomic interactions in many different materials.

See also references under "Luminescence" in the Index.

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(H. W. Lz.)

LUMPFISH (LUMPSUCKER), the name given to several fishes of the small marine family Cyclopteridae. The common lumpfish (*Cyclopterus lumpus*) has the ventral fins united into a circular concave sucker that enables it to attach itself firmly to rocks or stones. The body is short and thick with a thick, scaleless skin covered with rough tubercles. The first dorsal fin is a mere lump on the back. The lumpfish inhabits the coasts of both sides of the North Atlantic. In the spring the fish approaches the shores to spawn, clearing out a hollow on a stony bottom in which it deposits an immense quantity of pink-coloured ova. The male guards the spawn very assiduously until the young are hatched. A lump-

sucker may weigh as much as 20 lb. The male is only one-half or one-third the size of the female, and during the breeding season becomes bright blue, with red below. The bones are soft and contain little inorganic matter.

The arctic lumpsucker (*Cyclopteropsis macalpini*) is from the colder northern waters. Several species of spiny lumpsuckers (*Eumicrotremus*) occur in both Atlantic and Pacific waters.

LUNACHARSKI, ANATOLI VASILEVICH (1875–1933), Russian author, publicist and politician who, with Gorki, did much to ensure the preservation of works of art during the civil war, was born in Poltava and educated at the Kiev gymnasium and at Zurich university. In 1896 he returned to Russia, where his revolutionary activities led to his deportation to Vologda in 1898. In 1903 Lunacharski joined the Bolshevik group of the Social Democratic party, and in 1904 he started to work on the editorial board of the Bolshevik journal *Vpered* ("Forward"). He disseminated social democratic propaganda and organized lectures for Russian students and political refugees in foreign countries.

During the 1905 revolution Lunacharski was arrested and imprisoned. In 1909 he joined Gorki on Capri, where, together with A. Bogdanov, they started an advanced school for a select élite of Russian factory workers, but Lenin's opposition to this project quickly ended it. Lunacharski was preoccupied with the place of religion in the new social order, and in 1909 he published a book titled *Outlines of a Collective Philosophy*. During World War I he maintained an international pacifist attitude. In March 1917 he joined Lenin and Trotski in Russia and was appointed peoples' commissar for education in the same year. This position helped him to preserve many works of art and historic buildings from wanton destruction. His interest in the theatre encouraged a number of dramatic experiments and innovations. He himself wrote 14 plays, of which several were produced in Moscow and Berlin. Three were translated into English, under the title *Three Plays* (1923). In 1933 Lunacharski was appointed Soviet ambassador to Spain, but he died at Menton, France, on Dec. 27, 1933.

(R. Ha.)

LUNACY: *see* Insanity.

LUNATION, the period of return of the moon (*luna*) to the same position relative to the sun; for example, from full moon to full moon. Its duration is 29.5305884 days (*see* Moon).

LUND, a city and seat of a Lutheran bishop in Malmöhus *län* (county), Swed., is located 16 km. (10 mi.) N.E. of Malmö on the Stockholm-Malmö railway line. Pop. (1960) 40,331. The city centre is dominated by the 12th-century Romanesque cathedral, which has an imposing crypt and a famous medieval clock. Lund is known as the cultural centre of southern Sweden. The university, with faculties of law, medicine, theology, philosophy, science and economics, was founded in 1666. There is a technical high school. The most important of the city's museums are the Cultural History museum, the Archives of Decorative Art and the Art Exhibition hall. The various educational institutions and hospitals of the city employ a considerable part of the population, but there are also important industries, including food-industry equipment, packaging, printing and textiles.

Lund was founded about 1020 by the Danish king Canute, who is said to have named the place after London. In 1060 it was made a bishopric and in 1103 the seat of an archbishop for all Scandinavia. During the middle ages the city played an important part in Danish affairs. It was reduced in importance after the Reformation and the Swedish conquest in 1658, but after 1850 it developed rapidly.

(Sv. M.)

LUNDA, a Bantu people scattered over wide areas in the southern part of the Republic of the Congo, eastern Angola, the northwestern corner of Zambia and the Luapula valley. The various regional groups—the Lunda of Musokantanda, Kazembe, Shinje, Kanongesha, Mwinilunga, Ndembu, Luvale (Luena Balovale), Chokwe (*q.v.*) Luchazi, Songo and Mbunda—are all of Congo origin and broke away from the central Lunda kingdom in the Kapanga district of the southern Congo, which is still ruled by the paramount chief, the Mwata Yamvwa. The main dispersal took place about four centuries ago, when the Luba (*q.v.*) hunter Cibinda obtained supreme power from the Lunda queen Lueji. Most Lunda expansions occurred as peaceful infiltrations. In the southwestern Congo they have spread to the Kwango river, where they form the political authority among the Yaka and other tribes. The matrilineal Bemba (*q.v.*) of Zambia are also associated with them, but it is difficult to trace a direct link. With related people, including the Chokwe, they were estimated to number 1,500,000 in the mid-1960s.

The Lunda inhabit savanna country intersected by belts of forest along the rivers; the Luapula groups occupy flood plains and alluvial lands. Food gathering and hunting are important among many groups, fishing less so, except among the Luapula. All groups practise shifting hoe cultivation of manioc, millet, peanuts, beans and maize, and keep small stock; some groups, such as the Balovale, keep a few cattle. Local trade is widespread; the Lunda of Kazembe have been famous as traders of ivory and slaves.

Descent systems differ: the southern Lunda, Luvale and Luchazi are matrilineal; the Luapula Lunda are said to be patrilineal, whereas those of Kapanga have a bilateral system which functions over four generations. Inheritance and succession are matrilineal among the southern Lunda, but among the Lunda of Kapanga inheritance is matrilineal and succession to chiefly office is omnilineal within a descent group of four generations. Marriage is virilocal and residence usually avunculocal (*see* Kinship). Marriage payments are low; widow inheritance and cross-cousin marriage are practised. Lunda villages are small and compact. The central political organization is of extreme complexity among the Lunda of Kapanga; there exist a number of independent chiefdoms which have been or still are subordinate to the Mwata Yamvwa. The supreme being is either a sky or an earth god; ancestor-worship is practised.

See also Africa: *Ethnography* (*Anthropology*); Congo, Democratic Republic of the.

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(D. P. Bi.)

LUNDA, the northeastern district of the Portuguese overseas province of Angola in west central Africa, is bordered north and east by the Democratic Republic of the Congo. Pop. (1960) 247,430. Area 64,432 sq.mi. Its capital is Vila Henrique de Carvalho. Lunda is divided into the *concelhos* (counties) of Saurimo and Chitato and the circumscriptions of Camaxilo, Cassai Sul and Minungo. In all these divisions except Chitato the economy is chiefly agricultural (cereals, oil fruits and oil nuts, rubber, cotton, wax, honey). River fishing is important and game abundant. Chitato (area 16,493 sq.mi.) produces about 1,000,000 carats of diamonds annually. The chief centre of the diamond-mining area is Dundo, just south of the Congolese border. (A. A. G. P.)

LUNDY, BENJAMIN (1789–1839), U.S. philanthropist, prominent in the antislavery conflict, was born at Hardwick, N.J., on Jan. 4, 1789. From 1808 to 1812 he lived at Wheeling, Va. (now W.Va.), an important headquarters of the interstate slave trade. There he first became deeply impressed with the evils of the institution of slavery. In 1815 he organized an antislavery association, known as the Union Humane society. In 1821 he founded at Mount Pleasant, O., an antislavery paper, the *Genius of Universal Emancipation*, which he edited at irregular intervals and in diverse places until his death.

From Sept. 1829 until March 1830 Lundy was assisted in the editorship of the paper by William Lloyd Garrison (*q.v.*). Lundy traveled extensively on behalf of the cause, visiting Haiti twice, in 1825 and 1829, the Wilberforce colony of freedmen and refugee slaves in Canada in 1832 and Texas three times, 1830–31, 1833–34 and 1834–35. These visits were made, in part, to find a suitable place outside of the United States to which emancipated slaves might be sent. He was bitterly denounced for his antislavery agitation, and in Jan. 1827 was assaulted and seriously injured by a slave trader, Austin Woolfolk.

He was closely associated with John Quincy Adams in an effort to prevent the annexation of Texas. In 1836–38 Lundy edited in Philadelphia a new antislavery weekly, the *National Enquirer*, which under the editorship of Lundy's successor, John Greenleaf

Whittier, became the *Pennsylvania Freeman*. The last year of his life Lundy spent in Illinois where he died Aug. 22, 1839.

(R. F. N.)

LUNDY (from the Norse: *Lunde* [a puffin] and "ey" [an island]), at the entrance to the Bristol channel, lies 11 mi. N.N.W. of Hartland point, Devon, Eng. It is 3½ mi. long and averages ½ mi. wide with an area of 1.63 sq.mi. The highest point is 466 ft. Pop. (1963) 40, including lighthouse keepers and islanders who work on the mainland in the winter.

The island is surrounded by cliffs, notably Shutter rock at the southwestern end, and is made of granite, except in the southeast where Devonian slates have weathered to give the one landing cove. This is sheltered by Rat Island where the once common black rat survives. Lundy lends its name to a weather forecasting area that extends to the Scilly Isles and the southeastern tip of Ireland. The puffin and many other sea birds breed on Lundy.

A turbulent history includes its use as a base by pirates and smugglers. Owned by the crown from 1150 it was sold by parliament in 1647 to Lord Saye and Sele. The castle was erected between 1170 and 1200 by Sir William de Marisco whose family held the island periodically from 1150 to 1327. The church was built in 1896 by the Heaven family, owners of Lundy from 1836 to 1918. In the 1960s the owner was A. P. Harman. Lundy is reached by boat from Bideford and Ilfracombe. (C. Kt.)

LÜNEBURG, a town of Germany which after partition of the nation following World War II became part of the *Land* (state) of Lower Saxony, Federal Republic of Germany. It is situated on the Ilmenau, 57 km. (35½ mi.) S.E. of Hamburg by road where the undulating heathland changes to the alluvial plain flanking the Elbe. Pop. (1961) 59,574.

Lüneburg is one of the few undamaged towns built in the north German Gothic brickwork style. Features of interest include the town hall (13th–18th centuries), with its council chamber containing the wood carvings of Albert von Soest (1567–84); St. John's church (tower completed 1406); the Sand, a beautiful square of Gothic and Renaissance houses; St. Nicholas' church (1409; tower rebuilt 1895); and the ducal palace (1693–96) overlooking the market place. Municipal buildings include brine baths, a library, museum and theatre.

Lüneburg is on the main line from Hanover to Hamburg; other lines run to Lübeck, Dannenberg, Bremen and Buchholz. There is a port on the Ilmenau and the town has several main roads radiating from it. The saltworks have been operating since the 10th century, luxury goods, textiles, wax, building materials and by-products of salt are produced. There is trading in sugar, cereals, coal, salt and bone meal.

First mentioned as "Luniburc" in A.D. 956, Lüneburg probably obtained municipal rights under Henry the Lion before 1200. It was the residence of the Billungs and, later, of the Welfs until 1371. After the establishment of the ducal residence at Celle, Lüneburg enjoyed a period of great prosperity, being one of the chief members of the Hanseatic league, but the town decayed during the Thirty Years' War. Incorporated into Hanover in 1705, it became part of Prussia in 1866. On May 4, 1945, on the Lüneburger Heide to the southwest, Field Marshal Montgomery received the surrender of the German forces in northwest Germany, Denmark and the Netherlands. (G. J. L.)

LÜNEBURGER HEIDE, a district of Germany, in the *Land* (state) of Lower Saxony, lying between the Aller and the Elbe and intersected by the railways from Harburg to Hanover and Bremen to Stendal. Its main character is that of a broad saddleback, running for 88 km. (55 mi.) in a southeast-northwest direction (mean elevation about 250 ft. and greatest height, Wilseder Berg, 561 ft.). The soil is quartz sand and is chiefly covered with heather and brushwood, whose growth forms are caused by the extensive feeding of sheep (the celebrated Heidschnucken breed). In the north and in the deep valleys there are extensive forests of oak, birch and beech, and in the south of (planted) fir and larch. The heather is mixed with broom, gorse and juniper, the latter often forming small pyramidal cypresslike trees. Though the climate is raw and rich soil rare, the heath is not unfertile. The main products are sheep, potatoes, bilberries, cranberries and honey. The district is also remarkable for numerous megaliths, popularly called *Hünengräber* ("the graves of giants"), and a picturesque countryside with many beautiful old farmhouses with thatched roofs, built in the typical old style of Lower Saxony in red brickwork and oak beams. Large parts of the heath are under protection of the nature conservancy of the Federal Republic of Germany.

(H.-H. He.)

LÜNEN, a town of Germany which after partition of the nation following World War II became part of the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. It lies in the open Lippe country about 11 km. (7 mi.) N.N.E. of Dortmund by road. Pop. (1961) 72,171. The palace (1708) was the last seat of the statesman Freiherr vom Stein, and is now the Dortmund museum. Nearby is Schloss Kappenberg, a former Premonstratensian monastery whose Romanesque church has fine early 16th-century choir stalls. Lünen is the headquarters of the Westphalian Symphony orchestra and has various educational establishments. It is connected with the Ruhr and Münster by railway and the Cologne-Hanover motorway passes close by. Mining is the chief industry; aluminum, copper, iron and electricity are also produced.

LUNETTE, a crescent-shaped or semicircular object. In architecture the term is applied to any semicircular shape or panel which is decorated, and especially to those which occur under semicircular arches or vaults. By extension, the term is used of small vaults intersecting a larger vault at right angles, especially if used for lighting the larger vault, as in the clerestories of St. Paul's cathedral in London and St. Peter's in Rome. Oval or circular openings through any vault are also sometimes known as lunettes.

LUNÉVILLE, a town of eastern France, in Lorraine, the capital of an *arrondissement* in the modern *département* of Meurthe-et-Moselle. It is situated on the Meurthe river above the confluence of the Vezouze, 29 km. (18 mi.) S.S.E. of Nancy by road. Pop. (1962) 21,250. It was a walled town in the middle ages. After suffering in the Thirty Years' War and in the campaigns of Louis XIV, it flourished in the 18th century under the last dukes of Lorraine, and became part of France in 1766. The peace of Lunéville, between France and Austria, was signed there in 1801. Lunéville is a good example of 18th-century town planning, the château and church of St. Jacques being the chief buildings of interest. It is on the railway from Nancy to Strasbourg. Modern industrial development, particularly the manufacture of railway stock and other engineering, cotton spinning and pottery making, has been responsible for its modest growth. (Ar. E. S.)

LUNG, in anatomy, the name of each of the pair of organs of respiration in man and other air-breathing animals, the organs in fishes with the corresponding function being the gills. *See* Respiratory System, Anatomy of.

LUNG, DISEASES OF, comprise all those disorders affecting the lungs. Other diseases of the chest are discussed in Respiratory System, Diseases of and Pleura, Diseases of.

Lung Cancer.—Cells of the membrane lining the air passages in the lung undergo a change which leads to uncontrolled cell growth. The result is a malignant tumour which invades and destroys contiguous structures, blocks the air passages and spreads from its point of origin through the lymph channels and the blood stream to other parts of the body with results invariably fatal unless the growth is removed at an early stage. Bronchogenic cancer may be detected by the conventional chest X-ray examination, but the shadows cast by early symptomless cancers, often resembling harmless conditions, are difficult to identify. Thorough medical examination and sometimes exploratory surgery is necessary.

The remarkable increase in lung cancer during the 20th century has caused great concern throughout the world. It has become the most frequently encountered malignant tumour in men, occurring five to ten times more frequently in men than in women. Multiple causative factors may be involved, but the carcinogenic (cancer-causing) chemicals known to be present in the products of combustion are probably of greatest importance. Foremost among the fumes of combustion which enter the human lung in concentrated form is tobacco smoke, and statistical data are available to indicate

that smokers are peculiarly susceptible to bronchogenic carcinoma. The gaseous wastes from combustion of motor fuels and other atmospheric pollution have been accused of causing the high incidence of lung cancer in large cities. (*See* also CANCER; TOBACCO: *Tobacco and Disease.*)

Tuberculosis.—Although tuberculosis has diminished as a cause of death in most countries where hygienic conditions are optimal, it has diminished less rapidly than other preventable infectious diseases. In some countries it remains a principal cause of disability and death and is a serious social and economic drain upon human resources. Diagnosis of tuberculosis requires routine chest X-ray examinations of well-appearing persons, especially if a positive reaction to the tuberculin skin test has occurred. Shadows on the X-ray film suggesting tuberculosis require general examination and study of sputum and blood for other indications of active infection. Some cases of inactive tuberculosis or those of uncertain activity must be examined repeatedly for many months or years to detect the earliest evidence of activity.

Treatment of active tuberculosis requires the administration of two or more of the several potent antituberculosis drugs. Isoniazid, streptomycin and PAS (para-aminosalicylic acid) are the most commonly used and most safe and effective drugs in treatment of tuberculosis. Treatment is ordinarily prolonged long after every indication of activity has disappeared, two years of specific drug therapy being frequently recommended. Surgical treatment of tuberculosis is necessary to remove areas of infected lung which cannot be treated successfully with drugs alone. Lung collapse, once a popular procedure in the opinion of many specialists, is necessary only in unusual cases.

The prevention of tuberculosis requires that contagious cases be diagnosed promptly and treated successfully, remaining segregated during the period of communicability. Vaccination with bacilli of low virulence, such as the BCG strains, produces some degree of immunity, and such vaccination is desirable in those countries which lack adequate facilities for treatment and isolation of communicable tuberculosis. It is not generally recommended in countries where high standards of hygiene are maintained. (*See* also TUBERCULOSIS.)

Pneumonia and Pneumonitis.—Inflammation of the lungs, ordinarily acute and extensive, is called pneumonia. Less severe inflammation with less consolidation (filling of air spaces with exudate) is sometimes called pneumonitis. Many inflammatory agents can produce pneumonia, but bacteria and viruses are of greatest importance. Of the many bacteria which alone or in combination may cause pneumonia, the pneumococcus is best known and most often productive of very acute and dense consolidation of one or more lobes (lobar pneumonia).

Diagnosis frequently can be made by physical examination, but X-ray examination is necessary to follow the course of the disease and to detect complications. Distinction between lung cancer, tuberculosis, fungus infections and slowly resolving pneumonia may be very difficult. Treatment of the bacterial pneumonias with antibacterial drugs (antibiotics and other chemotherapeutic substances) is usually successful, and their use has resulted in a greatly diminished mortality rate, especially in cases of pneumococcus pneumonia. Treatment of the virus-caused pneumonias is less specific, but these infections are less likely to cause death and complications are rare. (*See* also PNEUMONIA.)

Fungus Infections.—Specific treatment (Amphotericin B) is available for serious cases of fungus infections. Coccidioidomycosis in certain dry areas (especially southwestern U.S.) and histoplasmosis of moist climates frequently cause no recognized symptoms but occasionally cause serious disease, sometimes confused with tuberculosis and cancer of the lung. Blastomycosis, cryptococcosis (torulosis) and actinomycosis are rare and often serious infections. (*See* also FUNGUS INFECTIONS.)

Emphysema.—Overinflation of the lung, an inability to exhale air from the abnormally dilated terminal air sacs (alveoli), is the essential feature of the usual type of pulmonary emphysema. It is attributed to loss of lung elasticity and to obstructive changes in the finer air passages. The obstruction is either of inflammatory origin or due to spasm of the involuntary muscles which encircle the smaller bronchi. Very prolonged and recurrent bronchial asthma and excessive tobacco smoking are among the recognized causes of pulmonary emphysema. The symptom of progressive shortness of breath on exertion, associated with an abnormally rounded chest (barrel chest), with or without wheezing respiratory sounds, most frequently prompts the patient to seek diagnosis and treatment. Unfortunately treatment is often ineffective when the condition is advanced, and prevention of further injury is all that the physician can hope to accomplish. (*See* also EMPHYSEMA.)

Bronchiectasis.—Bronchiectasis is a common disorder characterized by dilatation of the bronchi of one or more of the lung segments. Infection often becomes implanted in these bronchi where secretions stagnate. Symptoms of infection with cough, expectoration and recurrent episodes of lower respiratory tract infection are common. Bleeding from the lung is not uncommon. Medical treatment may yield temporary relief, but removal of the diseased segments is necessary for cure. (*See* also BRONCHIECTASIS.)

Pulmonary Embolism.—Blood may clot within the veins, especially leg veins, under abnormal conditions (thrombosis). If the clot (thrombus) becomes dislodged and is carried to the lungs it lodges in an artery of the lung and is called an embolus. A large embolus may interrupt blood flow and cause almost instantaneous death; small emboli cause less serious manifestations. Thrombosis and embolism occur most commonly after prolonged illness, certain surgical manipulations, fractures and prolonged immobilization. Obesity, varicose veins, advanced age and heart failure are additional predisposing factors. (*See* also THROMBOSIS AND EMBOLISM.)

Miscellaneous Disorders.—Prolonged inhalation of harmful dusts, especially silicon dioxide and asbestos, may cause permanent lung injury. Mild or severe temporary injury may result from inhalation of irritating fumes (pulmonary edema). (*See* also DANGEROUS OCCUPATIONS; PNEUMOCONIOSIS.) Lung trauma in wartime and in such injuries as occur from automobile accidents may cause lung puncture and other impairments of function requiring emergency treatment to prevent early death. Lung abscess is usually attributed to inhalation of contaminated and irritating materials such as vomitus and to bronchial obstruction from cancer, foreign body, etc. Many malignant growths, some generalized infections and such disorders as the collagen diseases, sarcoidosis, allergic conditions and parasitic infestations may involve the lungs as well as other organs. *See* HEART AND LUNG, SURGERY OF; *see* also references under "Lung, Diseases of" in the Index.

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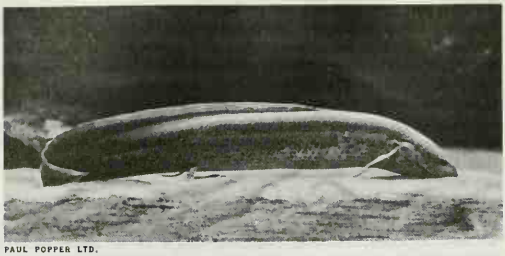
(H. C. H.; H. C. Hw.)

LUNG-CHING (LUNGCHOU, LUNGCHOW, LUNGTSIN), a town of about 14,000 population in southern Kwangsi Chuang Autonomous Region, China, about 6 mi. from the Vietnam border and about 90 mi. S.W. of Nan-ning. It is a river port for small boat traffic on the Li river, and is a highway centre for transborder traffic. It was opened to foreign trade in 1889, after the Indochina railway reached the border, but the failure in development of transport facilities on the Chinese side prevented the growth of important commerce. During the late 1930s, when China was under Japanese blockade, Lung-ching briefly carried on a tremendous trade.

(J. E. SR.)

LUNGFISH, the name given to the fishes of the order Dipnoi (Dipneusti) possessing both gills and a functional lung. One pair of nostrils opens into the mouth. A partly divided auricle is one of the other structures approaching the condition found in terrestrial vertebrates. Lungfishes have long, pointed pectoral and pelvic fins; the caudal fin is continuous with the dorsal and anal fins.

The family Ceratodontidae comprises one surviving species, *Neoceratodus* (or *Epiceratodus*) *forsteri,* of Queensland, Austr.; this species only occasionally breathes surface air. Its food habits are omnivorous, and it may grow to be 6 ft. long. Fossils of related species have been found in many parts of the world, and are generally considered as belonging to a separate genus, *Ceratodus.*



PAUL POPPER LTD.

AFRICAN LUNGFISH (PROTOPTERUS ANNECTANS)

The Lepidosirenidae, including *Protopterus* of Africa and *Lepidosiren* of South America, which inhabit swamps and marshes, must breathe air at frequent intervals; in the dry season, when the swamps dry up, these fishes curl up and rest at the bottom of a burrow, the entrance to which is closed with a plug of mud, with openings for air. These lungfishes are voracious and eat a variety of aquatic animals, including members of their own species. Fishes of other groups, particularly the African bichir (*Polypterus*), have a primitive lunglike air bladder used for breathing air. *See* FISH: *Survey of the Bony Fishes; see* also references under "Lungfish" in the Index. (C. HU.)

LUO (LWO, JALUO), a Nilotic-speaking people numbering about 757,000 in the 1960s and living in the flat country near Lake Victoria in the Kavirondo region of western Kenya; there are a few in the adjoining area of Tanganyika. The Luo are known as Kavirondo throughout east Africa. The area is divided into about 40 administrative units known as locations, which in most cases correspond to the areas traditionally occupied by a subtribe. Each subtribe is politically autonomous, there being no over-all political authority for the whole people. Most men of a subtribe belong to the same patrilineal, exogamous clan which settled in the territory after immigration from the northwest. Many residents are descendants of neighbouring non-Luo tribes which were conquered and partially absorbed by the invaders.

Luo are settled agriculturalists and keep many cattle. They are wealthy, producing much cotton and other cash crops. Luo are found outside Kavirondo throughout east Africa as labourers and tenant farmers on land owned by Europeans and by other tribes, and as workers in urban centres. They are one of the peoples most affected by modern developments in east Africa. Missionaries have been working in their country for most of the 20th century and most Luo are Christians.

The Luo are the most southerly of the large cluster of Nilotic peoples known as Lwo or Lwoo. These originated in the southern Sudan and migrated southward into Uganda and Kenya. In all, the Lwoo number almost 2,500,000; they are also known as Nilotes (*q.v.*).

See also KENYA; AFRICA: *Ethnography (Anthropology): East Africa;* KAVIRONDO.

See A. J. Butt, *The Nilotes of the Anglo-Egyptian Sudan and Uganda* (1952); J. P. Crazzolara, *The Lwoo,* 3 vol. (1950–54). (J. F. M. M.)

LUPERCALIA, an ancient Roman festival. Its rites were under superintendence of a corporation of priests called Luperci, whose institution is attributed either to Evander or to Romulus and Remus. But the festival itself, which was held on Feb. 15, contains no reference to these late fictions. It began with the sacrifice by the Luperci of goats and a dog, after which two of the Luperci were led to the altar, their foreheads were touched with a bloody knife and the blood wiped off with wool dipped in milk; then the ritual required that the two young men laugh. The sacrificial feast followed, after which the Luperci cut thongs from the skins of the victims and ran in two bands round the walls of the old Palatine city. A blow from the thong was supposed to cure sterility. The celebration of the festival went on until A.D. 494, when it was changed by Pope Gelasius I into the feast of the Purification.

The Luperci were divided into two colleges, called Quinctiliani (or Quinctiales) and Fabiani, from the gens Quinctilia (or Quinctia) and gens Fabia; at the head of each of these colleges was a magister. In 44 B.C. a third college, Luperci Iulii, was instituted in honour of Julius Caesar, the first magister of which was Mark Antony. In imperial times the members were usually of equestrian standing.

The ritual is apparently in honour of no god; Lupercus, whom authorities sometimes name, seems a mere invention, Faunus is a guess of the moderns. The Romans connected it with the Greek Lycaea (*see* LYCAON).

LUPINE, any plant of the genus *Lupinus,* which comprises about 300 species of annual and perennial herbaceous plants of the pea family (Leguminosae).

Native American species (*Lupinus perennis* and related species) with digitate leaves are found in moist fields and grassy hills along the cool Pacific coast from British Columbia to northern Chile. A few species occur in the Mediterranean regions. Others, with single leaflets, are found in Brazil and eastern North America. Many of these are good subjects in the wild garden.

WALTER SINGER

RUSSELL HYBRID LUPINE (LUPINUS)

The species of which earliest mention is made is probably *L. termis,* which was cultivated by the ancient Egyptians. It is wild in some parts of the Mediterranean area and is extensively cultivated in Egypt. Its seeds are eaten by the poor after being steeped in water to remove their bitterness. The lupine of the ancient Greeks and Romans was probably *L. albus,* which is extensively cultivated in Mediterranean countries for forage, for soil enrichment and for its round flat seeds, which form an article of food. Yellow lupine (*L. luteus*) and blue lupine (*L. angustifolius*) are also cultivated in Europe as farm crops for green manure. *L. subcarnosus,* the state flower of Texas, is the bluebonnet.

The flowers, borne on long spikes above the dark-green foliage, are of the usual pealike form and range in colour from white, yellow and shades of pink to blue and purple. Grown chiefly for ornamental purposes in the U.S. and especially in England (where the climate is very favourable for them), the one- to five-foot plants are well adapted to borders and beds and are beautiful as cut flowers. Numerous garden hybrids of unknown parentage have been developed and are easily cultivated in any rich light sandy soil (neutral to acid) in full or partial sun. Perennials, including the fine Russell hybrids, should be seeded in summer and given adequate winter protection for flowering the following summer. The roots of young plants may be divided in very early spring. Annuals are best sown in place early in the spring. As with all leguminous plants, inoculation with nitrogen-fixing bacteria encourages root nodules and increased vigour.

HUGH SPENCER

WILD BLUE LUPINE (LUPINUS PERENNIS)

LUPINO, the name of the oldest theatrical family in England. The earliest traceable Lupino—who spelled his name "Luppino" —was flourishing, probably in Italy, about 1612 and billed himself as Signor Luppino. His descendant GEORGIUS GUILLEMUS (1632–

1693), a professional singer and reciter and also a puppetmaster, went to England as a political refugee. His son GIORGIUS CAROLUS (b. 1662) became George Charles and was a performer and puppeteer at the age of eight. After the Restoration the Luppino family was granted a licence to play in the service of King Charles II.

John Rich had as an apprentice a small boy called GEORGIUS RICHARD EASTCOURT LUPPINO (1710–1787), the son of George Charles (1693–1725). Georgius Richard's son THOMAS FREDERICK (1749–1845), the first to spell the family name "Lupino," was a scenic artist and dancer.

The complicated family tree shows remarkably few intrusions of any calling unconnected with the stage. A particularly interesting member of the family, GEORGE HOOK LUPINO (1820–1902), had 16 children, at least ten of whom became professional dancers.

Almost the last of the old-style clowns was George Hook's eldest son, GEORGE (1853–1932), who was born in a dressing room of the Theatre Royal, Birmingham, Warwickshire, and was carried onto the stage in swaddling clothes when less than an hour old. He died a few hours after his last performance as the clown in a harlequinade with his son Barry as Harlequin. George's two brothers, ARTHUR and HARRY, were a famous turn in the music halls in the early years of the 20th century and Arthur, an incomparable animal impersonator, was chosen by Sir James Barrie to be the dog, Nana, in the first production of *Peter Pan*.

Of George's children, BARRY (1884–1962), besides being an actor, was the family archivist, and STANLEY (1894–1942) was a popular comedian, who died at the height of his powers and fame. Stanley's daughter IDA (b. 1918) became a film actress in Hollywood, Calif.

HENRY GEORGE (1892–1959), son of HENRY CHARLES (1865–1925), was a famous Cockney comedian better known under his stage name of Lupino Lane.

See Stanley Lupino, *From the Stocks to the Stars* (1934).

(A. H. D.)

LUPU, NICHOLAS (1876–1946), Rumanian politician, was born at Arsura, Rum. on Nov. 8, 1876. He started his career as a country doctor and entered politics in 1905. He played an important part during the peasant revolt in 1907 when, as prefect of the Falciu District, he succeeded in pacifying the peasants without having recourse to violent measures. In 1913 he was elected deputy and in 1919 he entered the Vaida-Voevod coalition cabinet as minister of the interior, representing, together with Ion Mihalache, the Peasant (Tsaranist) Party, of which Lupu became one of the principal leaders. During World War I, he visited Russia, France, England, Italy, and the United States on an active propaganda campaign on behalf of Rumania. During the succeeding period of Liberal government, Lupu remained in the background. He died Dec. 4, 1946.

LUPUS, PUBLIUS RUTILIUS, Roman rhetorician, flourished during the reign of Tiberius (A.D. 14–37), was the author of a treatise on the figures of speech, abridged from a similar work by the rhetorician Gorgias of Athens. In its present form it is incomplete. The work is valuable chiefly as containing a number of examples from the lost works of Greek rhetoricians. The author has been identified with the Lupus mentioned in the Ovidian catalogue of poets, and was perhaps the son of Publius Rutilius Lupus, a supporter of Pompey.

See editions by D. Ruhnken (1768), F. Jacob (1837), C. Halm in *Rhetores latini minores* (1863); monographs by G. Dzialas (1860 and 1869), C. Schmidt (1865), J. Draheim (1874), Thilo Krieg (1896).

LUPUS: *see* SKIN, DISEASES OF.

LUQMAN (LOKMAN), the name of two, if not of three, persons famous in Arabian tradition. The first was of the royal family of 'Ad, and is said to have built the great irrigation dam at Marib in Yemen and to have received the gift of life as long as that of seven vultures, each of which lived 80 years. The name of the second Luqman, called "Luqman the Sage," occurs in the Koran (31, 11). He wrote fables and proverbs with moral lessons. Two accounts of him are found. According to al-Masudi (i, 110) he was a Nubian freedman who lived in the time of David. According to some commentators on the Koran he was the son of Ba'ura, one of the sons of Job's sister or maternal aunt. Joseph Derenbourg in his *Fables de Loqmân le sage* (1850) believes the name Luqman to be a translation of *Balaam*. The grave of Luqman was shown on the east coast of the Lake of Tiberias (Sea of Galilee), also in Yemen.

BIBLIOGRAPHY.—The so-called *Fables of Luqman* are known to have existed in the 13th century, but are not mentioned by any Arabian writer. They were edited by T. Erpenius (1615) and have been reprinted many times. For the relation of these to similar literature in other lands, *see* J. Jacobs' edition of Caxton's *Fables of Aesop*, vol. i (1889). *See* also bibliography in FABLE.

LURAY CAVERN, a large limestone cave in Page county, Va., U.S., near the town of Luray. The largest cave in the state, it embraces a total of 64 ac., of which 27 are open to the public. Since 1878 when it was discovered, wide natural corridors and the installation of indirect lighting have revealed its beauties to millions of tourists.

Luray cavern was formed millions of years ago by underground rivers and seepage of acid-bearing water through layers of limestone and clay. In time the clay was washed away, leaving only the limestone shell. Long after the formation of the cavern and after many stalactites had developed from the dripping of water impregnated with lime, the excavation was completely filled with glacial mud. This mud was charged with acid which eroded the dripstone and altered its shape. When the mud was subsequently removed by flowing water the older eroded forms remained alongside the new growth. This turbulent history has made the striking display of many-hued stalactites, stalagmites, columns and cascades one of the most remarkable in the world, including massive columns wrenched from their perpendicular position and hurled on the floor. Clear water, apparently containing no forms of life, is found in basins up to 50 ft. in diameter and 15 ft. in depth. The temperature in the cave remains at 54° F. (12.2° C.) throughout the year. Of particular interest is the "stalacpipe" organ which substitutes carefully selected stalactites for organ pipes.

(G. M. BE.)

LURGAN, a market town and municipal borough of County Armagh, N. Ire., 21 mi. S.W. of Belfast. Pop. (1961) 17,872. It dates from the reign of James I who in 1610 granted land to John Brownlow and his son William who formed an English colony there. By 1619 there were 42 houses and at the end of that century linen manufacture, still the chief industry, was established. James Logan emigrated from Lurgan in 1699 to become one of the founders of Pennsylvania. Lurgan castle (now Brownlow house) was built in 1836 by Charles Brownlow, created Baron Lurgan in 1839; the demesne with its lake is a public park. Born in the town were George William Russell, the poet and writer known as Æ, in 1867; and Field Marshal Sir John Greer Dill in 1881.

LURIA, ISAAC BEN SOLOMON ASHKENAZI (1534–1572), Jewish mystic and founder of the "new Cabala" (Lurianic Cabala), was born in Jerusalem of German parents. Because of his descent he was surnamed Ashkenazi ("the German"); his followers called him Ari ("Lion") or Ari ha-Qadosh ("the Holy Lion"). Many legends are told about his miraculous powers. He went to Egypt as a boy, after his father's death, and was brought up there by his wealthy maternal uncle. At the age of 17 a Cabalistic manuscript came into his hands, and, already deeply versed in rabbinic learning, he now began to study Cabala. He spent six years in isolation from his friends, occupied with mystical meditation, especially on the *Book Zohar*, which had just appeared in print (1558) (*see* CABALA: *The Zohar*). There followed a further period of ascetic life in retirement in a hut near the Nile. About 1570 he settled in Safed (Safad), the Palestinian centre of Cabala, where he immediately gathered a large circle of enthusiastic disciples around him. He expounded his teachings while walking with them through the fields and visiting the tombs of ancient teachers. After a stay of only a year and a half in Safed, he died of the plague on Aug. 5, 1572, at the age of 38.

His fame soon spread, especially through the letters written by Shlomel Dresnitz of Moravia to his friends in Europe and published under the title *Shivhe ha-Ari* ("The Praises of the Lion"). Luria wrote only a commentary on certain parts of the *Zohar*. His doctrine is contained in the works of his disciples, particularly of

Hayyim Vital and Joseph ibn Tabul. In addition, Luria's hymns for the three traditional Sabbath meals allude in ecstatic poetry to the essence of his mystical doctrine of God.

The basic themes of Lurianic Cabala are: (1) the doctrine of *zimzum* or the "retraction" of God prior to the act of creation; (2) *shevirat ha-kelim* or the catastrophic "breaking of the vessels" —*i.e.* of the lower *Sefirot* (divine potencies), and the resultant emergence of evil as a domain of its own; (3) *tiqqun*, or the eschatological "restoration" of God's unity with the help of the holy life of men. Luria elaborated in mythical imagery motifs found in early rabbinic sources and used formulae which derive, in part, from the 15th-century Jewish mystic Joseph Alkastiel of Jativa (Spain). Unlike the earlier Cabalists, who regarded the transmigration (gilgul) of souls as a punishment for sins, Luria saw in it a chance for continuing the soul's task of self-perfection. This doctrine soon became part and parcel of popular Jewish belief. Under Luria's influence Jewish prayer and ritual assumed a distinctly mystical flavour, and became vehicles of meditation (*kawwanot*) in a highly technical sense. *See* also CABALA: *16th-Century Cabalists of Safed.*

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LURISTAN (LORESTAN), in the more restricted sense a former province of Iran, from 1938 to 1961 a (semiautonomous) part of the *ostan* (province) of Khuzistan and since 1961 a general governorship; in the wider sense, the "land of the Lurs," the region of western Iran which extends from the Iraq frontier and Kermanshah for about 400 mi. S.E. with a breadth of 100–140 mi., thereby separating the Khuzistan lowland from the interior uplands of Iran. The area is mountainous, having numerous ranges running northwest-southeast, some of which are still forested with a mixed oak-wood scrub. The central range, which is rarely identical with the main water divide, has many summits: Oshtoran Kuh, Kuh-e Garbosh, Zard Kuh, Kuh-e Gereh, Kuh-e Dinar (Dinah), rising to more than 14,000 ft. Several major rivers have their sources in these mountains; between the higher ranges are fertile plains, valleys and hilly districts, which are well watered and covered with lush pastures. Cultivation is scattered and rare, the main occupation still being pastoral nomadism.

The Lurs are thought to be of aboriginal stock with strong Iranian, Arabic and other admixtures. They speak a Persian dialect and are outwardly at least Shi'ite Muslims. The northern part of Luristan region, or Little Luristan, is inhabited by the Feili Lurs, divided into the Pishkuh (cismontane) Lurs in the east, and the Pushtkuh (ultramontane) Lurs in the west, adjoining Iraq. The Pishkuh area has kept the name Luristan and forms the province while Pushtkuh has become part of Kermanshah *ostan*.

Little Luristan was governed by independent princes of the Khurshidi dynasty, called atabegs, from 1155 to the beginning of the 17th century when the last atabeg, Shah Verdi Khan, was removed by Shah Abbas I, and the government of the territory given to Husain Khan, the chief of a rival tribe, with the title of vali. The descendants of Husain Khan retained the title.

The southern part of Luristan region, or Great Luristan, is composed of the Bakhtiari district inhabited by nomadic tribes (*see* BAKHTIARI) and the smaller districts of Kuhgalu (Kuhgiluiyeh) and Mamaseni. Bakhtiari is divided between Khuzistan and Isfahan *ostans*, Kuhgalu is in Khuzistan and Mamaseni in Fars. Great Luristan was independent under the Fazlavieh atabegs from 1160 until 1424, and its capital was Idaj, now only mounds and ruins at Malamir, 60 mi. S.E. of Shushtar.

Luristan became well known as the result of archaeological finds made from 1929 onward: powerfully designed, technically competent bronzes (vessels, implements, personal adornments and particularly horse trappings), covering a period from 2600 B.C. to A.D. 800. The majority of the finest pieces were datable from the cuneiform inscriptions to between the 19th and 12th centuries B.C.

LURISTAN GENERAL GOVERNORSHIP stretches between the Dez valley (used by the Trans-Iranian railway) and the upper Karkheh river, and northward to near Kermanshah and Nehavand. Its population (1961 est.) was 585,421 and area 11,737 sq.mi. The administrative centre is Khorramabad on the road from Ahvaz to Teheran and is connected also with Kermanshah by road. The produce of the province (as of the larger area) is mainly derived from the numerous flocks, rather than from agriculture. However, the main oil fields of southwest Iran also lie within the area of the Lurish tribes. (H. Bo.)

LUSAKA, the capital of Northern Rhodesia, Africa, and the seat of its government, is situated in the southeastern part of the country on a limestone plateau 4,200 ft. above sea level, 230 mi. N.E. of Livingstone. Its population in 1961 totaled 100,000, including 11,800 Europeans and 1,680 Asians. Cairo road, Lusaka's main thoroughfare, with its tree-lined boulevard and modern multistoried buildings, is regarded as one of the finest streets and shopping centres in the country. In the town are the legislative assembly building and offices as well as the Northern Rhodesia high court building, the British South Africa company's offices and the largest and most modern secondary schools in the country. Owing to its situation in an extensive limestone area, large quantities of cement are manufactured at Lusaka. It is also the centre of a major farming district which provides a large proportion of Northern Rhodesia's food. (C. L. Cs.)

LUSATIA (German LAUSITZ, Lusatian LUZICA, from *luz*, "meadow"), the country of the Luzicane or Srbi (Sorbs), whom the Germans called Lausitzer Sorben or Wenden, in central Europe. It has been incorporated since 1949 within the territory of the German Democratic Republic, lying along the southern extremity of the German-Polish frontier and to a lesser extent along the northern frontier of Czechoslovakia.

In the 9th century, when the *limes Sorabicus* was the eastern frontier of the Frankish empire, the area settled by the Sorbs, a Slavonic people, extended westward to the Saale (Solawa) river. Lusatia was conquered by the Germans in 928 and lost by them to the Poles in 1002. By the treaty of Bautzen it was incorporated with Poland in 1018. It was reconquered by the Germans in 1033 and later partitioned between Meissen and Brandenburg. Lusatia was then submitted to a ruthless germanization: Sorbs were forbidden to settle in towns, to occupy any office or to learn any trade; those with farms that had good soil had their lands taken from them. Their situation improved somewhat when the Holy Roman emperor Charles IV in 1368–70 made Lusatia part of the lands of the Bohemian crown. In 1635, by the peace of Prague in the Thirty Years' War, Lusatia became part of the electorate of Saxony. It was again partitioned in 1815 by the congress of Vienna: while Saxony retained Upper Lusatia, with Bautzen (Budysin), Lower Lusatia was then given to Prussia, which incorporated Hoyerswerda (Hojerky) and its vicinity in the province of Silesia and Kottbus (Chosebuz) and its vicinity in Brandenburg.

By 1815 the western parts of historic Lusatia were completely germanized; but the marshy and sandy east offered but a small prize, and there the Sorbs retained their language, dress and customs. After 1871 intensive germanization started there too, mainly through the schools; and by 1880 the number of Sorbian-speaking people was reduced to 185,000 (90% Lutheran and 10% Roman Catholic). The German census of 1925 claimed that only 62,000 Sorbian-speaking people remained, but the leaders of the Sorbian national minority estimated their number at 260,000 in 1939.

In 1935 the Lusatian National council or Sorbska Domowina petitioned Hitler for the creation of a *Reichsgau Lausitz* of about 4,900 sq.mi. In 1938 the Domowina was dissolved by the Germans and its chairman, Pawel Nedo, arrested. The daily newspaper *Srbske Nowiny* was closed down and its publisher, the Rev. Jan Cyz, arrested. Both Nedo and Cyz survived the Nazi persecution and in 1945, at the end of World War II, reformed the Domowina. In 1946 the Lusatian National council appealed to the U.S., British, French and Soviet governments for "liberation from German rule."

Article II of the constitution of the German Democratic Republic (1949) guaranteed to the Sorbian people equal development of their language and culture. A daily newspaper *Nowa*

Doba appeared at Bautzen, and an Institute of Sorbian Culture was founded there. Sorbian was made the teaching language in a number of schools. (K. Sm.)

LUSHAI (Lushei), a Tibeto-Burman-speaking tribe numbering about 150,000 in the 1960s and inhabiting the mountainous tract on the Assam-Burma border known as the Lushai hills, which extends between the Manipur river and the hills of Chittagong. Like the Kuki tribes, with which they have close affinities, the Lushai traditionally practised shifting slash-and-burn cultivation and moved their villages at frequent intervals. Their migratory habits facilitated rapid Lushai expansion at the expense of weaker Kuki clans in the 18th and 19th centuries. Lushai villages are situated on the crests of hills or spurs and until the pacification of the country under British rule were fortified by stockades and contained as many as 500 houses. Every village community, though comprising members of several distinct clans, was an independent political unit, ruled by a hereditary chief. All chiefs trace their descent from a common ancestor who lived in the early 18th century. The stratified Lushai society consisted originally of chiefs, commoners, serfs and slaves (war captives). Suppression of feuds and head-hunting under the British gradually changed the structure of Lushai society, but British policy until 1947 was to administer the Lushai hills through the indigenous chiefs, whose number had by that time risen to 400. Ever since 1898 Christian missions have exerted strong influence, and education, partly coupled with Christianity, has produced a new privileged class, whose members now work as government servants, physicians and teachers. *See* also Chin; Mizo.

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LUSHAI HILLS: *see* Mizo.

LUSIGNAN, a Poitevin dynasty that provided counts of La Marche and Angoulême in feudal France and kings of Jerusalem, Cyprus and Armenia. The castle of Lusignan (in the modern *département* of Vienne) is associated with the legend of Mélusine.

Early in the 10th century Hugh I, lord of Lusignan, was a vassal of the counts of Poitiers. Fifth in descent from him, Hugh VI the Devil, whose claim to the countship of La Marche by right of his mother came to nothing, went to Outremer (the crusader states of the east) in 1101 and was killed in battle at Ramleh in 1102. His grandson Hugh VIII the Brown, also a crusader (he was taken prisoner by the Muslims in 1165), had seven sons, three of whom founded the great fortunes of their house.

The Counts of La Marche.—Hugh VIII's eldest son and successor, Hugh IX the Brown or the Old (d. 1219), attached himself to his suzerain Richard I Coeur-de-Lion, king of England and count of Poitiers. Richard's successor John granted La Marche to Hugh in 1199 but alienated him in 1200 by taking his fiancée, Isabella of Angoulême, for himself, whereupon Hugh, with other great Poitevin barons, turned to John's enemy Philip II Augustus of France. His son and successor Hugh X of Lusignan (d. 1249) married Isabella of Angoulême, now John's widow, in 1220; made war on John's successor Henry III from 1219 to 1224; took Henry's side against France in 1230; and rebelled against Louis IX of France and his brother Alphonse of Poitiers in 1241–42, for which revolt he forfeited his principal strongholds. Yet his eldest son Hugh XI (d. 1260) succeeded as count of La Marche and of Angoulême (his mother's heritage), while in England the younger Lusignan half brothers of Henry III received notable advancement. Hugh XI's grandson Hugh XIII (d. 1303), however, pledged Lusignan and La Marche to Philip IV of France.

The Lusignans d'Outremer.—Hugh VIII's third son Amalric (*see* Amalric II, king of Jerusalem) went to Outremer, became constable of the kingdom of Jerusalem in 1179 and procured the marriage (1180) of his next younger brother, Guy of Lusignan, to Sibyl, elder sister of the leprous king Baldwin IV. Count of Ascalon and Jaffa, Guy was regent of the kingdom for some months (1183–84) but quarreled with Baldwin IV and forfeited the right to be regent. On the death of Baldwin V, however, in 1186, Sibyl became queen and crowned Guy as king; but Raymond of Tripoli, regent in Baldwin V's time, would not acknowledge him till 1187. Captured by Saladin's Muslims at the battle of the Horns of Hattin (July 1187) but released on parole in summer 1188, Guy was next faced with rebellion by Conrad of Montferrat and with the need to recover Acre (despite his parole) from the Muslims. Sibyl's death and Conrad's marriage to her sister Isabella (1190) further compromised Guy's royal title; and the contempt of the barons for Guy obliged Richard Coeur-de-Lion, who had long supported him, to recognize Conrad, the French king's nominee, as king of Jerusalem in 1192, on the understanding that Guy should be king of Cyprus. Guy died in his new kingdom in 1194.

Amalric succeeded Guy in Cyprus and became king of Jerusalem by marrying Isabella after the death, in 1197, of Henry of Champagne, whom she had married on Conrad's murder (1192). On Amalric's death (1205) his eldest son became Hugh I of Cyprus (d. 1218). This Hugh married Alice, Isabella's daughter by Henry of Champagne. Their son Henry I of Cyprus (d. 1253) left an infant son Hugh II (d. 1267), with whom the true male line of Lusignan in Cyprus became extinct. Henry I's younger sister Isabella of Cyprus, however, had married Henry of Antioch, and their son succeeded to Cyprus in 1267 as Hugh III (d. 1284), founding the line of Antioch-Lusignan. Hugh III was also crowned king of Jerusalem at Tyre in 1269, but returned to Cyprus in 1276 and failed in a last attempt on the mainland in 1279.

The empty title king of Jerusalem remained with Hugh III's successors in Cyprus. These were: his sons John (d. 1285) and Henry II (d. 1324), who was ousted by his brother Amalric prince of Tyre in 1306 but recovered his throne on Amalric's assassination (1310); their brother Guy's son Hugh IV (d. 1359), who abdicated in 1358; Hugh IV's son the crusader Peter I (d. 1369); Peter I's son Peter II (d. 1382); Peter I's brother James I (d. 1398); James I's son Janus (d. 1432); Janus' son John II (d. 1458); John II's daughter Charlotte (d. 1487), displaced in 1460 by her bastard half brother James II (d. 1473); and James II's posthumous son James III (d. 1474), whose mother was Caterina Cornaro (*q.v.*).

There were two kings of Armenia of the house of Antioch-Lusignan: Guy, son of Amalric prince of Tyre by King Hayton II's sister Zabel, king from 1342 to his murder in 1344; and Leo VI (V; d. 1393), son of Guy's brother John and king from 1374 to 1375.

LUSIN: *see* Lu Hsün.

LUSTRATION (Lat. *lustratio*, "purification by sacrifice"), a general term for the processes whereby an individual or a community was rid of ceremonial impurity (*e.g.*, bloodguilt, pollution incurred by contact with childbirth or with a corpse) or simply from the profane or ordinary state, which made it dangerous to come into contact with sacred rites or objects. The methods varied from sprinkling with or washing in water, especially (though not always) running water, through rubbing with various substances such as clay, bran or blood, or through bathing in the sea, to complicated ceremonies, some of which involved confession of sins, a form of purgation found in many cultures. There was also fumigation with various substances, including sulfur. The rites of swinging, either in person or by suspending surrogate objects on trees, probably aimed at purification by air or wind. A homicide had the blood of a pig poured over him, perhaps to make the ghost of his victim imagine that his blood had in turn been shed and vengeance thus taken.

When a community was to be purified, either from collective guilt or from the accumulated ill luck and ill doing of a period of time, the usual Greek method seems to have been to lead through the village certain persons or animals capable of absorbing the pollution. Notable examples were the *pharmakoi* ("human scapegoats") who, either to cure plague or other calamities (in Ionia) or as an annual precaution (at Athens), were led through and out of the city, after which some pretense was made of killing and burning them, thus destroying the contagion. The Romans led their purifying materials around the person or community in question: a woman supposed mad is advised *circumferri*, to have appropriate remedies carried around her. Many noteworthy public rites were of this kind, such as the Lupercalia (*q.v.*; around the

original Palatine settlement), the Ambarvalia (*q.v.*; around the fields of a landholder, or anciently around the *ager Romanus* itself) and the *amburbium* ("around the city"), in all cases tracing a magic circle to keep evil out and radiate blessings in, especially fertility.

See N. M. P. Nilsson, *Geschichte der griechischen Religion*, 2 vol., 2nd ed. (1955); W. Warde Fowler, *Religious Experience of the Roman People From the Earliest Times to the Age of Augustus*, pp. 209–218 (1911). (H. J. R.)

LUTE, a plucked stringed instrument, originally brought to Europe from the near east; much used in European music from the middle ages to the 18th century, it was still in use in many Arab countries in the second half of the 20th century. The distinguishing feature of the lute is the shape and complex structure of its body, which resembles half an almond or filbert, having a vaulted or barrel-shaped back, convex in each direction and wider toward the bottom end. The back was composed of several ribs or "staves," which were bent over a prepared mold; the edges were brought together and glued, afterward being lined with strips of paper or parchment. Much attention was paid to the shaping and proportions of the mold. The earliest European lutes followed the contemporary Arab pattern in having four strings; they were played with a quill plectrum. By the middle of the 14th century the strings had become pairs, or "courses." Existing representations of the lute in the 15th century show it then to have had a body usually composed of nine staves and five courses of strings (*i.e.*, nine strings, the lower courses in pairs, the highest single) laid on a short, flat neck carrying seven gut frets. The soundboard of the lute contains a circular sound hole, set nearly central, with a perforated ornament—the "rose"—cut in the soundboard wood. The bridge is of the tension type, glued directly to the lower part of the soundboard. The head or pegbox is sharply reflexed and turns back from the nut at the top of the finger board at nearly a right angle. The purpose of this reflection seems to be twofold: to reduce over-all length on this rather large instrument so that there is easier access to the pegs in tuning, and to ensure firm bearings at the nut for the very thin, slack double gut strings.

During the 15th century the use of the plectrum in playing was generally abandoned in favour of the fingers of the right hand; and by the 16th century the classic form and stringing of the lute were established, and the great Bolognese and Venetian schools of makers had arisen. These makers—Laux and Sigismond Maler, Hans Frei, Nikolaus Schonfeld and the Tieffenbruckers—by their fine workmanship and the tonal proportions of their instruments contributed much to the popularity of the lute in the late Renaissance and paved the way for its extensive and noble literature of solo music (fantasias, dance movements, chanson arrangements), song accompaniments and consort music. The neck was lengthened to take 9, later 10, semitone frets, and the standard stringing was six courses tuned to G c *f* a. d′ g′. Its technique was systematized and its music expressed in tablature, a form of notation representing not the musical sounds played but the strings and fret positions used in order to produce those sounds. These positions were indicated by a stave of horizontal lines representing the courses of the lute, letters or figures being placed on these lines to denote the fret to be stopped by the left hand and the strings to be played by the right hand.

PROPERTY OF ERIC HALFPENNY

LUTE BUILT BY HANS FREI, ABOUT 1550

Toward the end of the 16th century further bass strings were added, the neck and head being enlarged to take them. These "diapasons," which reached four in number, were usually tuned to a diatonic scale downward from the sixth course. From about 1600, modifications in the tuning were introduced by French lutenists and by about 1630 had generally replaced the "old tuning." At the same time further diapasons were added, the resulting instrument being known as the "French lute." This was primarily a solo instrument. Its repertory required a highly mannered and ornamented style of performance and a new technique of broken chords and slurred notes that had a marked influence on the 17th-century French harpsichord composers. With the introduction of the additional diapasons, problems of tonal balance arose and the lower strings were often lengthened beyond the normal nut and carried by means of an extension of the neck to a separate nut and pegbox.

The theorbo or "theorboed lute" was often a large instrument that continued to use the "old tuning" and had the diapasons carried on a second head. Because of its greater string length, which made only the simplest chordal playing practicable, it was mainly used for *continuo* purposes. A larger form of theorbo, the *chitarrone*, was developed in Rome about 1600; its diapasons were carried on a huge neck extension, the whole instrument often being 6 ft. in length. With a sonority approaching that of a contemporary harpsichord, it was capable of holding its own in the chamber ensembles of the 17th century. (E. HA.)

LUTETIUM is a silvery metallic element of the rare earth group. It reacts readily with oxygen, water, acids and most nonmetals. Of all the rare-earth metals, lutetium is the hardest, is the most dense (9.842 g. per cubic centimetre for the hexagonal close-packed structure) and has the highest melting point, 1,652° C. There are two naturally occurring isotopes: Lu^{175} (97.41% in abundance) is stable and Lu^{176} (2.59%) is radioactive with a half life of 2.2×10^{10} years. The radioactive isotope is used to determine the age of meteorites relative to that of the earth.

Lutetium was discovered by C. A. von Welsbach and G. Urbain working independently in 1907–08. Urbain derived the name for the element from *Lutetia*, the Roman name for Paris. The element, one of the rarest of the rare earths, occurs in many minerals, the most important of which are gadolinite, euxenite, xenotime and samarskite. It is also found in the products of atomic fission. Until the development of ion exchange techniques during World War II, lutetium was separated and purified by fractional crystallization and precipitation. The metal has been prepared by thermoreduction of the anhydrous halides by alkali or alkaline earth metals.

The symbol of lutetium is Lu, the atomic number 71 and atomic weight 174.97. The thermal neutron absorption cross section is 108 barns and the ionic radius is 0.848Å. The element behaves as a typical trivalent rare earth, forming a series of white salts such as Lu_2O_3, $Lu_2(SO_4)_3$ and $LuCl_3$. The colourless solutions of Lu^{3+} ions show no discrete absorption bands in the ultraviolet and visible regions of the spectrum; analysis is best carried out by emission spectroscopy. The ion is diamagnetic since there are no unpaired electrons. *See* RARE EARTHS. (LD. B. A.)

LUTHER, MARTIN (*c.* 1483–1546), the German religious Reformer who began the Protestant Reformation, was born on Nov. 10 (certainly), 1483 (probably), at Eisleben in Thuringian Saxony. His parents, Hans and Margaret Luther, had moved there from Möhra, and soon moved on to Mansfeld where Hans Luther worked in the copper mines, prospering enough to be able to rent several furnaces and to be among the councilors of the little town in 1491. Martin's few recollections of childhood which have survived reflect a sombre piety and strict discipline common in that age. His schooling seems to have been unremarkable: the Latin school at Mansfeld, a year at a school in Magdeburg (run by Brethren of the Common Life) and at Eisenach in his 15th year, where he made valued older friends. In April 1501 "Martinus Ludher ex Mansfeld" matriculated in arts at the University of Erfurt, one of the oldest and best attended universities in Germany. There he

talked long and enough to be nicknamed "the Philosopher," and played the lute. He took the usual arts course and graduated B.A. in 1502. He took his M.A. in 1505 and was placed second among 17 candidates. In an age when few students got as far as the M.A. he had fulfilled his parents' hopes. Like many other parents of his time, Hans Luther did not intend his son to enter the religious life but to become a lawyer, and he paid cheerfully enough for the expensive textbooks when Martin began legal studies. He was chagrined to learn that his son, without consulting his parents, had decided to enter religion and had sought admission to the house of Augustinian Hermits in Erfurt.

Brother Martin Luther.—On the reason for the decision the evidence is scanty. In the later, not always reliable, *Tischreden* ("Table Talk") it is related that on July 2, 1505, Luther was returning from a visit to his parents when he was overtaken by a thunderstorm near the village of Stotternheim and cried out in terror, "Help, St. Anne, and I'll become a monk." Luther himself in his *De votis monasticis* ("Concerning Monastic Vows," 1521) says "not freely or desirously did I become a monk, but walled around with the terror and agony of sudden death, I vowed a constrained and necessary vow." He sold his books, keeping back his Virgil and Plautus, and on July 16, 1505, bade farewell to his friends.

In joining the eremitical order of St. Augustine, Luther had joined a mendicant order of importance, which by the middle of the 15th century had over 2,000 chapters. In 1473 Andreas Proles carried through a reform and the house at Erfurt accepted the strict, observant interpretation of the rule, with Proles as vicar-general. Under his successor, Luther's mentor, Johann von Staupitz, a revised constitution was made in 1504. Luther made his profession in Sept. 1506 and was then prepared for ordination. He was ordained priest in April 1507 and his first Mass took place at the beginning of May. He had studied a treatise on the canon of the Mass by the famous Tübingen nominalist Gabriel Biel (d. 1495), and approached the ceremony with awe. To this occasion his father came with a group of friends, and Luther took this first opportunity to explain personally the imperious nature of his vocation. His father's disgruntled retort, "Did you not read in Scripture that one shall honour one's father and mother?" struck deep into his memory.

Luther was selected for advanced theological studies, under Johann Paltz and Johann Nathin. Like his other university teachers, Arnold von Usingen and Jodocus Trutvetter, they were nominalists (*see* NOMINALISM) of the "modern" way of William Ockham. In 1508 Luther went to the new University of Wittenberg (founded 1502), where, though Ockhamism had a foothold, the *via antiqua* was championed by the redoubtable Martin Pollich. The little town was a contrast to Erfurt, but at least the university was young and forward looking and to its comparative remoteness Luther would one day owe his life. The *Schlosskirche* of All Saints was closely connected with the university, and on both the elector of Saxony, Frederick III (*q.v.*) the Wise (head of the Ernestine branch of the house of Wettin) lavished generous patronage. In March 1509 Luther took the degree of *baccalaureus biblicus* at Wittenberg, returning to Erfurt for his next degree, of *sententiarius*. He had begun teaching with a course on the *Nicomachean Ethics* of Aristotle, and now began his career as a theologian with lectures on the *Sententiae* of Peter Lombard (1509). Some of his notes have survived, and if their theology is unexciting there is apparent an acid vehemence at the intrusion of philosophy and above all of Aristotle into the realm of theology.

Johann von Staupitz, vicar-general of the German Augustinians, was of moment in Luther's career as his teacher, friend and patron. Staupitz seems to have been theologically trained as a Thomist in the *via antiqua*, but was also influenced by the Augustinian tradition of his order, while his theology shows elements derived from the conflation in the late 15th century of the *devotio moderna* with German mysticism (Heinrich Suso, Johann Tauler). His attempt to revive stricter discipline and to unite the observant and conventual Augustinians in Germany led to dispute, and Luther was one of two monks chosen to present the appeal at Rome of some dissident houses. He made the journey, the longest of his life, probably late in 1510, and his Teutonic earnestness was shocked at the Italianate levity of the Roman clergy and by worldliness evident in high places. The appeal failed, and Luther returned to become a loyal supporter of Staupitz.

Staupitz became interested in his gifted pupil and, perhaps alarmed by his introspectiveness, encouraged him to proceed to his doctorate and to a consequent public teaching career. Luther took his D.D. on Oct. 12, 1512, at the hands of the dean, Andreas von Karlstadt. The degree was important for Luther, with its implications of public responsibility, and was soon joined with the duties of a professor when he succeeded Staupitz in the chair of biblical theology. This was his lifelong calling, and the exposition of the Bible to his students was a task which called forth his best gifts and energies, one which he sustained until ill health and old age made him relinquish it at the end of his life. In between lectures, so to speak, he began the Protestant Reformation.

Meanwhile, Luther's religious and theological difficulties became acute. He had entered on the search for evangelical perfection with characteristic and serious zeal, and sought exactly to fulfill the rule of his order. Nonetheless, he soon found himself in deep waters, struggling against uncertainties and doubts, unhappily bearing a crippling burden of guilt, which neither the sacramental consolations of the church nor the wise advice of skilled directors was able to assuage. This distress, which had its centre in his unquiet conscience, brought him into states of anxiety and despair. Nor were his difficulties lessened by the stress of the Ockhamist theology, which encouraged an extroverted moralism, throwing stress on the human will, and leaving alarming points of uncertainty at the very points where Luther needed most to be reassured. Temptation (*Anfechtung*) was to become an important word for Luther's theology, a term which suggests the fight for faith, of which Staupitz could say that such experiences were meat and drink to Martin Luther. These inward, spiritual difficulties were enhanced by theological problems.

"The Righteousness of God."—At the entrance to the world of Pauline thought Luther was halted, the road blocked by a word which intensified his difficulties to an almost intolerable degree. This was the conception of the "righteousness of God" (*justitia Dei*). His sombre childhood piety had made him intensely aware of God's judgment, and as a lecturer in the arts faculty at Wittenberg he had had to expound the Hellenic conception of justice, as he found it in book 5 of the *Nicomachean Ethics* of Aristotle. Encouraged by the use of *justitia* in Gabriel Biel and other nominalists, he thought of God's justice as being primarily the active, punishing severity of God against sinners. It was for him a final aggravation of his trouble that in Rom. i, 17 it is asserted that the justice of God is revealed in the gospel. Thus, the divine demand was shown as extending beyond outward obedience to the law, revealed in the commandments, to purity of heart, to inward motive and intention, so that grace itself became a demand and an exaction. Such a God could be feared but not loved, could be obeyed out of constraint but never with that happy spontaneity which Luther felt to be of the essence of Christian obedience.

To Luther's sense of failure was added the feeling of hypocrisy, which drove him to the edge of what the moral theologians described as "open blasphemy." In 1545, in the celebrated autobiographical fragment which he prefaced to his complete works, he thus described his feelings:

> For however irreproachably I lived as a monk, I felt myself in the presence of God to be a sinner with a most unquiet conscience, nor could I believe that I pleased him with my satisfactions. I did not love, indeed I hated this just God, if not with open blasphemy, at least with huge murmuring, for I was indignant against him, saying "as if it were really not enough for God that miserable sinners should be eternally lost through original sin, and oppressed with all kind of calamities through the law of the ten commandments, but God must add sorrow on sorrow, and even by the gospel bring his wrath to bear." Thus I raged with a fierce and most agitated conscience, and yet I continued to knock away at Paul in this place, thirsting ardently to know what he really meant.

Thus, the dilemma. Illumination came at last, as in prayer and meditation he pondered the text, examining the connection of the words.

At last I began to understand the justice of God as that by which the just man lives by the gift of God, that is to say, by faith, and this sentence, "the justice of God is revealed in the Gospel," to be understood passively, that by which the merciful God justifies by faith, as it is written. "The just man shall live by faith." At this I felt myself to have been born again, and to have entered through open gates into paradise itself.

There has been great controversy about this inner conflict, but it seems certain that there was for Luther just such a crisis as he later described and that it was resolved in the manner he narrates. There has also been argument about the novelty of this discovery. There is in fact a profound difference between the Hellenic conception of distributive justice and the biblical doctrine of the rightousness of God as a divine, saving activity displayed in the field of history and of human experience, and Luther had penetrated deeply into the Pauline vocabulary at this point. The accuracy of Luther's memory about this, and indeed, his integrity, have sometimes been impugned, notably by H. Denifle, but the verdict of another Catholic historian, J. Lortz, may stand: that if the discovery were not new, it was at any rate "new for Luther."

Had Luther not written this account, it would have been necessary to conjecture something like it, to account for the new importance which he gave to justification by faith, a priority it retained in the new theological framework of Protestantism. This became for him the nerve of the gospel, that salvation is to be thought of primarily in terms of grace, and of a divine gift; that God's free, forgiving mercy is displayed in Jesus Christ; that the conscience, forgiven and cleansed, may be at peace, and that the soul, free from the burden of guilt, may serve God with a joyful, spontaneous, creative obedience. In his translation of the Bible Luther came to add "alone" after the word "faith" in the verse "For we hold that a man is justified by faith apart from works of law" (Rom. iii, 28) because he felt it to be demanded by the German language. The word "alone" or "only" was retained by the Reformers after him because it seemed to safeguard this important doctrine against such perversions as might seem to make salvation dependent on human achievement or a reward for human merit.

This experience ought not perhaps to be isolated, for Luther speaks of other problems of vocabulary (*e.g.,* the conception of repentance, *poenitentia*), and it cannot be assumed that this was for him a catastrophic personal experience such as befell St. Augustine in the garden at Milan or John Wesley at Aldersgate street. About the date of the occurrence there has been much controversy. The publication of Luther's early lectures led naturally to the examination of these first fruits of the young professor. The view argued most persuasively by Erich Vogelsang that it must have occurred during the period of Luther's first lectures on the Psalms (1513–14) has been damagingly criticized, but Vogelsang drew attention to Luther's use of the many-sided allegorism of the middle ages, which often found three or four levels of meaning in a single text; to Luther's concentration on the one historical meaning; and to the Christocentric core of Luther's theology of justification. Many will think that the illumination must have come to him before his fine and impressive lectures on the Epistle to the Romans (1515–16).

Something depends on how the discovery itself is assessed: if it was a discovery that justification is a gift, that it is to be taken passively rather than actively, then (as the reference to Augustine's *De spiritu et littera* suggests) Luther was hardly moving beyond the Augustinian framework. If on the other hand it was the more mature discovery of the relation of saving faith to the word of God then it must be placed later, perhaps in 1518–19; the trend of scholars such as Wilhelm Link, U. Saarnivaara and Ernst Bizer has been in this direction and to emphasize how Luther's thinking was stimulated and redirected by the urgent pressure of the church struggle which began in 1517.

The net gain of this chronological discussion has been to demonstrate how important is the whole period of Luther's development from 1509 to 1521, and that his technical vocabulary and the categories of his theology were in movement throughout the whole of this period. Certainly the great courses of lectures on the Psalms (1513–15), on Romans (1515–16), Galatians (1517) and Hebrews (1517–18) show the growing richness and maturity of his thought. Meanwhile, his other duties had accumulated. From 1511 he had been preaching in his monastery and in 1514 he became preacher in the parish church. This pulpit became the centre of a long and fruitful preaching ministry where Luther expounded profoundly and beautifully the Scriptures for the common people and related them to the practical context of their lives. Within his order, he had become prior, and then in May 1515 district vicar over 11 other houses. Thus he became involved in a world of practical administration and of pastoral care which gave him valuable experience, standing him in good stead in later years when a large part of his vast correspondence would be concerned with the care of the German churches and the cure of needy souls.

The new University of Wittenberg found it must take sides in an academic crisis which faced the European universities of that day, the tension between an old and a new academic program. Before Luther's advent Martin Pollich had shown himself hospitable to humanist influences, despite his preference for Thomism. Now Luther took the lead in inaugurating a new program, involving the displacement of Aristotle and the scholastic theologians by a biblical humanism which turned to the direct study of the Bible, using as tools the revival of Greek and Hebrew and a renovated Latin and as a dogmatic norm the "old Fathers" and especially St. Augustine. Such a program Luther planned with the help of his senior colleague, Andreas von Karlstadt, and his young friend Philipp Melanchthon. In Feb. 1517 he penned a series of theses against the scholastic theologians, which he offered to defend at other universities, and though the attempt to export the Wittenberg program met with no success he could write in May that the battle was won in Wittenberg—"our theology, and that of St. Augustine reign." But if his theses remained dormant, a very different fate awaited those which he wrote later in that same year. He could hardly have thought that these would fire a train which would explode the western Christian world.

Indulgence Controversy.—The nature and scope of indulgences had been more and more defined during the later middle ages, but there was still an element of that dogmatic uncertainty which J. Lortz has called a theological weakness of the age. Indulgences were the commutation for money of part of the temporal penalty due for sin, of the practical satisfaction which was a part of the sacrament of penance. They were granted on papal authority and made available through accredited agents. Not at any time did they imply that divine forgiveness could be bought or sold, or that they availed for those who were impenitent or unconfessed. But during the middle ages, as papal financial difficulties grew more complicated, they were resorted to so often that the financial house of Fugger had to superintend the *sacrum negotium.*

The way was open for further misunderstanding when in 1477 Pope Sixtus IV extended their authority to souls in purgatory. The appeal to cupidity and fear, the pomp and circumstance with which these indulgences were attended, the often outrageous statements of some indulgence sellers were a matter of complaint. Luther himself had frequently preached against these things, for his patron, the elector Frederick, had amassed a great collection of relics in the castle church at Wittenberg, to which indulgences were attached. But the immediate cause of Luther's public protest was an indulgence which Frederick had prohibited from his lands, though it was available in nearby territory. This was a jubilee indulgence, offering special privileges, the ostensible purpose of which was the rebuilding of St. Peter's in Rome. In fact, by a secret arrangement, half of the German proceeds were to go to the young Albert, archbishop of Mainz, who was up to the ears in debt owing to his rapid promotion to a number of high ecclesiastical offices.

Of this Luther knew nothing until some time afterward. The provocation came for him in the extravagant utterances of an old, tried hand at this kind of thing, the Dominican Johann Tetzel (*q.v.*). With these claims in mind, Luther drew up the 95 Theses, "for the purpose of eliciting truth," and fastened them on the door of All Saints church, Wittenberg, on Oct. 31, 1517, the eve of All

Saints' day and of the great exposure of relics there. These were tentative opinions, about some of which Luther himself was not committed. They did not deny the papal prerogative in this matter, though by implication they criticized papal policy; still less did they attack such established teaching as the doctrine of purgatory. But they did stress the spiritual, inward character of the Christian religion, and the 1st thesis, which claimed that repentance involved the whole life of the Christian man, and the 62nd, that the true treasure of the church was the most holy gospel of the glory and the grace of God, showed the author's intention. The closing section attacked the false peace, that "security" which as a young lecturer he had so often attacked, of those who thought of divine grace as something cheaply acquired and who refused to recognize that to be a Christian involved embracing the cross and entering heaven through tribulation. Luther sent copies of the theses to the archbishop of Mainz and to his own ordinary. But here the invention of printing intervened: it enabled copies to be circulated far and wide, so that what might have been a mere local issue became a public controversy discussed in ever widening circles.

The archbishop of Mainz, alarmed and annoyed, forwarded the documents to Rome in Dec. 1517, with the request that Luther be inhibited, at the same time reprimanding the indulgence sellers for their extravagance. At this time it seemed to many that this was just another squabble between religious orders, the Dominicans and the Augustinians. Colour was given to this by the countertheses prepared by the theologian Konrad Wimpina which Tetzel defended before a Dominican audience at Frankfurt at the end of Jan. 1518. When copies of these reached Wittenberg in March they were publicly burned by excited students. At Rome the pope merely instructed the vicar-general of the Augustinians, Gabriel della Volta, to deal with the recalcitrant monk through the usual channels, in this case through Staupitz. Luther himself prepared a long Latin manuscript with explanations of his 95 theses, publication of which was held up until the autumn of 1518; it is a document of some theological importance, and shows how far from superficial had been Luther's original protest. Meanwhile, the chapter of the German Augustinians was held at Heidelberg, April 25, 1518. Luther was relieved of his extra duties as district vicar, in the circumstances a great relief and intended as such. He found great comfort in the support of his friends, and was himself in great form, winning over two young men, Martin Bucer (*q.v.*), a Dominican, and the future scholar Theodor Bibliander.

At this period Luther's theology was very specially a "theology of the cross"; *i.e.*, a theology that stressed the revelation of Christ on the cross, which seems foolishness to the wisdom of the world and which is opposed to the natural theology of divine power and majesty, attacked by Luther as a scholastic "theology of glory." Important for him at this time was the inward religion of Johann Tauler and of the short 14th-century mystical tract which he himself edited and published (1516–18), the *Theologia Germanica;* in these months, therefore, he lays great stress on the need for the Christian to share the cross of Christ, in suffering and in temptation. These stresses were to fall into the background of Luther's developing theology but were to remain important for the radical Reformation in the following years, for which the *Theologia Germanica* would be an important and seminal document.

During Luther's absence, and perhaps catastrophically, his senior colleague, Karlstadt, had taken action which was greatly to widen the scope and publicity of the controversy. The scholar Johann Eck (*q.v.*) of Ingolstadt, a man with a zest for disputation and of some learning, with whom Luther was already in friendly contact through their common friend Christopher Scheuerle, became involved in the controversy. He had penned some observations on the 95 Theses, written for his friend the bishop of Eichstätt, and these manuscript observations, the so-called *Obelisci,* reached Wittenberg shortly before Luther went off to his chapter at Heidelberg; Luther himself replied with a few *Asterisci,* but Karlstadt, concerned to defend the Wittenberg program, sprang into the fray with 380 theses, adding another 25 before publication, in some of which Eck was impugned. The Dominicans continued to press for Luther's impeachment, and proceedings against him for heresy began to move slowly in Rome. Luther himself did not improve matters by publishing a bold sermon on the power of excommunication which made it clear that here was not a man who would accept unquestioned whatever might be decided by the pope in terms of some undefined plenitude of power.

Augsburg Interview, 1518.—A citation to Rome was sent to the cardinal Cajetan, a renowned Thomist, at Augsburg. But at this perilous moment politics fatefully intervened, and the period when the Luther affair might have been swiftly, drastically disposed of without wider disaster to the church was whittled away by considerations of policy. The elector Frederick, as one of the seven prince electors of the Holy Roman empire, was most important to the pope, in view of the imminent choice of a new emperor, and the pope could not afford to antagonize him. The result was that Luther was bidden to a personal interview with Cajetan at Augsburg. He arrived there on Oct. 7 with an imperial safe-conduct. The discussion had moved from indulgences to the discussion of the relation between faith and sacramental grace, but a wrangle developed between the two theologians about the meaning of the "treasure" of merits which the papal definition of Sixtus IV said that Christ had acquired, and the incensed cardinal dismissed Luther from his presence, telling him to stay away unless he would unconditionally recant.

While Luther waited uneasily the Saxon councilors reported rumours that he would be taken in chains to Rome. Eventually, bundled through a postern by his friends, he fled the city. Now he wrote an appeal from the pope to a general council and a full defense of his actions to his prince. Cajetan also lost no time in denouncing Luther to Frederick, who was in something of a dilemma, though it counted much for Luther that he had the admiring friendship of the elector's secretary, the humanist Georg Spalatin. At this time, too, the Wittenberg theological faculty addressed the prince on his behalf, pointing out that the fate of the university and its reputation would be involved in Luther's disgrace. At one moment, it seemed that Luther might have to depart, perhaps for France or Bohemia. There then appeared a papal diplomat, a German, Karl von Miltitz, who applied "stick and carrot" tactics to the elector, dangling before him at one moment threats against Luther and at the next the signal compliment of the golden rose. Miltitz promised more than he could possibly perform, and after an interview with him at Altenburg, in Jan. 1519, Luther sensed this; he retained a lively and unimpressed distrust of this sentimental and lachrymose arbiter. A papal definition about indulgences, issued at Cajetan's request, would seem to show that Luther had indeed put his finger on some fatal ambiguities.

Leipzig Disputation, 1519.—At Augsburg Luther had been in touch with Eck and arrangements went forward for a public disputation at Leipzig in the summer. This was in the first place a debate between Eck and Karlstadt, though Luther was Eck's ultimate objective, but the hostility toward the Reformer on the part of George, duke of Saxony (head of the Albertine branch of the house of Wettin and the elector Frederick's first cousin), raised difficulties about Luther's participation. Eventually it was arranged that Eck should debate with the two Wittenberg theologians in turn, in the castle of the Pleissenburg, Leipzig, at the end of July. There was a preliminary pamphlet skirmish. The issue between Eck and Karlstadt was the Augustinian doctrine of grace and free will, and Karlstadt wished to meddle neither with indulgences nor with papal authority. Now among the preliminary matters that of the origin of the papal power was raised and so Luther turned to a study of church history and canon law in the fateful weeks before the debate. A large contingent from Wittenberg attended, and in the presence of theologians from both universities, Duke George and notables of church and state, the debate began. Eck showed some skill in maneuvering Luther into a position where he cast doubt on the authority of the great German Council of Constance, and defended some of the propositions of John Huss. Leipzig was a part of Germany with a strong feeling against Bohemia, and the admission was received as damaging, giving ground for Eck's loud boast that the disputation had been his personal triumph.

Eck was able to go off to Rome with new prestige to give sharpness to the process of Luther's official condemnation. Luther had now to examine the further implications of his actions to date, in relation to the authority of the church, of councils and of Scripture; his correspondence shows that he was reaching something like a crisis in his attitude to papal authority. There had been a small pamphlet war after the disputation which made it plain that there was strong support for Luther among the humanists such as Willibald Pirckheimer and the brothers Bernhard and Konrad von Adelsmann in Germany, and Joachim Vadianus and Huldreich Zwingli in Switzerland. Luther himself became involved in controversy with three diverse theologians of Leipzig, Hieronymus Dungersheim, Hieronymus Emser and Augustinus Alveldus, and if he now wrote in the vernacular with increasing power and violence, his polemical writings reveal also his deep perceptions of the issues between himself and contemporary theology. Two Catholic universities, strongholds of tradition, Cologne and Louvain, now condemned Luther's teaching. But polemic was not Luther's main concern, and his fine treatise *Von den guten Werken* ("Of Good Works"), issued in June 1520, is an important exposition of the ethical implications of justification by faith, a tract that deserves to be associated with the more famous tract on Christian liberty of the next months. On June 15, 1520, appeared the papal bull *Exsurge domine* against 41 articles of Luther's teaching, followed by the burning of Luther's writings in Rome. Eck and the humanist diplomat Girolamo Aleandro were entrusted with the task of taking the bull to the cities of Germany.

Treatises of 1520.—Eck and Aleandro were alarmed to find how swiftly German opinion had moved to Luther's side. Eck had to seek refuge in Leipzig from physical violence—a contrast to his treatment the year before. Aleandro did what he could in agitated correspondence to shock the *curia* into realizing the grave danger facing the church in Germany. Luther's friends, notably Spalatin and Philipp Melanchthon, aware how precarious was his position, sought to moderate his violence, but he now moved well beyond their horizon. The result was the defiant tracts of the summer of 1520. The first, the real manifesto, was his *An den christlichen Adel deutscher Nation* ("Appeal to the Christian Nobility of the German Nation"), addressed to the rulers of Germany, princes, knights, cities, under the young emperor Charles V. In the present crisis, when the spiritual arm had refused to take in hand the amendment of the church and the often expressed grievances of the German people against Rome, it was for the secular arm to intervene and call a reforming council. The document was ill arranged and tailed off, but it found deep response among sections of the nation, and in the next months Luther was carried along with the tide of national resentment against Rome.

His second treatise, *De captivitate Babylonica ecclesiae praeludium* ("A Prelude Concerning the Babylonish Captivity of the Church"), intended for clergy and scholars, was an act of ecclesiastical revolution. It inevitably estranged many moderate humanists, for it reduced to three the seven sacraments, denied Mass and attacked transubstantiation, made vehement charges against papal authority and asserted the supremacy of Holy Scripture and the rights of the individual conscience. The third work, dedicated to the pope, was as a still, small voice after the uproar, a minor classic of edification, *Von der Freiheit eines Christenmenschen* ("Of the Liberty of a Christian Man"), which made clear the ethical implications of justification by faith, and showed that his thought and his public actions were connected by a coherent theological core. On Dec. 10, 1520, the students lit a bonfire before the Elster gate in Wittenberg, and as they fed the works of the canonists to the flames Luther added the papal bull against himself with suitable imprecation.

In Jan. 1521 the pope issued the bull of formal excommunication (*Decet Romanum pontificem*), though it was some months before the condemnation was received throughout Germany. Meanwhile the imperial diet was meeting at Worms, and there was a good deal of lobbying for and against Luther. In the end Frederick the Wise obtained a promise from the emperor that Luther should not be condemned unheard and should be summoned to appear before the diet. This enraged Aleandro, who asserted that the papal condemnation was sufficient and that the secular arm had only to carry out its orders. It also alarmed Luther's friends, who did what they could to dissuade him. Luther was firm in his determination to go, and began the journey in April 1521, undeterred by the news, on the way, that the emperor had ordered his books to be burned. What was meant to be the safe custody of a heretic turned out to be something like a triumphal procession, and when Luther entered Worms on April 16 he was attended by a cavalcade of German knights and the streets were so thronged as to enrage his enemies.

Diet and Edict of Worms, 1521.—In the early evening of April 17, 1521, Luther appeared before the notables of his world and faced the young emperor Charles V, whom he found cold and hostile (*see* CHARLES V). A pile of writings lay before him, but when he was formally asked whether he acknowledged them, his legal adviser, Jerome Schurpf of Sankt Gallen, insisted that the titles be read. In view of the gravity of recantation, Luther now asked for time to think, a request which may have taken his enemies off guard. A day's respite was granted, and the following afternoon, in a larger hall, and before an even more crowded assembly, Luther reappeared. This time he could not be prevented from making a long speech. He distinguished between his writings: for the works of edification he need not and ought not to recant, for the violence of his polemic he would apologize, but for the rest he could not recant; and, as he went on to explain why, the demand was brusquely made for a plain, simple answer. This he now gave in words of unyielding defiance. He would recant if convinced of his error either by Scripture or by evident reason. Otherwise he could not go against his conscience, which was bound by the word of God. The evidence is tilted against the authenticity of the famous conclusion, "Here I stand. I can do no other," but it registers the authentic note of Luther's reply in a moment which captured the imagination of Europe. There was a moment of confusion with Eck and Luther shouting, and then the emperor cut short the proceedings. Luther strode through his thronging enemies to his friends, his arm raised in a gesture of relief and triumph.

There followed a diplomatic flurry. It was evident that Luther had powerful friends, and there was some sabre rattling from the knights, while the peasant emblem *Bundschuh* appeared in the streets. There is evidence to support Luther's boast that had he wished he would have started such a game that the emperor's life would not have been safe. Thomas Müntzer (*q.v.*) later asserted that had Luther recanted the angry knights would have killed him. At any rate, Luther was now given what he had long asked for in vain, something like a real hearing before reasonably impartial judges, while he was kindly handled by the archbishop of Trier. But he could not now make minor concessions, and the discussions broke down on the fallibility of councils. He was formally dismissed and departed under his safe-conduct.

Nonetheless, despite the spectacular moral triumph, his enemies achieved something important at this point when a rump diet passed the edict of Worms. It declared Luther to be an outlaw whose writings were proscribed. It was to overshadow him and fetter his movements all his days. It meant also that his prince must, for a time at least, walk delicately and could not publicly support his protégé. The result was the pretended kidnapping of Luther who was lodged secretly in the romantic castle of the Wartburg, near Eisenach.

In this eyrie among the trees Luther remained until March 1522. Known as "Junker Georg," he dressed as a layman, grew a beard and put on weight. The lack of exercise, the unwontedly rich diet, brought on physical distress, constipation and piles, while his mind, flung back on itself after months of crisis, knew intense reaction in a period of acute depression of the kind which Luther ranked high among temptations (*Anfechtungen*). But he was far from idle. He finished a beautiful exposition of the *Magnificat* and prepared an edition of sermons on the Epistles and Gospels at Mass, *Enarrationes epistolarum et evangeliorum, quas postillas vocant*, which he thought was perhaps his best writing. Although away from books, he wrote his ablest controversial piece, *Rationis*

Latomianae confutatio, with its luminous exposition of justification. Most important of all, he began to translate the New Testament from the original Greek into German. He did not believe that such work should be left to one mind, and soon enlisted his colleagues, notably Melanchthon, in the enterprise. But Luther's was the controlling genius, and the resulting New Testament (published in Sept. 1522) and the Old Testament, translated from the Hebrew, which followed later (1534), was a monumental work, which had deep and lasting influence on the language, life and religion of the German people (*see* also GERMAN LITERATURE: *The Reformation;* BIBLE, TRANSLATIONS OF). He had now to deal with some practical implications of his revolt, for private Masses, celibacy of clergy, religious vows were no theoretic questions but were themselves entangled in a network of legal, financial and liturgical affairs. He wrote about these things forthrightly, and Spalatin tried in vain to hold up their publication. For in Wittenberg there were growing difficulties, and the prince, the university and the cathedral chapter were all, for various reasons, anxious to go slowly.

Commotion in Wittenberg, 1521–22.—There was a lively section of town and gown, however, that was determined to force the pace, and there were violent scenes in the streets and churches early in Oct. 1521. Yet Luther on a secret visit to his friends early in December was not alarmed, and it was his influence which led the Augustinians to decide, in the new year, that those of them who wished might return to the world. Two radical leaders now appeared, the incorrigible troublemaker Karlstadt and an ebullient spellbinder from the Augustinians, Gabriel Zwilling. When Karlstadt announced his betrothal to a girl of 16, and at Christmas administered communion in both kinds, dressed as a layman, attacked images in a violent tract and in innumerable theses denounced vows, Masses and demanded a vernacular liturgy, it was evident that here was a program which in timing and method differed from Luther's. Moreover its appeal to Scripture was legalistic and made matters of necessity things which for Luther lay within the option of Christian liberty. In the new year, the town council issued a notable and pioneering ordinance regulating religion, public morals and poor relief, a document which owes much to Luther's teaching and perhaps something to the initiative of Karlstadt. At the end of 1521 confusion was increased by the arrival of the so-called "Zwickau prophets," radicals on the run, who spoke impressively of revelations given them through dreams and visions. A flustered and outmaneuvered Melanchthon wrote urgently for advice to Luther, who sent wise and calm counsel.

In the next months the situation worsened and in March 1522 Luther returned to Wittenberg, explaining the reason for his disobedience to instructions in a justly famous letter to his prince. Then, deliberately habited as an Augustinian monk once more, he took charge of his town pulpit and in a powerful series of sermons redressed the balance of reform. In these important utterances, the difference between Luther's conservatism and the radical pattern of reform is made plain. Luther deplored the use of violence, for the word of God must be the agent of reform. The real idols are in the hearts of men and if their hearts are changed the images on church walls must fall into disuse. Moreover the pace of reform must take into account the unconverted, weaker brethren. From this time onward Luther fought a war on two fronts, against the Catholics and against those whom he lumped together as *Schwärmer* (fanatics). One result of the Wittenberg crisis was to slow down the practical reforms, and though Luther introduced a reformed rite (*Formula missae et communionis,* 1523) it was not until 1526 that he provided a vernacular liturgy (*Deutsche Messe*). Throughout Germany the evangelical movement continued to grow, and it was apparent that the edict of Worms would not be everywhere enforced. A diet at Nürnberg, 1522–23, refused to suppress the evangelical preachers and demanded a reforming, national council; though Catholic pressure was stronger in the following year, the diet again pressed for a council and would consent only to the enforcement of the edict "as far as possible."

Peasant War.—On his journeys to and from Worms Luther had been dismayed by the evident social and political unrest. In the next months he wrote open letters, warning the rulers of Saxony and the councils of cities such as Strasbourg of the danger that the new radical teaching would provoke revolution. In 1523 he made his own views of secular government plain in the important treatise *Von weltlicher Obrigkeit* ("Of Earthly Government"), in which he firmly asserted the duty of a Christian prince and the place of secular government within God's ordinances for mankind; he distinguished between the two realms of spiritual and of temporal government, through which the one rule of God is administered, and stressed the duty of civil obedience and the sinfulness of rebellion against lawful authority.

In Saxony the radical teachers posed a problem for their untheological rulers. In Orlamünde Karlstadt had converted the community to his own brand of mystical quietism, drawing heavily on Tauler and on the *Theologia Germanica,* as well as on Augustine. Luther made a preaching tour of the area at the request of his prince, and was greeted with hostility and ridicule. Luther himself denounced social evils such as usury, but in Eisenach the fiery preacher Jakob Strauss conducted a violent campaign against usury and tithes. Most formidable of all, in the little town of Allstedt Thomas Müntzer, an unruly genius, combined his own ingenious liturgical reforms with a program of holy war. Himself a former "Martinian," he not only shared Karlstadt's enthusiasm for the mystics but added an explosive element (perhaps influenced by Hussite teaching) which gave point to Luther's worst fears. Luther's warnings and events themselves forced the rulers to take action, and in the summer of 1524 Müntzer fled and Karlstadt was exiled. Karlstadt wrote a series of tracts against his former comrades, denouncing, among other things, the corporeal presence in the Eucharist. Luther replied in a devastating and profound treatise, *Wider die himmlischen Propheten, von den Bildern und Sakrament* ("Against the Heavenly Prophets in the Matter of Images and Sacraments").

In the summer of 1524 the peasants' revolt had broken out in the Black Forest area. Their program was variously motivated. Their demands were for concrete medieval liberties connected with the game and forest laws or with tithes. Some of them drew on Catholic teaching, others on the theology of Zwingli and of Luther. The latter had set an example of successful defiance of authority and had been no respecter of dignities, such as the pope and Henry VIII of England. His teachings about Christian liberty and a priesthood in which all believers shared were plainer than his subtle distinctions between two kingdoms. Thus, both where he was understood and where he was misunderstood, his influence has to be taken into account. Some of the moderate peasants included Luther among possible arbitrators. He himself published in May 1525 the *Ermahnung zum Frieden,* an analysis of the "12 articles" of the Swabian peasants, sympathizing with just grievances, criticizing the princes, but repudiating the notion of a so-called "Christian" rebellion: "My dear friends, Christians are not so numerous that they can get together in a mob."

In the spring of 1525 the Thuringian peasants rose, with Thomas Müntzer among their leaders, and at first seemed likely to carry all before them. Faced with imminent political chaos, Luther wrote his brutal, virulent broadsheet, *Wider die räuberischen und mörderischen Rotten der Bauern* ("Against the Murdering, Thieving Hordes of Peasants"). The writing was less violent than Müntzer's hysterical manifestoes, but it was bad enough. It appeared, however, as an appendix to his moderate tract about the "12 articles." Moreover, words written at the height of the peasant success read very differently after the collapse at the battle of Frankenhausen, May 15, 1525, and in the bloody reprisal which followed. It was typical of Luther that he refused to climb down, to regain lost popularity, and neither thereafter nor at any time can he be accused of subservience to rulers. As he had refused to become the tool of the knights, in the time of Franz von Sickingen's desperate rising in 1522, so he had never "taken up" the peasant cause. But he confirmed many peasants in their preference for the radical ideology, which was soon to find more peaceful coherence in the Anabaptist movement.

Watershed Year, 1525.—In other ways, too, 1525 was a watershed in Luther's career. At the height of the peasant war in

June 1525, "to spite the devil" he had married Katherine von Bora, a former nun. He certainly needed looking after, and she proved an admirable wife and a good businesswoman. His home meant a great deal to him, and was an emblem for him of Christian vocation, so that he included domestic life among the three hierarchies of Christian existence in this world, the other two being political and church life. In the same year there came his open break with Erasmus. The differences between the two men had long been apparent, and Erasmus found in Luther the type of violent, dogmatic mendicant theologian he had always detested, while he liked what he saw of the Reformation less and less. Nonetheless, both men had a common band of admirers and friends, and entered the arena with reluctance. Erasmus, in his *De libero arbitrio* (1524), attacked Luther's doctrine of the enslaved will and provoked the resounding reply of Luther's *De servo arbitrio* (1525), a one-sided, violent treatise which nevertheless includes profundities still fruitfully debated. In that year, too, Frederick the Wise died. The two men met but once, but Luther owed much to this prince. The new ruler, the elector John, and his successor John Frederick, were Luther's devout supporters, and with other princes, notably Philip, landgrave of Hesse, and Albert of Brandenburg, formed a coherent group in the imperial diet.

The hostility of Charles V to the Reformers and his devotion to the Catholic faith never altered, but he had to take account of political exigencies, his quarrels with the pope and with the king of France and the need for support against the Turks. At the diet of Speyer in 1526 the edict of Worms was suspended, pending a national council; in the interval it was ruled that each prince must behave as he could answer to God and to the emperor. As a result, it was possible to plan the reorganization of the Saxon church, and a visitation was carried out by jurists and theologians, 1527–28. Some have seen a tension between Melanchthon's *Instruktion für die Visitatoren* (1527) and Luther's comments, which may reveal his distrust of secular intervention in spiritual affairs; and though he thoroughly approved of the development of the evangelical *Landeskirchen*, there were to be aspects of Lutheranism which blurred rather than reflected Luther's theological distinctions. At the second diet of Speyer in 1529 renewed Catholic pressure led to the reversal of earlier concessions, drawing from the evangelical princes, and from a number of cities, a protest which won them, for the first time, the name "Protestant."

Eucharistic Controversy.—The difference about the Eucharist broke the common evangelical front. While all the Reformers repudiated the sacrifice of the Mass, they were deeply divided about the nature of the divine presence. Luther, with simple Biblicism, insisted that Christ's words "This is my body" must be literally interpreted, since allegory is not to be used in interpreting Scripture unless the context plainly requires it. Karlstadt's fanciful argument (that the word "this" referred not to bread and wine but the Lord's physical body) was soon dropped. But Zwingli won many to his view that "is" must be taken as "means," while his learned friend John Oecolampadius (*q.v.*) brought patristic support for a spiritual presence and stressed a phrase of Tertullian that "body" meant "sign of the body." Thus the initial debate was about exegesis, about the words of institution, though the scriptural argument moved to the relevance or irrelevance of the Gospel of John (*e.g.*, "he who eats my flesh and drinks my blood has eternal life," John vi, 54).

The debate turned to the intricate matter of Christology. Zwingli insisted on the distinction between the two natures of Christ, and that since to be in one place is the property of a human body, Christ's human body was not here but in heaven. Luther stressed the indivisible unity of the one person of Jesus Christ, the mediator. Without going into a metaphysical doctrine of "ubiquity" (which was developed by his disciple Johann Brenz and other Lutherans) he asserted that Christ is present where he wills to be, and that we are not to think of him in heaven "like a stork in a nest." Martin Bucer and the Strasbourg theologians echoed the more positive stresses of the Swiss, and Bucer used the realist language of the Fathers to support a true, spiritual presence. Luther's treatise *Dass diese Wort Christi "Dass ist mein Leib" noch fest stehen wider die Schwarmgeister* ("That these words of Christ 'This is my Body' still stand firm against the fanatics," 1527) showed that in three years of controversy he had not budged. Zwingli's Latin tract *Amica exegesis* ("A Friendly Exegesis," 1527) was far less amicable than the title suggests and brought a great outburst from Luther, the impressive *Vom Abendmahl Christi, Bekenntnis* ("Confession About the Lord's Supper," 1528). This convinced Bucer that he had misunderstood Luther, who did not mean a local, confined presence, and from now on he intensified his awkward, well-intended attempts to make peace.

The political advantages of a common front were obvious, not least to the vulnerable Zwingli and Philip, landgrave of Hesse, and the prince invited theologians of both sides to a private colloquy at Marburg in Oct. 1529 (*see* MARBURG, COLLOQUY OF). After three days' debate there was no agreement about the Eucharist, though it cleared the air of many misunderstandings. But if the conference failed there were agreements on other issues and these might have been fruitful had not the coming imperial diet caused the Wittenberg theologians to draw away from the Swiss. As an outlaw Luther could not attend this fateful diet of Augsburg, and had to fidget in the castle of Coburg, leaving the care of the gospel to Melanchthon, who did very well and produced in the Augsburg Confession (1530) one of the great documents of the Reformation, as well as a normative confession of Lutheranism (*see* AUGSBURG CONFESSION; CONFESSIONS OF FAITH, PROTESTANT).

Luther used his influence to stiffen the elector against compromise, though from this time onward he could not refuse his consent to political Protestantism as it took a more and more military shape in the League of Schmalkalden in preparation for armed resistance to Catholic aggression. Again the political situation changed swiftly, however, and, confronted with the Turkish invasion, the emperor agreed to a truce with the Protestants in the religious peace of Nürnberg (1532). This was a valuable breathing space, and its effects are evident in Luther's writings in the next years. Now Luther left more and more matters to the action of Melanchthon.

Growth of Lutheranism, 1530–46.—Luther acquiesced in the eucharistic agreement which the triumphant Bucer brought off with Melanchthon in 1536 (the Wittenberg concord), though Bucer was unable to widen the agreement and bring in the Swiss. When an English embassy came from Henry VIII to discuss joining the Schmalkaldic league, it was Melanchthon who drew up the theological agenda (the Wittenberg articles, 1535) with an ambiguous statement of justification of which Luther wrote "this agrees well with our teaching." But he would not follow Melanchthon when he thought he wrote too irenically about the papacy, and as the papal council loomed near he penned his own uncompromising Schmalkaldic articles, a noble document (1537).

Melanchthon's great work in the field of education was to earn him the name "preceptor of Germany," but Luther too was important in this matter. His open letter to the councilors of Germany about the need for schools, *An die Ratherren aller Städte deutschen Lands* (1524), and his published sermon *Dass man Kinder zur Schulen halten solle* ("On Keeping Children at School," 1530) show how wise and forward looking was his concern for education. He himself composed two important catechetic documents, the lovely classic, *Der kleine Katechismus* ("Small Catechism") and *Der grosse Katechismus* ("Larger Catechism," 1529) for teachers and pastors (*see* CATECHISM).

In Wittenberg Luther had a group of able colleagues: Justus Jonas, Johann Bugenhagen, Feliks Krzyzak (Cruciger). In scores of cities his disciples and friends spread the evangelical teaching which in these years formed the Lutheran pattern of church life. In the north of Germany and in Denmark it owed much to Bugenhagen. Luther, though not pre-eminent as a liturgist, provided orders of worship from which numerous other *Kirchenordnungen* were derived. The influence of Luther's writings was everywhere felt in the western Christian world. It was in Scandinavia that the Lutheran Church struck its deepest roots and won its most complete ascendancy, but it also had deep influence in Austrian and Hungarian lands. Luther realized the importance of hymns and encouraged his friends to write them. He wrote a score of fine

hymns, four of which appeared in the first Protestant hymnbook in 1524. The famous *Ein feste Burg ist unser Gott* ("A Safe Stronghold Our God is Still" or "A Mighty Fortress Is Our God") became almost an event in European history (*see* HYMN). In the last decade of his life Calvin was the rising portent in Switzerland, though Luther's personal contact with him was slight. He continued to attack bitterly the *Schwärmer*, who now included besides the Anabaptists a number of radicals such as Sebastian Franck and Kaspar von Schwenckfeld. Although he maintained to the end his view that error can be conquered only by the Word, he came to accept the punishment of the Anabaptists.

In 1540 Bucer and Melanchthon took the initiative in conniving at the deplorable bigamy of Philip of Hesse, but Luther was involved and had he willed could have stopped it (*see* PHILIP [the Magnanimous]). It would have been easy for Philip to remedy his incorrigible incontinence by taking a mistress, but this he refused to do, though his guilty conscience kept him from the sacrament. The desperate device, as a lesser of evils, was to grant him a secret dispensation to take a second wife. When the affair became public Luther angrily threatened to write exposing the whole story. He himself was so far from lowering moral standards that in the next years he threatened to leave Wittenberg, since the public morals were a shame on a city which had known the evangelical teaching so long. After a serious illness in 1537 he was an almost chronic invalid, prematurely aged, seldom free from discomfort, often in pain, and he brought his teaching career to an end with the fine lectures on Genesis. In the last decade of his life he had to witness the recovery of the papacy, which he thought to have been mortally wounded, in the preparations for the Council of Trent, and the growing menace of Catholic military might. His last outstanding controversial treatise was *Von den Conziliis und Kirchen* ("Of Councils and Churches," 1539) though there are fine insights in the polemical *Wider Hans Worst* (1541). Among his last writings, against the Anabaptists, against the Jews, against the "Papacy at Rome, founded by the Devil" the most violent is his antipapal tract, coarse and angry, but still defiant.

Early in 1546 Luther was asked to go to Eisleben, to mediate in a quarrel between two arrogant young princes, Counts Albrecht and Gebhard of Mansfeld (*see* MANSFELD). He was old and ill, but they were his *Obrigkeit* to whom he owed obedience and he set off in the snowy winter, leaving his wife stiff with anxiety. His letters to her teased her, comforted her and spoke at last of a mission successfully accomplished. But he had overtaxed his strength and in a few hours the chill of death came upon him. He died in Eisleben, the town where he was born, on Feb. 18, 1546, and his body was interred in the Church of All Saints, Wittenberg. The great funeral orations by Bugenhagen and Melanchthon, who knew him so well, are not to be dismissed as simply panegyric. They witness that his intimates regarded him as a really great man, one standing within the historic succession of prophets and doctors of the church, through whose life and witness the Word of God had gone forth, conquering and to conquer.

Luther as Theologian.—Luther was no systematizer, like Melanchthon or Calvin, though the dissensions among Lutheran theologians after his death, each appealing to one aspect of his thought, testify to the width, coherence and delicate balance of Luther's own teaching. The basis of his theology was Holy Scripture; and though the differences between his own and Augustine's thought are important, Augustine must stand next to the Bible among the influences upon his mind. The doctrines of salvation are of prime importance for him, and here the two great, many-sided complex conceptions of the Word and of faith are important. His often subtle doctrine about civil obedience was not always understood by his later followers, and nontheological factors in German history perpetuated and even perverted this misunderstanding. His doctrine of Christian vocation in this world, and the importance of human life in the world, became part of the general Protestant and Puritan inheritance. In other matters—in the room allowed for Christian liberty, in his conception of the part played by law in Christian life and in his insistence on the Real Presence in the Eucharist—his theology differs from the patterns which emerged in the Reformed (Presbyterian) churches, in Puritanism and in the sects such as the Anabaptists.

See also REFORMATION; GERMANY: *History;* LUTHERANISM; and references under "Luther, Martin" in the Index.

BIBLIOGRAPHY.—This highly selective list can be supplemented by the comprehensive book list published annually in the *Luther-Jahrbuch*, ed. by Franz Lau; by the publications of the International Congress for Luther Research; and by the monthly literature survey in English and German published by the Lutheran World federation.

Editions and Translations: The Weimar edition by J. C. F. Knaake *et al.* (1883–) is the indispensable tool for serious Luther studies. Of older collections, that of Erlangen, ed. by J. G. Plochmann and J. K. Irmischer (1826–57) and by J. G. Walch (1740–50; rev. 1881–1910), are useful, that by Walch containing also rare tracts by Karlstadt and others. There is a key to these editions in K. Aland, *Hilfsbuch zum Luther-Studium* (1956). The most useful short edition is by O. Clemen (1950). The Munich edition of the German works by H. H. Borcherdt and G. Merz (1913–25, 1951–53) has good notes and introductions. The American edition of Luther's works in Eng. trans., ed. by J. Pelikan and H. T. Lehmann (1955–), supersedes the Philadelphia edition, 6 vol. (1915–32). *See* also Luther's primary works in Eng. trans., ed. by H. Wace and C. A. Buchheim (1896); B. L. Woolf, *Reformation Writings of Martin Luther,* 2 vol. (1952); T. G. Tappert, *Letters of Spiritual Counsel,* Eng. trans. (1955); P. S. Watson (ed.), *Commentary on St. Paul's Epistle to the Galatians,* Eng. trans. (1953); J. I. Packer and O. R. Johnson, *On the Bondage of the Will,* Eng. trans. (1957).

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LUTHERANISM, the general title given to the branch of the Western Christian church that adopted the religious principles of Martin Luther (*q.v.*), as opposed to those of the Roman Catholic Church and of the followers of John Calvin, the Anglican communion and the sectaries of the times of the Reformation. Lutheran churches often term themselves Evangelical as distinct from Reformed, but these uses are not always strictly applied.

Lutheran doctrinal statements are usually said to include nine separate formulations which together form the Book of Concord (*see* CONCORD, BOOK OF). Three belong to the early Christian church—the Apostles' Creed, the Nicene Creed in its western form and the so-called Athanasian Creed (*see* CREED). Six derive from the 16th-century Reformation—the Augsburg Confession, the Apology for the Augsburg Confession, the Schmalkald Articles, Luther's two Catechisms and the Formula of Concord (*see* AUGSBURG CONFESSION; CATECHISM; CONFESSIONS OF FAITH, PROTESTANT). Only the three early creeds and the Augsburg Confession are recognized by all Lutherans. Luther's Catechisms have met almost universal acceptance, but many Lutheran churches re-

jected the Formula of Concord because of its strict and detailed doctrinal statements. The Augsburg Confession and Luther's Small Catechism may properly be said to define Lutheranism inclusively in its doctrinal aspect, though Lutherans may be divided on many issues raised since the Augsburg Confession of 1530.

Lutheranism acknowledges no world headquarters, but the vast majority of the world's Lutherans co-operate in the Lutheran World federation, which has offices in Geneva, Switz. Statistics of the bodies which make up Lutheranism are difficult to gather, in part because many Lutherans live behind the "iron curtain" and in various underground situations. Estimates at the end of the 1950s placed the total number of Lutherans in the world at 70,000,000 to 80,000,000; over 50,000,000 of these were represented in the federation. In the United States, Lutheranism makes up the third largest family of Protestant denominations, with 8,000,000 baptized members, over 5,500,000 of whom are confirmed.

The oldest and the largest of non-Roman Catholic, non-Orthodox families of Christians, Lutheranism is represented in most areas of the world. But its particular geographical orientation has been in northern and western Europe and in younger countries settled by Germans and Scandinavians. It has been represented with less strength in Switzerland, the Lowlands and Scotland, where Reformed confessions predominated, and it has been a secondary influence in the British empire and the Commonwealth of Nations, where the Anglican communion has prevailed. Because of early and persistent efforts of continental missionary societies and later separate Lutheran denominations, Lutheranism has been significantly represented in the mission fields and in the formation of what were formerly called the younger churches.

HISTORY

Origins.—Lutheranism considers itself to be "catholic" in its affirmations about its own universality and its continuity with Christian expression in every time and place; it considers itself to be "protestant" in that its root experience involved a rejection of much of Western (or Roman Catholic) dogma and piety. The movement which gave Lutheranism its birth as a separate entity within Christendom originated with the German Augustinian monk Martin Luther. Lutheranism cannot be defined or understood without some reference to the personal experience and the biblical studies of Luther, which came to voice in 1517 in his theses for debate over indulgences and in his attack on the theology and sacramental practice of the late medieval church of the west. In 1521 Luther was excommunicated; his followers accepted the designation "Lutheran" in part against his will and in spite of the fact that it was filled, in many instances, with implications of derision and sectarianism. The Lutheran movement spread from the University of Wittenberg through much of Germany and into Scandinavia.

Germany.—So much of the formative experience of Lutheranism occurred in Germany that it is profitable to trace developments there. Luther died in 1546; after his death the more rigid Lutherans declared it to be their duty to preserve the status of religion in Germany as it had been established by Luther and to watch over the Christian teaching as it had been committed to their charge. Luther, however, had been greater as a preacher than as a systematic thinker; this made it difficult to determine what the measure of Lutheran thinking was, and controversies resulted among the Lutheran theologians of the 16th century.

1. The Antinomian controversy (*see* ANTINOMIANISM), the earliest (1537–60), arose from differences about the precise meaning of the word law in Luther's distinction between law and gospel. Luther had limited the meaning of the word to imply a definite command accompanied by threats, which counts on terror to produce obedience. He declared that the Christian was not under the dominion of the law in this sense of the word, and that believers enter the Christian life only when they transcend a rule of life which counts on selfish motives for obedience. But law may also mean ethical rule, and the Antinomians so understood it and interpreted Luther's declaration to mean that believers are not under the dominion of the moral law.

2. The Arminian controversy in the Reformed Church and the Jansenist controversy in the Roman Catholic Church (*see* ARMINIANISM; JANSENISM) had their parallels in disputes among the Lutherans lasting from 1550 to 1580. In the end it was generally agreed that sin had not totally destroyed man's ethical nature, and that grace changed what was morally insensitive into what was morally sensitive, so that there could be a co-operation between God's grace and man's will ("synergism").

3. The controversy raised by Andreas Osiander (*q.v.*) was more important. Osiander felt that Luther had omitted to answer adequately an important practical question, how Christ's death on the cross could be brought into such connection with every individual believer as to be the ground of man's justification. It was answered that the principal effect of Christ's work on the cross was to change the attitude of God toward the whole human race, and that, in consequence, when men come into being and have faith, they can take advantage of the change of attitude effected by the past historical work of Christ. The Reformed Church, on the other hand, had its own distinctive doctrine of the atonement, with a strong emphasis on predestination.

4. The other controversies concerned mainly the doctrine of the sacrament of the Lord's Supper and Luther's view of the Real Presence, sometimes described as consubstantiation. This required a doctrine of ubiquity, or the omnipresence of the body of Christ extended in space, and therefore of its presence in the communion elements. Calvin had taught that the true way to regard substance was to think of its power (*vis*), and that the presence of a substance was the immediate application of its power. The presence of the body of Christ in the sacramental elements did not need a presence extended in space. Philipp Melanchthon and many other Lutherans, leaning toward the theory of Calvin, claimed that Luther had approved of it before his death. Thereupon the more rigid Lutherans accused their brethren of crypto-Calvinism and began controversies which dealt with that charge and with a defense of the idea of ubiquity. The University of Jena was the headquarters of the stricter Lutherans, led by Matthias Flacius Illyricus; Wittenberg and Leipzig were the centres of the Philippists or followers of Melanchthon (*see* also FLACIUS ILLYRICUS, MATTHIAS; MELANCHTHON, PHILIPP). Conferences were called, but they served only to increase the differences. The Lutheran Church seemed in danger of falling to pieces. In the end, however, due mainly to the efforts of Augustus, elector of Saxony, the greater proportion adopted the Book of Concord (1580). The churches within Germany that refused the Book of Concord became for the most part Calvinistic or Reformed; as was the fashion among the Reformed churches, they published separate creeds, but almost all accepted the Heidelberg Catechism (*q.v.*).

The divided state of German Protestantism that resulted from these theological differences contributed in no small degree to the disasters of the Thirty Years' War, and various attempts were made to unite the two confessions. Conferences were held at Leipzig (1631), Thorn (1645) and Kassel (1661), but without success. At length the union of the two churches was effected by the force of the civil authorities—in Prussia (1817), in Nassau (1817), in Hesse (1823), in Anhalt-Dessau (1827) and elsewhere. These unions for the most part aimed not at incorporating the two churches in doctrine and in worship but at bringing churches or congregations professing different confessions under one government and discipline. Each congregation was permitted to use at pleasure the Augsburg Confession or the Heidelberg Catechism.

In Prussia the enforced union was combined with the publication of a new liturgy intended for use in all churches, and this led to secessions from the state church. The seceders were at first treated with great harshness, but through the years won their way to toleration; they were eventually permitted to form the Lutheran Free or Old Lutheran churches of Germany.

After World War I a strong effort was made to separate church and state in Germany. The churches were guaranteed diminishing state support, with the ultimate purpose of divorcing them entirely from the state, or *Länder*, governments. The acute economic depression of 1922–24 affected most disastrously those elements of the laity from which the greatest measure of church support was

to be expected, and it subjected the clergy to severe privations. When Nazi rule imposed its discipline on the German Lutheran churches it was met with acquiescence and even support by some who made up the so-called German Christian movement, actually sponsored by the Nazi government. But leading Lutherans also took a prominent part in the Confessing Church movement, which resisted Nazi efforts to use Christianity for its own ends (*see* GERMAN CONFESSING CHURCH). After the defeat of Germany in 1945 the Protestant churches were particularly affected by the partition of Germany. The area controlled by the U.S.S.R. was the most strongly Protestant part of the country, and of the 11,000,000 and more refugees from the east in the Federal Republic of Germany a decade after World War II the great bulk was Protestant, for the most part Lutheran.

Outside Germany.—From the first days of the Reformation Lutheranism spread quickly from Germany to other countries, but its course of development elsewhere was different. The most significant converts to Lutheranism were the people of the Scandinavian countries. Change began to occur there in a time of rising nationalism under Christian III (*q.v.*), who established in Denmark codes limiting corrupt practices in the church and ecclesiastical ownership of property, and permitting the clergy to marry. But as political situations changed, so did the fortunes of Lutheranism, and its successes were not fully apparent until a generation of the influence of Lutheran scholars, particularly from Wittenberg, had been felt. Under Gustavus I (*q.v.*) Vasa, modern Sweden and Lutheran Sweden developed; later Roman Catholic kings could not bring about a reversion to Roman Catholicism. Iceland and Norway followed, though at first the imposition of Reformed Christianity was not popular. Under the influence of Michael Agricola, Finland also chose Lutheranism.

In these northern countries the Lutheran Church was established by law, and to this day the vast majority of the population is at least nominally Lutheran. These national churches have retained the traditional episcopal system of government from the medieval church, but only Sweden has kept unbroken the succession of episcopal consecration. Particularly in the 20th century the Scandinavian churches have been theological leaders in world Lutheranism.

Lutheranism had early spread also to eastern Europe, though it never became dominant there. Hungary was attracted in part because of German cultural influence in the 16th century. Several Czechoslovakian religious parties were affected by Lutheranism. The greatest extent of Lutheran influence in eastern Europe, however, could be seen in the Baltic states, where independent Lutheran churches were formed when political independence came after World War I. But the organization of the churches in Latvia, Estonia and Lithuania was disrupted by successive German and Soviet occupations during and after World War II, after which many of their members became refugees from Communist rule and established Baltic churches "in exile." While Estonian, Lithuanian and Latvian churches are the only Lutheran churches recognized in the U.S.S.R., numbers of Lutherans were permitted to organize officially in Russia in 1924; however, Communist suppression greatly reduced their numbers. Czechoslovakian and Hungarian churches are members of the Lutheran World federation. Some Lutherans are found in almost every nation, and significant numbers appear in the parts of the world—*e.g.*, Brazil, India and Indonesia—where European and American mission work has been vigorous.

United States.—Lutherans were among the earliest American colonists who settled in New Netherland and New Sweden (on the Delaware river), and they were followed by German colonists who settled especially in the present Middle Atlantic states, the Shenandoah valley, Georgia and Nova Scotia. Because of some geographical and much linguistic isolation and because the majority of American Protestantism was at first of Reformed background, Lutheranism did not play a major role in helping shape the early political and religious complex of the nation. Because of its minority status and its relative strength in the middle colonies, its tendency in America, contrary to its generally Erastian relationships in Europe, was to favour separation of church and state against the establishments of the late colonial and early national periods.

The geographical spread of Lutheranism was extended by migrations to the western frontier and by the large immigrations during the 19th and early 20th centuries of Germans, Norwegians, Swedes, Danes and Finns. Many of these immigrants settled in the middle west, and from there later pushed on to the far west. Consequently Lutherans came to be distributed among all the states of the United States and the provinces of Canada. Their strongest concentrations are in the New York-Pennsylvania-Maryland-Virginia arc and in the upper midwest.

Since immigrants brought with them from Europe a variety of languages and customs, they organized in congregations and later synods according to their national origins; originally the names of synods tended to reflect their members' European provenance. It was the prolongation of linguistic and ethnic barriers that prevented Lutheran union until well into the 20th century, when the barriers broke down and advance into intra-Lutheran ecumenical relations became rapid. Traditionally, Lutheran growth from insignificance in the colonial period to third place in American Protestantism was accounted for in terms of immigration and propagation. However, as geographical and linguistic isolation disintegrated, most Lutheran bodies undertook expansive and energetic missionary activities which help to account for a rapid growth rate. In the American environment all Lutherans in time adopted the English language—more quickly in the east than in the west, where the effects of immigration were felt longer—and this was accompanied not only by the discarding of national references in synodical ties but also by closer association on the part of once-separated people and by an inclination of some Lutheran expression to be hyper-American.

During the period of rapid Lutheran growth in America in the mid-19th century, when immigration from central Europe increased, the efforts of such men as Samuel Simon Schmucker of Gettysburg seminary to write Lutheranism into the common fabric of American evangelicalism were countered by a vigorous and conservative confessionalism, typified by Charles Philip Krauth in the east and Carl Ferdinand Wilhelm Walther in the midwest. The resurgence of confessionalism and the variety of national origins inhibited the attempt to "Americanize" and unite Lutheranism. However, even in this period efforts were made toward reunion. These took, unfortunately, four different forms: (1) the General Synod of 1820, weakened now by the advance of confessionalism; (2) the United Synod in the South, a product of the Civil War; (3) the General Council (1867), itself conservative in its protest; and (4) the intransigent Synodical Conference (1872) led by the Missouri Synod.

The most significant turn toward union of Lutheran bodies came in the formation in 1918 of the United Lutheran Church in America out of dozens of once-autonomous synods; this marked a trend that still continues. Co-operative efforts were carried on not only along lines of merger but also by councils and federations, among them the National Lutheran council and the American expressions of the Lutheran World federation. All the larger bodies except the Missouri Synod have united in these, and Missouri, which undertook some co-operative activities with them, has grown closer to the councils and federations. The most significant trend in American Lutheranism after 1918, for better or for worse, was its tendency to let itself be seen as a typical or mainstream American denomination instead of as a stream parallel to Methodism, Episcopalianism, etc.

There are about 8,000,000 baptized Lutherans in the United States. As new mergers are effected, American Lutheranism is taking on more and more a tripartite jurisdictional arrangement, with three approximately equal-sized groups: (1) American Lutheran Church, formed in 1961 by amalgamation of American Lutheran Church, Evangelical Lutheran Church, United Evangelical Lutheran Church and Lutheran Free Church; (2) Lutheran Church in America, formed in 1962 and made up largely of United Lutheran Church in America, Augustana Evangelical Lutheran Church, Finnish Evangelical Lutheran Church (Suomi Synod), and American Evangelical Lutheran Church; and (3) Evangelical

Lutheran Synodical Conference of North America (Synodical Conference), formed in 1872 and including the Lutheran Church—Missouri Synod and the Synod of Evangelical Lutheran Churches; formerly the Wisconsin Evangelical Lutheran Synod and the Evangelical Lutheran Synod were included in the Synodical Conference but later became independent.

Five or six small independent groups with a total membership of fewer than 50,000 adults complete the Lutheran picture in the United States.

International.—Internationally, Lutherans became most aware of each other after World War II, when physical and spiritual needs were most dramatic. No other Protestant family of churches had been in geographical situations where so much suffering occurred. Among the most fortunate in avoiding the sufferings of war were the Americans, who were able to share their resources with displaced and exiled refugee Lutherans and with Christians rebuilding in western Europe. The main organ of this relief activity was the Lutheran World federation; among nonmembers of the federation, the Lutheran Church—Missouri Synod played a predominant role. All these bodies worked to establish new churches where none had existed or to strengthen existing churches, along with relief work. It was this form of activity, for example, that led to the formation of the Lutheran Church in Britain, where Lutherans had been largely unrepresented. Lutherans also have made major contributions to the World Council of Churches.

POLITY, WORSHIP AND DOCTRINE

Polity.—The church of the Augsburg Confession does not define itself in the language of polity or church government. Its unwillingness to do so has complicated ecumenical discussion with those churches that do. Concerned for good order in the church, it has not historically tied itself to a theological insistence on one specific form of order. It sees various forms of polity to be of the *bene esse*, but ordinarily none of them to be of the *esse* of the church. Minimally, Lutheran order consistently strives on the one hand against anarchy in church government; this is consistent with the denomination's general respect for authority in response to Pauline teaching in Rom. xiii. On the other hand, its order seeks to resist the authoritarianism which historic Lutheranism saw in Roman Catholicism.

The churches of Scandinavia, where the transition to Lutheranism was most easily effected, have kept the episcopal form of government, but only in Sweden has there been a stress on the continuity of orders from apostolic times in unbroken succession. The German churches for the most part have functioning bishops without insistence that their office belongs to the *esse* of the church. In American Lutheran polity, bodies are organized co-operatively into synods, but individual congregations retain a great measure of local autonomy.

The Lutheran churches, though they attacked the clericalism of the medieval church, refused to see ordination as a sacrament and insist on the priesthood of all believers, have always tended to regard the ministry of the Word and sacrament in high and special terms. No one was to engage in public ministry or to administer the sacraments (*nisi rite vocatus*) unless he was properly called (though propriety was not defined in detail). The tendency to elevate the ministry is due in large part to the Reformation's insistence that the preacher be a scholar, adept at exegesis and exposition of the sacred Scriptures. Thus while in theory an educated layman may possess all the charismatic powers a clergyman does, good order usually militates against thinking of him as technically equipped for the public ministry.

The prime ecclesiastical unit of American Lutherans (as for most of world Lutheranism) is the local congregation, the product of the original settlements or of aggressive home missionary activity. In the United States, because of the original rural dominance, Lutheran congregations on the average number fewer than 500 baptized and 300 confirmed members, usually organized under the pastoral care of one "called" minister and administered on conciliar and democratic lines. The congregation is seen to be a microcosm of the whole church, possessing all rights and privileges of the whole Christian church (including, for example, the right to call their pastors and confirm their members); surrender of any of these rights for the sake of good order to ecclesiastical jurisdiction beyond the local level is voluntary. However, the complexity of a specialized and technical society has led American Lutherans more and more to organization and away from strong emphasis on congregationalism in most ecclesiastical functions. Local congregations usually preserve biblical terminology in relation to public office (pastor, elder, deacon, etc.); on the national level the language of democratic institutions (president, executive secretary, etc., instead of bishop, canon, etc.) predominates.

For church organization in countries where Lutheranism is the established church, *see* DENMARK; FINLAND; ICELAND; NORWAY; SWEDEN.

Missionary Activity.—While the early movement of Lutheranism was largely through the official conversion of states and nations from Roman Catholicism, later Lutheranism compensated for the general lack of missionary interest in the 16th and 17th centuries. During the half-century when the modern missionary movement was getting underway a number of Scandinavian and German missionary societies were initiated, usually at the behest of groups within the churches and not by the official bodies. This period of missionary societies' prevalence lasted from the 1790s into the middle half of the 19th century. In later years the official churches of Germany and the denominational boards in the United States churches took over much of the initiative from the voluntary societies, and Lutherans are represented in most of the Christian mission fields. They have worked with particular effectiveness in India, Indonesia (Sumatra) and in Tanganyika and other African regions.

Education.—Lutheranism was born in scholastic disputes, and since it emphasizes faith, the knowledge that accompanies faith, and the study of the Holy Scripture it has historically shown interest in the educational enterprise of the church. Martin Luther was instrumental in bringing about reforms in the education of German children; his Small Catechism illustrates his pedagogical interest. At many of the state-supported universities of Germany and the Scandinavian countries the theological faculties have been Lutheran.

In the western hemisphere much of the church's concern for education has continued. Some Lutheran groups, notably the Lutheran Church—Missouri Synod, have established parochial schools on the elementary and secondary level. In general the colleges that were founded under Lutheran auspices have remained under church control. Each branch of American Lutheranism has a number of theological seminaries, which insist on high intellectual standards for the ministry. In these educational ventures Lutheranism professes its first concern to be the development of students of the sacred Scriptures.

Deaconess Movement.—The modern employment of women for Christian service in the form of a diaconate received its major impetus from continental Lutheran sources. Theodor Fliedner (*q.v.*), beginning at Kaiserswerth, Ger., about 1833, encouraged young women to participate in orders devoted to acts of Christian mercy. In 1836 he established a "mother house" at Kaiserswerth that became the model for many successors. The deaconesses were consecrated for their activity, but took no vows as members of Roman Catholic orders do. Through the activity of Konrad Wilhelm Loehe at Neuendettelsau (1849) the work of deaconesses came to be known in America; in the middle of the 19th century chapter houses began to appear in the United States, and deaconess work continues to this day. Characteristically, deaconesses are involved in eleemosynary activity at hospitals, institutions or in parishes.

Publishing.—Lutheranism, because of its devotion to the interpretation of Scripture and its concern for doctrine, propagated itself from the first in no small measure through the printed page. Luther and his associates immediately seized on the new invention of printing to publicize their doctrines and wage verbal warfare against their enemies. Both continental and American branches of the church body have established publishing houses to supply Bibles, hymn and prayer books, doctrinal studies and, more re-

cently, practical aids to church life. Among the larger commercial ventures in the United States are Fortress (formerly Muhlenberg) Press, Augsburg Publishing House and Concordia Publishing House.

Worship.—Lutheran worship to the present time, despite local and temporal cultural accommodation, derives largely from principles enunciated by Martin Luther. His *Deutsche Messe* of 1526 was a common service which returned vernacular worship and enlarged congregational participation; his more formal and conservative *Formula missae et communionis* retained more of the medieval liturgy but was equally careful to purge what were seen to be unevangelical developments. Thus, unlike the radical Reformers, Lutheran participants did not conceive of themselves returning to New Testament primitivism but allowed for traditional and historical development. Luther's services were, with some marked exceptions, carry-overs from the medieval offices.

Luther himself described worship in dialogic terms, as a conversation between man and his Maker, and Lutheran architecture and liturgy seek to preserve this conception. Luther saw Word and sacrament as two poles of an ellipse, refusing to grant priority to one or another because he saw in them a perfect relation. His successors, when under Reformed influence, have emphasized the pulpit and the read or preached Word at the expense of baptism and the Lord's Supper. Others, of "high" church tendencies or under Roman or Anglican influence, in subsequent centuries have championed the sacraments, sometimes at the expense of the written and spoken Word. The eucharistic recovery and renascence characteristic of all Christian churches in the 20th century has also been marked in Lutheranism, where emphasis on the sacraments has restored Luther's concrete conception of the work of the Holy Spirit with no accompanying loss of interest in preaching and expounding the Scriptures.

The chief changes effected by Luther and Lutherans as they assumed the order of the Mass are these: the service was in the vernacular; the sermon was no longer an optional but an organic element in the service; the sacrificial prayers of the canon of the Mass were removed; the singing of hymns became prominent. This last element came to characterize the Reformation movement, flowered in the form of the Lutheran chorale and reached its climax in the musical tradition typified in the work of J. S. Bach.

Lutheran services are ordinarily formal but relatively simple. Lutheran architecture varies according to time and place, but pulpit and altar are always given prominent places. While Lutheranism does not insist on uniformity in worship, a degree of uniformity has developed because of the inner logic of the service as it is connected with Lutheran theology and because of the widespread acceptance of common hymnals and books of order. (*See* also LITURGY: *Protestant Liturgies.*)

Doctrine.—The Lutheran Church is characterized primarily by its doctrinal rigour and by its organization around loyalty to a central Christian teaching classically expressed as the doctrine of justification by faith (*justificatio sola fide*). As no aspect of Luther's theology can be understood without reference to the witness to God's forgiving activity in Jesus Christ, so the core of Lutheran theology, "the article upon which the church stands or falls," is justification, as expounded decisively in article iv of the Augsburg Confession:

> We cannot obtain forgiveness of sin and righteousness before God by our own merits, works, or satisfactions; but we receive forgiveness of sin and become righteous before God by grace, for Christ's sake, through faith, when we believe that Christ suffered for us and that for his sake our sin is forgiven and righteousness and eternal life are given to us.

At the base of this belief is a serious view of man's distance from God as the result of his sin, which removes him as a total being from God's favour. He cannot please God or become righteous by his own achievements. Thus man's salvation, which is a loving God's central concern, depends entirely upon God's initiative in his reconciling activity in Jesus Christ.

Lutheran teaching was ranged against Roman Catholic ideas of man's righteousness as based at least in part on his own efforts or merits. According to Lutheran doctrine, man cannot even prepare himself to receive grace. All initiative remains with God, so that he shall receive all honour and man shall have greater certitude. Man becomes part of this divine and sovereign saving activity by faith. While response in faith is the key to Christian living in Lutheran eyes, Lutheran theologians have always been careful to insist at this point also on the exclusiveness of divine grace in the operation of reconciliation. Faith is instilled, says article v of the Augsburg Confession, by the Holy Spirit when and where it pleases God, in the hearts of those who hear the gospel. The accent in such a view of faith's response is on *fiducia* or confidence, in distinction to the Roman stress on assent. The justified man, in Lutheran teaching, after the imputation of righteousness, remains a sinner (*simul justus et peccator*). The emphasis on divine initiative also separates Lutheran teaching from those Reformed confessions which retain elements of synergism, and in particular is distinct from Arminianism, with its great interest in man's striving and his co-operation. Thus within Protestantism, Lutheran theology is somewhat set apart by a relative understress on sanctification. This avoidance of preaching on man's co-operative part has led to certain elements of quietism and ethical disinterest in Lutheran orthodoxy, which has been countered repeatedly through Lutheran history by pietist movements (*see* PIETISM).

There are also resources within classic Lutheranism to prevent it from lapsing into ethical apathy and unconcern or into Antinomianism. A radical distinction between law and gospel lies at the heart of this resource. For Luther the mark of the theologian was his successful discrimination within the Word of God between law and gospel. The law always accuses, serving less as a guide than as an agent to drive man into the waiting arms of a forgiving God and Father. The gospel brings the good news of salvation and is the proper work of God (*opus proprium* as opposed to *opus alienum*, a distinction taken over from Is. xxviii, 21).

The rest of Lutheran teaching is largely a corollary or an outgrowth of its central teaching of justification. This teaching has brought Christology or soteriology to focus in all Lutheran theological discussion, a focus evident in the piety and preaching of Lutherans for four and one-half centuries. The ethical stress of the confession then becomes the belief that man can be a Christ to his neighbour, that faith becomes active in love. A righteousness based on the law, or good works based on legalistic motives are completely ruled out. Again, Lutherans have tended to lay greater stress on the doctrines of the atonement than on creation and incarnation, because it is in the atonement that God's initiative in human history is largely concentrated.

It is in the light of its Christology that Lutheran emphasis on the Real Presence of Christ in the Eucharist (article x of the Augsburg Confession) is seen. It would guard against overmaterializing the Presence as it believes Roman Catholic views of transubstantiation (*q.v.*) do, and equally against overspiritualizing, as in the case of Reformed teaching. Christ is present in a bodily way with the bread and wine of the Lord's Supper through a sacramental union. Yet the elements remain bread and wine and the communicant receives both. The body and blood are present "in, with and under" these elements. Lutheran theology agrees with the Catholic tradition that Christ is present in both his divine and human natures. This led to disputes with the Reformed, who argued against such a view with its implication that both Christ's divine and human natures are omnipresent. Insistence on the "hypostatic union" and thus on the Catholic witness to the fullness of the Person of Christ was behind Lutheran intransigence in its meetings with Reformed theologians in the unity efforts of the 16th century and remains as the hidden interest behind all sacramental discussion to this day.

The formal principle of Lutheran theology is its insistence that the canonical Scriptures are the only source and norm of Christian faith and practice. Most Lutherans hold to a very elevated view of scriptural authority; they see the Scriptures from within the church, finding the evangelical accent of their confessions to be the key to understanding the Bible, and the doctrine of justification by faith in its residence in Christology to be the note around which all scriptural witness is gathered.

Distinctiveness.—Since the Lutheran confessions try to stand in the ancient and catholic tradition it is difficult to find absolute distinctions between Lutheranism and its Christian alternatives. But relative distinctions there are. It is doctrinally more rigorous than most; its worship is serious, but it represents a *via media;* its political interest has been a fairly consistent witness to God's authority in setting up human authorities. For the most part Lutherans have taken an active part in the ecumenical movement, trying to find ways to accept other Christians as brothers in Christ without diluting Lutheran strength in the matters of God's initiative and man's response through faith in Jesus Christ.

See also references under "Lutheranism" in the Index.

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(MA. E. M.)

LUTHULI, ALBERT JOHN (1898–), South African tribal chief who was awarded the Nobel peace prize for 1960, was born in Southern Rhodesia, the son of an African Christian missionary of Zulu stock, to whose family home at Groutville, Natal, he was taken while still a boy. After completing his education at Adams college, near Durban, he taught there for 15 years till 1935, when he was elected tribal chief of Groutville. He then did much to improve the economic position of African sugar farmers in Groutville and elsewhere. Just before World War II he was a delegate to an international missionary conference at Madras, India, and in 1948 he went to the United States to lecture about Christian missions in South Africa. Long interested in the political advancement of Africans, he finally joined the African National congress (A.N.C.) at the end of World War II. An advocate of nonviolent resistance to the South African government's policy of apartheid, he helped to organize a campaign of civil disobedience in 1952. For refusing to resign from the A.N.C., of which he was elected president (also in 1952), he was deprived of his chieftainship by the Native Affairs department. Arrested on a charge of high treason in 1956 but later released, he was in 1959 forbidden for five years to leave his home district; in 1960 the South African government banned the A.N.C. In announcing the award of the Nobel peace prize to Luthuli the prize committee cited his long fight against racial discrimination by nonviolent means. The South African government denounced the award but nevertheless granted Luthuli and his wife permission to travel to Oslo, Norway, to accept the prize in Dec. 1961. The following year Luthuli published his autobiography, *Let My People Go.*

LUTON, an industrial and market town, parliamentary and county borough (1876) of Bedfordshire, Eng., is 31 mi. N. of London by road. Pop. (1961) 131,505. The town lies on the source of the river Lea and has spread north and east over the surrounding Chiltern hills. George street, the main shopping centre, has the town hall (1936) at one end, and Park square, where there is a large technical college (1959), at the other. The principal parks are Stockwood (244 ac.) and Wardown (50 ac.), which adjoins a large open-air swimming pool. The parish church of St. Mary is mainly 15th century; special features are the unique canopied baptistery, and the Wenlock chapel, which contains the helmet and gloves worn by Sir John Wenlock at the battle of Tewkesbury (1471). Long famous for the manufacture of straw hats, particularly "boaters," Luton is now principally a light engineering town with two large motor vehicle works, one of which employs more than 25,000 people. Other manufactures include aircraft, ball bearings, precision instruments, refrigerators, vacuum cleaners and other electrical goods. The hat trade still prospers, though felt hats are now principally made. The modern municipal airport has charter and freight services.

The district was populated in prehistoric times and many discoveries have been made of settlements from the Old Stone Age to the Iron Age. A large collection of artifacts is on view at the museum in Wardown park, which also specializes in the history of the straw plait and hat industry.

King John granted Luton to the notorious Falkes de Bréauté (*see* BRÉAUTÉ, FALKES DE), who established a castle there. Later lords of the manor lived at Luton Hoo, 2 mi. S.E., present site of the priceless Wernher collection of porcelains, enamels and other art treasures.

(F. M. GA.)

LUTSK, a town and administrative centre of Volyn *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., is 136 km. (85 mi.) N.E. of Lvov and stands on the Styr river, where it emerges from the Volyno-Podolsk upland into the Polesye lowland. Pop. (1959) 56,282. Lutsk is one of the oldest towns of Russia. First mentioned in documentary evidence in 1085, it is believed to have been founded in the 10th century. It was successively dominated by Lithuanians (1336), Poles (1569), Russians (1791) and from 1920 to 1939 it was again included in Poland and known as Luck. The town was occupied by Russian troops in 1939 and by the Germans in 1941; in 1945 it became part of the U.S.S.R. Lutsk is the centre of an agricultural region and manufactures farm machinery and clothing, and processes foodstuffs, timber and leather. There is a pedagogic institute. (R. A. F.)

LUTTRELL, HENRY (*c.* 1765–1851), English wit and writer of light social satire. The illegitimate son of Henry Lawes Luttrell, 2nd earl of Carhampton, he entered society under the patronage of the duchess of Devonshire and became famous for the brilliance of his conversation, being described by Byron as "the most epigrammatic conversationalist I ever met," and by Lady Blessington as the one talker "who always makes me think." His *Letters to Julia in Rhyme* (1823; expanded from *Advice to Julia,* 1820), in neat couplets, contain lively descriptions of a thunderstorm in Hyde park, evenings at Almack's and the opera and excursions to Richmond and Hampton Court, but with an undertone of criticism—

> Folks rise and flourish and are undone
> Nowhere so quickly as in London.

He also published *Crockford House* (1827), a satire on the fashion for high play. He died in London, Dec. 19, 1851.

LÜTZEN, BATTLE OF, a battle of the Thirty Years' War (*q.v.*), fought outside Lützen in Saxony on Nov. 16 (new style; 6, old style), 1632. After his inconclusive battles against the Swedes under Gustavus II Adolphus around Nürnberg in September, Wallenstein, the Holy Roman emperor Ferdinand II's general, moved northward to take up winter quarters in Upper and Lower Saxony. He also planned to exert pressure on the elector John George I of Saxony and to protect Poland against the Swedish contingent stationed in Prussia. On the news of the dispatch by Wallenstein of Gallas and Pappenheim on separate missions, Gustavus, wishing to help his North German allies, to beat Wallenstein and to keep watch on the events in Poland, abandoned his plan to attack Bavaria. He marched rapidly through Thuringia and, reinforced by Bernhard of Saxe-Weimar and other detachments, offered Wallenstein battle between Naumburg and Leipzig. The Swedes numbered about 14,000, the imperial forces (without Pappenheim) about 12,000 men.

Gustavus' hope for an early decision was dashed by a thick fog that delayed the Swedish attack until nearly 11 A.M., by which time Pappenheim, hastily summoned back by Wallenstein, had arrived with his cavalry. Pappenheim's tempestuous charge was beaten off, and he was mortally wounded. But Wallenstein's centre, led by Ottavio Piccolomini, was victorious, and Gustavus was killed while trying to rally his men. The Swedes were on the point of giving way when Bernhard assumed command and retrieved the situation all along the line, capturing the whole artillery of the imperial forces. The arrival of Pappenheim's infantry permitted Wallenstein to disengage himself in good order.

(S. H. S.)

LÜTZOW, ADOLF, FREIHERR VON (1782–1834), Prussian cavalry officer, best known as an organizer of guerrilla-type forces during the Napoleonic Wars, was born in Berlin on May 18, 1782, and entered the Prussian army in 1795. He took part in Ferdinand von Schill's abortive rising against the French in

Germany in 1809. In Feb. 1813, at the outbreak of the War of Liberation, he obtained permission from Gerhard von Scharnhorst (the chief of staff) to raise a "free corps" or a guerrilla force of non-Prussian volunteers to operate in the rear of the French army. His troops, who eventually numbered 3,000 and were named the "black band" after their uniform, met with a disaster at Kitzen (near Leipzig) on June 17 because poor communications had prevented their being notified of the armistice of June 4: caught on the wrong side of the demarcation line, they were practically annihilated. Lützow however reorganized the force, which then fought at Gadebusch, at Göhrde (where he was wounded) and at the siege of Jülich. The black band was of little military value but owed its reputation to the enlistment of public figures such as the poets Joseph von Eichendorff and Theodor Körner.

At Ligny (June 16, 1815) Lützow led the 6th Uhlans in an abortive charge which ended in their being routed by French cavalry. Lützow was captured, but escaped at Waterloo (June 18). Some years afterward, this incident led to his sending a challenge to Blücher, who had made some disparaging remarks about the conduct of the 6th Uhlans at Ligny. Lützow died in Berlin on Dec. 6, 1834.

See K. von Lützow, *Adolf Lützow's Freikorps* (1884). (C. N. B.)

LUWIANS, an extinct people of ancient Asia Minor, also known as Luites. Their language, Luwian (Luvian, Luish), is known from cuneiform texts of the 14th and 13th centuries B.C. found at Boğazköy, the capital of the Hittites (*q.v.*), where it is referred to by the adverb *luwili* (*lu-u-i-li*), "in Luwian." This language is related to, but distinct from, Hittite; with Hittite and Palaic it belongs to the Anatolian group of Indo-European languages (*see* ANATOLIAN LANGUAGES). The language written with the so-called Hittite hieroglyphs, which were used for inscriptions from the 14th to the 7th century B.C., is very close to Luwian, probably nothing but a dialect of it; and the Lycian language, written in a variety of the Greek alphabet in the 5th and 4th centuries B.C., is equally related and may go back to still another dialect of Luwian. Personal names that have been claimed as Luwian are attested in Asia Minor from the 19th century B.C. to the Roman period.

Language.—Luwian shares with Hittite and Palaic the following characteristics: (1) it has only two genders, masculine-feminine (*genus commune*) and neuter; (2) the verb has a present and a preterit tense in the indicative mood and an imperative but no other moods; and (3) it has an active and a middle form. The main differences between Luwian and Hittite are: (1) replacement of the genitive by a possessive adjective in *-assi-;* (2) a case in *-ti* serving as ablative and instrumental; (3) plural of the *genus commune* in *-nt;* nominative in *-nzi,* accusative in *-nza* (in cuneiform Luwian only, not in hieroglyphic). (4) The verb has 1st singular present in *-wi* (against Hittite *-mi*), 3rd singular in *-ti,* plural in *-nti* (against Hittite *-zi, -nzi*), preterit *-ta, -nta* (against Hittite *-t,* plural *-er*). (5) In the vocabulary, Luwian has a set of connective particles different from the Hittite. Some words are identical with or very close to their Hittite counterparts (often replacing Hittite *e/i* by *a*); others are different, such as *tati,* "father," against *atta;* and *massana,* "god," against *siuni,* etc.

Distribution and History.—The Hittite laws, datable to about 1500 B.C., mention Luwia as a foreign country. One copy of the laws replaces "Luwia" by "Arzawa." The term Luwia is not used thereafter, whereas Arzawa (Arzava) is frequent as the name of a large region comprising several principalities, probably in southwestern Asia Minor. If the variant means that "Luwia" and "Arzawa" were roughly synonymous (the older term standing for or at least including Arzawa), then Luwians would have lived in the southwest. The language is, however, also attested in Kizzuwatna, a country including the Cilician plain in the south, so that the old term Luwia may include that region also. Both Arzawa and Kizzuwatna were independent kingdoms during the Old Hittite period (*c.* 1700–1370 B.C.) but later became vassals of the Hittite empire, Kizzuwatna under the ruler Suppiluliumas (*c.* 1370 B.C.) and Arzawa under his son, Mursilis II. Apparently Luwians both shared in and contributed to Hittite civilization. The Luwian texts found in the Hittite capital (mostly magic spells) as well as the use of hieroglyphs throughout the empire and the appearance of Luwian loanwords in Hittite texts testify to the penetration of the Hittite empire by Luwians, a process that increased toward the end of the empire, in the 13th century.

Since Luwians lived in southwestern and southern Anatolia, attempts have been made to ascribe to them certain types of pottery found in those regions, but these attributions remain hypothetical. Similarly, place names formed with the suffixes *-nd-* and *-ss-*, which are found in parts of Asia Minor and in Greece, have been claimed as Luwian. Closer examination of the place names occurring in Hittite texts has shown, however, that many of them are not Luwian and that they also occur outside the Luwian area. Personal names of Luwian type first occur in limited numbers toward the end of the Assyrian merchant colony period (*c.* 1800 B.C.). They were common in the Hittite period and survived until Roman times.

After the downfall of the Hittite empire (*c.* 1190 B.C.) hieroglyphic inscriptions in Luwian are common in southeastern Anatolia and northern Syria. Their appearance in Syria indicates an expansion of Luwians into regions not previously held by them. The history of the Luwians in the 1st millennium B.C. thus is the history of the so-called Late Hittite principalities—Tabal (biblical Tubal) around Kayseri, Tuwanuwa (classical Tyana), Gurgum with capital Marqasi (Maraş), Milit (Melitene, Malatya), Carchemish on the Euphrates, Hattina (the plain of Antioch) and Amatu (Hamath). The hieroglyphic inscriptions are of votive character, containing little more than the names of rulers, sometimes with genealogies. Most historical information about these states comes from the annals of Assyrian kings, who repeatedly raided them and imposed tributes, until Sargon II (722–705 B.C.) incorporated them as provinces into his empire. Most Syrian states were conquered by Aramaeans prior to the Assyrian conquest; but in the Anatolian principalities (Tabal, Tuwanuwa, Milit) and above all in Carchemish, the most important kingdom of the group, Luwian proper names and hieroglyphic script remained in use until the end. From roughly 700 B.C. also is dated the bilingual inscription in Phoenician and hieroglyphic Luwian discovered at Karatepe in eastern Cilicia. What little is known about Lycia (*q.v.*), finally, comes from classical sources.

Religion and Civilization.—Luwian gods were incorporated into the pantheon of the Hittites. On the whole, the beliefs of the two peoples were very similar so that their gods could easily be identified with one another. The chief god in both systems was a god of thunderstorm and rain, called Tarhunt in Luwian. The Luwian sun god was called Tiwat; the moon god had the same name, Arma, in both languages. Other gods worshiped in Luwian belong to different ethnic groups; *e.g.,* Kupapa, the main goddess of Carchemish. A Luwian dialect was used in the cult of the gods of the town of Istanuwa (location unknown). The presence of Luwian magical rituals in the Hittite capital indicates that Luwians had a certain reputation as magicians. In the late hieroglyphic inscriptions some of the gods known from earlier cuneiform texts recur. In these inscriptions the gods are asked to punish anyone who might damage the object or the text.

As stated earlier, the Luwians partook in the general Hittite civilization. Whatever institutions or cultural traits may have been typically Luwian remains to be determined. The small Luwian states of the 1st millennium carried on the Hittite tradition, as witnessed by the traditional Hittite names of some of their rulers, such as Lubarna, Sapalulme, Katuzili or Muwatalli, and by the name "Hittite" given them by both the Assyrians and the Israelites of the period of the monarchy. The art of these states combines Hittite motifs with others of more generally near-eastern origin; its style, which differs markedly from that of the Hittite empire, was influenced by that of the Aramaeans and, later, of the Assyrians, so that it is hard to identify specifically Luwian characteristics. On the whole it appears that the main importance of the Luwians lies in the continuation of Hittite tradition after the downfall of the empire.

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LUXEMBOURG, FRANÇOIS HENRI DE MONTMORENCY-BOUTTEVILLE, Duc de (1628–1695), French marshal, the great opponent of William III of Orange in the wars of Louis XIV's reign, was born in Paris on Jan. 8, 1628. He was the posthumous son of François de Montmorency, comte de Boutteville, who had been executed in June 1627 after killing his opponent in a duel. The dead man's father's cousin, Charlotte de Montmorency, princesse de Condé, brought the boy up; and her son, the Great Condé, remained devotedly attached to him and to his sister Isabelle, later duchesse de Châtillon. Boutteville was hunchbacked and physically weak at first, but Condé trained him for war and recommended him for a regiment after the battle of Lens (1648).

When the imprisonment of Condé in 1650 led to the second war of the Fronde (*q.v.*), Boutteville joined Turenne in rebellion and was captured in the battle of Rethel. In the third war of the Fronde he held Bellegarde on the Saône for Condé until June 1653, after which he joined Condé in the Spanish army. He returned to France after the peace of the Pyrenees (1659).

Boutteville came to be styled duc de Luxembourg through his marriage (1661) with Madeleine Charlotte de Clermont-Tonnerre, great-granddaughter of François de Luxembourg, who had been created a peer of France with the title of duc de Piney, in 1581. Assuming the name of Luxembourg, he secured recognition of his French peerage in 1662, thanks to Condé. This promotion provoked envy, and there was much opposition to his return to the French army, which Condé secured in 1668.

When war with Holland broke out in 1672 (*see* Dutch Wars), Luxembourg was at first sent to command German troops as field marshal of the bishop of Cologne, Maximilian Henry of Bavaria; then he was left for two winters in command at Utrecht against the forces of William of Orange. When Holland had to be evacuated, his skill in retreating from Utrecht in face of large forces was generally acknowledged, and in 1674 he fought at Seneffe. Thus when Turenne was killed he was one of the eight marshals appointed to succeed him (July 1675). The marquis de Louvois favoured him, though Louis XIV remembered his rebellion during the Fronde and also disapproved of his private morals. When in 1676 Luxembourg took Condé's place in the Rhine command, his military reputation fell, as Charles V of Lorraine captured Philippsburg from him. Little credit was given to his share in the Flanders campaign of 1677–78; and his defeat of William at St. Denis near Mons (Aug. 1678) brought him more criticism than honour, since his losses were heavy and the battle took place three days after the conclusion of peace.

When Luxembourg returned to Paris his name was being associated with the scandals that developed into the Affair of the Poisons. On Jan. 24, 1680, the king sent him to the Bastille on charges of sacrilege and the practice of "black arts"; and on his acquittal he was exiled from Paris and Versailles (May). Condé interceded, however, and in 1681 Luxembourg was recalled to court; but when war was resumed in 1688 (*see* Grand Alliance, War of the), he was not given a command.

The defeat of the marshal d'Humières (Louis de Crevant) at Walcourt in 1689 left the king with no alternative but to turn to Luxembourg. In April 1690 Luxembourg took command in Flanders; and on July 1 he crushed George Frederick of Waldeck's smaller army at Fleurus. In the next four years he fully matched William of Orange: he took Mons (April 1691), covered the successful siege of Namur (May–July 1692) and defeated William in the great battles of Steenkerke (Aug. 3, 1692) and Neerwinden (July 29, 1693). His battles, from which he sent so many captured flags to be hung in the cathedral in Paris that the prince de Conti (François Louis de Bourbon) called him the *tapissier de Notre Dame*, were marked by the tactical vigour he inherited from Condé; and if they decided nothing, this could be attributed to the king's system more justly than to the marshal's alleged apathy when he was not on the field of battle. After a last campaign in 1694 Luxembourg returned in high honour to Versailles, but died suddenly on Jan. 4, 1695.

See P. de Ségur, *La Jeunesse du maréchal de Luxembourg* (1900), *Le Maréchal de Luxembourg et le prince d'Orange* (1902) and *Les Dernières Années du maréchal de Luxembourg* (1904). (I. D. E.)

LUXEMBOURG (Grand-Duché de Luxembourg). A sovereign grand duchy of Europe, Luxembourg is bounded on the north and west by Belgium, on the east by Germany and on the south by France. It has an area of 2,586.4 sq.km. (999 sq.mi.), with maximum distances of 82 km. (51 mi.) from north to south and 57 km. (35 mi.) from east to west. The country comprises part of the southern Ardennes uplands and part of the adjoining plateau of Lorraine, both areas being drained eastward to the Moselle by the Sûre and its tributaries. The old name Lützelburg and the dialect name Letzeburg, still used, are variants derived from an early form, Lucilinburhuc ("little fortress").

Physical Geography.—The Ardennes region (or Oesling) in the north, forming one-third of the country, is a plateau consisting of Devonian slates, grits and quartzites varying in altitude from 1,300 to 1,600 ft., although a few summits rise above 1,800 ft. It is dissected by deep, winding valleys in which the streams are entrenched. The steep valley slopes are heavily wooded, but the upland surface is mostly cultivated and supports many villages. The rest of the country, consisting largely of Triassic marls and Lower Jurassic sandstone and clays, forms a lower plateau with a mean altitude of 900 ft.; it is called the Bon Pays or Gutland because of its superior agricultural conditions. In the southwest Lower Jurassic rocks containing ironstone extend from Lorraine into the grand duchy, providing the basis for an important iron and steel industry.

The climate of Luxembourg is transitional between the maritime type of northwestern Europe and the semicontinental type experienced farther into the interior. The Ardennes, however, has cool summers, relatively severe winters and a greater precipitation than the Bon Pays, although the highest rainfall (nearly 40 in. a year) occurs in the extreme southwest. The lowest rainfall (less than 27 in.) is found along the Moselle valley. Mean monthly temperatures for Luxembourg city range from 0° C. (32° F.) in January to 17° (63°) in July. Until the early 18th century Luxembourg was almost entirely covered with forest, mainly of oak and beech, and during the period of French rule (1795–1815) it was called the Département des Forêts. Much of the forest was later removed but oak in the Ardennes and beech in the Bon Pays remain the dominant woodland trees. With afforestation schemes for softwood timber, coniferous woods are increasing.

History.—At the time of the Roman conquest, between 57 and 50 B.C., the area of what is now Luxembourg was inhabited by a Belgic tribe, the Treveri. The population received some Roman infusion during the occupation. After A.D. 400 Germanic invaders began to penetrate the region, and it became part of the Frankish kingdom of Austrasia and later of Charlemagne's empire. By the treaty of Verdun (843) the area was included in the central division of the three into which that empire was split, but it became an independent entity in 963 under Siegfried, count of Ardennes. Conrad (d. 1086), a descendant of Siegfried, took the title of count of Luxembourg about 1060, and his successors enlarged their possessions, chiefly by marriage. Conrad's great-granddaughter, the countess Ermesinde (1196–1247), granted charters of franchise to most of the important towns of the county. Her great-grandson Henry IV became German king in 1308 and Holy Roman emperor as Henry VII, and the Luxembourg dynasty was continued on the imperial throne in the persons of Charles IV, Wenceslaus and Sigismund (d. 1437). In

1354 the emperor Charles IV made the county a duchy. The French branch of the house of Luxembourg descended from Waleran of Ligny, younger son of Ermesinde's son Count Henry II.

The country was bought (1442) by Philip the Good of Burgundy from Sigismund's Habsburg successors but reverted to the Habsburgs on the partition of Burgundy in 1506. Spanish domination began in 1555–56, with the abdication of the emperor Charles V. In the revolt of the Low Countries against Philip II, Luxembourg took no part; it was to remain united with what is now Belgium as part of the Spanish Netherlands. During the 17th century the French under Louis XIV annexed several towns of the area, and Luxembourg itself was captured in 1684 but was returned 13 years later to Spain by the treaty of Rijswijk. In 1713 Luxembourg with Belgium passed from the Spanish to the Austrian Habsburgs. It was occupied by the French republic in 1795 and became a *département* of France under Napoleon.

The congress of Vienna in 1815 gave Luxembourg as a grand duchy to William I, king of the Netherlands. Districts lying to the east of the Moselle, Sûre and Our were handed over to the king of Prussia. Luxembourg had the legal position of an independent state, in personal union only with the Netherlands, and was included within the German confederation. However, William I succeeded in uniting the grand duchy *de facto* and *de jure* with his kingdom as its 18th province. When the Belgian provinces revolted against William, most of the country, with the notable exception of the town of Luxembourg itself (then garrisoned by Prussians), sided with them. In 1831 the powers divided the country into two parts, of which the larger (now the Belgian province of Luxembourg) went to Belgium and the smaller, in the east, was retained by William I, who, however, refused to accept the decision until 1839. From that year until 1867 the grand duchy was administered separately from the Netherlands. It received from William II a restricted constitution in 1841 and a more liberal one in 1848. After the dissolution of the German confederation in 1866 the link which bound Luxembourg to Germany was broken, but the Prussian garrison remained in the capital. In 1867, by the treaty of London, this garrison was withdrawn; the neutrality of the grand duchy was guaranteed by the powers and its sovereignty was vested in the house of Nassau. On the death of William III of the Netherlands in 1890 without a male heir, the grand duchy passed, in accordance with the Nassau Succession agreement (1783), to Adolphus, duke of Nassau-Weilburg (d. 1905), who was succeeded by his son William (d. 1912). In 1914 the neutrality of Luxembourg was violated by Germany. On Jan. 15, 1919, after the duchy's liberation, William's daughter, the grand duchess Marie Adélaïde, who had shown pro-German sympathies, abdicated in favour of her sister Charlotte. Charlotte (b. 1896) was married in 1919 to Prince Félix of Bourbon-Parma. Prince Jean, their eldest son (b. Jan. 5, 1921), was married on April 9, 1953, to Princess Joséphine Charlotte, daughter of former king Leopold III of Belgium, and on April 16, 1955, she gave birth to a son, Henri. On May 4, 1961, Prince Jean was installed as *lieutenant-représentant* of Charlotte, and began to exercise all her constitutional powers. Her abdication in favour of the prince was announced in 1964.

Luxembourg was occupied again by the Germans from 1940 to 1944, during World War II. Civil government was finally established in Sept. 1944. Though it suffered some damage in the fighting of 1944, the industrial capacity of Luxembourg was not seriously impaired and the country soon regained its prosperity. Perpetual neutrality, guaranteed by the treaties of 1839 and 1867, was abandoned in 1948 when the duchy became a signatory to the Brussels and North Atlantic treaties. Luxembourg, which entered into a customs union with Belgium in 1922, became, after World War II, a member of Benelux (*q.v.*) and of the European Economic Community. (*See* ECONOMIC UNION.)

Population.—The population of Luxembourg was 314,889 at the census of 1960 and in 1962 was estimated at 319,526. The rural population, living mostly in compact villages, exceeds the urban population which is largely concentrated in the capital and the metallurgical district. The chief towns are Luxembourg (pop. [1960] 71,653), the capital, Esch-sur-Alzette (27,954) and Differdange; smaller ones include Echternach, Diekirch, Ettelbruck, Vianden, Wiltz, Grevenmacher and the spa-resort Mondorf-les-Bains. The inhabitants include about 40,000 foreigners, chiefly from neighbouring countries and from Italy, many being employed in iron ore mining or as officials of international organizations in the capital.

The people are essentially a peasant stock, and are inspired by a strong sense of nationality. They form a bilingual nation and possess, besides French and German, their own spoken dialect. French and German became official languages in 1830. Education is given in both tongues, and the native speech, Letzeburgesch (a Moselle-Franconian dialect of the West Middle German group), is used by all classes. In 1939 it was made the third official language. More than 97% of the inhabitants are Roman Catholic. An episcopal see was created in 1870. Protestants (chiefly Lutherans) and Jews are estimated at 3,000 and 1,000, respectively.

Administration and Social Conditions.—The grand duchy is a constitutional monarchy with a hereditary ruler. Failing legal issue a successor is elected by a chamber of deputies. The constitution, modeled on that of Belgium, was proclaimed in 1868 and modified in 1919, 1948 and 1956. Sovereignty is vested in the people, and a parliamentary regime exists. Besides embodying such concepts as individual liberty, legal equality, freedom of religion, expression and association, and the right to employment, the constitution asserts such needs as the provision of medical services and social security. In 1956 the possible temporary transfer of certain sovereign powers to supranational organs was accepted.

The ruler exercises executive power through a ministerial council (cabinet), has certain judicial functions and possesses the right to propose legislation. The ruler also makes most appointments to military and civil posts and is commander of the armed forces. The ministerial council (constitutionally of at least three members, and numbering seven in the early 1960s), headed by a minister of state (prime minister), is the governing body responsible to the chamber of deputies. Its members cannot be deputies, but have the right to address the chamber and can be summoned before it. This council is nominated and can be dissolved by the sovereign.

A council of state (21 members nominated largely by the ruler) has many of the functions of a second chamber, and is in fact a political as well as a judicial consultative body. It may pass an opinion on all matters of public interest. Its opinion on draft legislation must be expressed before discussion in the chamber, and indeed it helps to shape much legislation. It determines the order in which bills are discussed. It also advises on administrative matters, and from its members is chosen a committee (*comité du contentieux*) which acts as a final court in disputes relating to the powers of the administration.

The chamber of deputies (comprising not more than one member for every 4,000 voters and not less than one for every 5,500) has been elected since 1919 by all adult citizens. Voting is obligatory and is carried out according to a proportional representation system within four constituencies. Deputies, who must be over 25, serve for five years. The chamber can initiate legislation and amend draft measures, all decisions being taken by a majority vote. The elections of 1959 returned 21 members of the Christian Social party, 17 Socialists, 11 Democrats and 3 Communists.

Six consultative chambers (*chambres professionelles*), representing agriculture, handicrafts, commerce, civil servants, private employees and labour, have the right to express their opinions on measures concerning their respective occupations before these are passed by the chamber.

Local Government.—The basic unit of local government is the commune, administered by an elected council, with a burgomaster and two aldermen (*échevins*) appointed by the sovereign as executive heads. The council is responsible for such matters as public undertakings, elementary education and health, and also acts as an instrument of the central authority. It can be dis-

missed by the sovereign. The 126 communes are grouped into 12 cantons, and these in turn into 3 *arrondissements administratifs*, each under a *commissaire de district*, who represents the ministry of the interior and is appointed by the sovereign.

Legal System.—The law, based on that of Belgium, is codified and its administration is centralized in a minister of justice. Tribunals can be set up only by law, and judges are nominated by the ruler. Within each canton a *juge de la paix* has summary jurisdiction over breaches of police regulations and minor civil cases. Above come two *tribunaux d'arrondissements* which serve as courts of appeal and try more serious offenses. Finally there is a *cour supérieure* which acts as a court of appeal and of cassation. Periodically this body appoints a *cour d'assises* of six judges (also acting as jurors) to try major offenses; their verdict is by majority vote with acquittal in case of equal division.

In 1930 a central police force was created, headed by a director. Under him is a commissioner in each of three police districts, with local commissioners within the communes. The police is supplemented by a small force of gendarmes.

Education.—Education is compulsory between 6 and 13 years of age, and *écoles gardiennes* (nursery schools) also exist. Free instruction is given in ordinary and advanced state primary schools, and by means of continuation classes. There are also free secondary schools where instruction is given in French for pupils from about 12 years of age. Higher education is provided by institutions or centres for training in arts and crafts, literature and sciences, technical subjects, agriculture and teaching. In the early 1960s the International University of Comparative Sciences had faculties of law and economics only, but students could continue their education in foreign universities.

Social Security.—After World War II social security was extended by successive laws and regulations so that provision for industrial accidents, sickness and unemployment exists for most classes. Other benefits include birth, family and unemployment allowances. There is a minimum legal wage. The protection of health has been increasingly promoted by legislation, controlling and organizing the health services and improving labour conditions and public hygiene. Patients have to make only a small contribution to the cost of medical treatment.

Defense.—In 1944 obligatory military service was introduced; service is for nine months. In 1948, when neutrality was abandoned, the duchy's standing force was integrated into the military organizations set up by the Brussels and North Atlantic treaties. In the early 1960s it consisted of about 3,000 men.

Economy.—The economy of Luxembourg is dominated by the iron and steel industry, which accounts for nearly four-fifths of the gross national product, but agriculture is still the main source of employment. Apart from iron ore, mineral output (chiefly slates and building stone) is slight. With 34,804 ac. under forest, timber production is of some importance, although a considerable net import is necessary. Manufacturing is increasing and to the older industries of engineering, pottery, clothing and leather, new ones such as cement, chemicals and tire manufacturing have been added. There is also a rapidly growing tourist industry.

Though without coal resources, Luxembourg is well supplied with electricity, chiefly from the steelworks in the south. Two small supplementary hydroelectric stations have been built, at Esch-sur-Sûre and at Rosport on the Moselle, and another was constructed near Vianden on the Our in the early 1960s.

As a member of Benelux, Luxembourg is economically integrated with Belgium and the Netherlands, all three being members of the European Economic Community. The monetary unit is the Luxembourg franc, at par with the Belgian franc.

Agriculture.—In the early 1960s there were about 57,184 ac. of farmland giving direct employment to about 35,000 people. Three-quarters of the farms were of less than 50 ac., being owned by those who worked them. Mixed farming is the rule, in both the Oesling and the Bon Pays, with an emphasis on livestock, especially Frisian cattle. Crop yields, though lower than in neighbouring countries, owe much to the use of basic slag fertilizer, a by-product of the steel industry. The division of holdings into separate *parcelles*, sometimes distant from the village, is disadvantageous but methods were being improved and the number of tractors almost quintupled between 1950 and 1960. In amount, arable land generally exceeds that under pasture, the area under crops being fairly evenly divided between grain, roots and green fodder such as clover and lucerne. Wheat, rye and potatoes are grown primarily for human consumption, and oats, barley and roots for animals. Cattle raising, increasingly for dairying, is the main enterprise, and pigs are also important, hams from the Ardennes being a specialty. Sheep have declined greatly in numbers. The specialized cultivation of rose trees in the Alzette valley, largely for export, has dwindled, but viticulture along the Moselle and lower Sûre valleys provides a considerable output of dry white wine. Many of those engaged in the iron and steel industry in the south work small part-time holdings.

Iron and Steel.—Steel production is based on exploitation of the ore deposits (minette) extending from Lorraine into the southwestern corner of the grand duchy. The ore, covering about 9,000 ac., is easily worked but of low grade, averaging barely 30% iron and containing phosphorus. Of the approximately 30 mines, half are opencast, and the output of ore is about 6,500,000 tons annually. Although pig iron was produced before 1870, it was not until the introduction of the Thomas-Gilchrist basic process in 1879 that this phosphoric ore could be used for making steel. Thereafter, large units were established on the ore field, including blast furnaces, steel converters and rolling mills. These are situated at Esch-sur-Alzette, Dudelange, Differdange and Rodange, all close to the French frontier, and another plant is at Dommeldange just north of the capital. Fuel requirements are met by imports of coke from the Ruhr and smaller quantities from Belgium and the Saar, ore and pig iron being exported to Germany and Belgium. Steel output is about 3,500,000 tons annually, making Luxembourg a leading producer. Luxembourg is a member of the European Coal and Steel Community and, despite rather high production costs, 95% of the steel output is exported. The reserves of ore, far less than those of Lorraine, are estimated at 300,000,000 tons. Important by-products of the industry are basic slag fertilizer and the generation of electricity from waste furnace gases.

Communications.—The state-owned railway system forms a link between Belgium and the Netherlands, France, Germany and Switzerland and carries much international traffic. About half the mileage is double-tracked. Electrification of the main Arlon-Luxembourg-Thionville (France) line was completed in 1956 and diesel trains are being brought into use. The grand duchy is served by a good system of roads, about half of which are state highways connecting all the principal centres. The remainder includes those belonging to the communes but maintained by the state, two grades of local roads owned and maintained by the state and two grades of local roads owned and maintained by the communes. Air transport is rapidly increasing, especially between the city of Luxembourg and major European centres. The enlarged, modernized airport at Sandweiler, less than 4 mi. E. of the capital, is equipped to handle modern jet aircraft. The canalization of the Moselle, begun in 1958, was completed after 1965. The postal, telephone and telegraph systems are owned and operated by the government. The radio and television stations are privately owned and Radio Luxembourg broadcasts are beamed to a wide area of Europe.

See also references under "Luxembourg" in the Index.

(K. C. E.; J. D. L.)

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LUXEMBOURG, the largest and most southerly of the nine provinces of Belgium, consists of five administrative *arrondissements,* 20 judicial cantons and 233 communes. Area 4,419 sq.km. (1,706 sq.mi.). Pop. (1961) 216,848. It became a province of Belgium in 1831, before which it was part of the grand duchy of Luxembourg whose history it shared. Much destruction was caused in the northeast during the latter part of World War II.

Three-quarters of the province consists of the Ardennes (*q.v.*), drained by three tributaries of the Meuse: the Ourthe in the north, the Semois in the southwest and the headstreams of the Lesse in the west. In the extreme south an area of about 1,000 sq.km. (400 sq.mi.) comprises Belgian Lorraine.

Much of the Ardennes region lies within the province, the plateau consisting mainly of Devonian sandstones, quartzites and slates. The highest point in the northeast is the Baraque Fraiture (1,968 ft.) on the Plateau des Tailles between the Ourthe and Amblève valleys; the Forêt de St. Hubert between the Ourthe and the Lesse attains 1,837 ft. Most of these plateaus form rounded, heath-covered summits separated by shallow depressions containing peat bogs or wet moorland. Woodland occupies about one-third of the total area; there are oak-birch and beech forests in the valleys, and plantations of spruce and Scots pine on the plateaus. The streams on the plateaus flow mostly in deep valleys, the Semois forming a series of deeply incised meanders in the south.

Belgian Lorraine affords a marked contrast. In the east a narrow tongue of clayey red Keuper sandstones and conglomerates extends for 15 mi. along the southern margin of the Ardennes. Then follows a succession of Jurassic calcareous sandstones, limestones, shales and marls, trending in parallel outcrops from west to east. The highest point in Belgian Lorraine is the Hirtzenberg (1,526 ft.). The sandstones and limestones form north-facing scarps. In the north is the Côte des Grès de Luxembourg of yellowish Lower Lias calcareous sandstone. A few miles farther south is the Côte des Macignos d'Aubange, also calcareous sandstone, rising to 1,348 ft. Along the Franco-Belgian frontier lies the Côte Calcaire de Longwy whose highest point in Belgium is 1,322 ft. Between these ridges occur clays, marls and shales of the Middle and Upper Lias, through which the Semois and various tributaries of the Chiers drain to the Meuse.

The Ardennes is of limited agricultural value, with its thin acid soils, considerable areas of bog, heavy precipitation, high cloud incidence and frequent frosts. Most of the small area of farmland is under permanent pasture, raising beef cattle to be sent to the lowlands for fattening, with dairy farming in the sheltered valleys and a small amount of arable farming, chiefly oats, rye, trefoil and potatoes. On alluvial flats in the Semois valley smallholders grow tobacco intensively with heavy fertilization.

Nearly half of Belgian Lorraine is still largely wooded, mainly birch and pine on the escarpments and patches of beech and oak on the heavier clays. Less than one-third is farmland and two-thirds of this is under pasture, the rest growing wheat, potatoes and fodder crops. About one-third of the cattle are dairy animals. Pigs are raised and some fruit is grown.

Industrially the Ardennes is of little importance. Timber is cut and exported, and quarrying of quartzite for road metal is widespread. A few slate quarries still operate. A small portion of the French Lorraine iron ore field extends into Belgium, but in the early 1960s there was only one active mine, producing about 140,000 tons annually. The ore being too friable to stand transport, blast furnaces were built at Musson and Halanzy and a steelworks at Athus.

The Ardennes has a population density of less than 100 per square mile. A few small towns stand on the plateau, mainly on the railway lines. They are market centres and tourist resorts, notably Houffalize at about 1,100 ft., La Roche-en-Ardenne on a meander core of the Ourthe valley, St. Hubert, Libramont, Neufchâteau and Vielsalm. Several pleasant little towns (Florenville, Chiny) are in the Semois valley. The population density of Belgian Lorraine is about 160 per square mile in the *arrondissement* of Arlon, but less than 130 in that of Virton. The population is mostly grouped in small, nucleated villages in the vales. The only town of any size is Arlon (13,275 in 1959), on a hill overlooking the headstreams of the Semois. It is the headquarters of the province and a market centre. The meeting point of 11 main roads, it is also the frontier station for the international Brussels-Namur-Luxembourg railway line. (F. J. M.)

LUXEMBOURG (dial. LËTZEBURG, "Little Fortress"), capital of the grand duchy of Luxembourg, is situated on the Alzette, a tributary of the Sûre. Pop. (1961) 71,653. The city stands on a sandstone plateau into which the Alzette and its tributary, the Petrusse, have cut deep, winding ravines. Within a loop of the Alzette a rocky promontory called the Bock (Bouc) formed a natural defensive position recognized by the Romans. The medieval town developed around it. The old town with the palace (1572), town hall and cathedral of Notre Dame (1613) occupied the plateau, spreading to the west later, and the suburbs of Grund, Clausen and Pfaffenthal developed in the valley below. The cathedral contains the remains of John the Blind, king of Bohemia and count of Luxembourg (d. 1346). The fortress, gradually elaborated to become the strongest in Europe after Gibraltar, was dismantled in 1867. On the western fringe of the old town attractive parks, in which are the studios of Radio Luxembourg, have replaced earlier fortifications. Beyond, residential districts spread farther westward. Across the gorge of the Petrusse a viaduct (Pont Adolphe) gives access to the area of modern hotels, shops and offices on the Plateau Bourbon and around the railway station to the south, near which is the industrial suburb of Hollerich. Other viaducts carry the railway through the town to the north. At Hamm to the east is a military cemetery containing the graves of more than 5,000 U.S. soldiers including that of Gen. G. S. Patton. A little farther out is the airport. At Eich, a northern suburb, iron foundries stand on the site of the first ironworks (1845) to use the ore from the southern part of the country. Luxembourg, for long an important road and railway focus and financial centre, is the seat of the high authority of the European Coal and Steel Community. Two annual fetes are celebrated, one on the Sunday preceding Ascension day in honour of Our Lady of Luxembourg, and the other in late August or early September, the *Schobermesse* ("tent fair"), dating from 1340. (K. C. E.)

LUXEMBURG, ROSA (1870?–1919), one of the most important women in the history of international socialism and a revolutionary who might have had a decisive influence on the development of the working-class movement in Germany, was born at Zamosc in Russian Poland on March 5, 1870 (or perhaps, according to a statement of her own, 1871), of a Jewish merchant family. On leaving the Warsaw *Gymnasium* she joined the Polish revolutionary socialist party "Proletariat" but fled abroad in 1889 to escape imprisonment. In Switzerland she studied natural sciences and political economy at Zürich and took her doctor's degree with the dissertation *Die industrielle Entwicklung Polens* (1898). In Switzerland also she met the Russian champions of Marxism, G. V. Plekhanov, Pavel Axelrod and Vera Zasulich; most important was her close relationship with Leo Jogiches. Together with Jogiches she took over the leadership of the Social Democratic Party of the Kingdom of Poland and Lithuania, which had been formed in 1893 after quarrels among the Polish Socialists. Contrary to the patriotic attitude of the Polish Socialist party, Rosa Luxemburg repudiated the idea of reconstituting an independent Polish national state: she insisted that the Polish proletariat should not aim ultimately at the liberation of Poland from Russia but should serve the higher socialist task, namely the elimination of tsarist absolutism. This attitude foreshadowed her later controversy with Lenin over the right of national self-determination (the importance of which she consistently underrated).

Rosa Luxemburg obtained German nationality through a fictitious marriage and settled in Germany in 1898 in order to work with the German Social Democratic party, the largest and strongest party of the Socialist International. Her activities as a journalist and her spirited behaviour at party congresses soon made her one of the best-known leaders in the fight against the revisionist ideas of Eduard Bernstein (*q.v.*). She opposed Bernstein's theses mainly in a series of newspaper articles which were republished as a pamphlet, *Sozialreform oder Revolution* (1899). During the Russian revolution of 1905 she wanted to take her place at the head of the fighting Polish proletariat, but a serious illness prevented her leaving for Warsaw before the end of the year. In Poland she was imprisoned in the spring of 1906 but was released on bail after a few months because of the state of her health. Back in Berlin she began a new career as teacher at the party school. This educational activity helped her to produce her main works: *Die Akkumulation des Kapitals* (1913), an important contribution to the Marxist theory of imperialism; and *Einführung in die Nationalökonomie*, published after her death by Paul Levi in 1925. (*See* MARXISM.)

In the decade preceding World War I, Rosa Luxemburg came to oppose ever more sharply the Social Democratic party line upheld by August Bebel and Karl Kautsky, though she had so far worked together with them against the spread of Bernstein's revisionism. She and Karl Liebknecht (*q.v.*) became the leaders of the extreme left wing of the party and found themselves opposed by a united front of all the other groups within the party—by Bebel and Kautsky no less than by Bernstein. Rosa Luxemburg believed that both the "strategy of exhaustion" (Kautsky) advocated by the heads of the party organization and the cautious attitude of the trade union leaders concealed a disinclination to run any serious risks and thus condemned the Social Democrats to fruitless inactivity.

The quarrel within the party flared up openly over the question of political mass strike. This question became a matter of urgency in 1905, in view of the events in Russia. Rosa Luxemburg maintained from the start that action could not be limited to parliamentary measures alone; and her book *Massenstreik, Partei und Gewerkschaften* (1906) was an attempt to draw profitable conclusions for the German workers from the Russian people's experiences. She called the political strike "the living pulse beat of the revolution and likewise its most powerful driving force." She stressed again and again "the element of spontaneity" as a decisive precondition for such a mass strike, and the Bolsheviks reproached her for propagating a one-sided "theory of spontaneity." This contains an element of truth in so far as she gave more weight to the unorganized proletarian masses than did Lenin, who regarded the party, organized in cells, as the most important instrument of revolution. Her view of the nature of proletarian democracy did not accord with Lenin's ideas: after the split in the Russian Social Democratic party (1903) she had denounced the excessively centralized structure of the Bolshevik party and the supposed "Blanquism" of Lenin himself; and her criticism of the Bolshevik terror after the Russian Revolution of 1917 (in her book *Die russische Revolution*, written in prison in the autumn of 1918 and published by Paul Levi in 1922 from a faulty copy) was to proceed on the same lines. She held, in contrast to Lenin, that "the dictatorship of the proletariat consists in the application of democracy, not in its abolition."

In the autumn of 1914, after the outbreak of World War I, the extreme left wing split itself off from the Social Democratic party to form the *Spartakusbund* or Spartacus league, over whose subsequent attitude Rosa Luxemburg exercised great influence, though she was in prison from Feb. 1915 to Jan. 1916 and from July 1916 to Nov. 1918. She gave to the *Spartakusbund* its theoretical basis in the pamphlet *Die Krise der Sozialdemokratie*, published in 1916 under the pseudonym Junius; and she took part in the political quarrels of the day through numerous articles smuggled out of prison and published in the illegal *Spartakusbriefe*. Set free when revolution had broken out in Germany, she drafted the program accepted by the Communist party of Germany, into which the *Spartakusbund* was transformed at the party congress held from Dec. 30, 1918 to Jan. 1, 1919. Two weeks later, on Jan. 15, Rosa Luxemburg and Karl Liebknecht were arrested and murdered in Berlin by Volunteer officers, members of a *Freikorps* (*see* GERMANY: *History*).

It is impossible to evaluate what Rosa Luxemburg's death meant for the future development of German Communism: a Communist party led by her would hardly have become the spineless instrument of the Third International in Moscow.

See P. Frölich, *Rosa Luxemburg: Her Life and Work*, Eng. trans. (1940; 2nd ed. of German original, 1949). (E. MA.)

LUXEUIL, a thermal centre since Roman times, was famous for its abbey (founded *c.* 590), the greatest of the three houses established in Burgundy by St. Columban through the liberality of Sigebert, king of Austrasia and Burgundy. It was for a time the centre of Irish monasticism on the continent and followed a rule of absolute poverty and renunciation and very strict discipline. The third abbot, Walbert (629–*c.* 670), adopted Benedictine usages to fill the gaps in the rule of St. Columban and mitigate its severity, and from that time the most interesting feature of the monasticism of Luxeuil was its mixed Columban-Benedictine rule. In its early days it had a renowned scriptorium and a fine library; the most famous manuscript is the late 7th-century lectionary of Luxeuil (now in the Bibliothèque Nationale, Paris). After being sacked by the Saracens (*c.* 732) the abbey was restored by Charlemagne. Its final suppression came in 1790.

The modern town of Luxeuil-les-Bains (pop. [1962] 8,158), about 20 mi. N.E. of Vesoul, in addition to its mineral springs is noted for fine lace. The remains of the abbey include a 13th to 14th-century church and 16th-century palace, and there are several secular buildings of the 15th and 16th centuries.

See M. Dubois, *S. Columban* (1950). (M. M. CH.)

LUXOR (in Arabic AL UQSUR or EL AKSUR, meaning "the castles" or "palaces"), a town of upper Egypt in Qina *muhafaza* (governorate) on the east bank of the Nile in a broadening of the valley, 450 mi. above Cairo by river and 418 mi. by rail. Pop. (1957) 32,246. It is the modern town standing with Al Karnak village amid the antiquities of Thebes (*q.v.*) and the centre for visitors to the ruins, being provided with hotels, Anglican and Roman Catholic churches and a hospital. The manufacture of copies of Theban antiques is an important occupation.

(A. B. M.)

LUXORIUS (fl. 5th/6th century), writer of Latin epigrams in the classical tradition, lived in north Africa and seems to have been a Christian, but little further is known of his life. His poems are preserved in the *Anthologia Latina*. There is a group of 86 epigrams in various metres on a number of themes, including works of art and erotic subjects. He also compiled a Virgilian cento in the form of an epithalamium. It is not certain, however, if he is the author of 42 elegiac couplets on mythological characters in each of which the first three words are the same as the last three.

See *Anthologia Latina* ed. by A. Riese, vol. 1 (1894), in the Teubner series, and Pauly-Wissowa, *Real-Encyclopädie der classischen Altertums wissenschaft*, vol. 13 (1927).

LUXURY. The word luxury implies a relatively large consumption of wealth for nonessential pleasures. But there is no absolute definition of luxury, for the conception is relative to both time and person. It is a commonplace of history that the luxuries of one generation may become the necessities of a later period; no hard and fast line can be drawn between luxuries, comforts and necessities. The private bath was one of the greatest luxuries of the Roman empire; in the 19th century its use was largely confined to the wealthy; today it may be ranked among the necessities of civilized life. Looked at from one important standpoint, luxury might be defined as any expenditure in excess of the normal and customary standard of living of the class to which the individual belongs.

The problem of luxury involves economic, social and ethical considerations.

The Economic Aspect.—Luxury has undoubtedly played a great role in the history of economic development. Werner

Sombart in his *Luxus und Kapitalismus* showed that the luxurious expenditure of the papacy and of the courts in the middle ages stimulated the growth of modern capitalism. The rentals of distant estates were concentrated at some central spot; wealth was accumulated there; a relatively large market was created for the products of certain industries and the necessary conditions for the development of capitalist enterprise were fulfilled.

In France, the classic land of luxury, the continual drain of wealth from the countryside to Paris and Versailles was combined with a vicious system of taxation and the burdensome restrictions of feudal tenure. These conditions produced, on the one hand, a considerable amount of industrial activity carefully fostered by the mercantilist policy of the statesman Jean Colbert and his successors; but, on the other hand, they led eventually to the disruption of the old social order amid the turmoil of the French Revolution. It is one of the paradoxes of history that a precisely opposite view and method of life—that of the Puritans, with their strong moral condemnation of luxury and their emphasis on the value of hard work and abstinence from all unnecessary consumption—should have contributed even more notably to the growth of capital and to the expansion of industry and commerce in other countries.

In other directions, also, luxury has made its influence felt. Thus in Italy the rise of the merchant princes gave a new direction to the whole course of art, for the medieval church ceased to be the chief patron of the artist, who now had to conform in his work to the standards and tastes of those who provided the market for his products. The simple piety of the primitives gave place to the sumptuous paganism of the Renaissance period, and that in turn to the elaborate ornamentation and decorative inventiveness which was perhaps at its best in the metal work of Benvenuto Cellini, until at length the over-refinements of a decadent social life killed all artistic inspiration.

Luxury is the inevitable concomitant of the growth of wealth, which brings with it the increase and the differentiation of wants. The fact that the fundamental needs of mankind for a minimum of food, clothing and protection from the weather are relatively soon satisfied gives rise to a demand for greater variety and finer qualities as soon as income rises above the bare subsistence level. This demand, which is especially strong among the feminine portion of the human race, has, in the past, been a great stimulus to economic progress for it has provided an enormously strong incentive to work and effort.

The attitude of the great majority of people toward the luxurious expenditure of the rich is a mixture of envy, sometimes accompanied by, but often devoid of a feeling of resentment; and of approval based on popular economic reasoning. It is a very widespread belief that such expenditure is good for trade because it makes money circulate and therefore increases employment. The classical economists, down to and including Alfred Marshall, had no hesitation in declaring that this reasoning was based on a fallacy. They agreed that the maintenance of racing stables or private yachts, the purchase of magnificent furs or jewelry, does give employment to those engaged in the trades concerned, and that the localities in which these trades are situated benefit from such expenditure. But they argued that the fallacy of such reasoning lay in ignoring the fact that the aggregate real resources of producing power in a country are limited at any one time. A large amount of capital and labour is required to make and equip yachts and racing stables, and this capital and labour is withdrawn from other uses to which it would be put. If the wealth consumed extravagantly were saved and invested, the volume of capital would be increased, the rate of interest would tend to fall and there would be a larger demand for labour to produce goods consumed by other sections of the community. If, in a capitalist society, there was a sudden change in the standards of expenditure of the wealthy classes such that all expenditure commonly recognized as luxurious was regarded with strong social disapprobation, these persons would find themselves impelled to save on a much larger scale than formerly, and a great deal more capital would be available for production. But as the ultimate aim of production is consumption the net effect of the change of policy in regard to expenditure would be to transfer additional spending power to all the less wealthy members of the community. The latter would benefit by higher money wages, because of the greater demand for their services, and from the still higher *real* wages, because of the fall in the rate of interest and the larger production of the type of commodities that they consume. Some proportion of this increased wealth would be consumed by the poorer classes in the form of luxuries, as we have defined this term above, or in an increased enjoyment of leisure. The ultimate consequences of such a change would depend upon the economic and social effects of this transfer of real income to the poorer classes and upon the willingness of the wealthier classes to continue to work as hard and efficiently as formerly to produce incomes which they do not themselves enjoy by consumption, and the spending power of which they in fact transfer to other people. The classical view of the economic effects of luxurious expenditure was accepted thus far. Later, however, and particularly under the influence of the ideas put forward by the economist Lord Keynes, a fresh turn was given to the discussion.

When closely examined the classical view is found to depend for its validity upon the assumption of full employment of the community's available resources. If there are idle resources and if the saving portion of the community prefer to hold their savings in the form of money rather than in the form of investing them in some income-yielding use (other than the purchase of old securities), then any additional expenditure on the part of any section of the community will increase the volume of employment and make the total national income larger than it would otherwise have been.

While it is true, on the one hand, that the country as a whole cannot save what it cannot invest, any given level of investment and saving may fall short of occupying fully all the resources of the economy. Under these conditions a decision by an individual to save rather than to spend part of his income may merely have the effect of inflicting an equivalent loss on other individuals. The saver will, it is true, hold a larger command over the community's wealth than before, whether in the form of money, or in the form of securities which have had to be sold by other members of the community in order to finance their losses, but the total savings of the community have not been increased, they have diminished, because of the resultant fall in the national output and income. It still remains true that the community will normally benefit more by an expansion of investment than by an increase of luxurious expenditure, but if the savings would otherwise run to waste in an increase of hoarding, then a rise in what is called the "propensity to consume" will increase the total volume of employment and output, and will not, as in the classical case, be at the expense of an equivalent amount of investment which would otherwise have been made. In this way the popular argument has partially come into its own again in relation to short period analysis and to certain phases of the business cycle when there is a shortage of effective demand.

The Social Aspect.—As T. B. Veblen showed in his *Theory of the Leisure Class* the evils of bad standards of expenditure are not confined to the wealthy classes from which they spring; they propagate and perpetuate themselves by example and imitation right down the social scale from top to bottom; what is called snobbishness is a very potent social force, and it is one which can work for the good as well as for the harm of humanity. It has been well said that mankind is nowhere more vulgar than in the way in which it spends its income.

No amount of time, effort or thought is grudged to the acquiring of wealth, but when we come to consume it we dissipate the fruits of our labours often with small gain to ourselves and with unforeseen and undesired repercussions on the welfare of the community as a whole. What Richard Henry Tawney termed *The Acquisitive Society* (see *Bibliography*) is the outcome of false social values inspired by the all-pervading impulse to acquire riches to the elimination, or at least repression, of other higher ideals. While the churches wrangled over doctrine, they largely ignored the great problem of the art of spending which had become so large a part of the art of living.

The Moral Aspect.—Moralists of all ages have attacked luxury on ethical grounds: the Stoics, because it ran counter to their ideals of simplicity of life; the early Christian Fathers, because they exalted asceticism and poverty into an ideal; the Puritans, because they feared lest the distractions and temptations of luxury might imperil the immortal soul and endanger its chances of salvation; the socialists, because they hold unnatural and immoral the co-existence of luxury on the one side and poverty on the other.

In later times the tendency was increasingly for the moral judgment of luxury to be associated with the general problem of the unequal distribution of wealth—a view which, as is pointed out above, overlooks the fact that luxury is not confined to the richer sections of the community. The rigid condemnation of all luxury on moral grounds is untenable, if only for the reasons that there is no absolute measuring rod by means of which the ultimate social ethical value of expenditure can be tested, and that economic progress and changing standards of life so quickly alter contemporary notions of the types of expenditure that may be included under the category of luxuries. However, a great deal of luxury is undoubtedly a waste of life, not only because of the ill effects it may have upon the individuals themselves, but also because the resulting satisfaction is frequently out of all proportion to the expenditure. As Arthur Cecil Pigou pointed out in his *Economics of Welfare:* "It is at least arguable, that, after a point, as growing wealth gives a man command over more and more luxuries the satisfaction that he gains from each one is, as it were, taken out of relaxed interest in the others, so that the satisfaction which he derives on the whole is not substantially increased." Consumption has its ethical as well as its economic aspects and there are heavy moral responsibilities involved in the exercise by the individual of his right of disposal over the wealth which economic forces and social laws have placed in his hands.

Bibliography.—T. B. Veblen, *The Theory of the Leisure Class* (1899; 2nd ed. 1924); E. J. Urwick, *Luxury and Waste of Life* (1908); W. Sombart, *Luxus und Kapitalismus,* vol. i, of *Studien zur Entwicklungsgeschichte des modernen Kapitalismus* (1913); R. H. Tawney, *The Acquisitive Society* (1921) and *Equality* (1931); J. Konrad and W. Lexis, "Luxus" and "Luxussteuer" in *Handwörterbuch der Staatswissenschaften,* 4th ed. (1923, etc.); C. Brinkman, "Luxury" in *Encyclopaedia of the Social Sciences* (1930–35); J. K. Galbraith, *The Affluent Society* (1958). (C. W. G.)

LUXURY TAX, a tax on commodities or services that are considered to be luxuries rather than necessities. Modern examples are taxes levied on the purchase of jewelry, perfume and tobacco.

Great Britain.—In the late 18th and early 19th centuries, taxes were levied in England on carriages and manservants in order to secure revenue from the rich. Such taxes contrasted with those on corn, sugar and timber, which also fell on the poor, often calamitously. While the development of a progressive income tax has modified the whole fiscal structure, luxury taxes on certain commodities, like perfume and furs, have remained.

There are three problems relating to luxury taxes. First, they may lead to a heavy fall in demand and to a reduction in revenue. The English window tax (1695–1851) reduced the number of windows considerably. Against the background of a progressive tax system, a second problem arises even where demand is inelastic. High luxury taxation reduces the volume of private savings and consequently may increase the amount of taxation required for adequate revenue. The third problem concerns the definition of "luxury." (*See* Luxury.) Clergymen and doctors complained persistently in the 19th century that carriages were "*bona fide* articles required for the practice of a hard-working profession" and should be exempt from duty. Apart from such burdens on special groups of consumers, experience has shown that the luxuries of today become the necessities of tomorrow. High luxury taxation may inhibit the distribution of commodities which would fall rapidly in cost given greater demand.

The favourite argument used by exponents of luxury taxation has been moral rather than economic. Paternalist governments have imposed luxury taxes to restrict private expenditure in certain directions. In England from the 14th to the 16th centuries sumptuary legislation was designed to repress the ostentation and extravagance of private persons. (*See* Sumptuary Laws.) In the 19th and 20th centuries, increased taxes have been placed on private expenditure upon alcohol, tobacco, entertainment and automobiles. Such expenditure is superfluous in the sense that a large part of it may be said to be in excess of what is required for economic efficiency and personal well-being, although the expenditure affects large numbers of people. Governments have retained such taxation in free economies because the taxes are easy to collect and yield large sums quickly. The moral argument has been pushed into the background in affluent societies.

In time of war luxury taxation is widely used, when it is often considered necessary to interfere with the consumption pattern. William Pitt introduced a wide range of sales taxes during the Napoleonic Wars, while during World War II similar taxes were levied on a long schedule of commodities. In time of peace, also, there is often pressure to impose luxury taxation for reasons connected with the international balance of payments. One of the motives of medieval sumptuary legislation was the reduction of imports of foreign materials. Similarly during the 18th century laws against the wearing of French lawns and laces were designed partly to protect English manufacturers and partly as a weapon of offense against the French. In the 20th century import-restriction policies have often been associated with luxury taxation.

(A. Bri.)

United States.—Unlike the bold groupings and sharply differentiated rates of the British excise and purchase taxes, the varied rates of U.S. excises reflect no clear-cut classification as to degree of essentiality. Perhaps the closest parallel to the British system is found in the heavy reliance upon liquor and tobacco taxes, an expression of the moralistic conception of luxury taxation. Thus, in the early 1960s these two taxes accounted for about 7% of total tax revenues of the central governments of Canada and the United States, as well as about 9% of the tax revenues of the states.

Such revenue importance could only be achieved by heavy consumption in the face of very high tax rates. For example, in the United States the federal whisky tax in 1963 was $10.50 per proof gallon, to which most states added $1 to $3. Beer was taxed at $9 per barrel by the federal government, plus $1 to $4 in most states. To the federal cigarette tax of 8 cents per pack of 20, most states added 3 to 5 cents, and municipalities in several states added a third tax layer. The Canadian excises on whisky and beer were at much the same levels (plus a 10% federal manufacturers' excise tax), but the cigarette tax was almost double that in the United States.

Apart from commodities whose consumption is thought to be harmful, those which legislators consider nonessential for a "reasonable" or "decent" standard of living or more likely to be bought by the rich than by the poor are often embraced in the concept of luxury taxation. Of about 50 items subject to U.S. excise taxation in the early 1960s few met this dual test. The excises levied (mostly at 10%) on furs, jewelry, leather goods, silverware, cameras and films, admissions, dues and initiation fees and a few other items were widely recognized as taxes on nonnecessities. Moreover, consumer studies suggested that these taxes as well as those on new automobiles, electrical appliances, radios, television sets, phonographs, and musical instruments and transportation of persons by air were progressive in their impact, taking a larger proportion of high than of low incomes. Yet even this list includes several items whose designation as luxuries would be challenged by many. The remaining federal excises—on telegraph and telephone communications, gasoline, auto parts, tires and tubes, electric light bulbs, matches, toilet preparations and a few others—fall out of the luxury category entirely.

A different approach to luxury taxation, much less frequently found, seeks to single out the luxury component of spending on a given object rather than taxing specified goods and services as luxuries. One example of this is the Massachusetts 5% tax on restaurant meals of $1 or more (a dividing line which may have singled out luxury dining in the 1930s when it was enacted, but did not serve this purpose after the post-World War II inflation).

The federal rate differential between watches selling above and below $65, discontinued in 1954, was another case in point. Difficulties of definition as well as administrative complexity militate against wide use of this approach. If these difficulties could be overcome, luxury components of spending on such basic items as food, clothing, furniture and shelter would become eligible for special taxation.

See also AMUSEMENT TAX; EXCISE TAX; TAXATION.

(W. W. HE.)

LUYNES, CHARLES D'ALBERT, DUC DE (1578–1621), French statesman, for a few months constable of France, was born on Aug. 5, 1578, the son of Honoré d'Albert, seigneur de Luynes (the lordship of Luynes was in Provence). Keeper of the king's birds from 1611, he won complete ascendancy over the neglected Louis XIII (*q.v.*) and was already a councilor of state and governor of Amboise when he sponsored the plot that led to the murder of the marquis d'Ancre on April 24, 1617, and to the exile of Marie de Médicis (*q.v.*) from Paris. Master of France, he recalled Henry IV's old ministers, took a firm line against the Spaniards in Italy, initiated a *rapprochement* with Savoy and with England and tried by diplomacy to contrive a balance of power between the Habsburgs and the Protestants in Germany and Bohemia (*see* THIRTY YEARS' WAR). The first attempt at rebellion by Marie de Médicis was stopped by negotiation (April 1619), the second by a victorious campaign (Aug. 1620). The king's army then went southwest (Sept.–Nov. 1620), where Béarn had to be awed into obedience. Personally, meanwhile, Luynes had been married to Marie de Rohan-Montbazon, the future duchesse de Chevreuse (*q.v.*), in Sept. 1617; had had his countship of Maillé in Touraine erected into the peerage-duchy of Luynes in Aug. 1619; and had strengthened his power in 1619 by taking the governorship of Picardy. To subdue the long-malcontent Huguenots, he had himself made constable of France (March 31, 1621) and marched southwest again. During the campaign he was even appointed keeper of the seals (August); but his 12-week siege of Montauban had to be raised (Nov. 10), and he died of fever at Longuetille, in Guienne, on Dec. 15, 1621. As he had prevented Richelieu (then the ablest partisan of Marie de Médicis) from becoming cardinal in Jan. 1621, Richelieu consistently denigrated him; yet Luynes had foreshadowed the future policy of Richelieu.

See V. Cousin, "Le Duc et connétable de Luynes," 13 articles, *J. des Savants* (1861–63); B. Zeller, *Études . . . le connétable de Luynes . . .* (1879).

LUZÁN CLARAMUNT, IGNACIO DE (1702–1754), Spanish critic and poet who introduced neoclassical theories into Spain, was born in Saragossa on March 28, 1702, but was brought up and educated in Italy, where he studied under the philosopher Vico and adopted the literary principles of classicism. Returning to Spain in 1733, he published *La Poética o reglas de la poesía en general y de sus principales especies* in 1737. It is based largely on Lodovico Muratori's treatise on poetry, and to a lesser degree on earlier Italian commentators on Aristotle, as well as on Boileau and other French critics. He was elected to the Real Academia, held various government posts and died in Madrid on May 19, 1754. He translated from many languages, and published versions of Greek poets and Milton. Luzán's own poetry is much less important than his criticism.

La Poética is typical of neoclassic literary theory, which Luzán saw as the means of rehabilitating Spanish literature. He severely censured the poetry and especially the drama of the 17th century, which he attacked for having forsaken the classical unities, for a lack of moral sense and for the superficiality of its characters. This criticism proved powerless to produce literary works of appreciable merit, but Luzán's influence was greater than can be measured by the overt failure of the neoclassic formula in Spain, and informs some of the most important writing of the first half of the 19th century. (J. F. SR.)

LUZERN: *see* LUCERNE.

LUZON, the main and largest island of the Philippines, located in the northern part of the archipelago. Area 40,420 sq.mi. Most of the island lies north of Manila in a north-south oriented rectangular area; south of Manila lies the volcanic Batangas peninsula and extending southeast of this is the long, narrow, irregular Bicol peninsula. The island has extreme dimensions of 460 mi. by 140 mi., and a coast line measuring 2,242 mi. In 1960 it had a population of 13,929,790, or an over-all density of 345 people per square mile. Densities are very high along the northwest coast, in the central plain and many parts of the Bicol peninsula. The east coast and the Sierra Madre mountains have very low population densities; the Mountain province and the Cagayan valley are moderately populated.

The more important mountain ranges are the Cordillera Central in the north, the Sierra Madre following much of the east coast and the Zambales range on the central west coast. Mt. Pulog, 9,606 ft., in the Cordillera Central, is the highest peak. Isolated volcanic cones, as the near perfect Mt. Mayon, 7,943 ft., are found in the Bicol peninsula.

Agriculturally Luzon is the leading island, producing over 65% of the country's rice; the central Luzon plain, stretching for 100 mi. N. of Manila, is the chief centre. On the Bondoc and Bicol peninsulas are found the most extensive coconut plantations in the world; this is a leading area for the export of copra. The southern end of the Bicol peninsula is noted as a producer of abacá while both the Ilocos provinces and the Cagayan valley provide tobacco surpluses. Spectacular rice terraces have been built by the peoples of the Mountain province. Sugar cane is an important cash crop in the Central plain and in Batangas. Manufacturing is largely limited to Manila and suburbs, a notable exception being the modern petroleum refinery at Batangas.

Iron, gold and manganese are mined in the Camarines provinces while Zambales is noted for the production of both chromite and copper. The Cordillera Central produces large amounts of gold and copper and has good pine forests which provide considerable timber for the mining industry. Other forest areas, notably along the east coast, produce excellent hardwoods for cabinet work and the production of quality veneers.

Administratively, the island is divided into 24 provinces, Abra, Albay, Bataan, Batangas, Bulacan, Cagayan, Camarines Norte, Camarines Sur, Cavite, Ilocos Norte, Ilocos Sur, Isabela, Laguna, La Union, Mountain, Nueva Ecija, Nueva Vizcaya, Pampanga, Pangasinan, Quezon, Sorsogon, Tarlac (*qq.v.*), Rizal and Zambales. Its chartered cities include Baguio, Manila, Quezon and San Pablo (*qq.v.*).

For the ethnology and history of Luzon *see* PHILIPPINES, REPUBLIC OF THE. (R. E. HE.)

LUZZATTI, LUIGI (1841–1927), Italian economist and statesman who did much to strengthen his country's finances both internally and externally, was born of Jewish parents in Venice on March 1, 1841. After studying law at Padua, he had to go into exile because of his participation in a scheme for establishing a workers' mutual aid society. In 1863 he became economics lecturer at the technical institute in Milan. When Austrian rule in Venetia came to an end he returned to become professor of constitutional law at Padua in 1867. Later he was appointed to chairs at Perugia (1894) and at Rome (1898).

A believer in the co-operative ideas of F. H. Schulze-Delitzsch, Luzzatti worked to realize them in Italy: he contributed to the spread of "people's banks" to provide credit on reasonable terms for those whose small incomes barred them from recourse to the big national banks; and he founded the first co-operative store in Italy (1865). In 1869 Marco Minghetti, minister of agriculture and commerce, appointed Luzzatti secretary general of the ministry of agriculture and commerce. Together they brought about the abolition of government control over commercial companies. Luzzatti entered parliament in 1871 and was continually re-elected until 1921, when he was made a senator.

Theoretically a free trader, Luzzatti yet helped to create the Italian protective system. He compiled the Italian customs tariff in 1878 and took a leading part in the negotiation of the commercial treaties between Italy and other countries. In 1898 he ended the tariff war with France.

Luzzatti was minister of the treasury in four cabinets between 1891 and 1906. During his last term at the treasury he achieved the conversion of the Italian 5% debt (reduced to 4% by the tax)

to 3¾%—to be eventually lowered to 3½%. Though the actual conversion was not completed until after the fall of the cabinet to which he belonged, the project was recognized as his and he was given the title of minister of state for life (1906).

Luzzatti was minister of agriculture and commerce in 1909 and prime minister from March 1910 to March 1911 (*see* ITALY: *History*). He died in Rome on March 29, 1927. His memoirs were published in 1931–35.

LUZZATTO, MOSES HAYIM (1707–1747), Italian Jewish cabalist and writer, born in Padua, was one of the founders of modern Hebrew poetry. He wrote lyrics and the drama *Migdal 'Oz* ("Tower of Victory"), but early turned to cabalist studies, claiming to receive heavenly messages and to be the Messiah. After being expelled by the Italian rabbis, who feared a further outbreak like that of Sabbatai Zebi (*q.v.*), he moved to Amsterdam (1736), where he wrote his morality play *La-Yesharim Tehillah* (Eng. trans., *Praise for Uprightness,* 1915) and an ethical work, *Messilath Yesharim* (Eng. trans., *The Path of the Upright,* 1936), which still ranks as a classic. He died of the plague in Palestine in 1747.

See S. Ginzburg, *The Life and Works of M. H. Luzzatto* (1931).

LUZZATTO, SAMUEL DAVID (1800–1865), Italian Jewish writer and scholar, known from his initials as Shedal, was born in Trieste on Aug. 22, 1800. In 1829 he became professor at the rabbinical college in Padua, where he died on Sept. 30, 1865. In his writings, which are in Hebrew and Italian, he presents an emotional and antiphilosophical concept of Judaism, and his Hebrew poetry is also pervaded by national spirit. His chief merit as a scholar lies in biblical exegesis, Hebrew philology and the history of Hebrew literature. His extensive correspondence in Hebrew was published in 1882–94 and in other languages in 1890. His autobiography in Italian appeared in 1882.

See M. Klotz, *S. D. Luzzatto als Bibelexeget* (1925); S. Morais, *Italian Hebrew Literature* (1926). (S. M. SN.)

LVOV, GEORGI EVGENIEVICH, PRINCE (1861–1925), head of the first Russian provisional government set up during the March Revolution of 1917. He was born at Popovka, near Tula, on Nov. 2 (new style; Oct. 21, old style), 1861, of an old aristocratic family in which he was brought up to have firsthand experience of peasant life. After graduating in law from Moscow university in 1885, he joined the civil service, but resigned in 1893. Fired by a lofty idealism, which he combined with a talent for practical organization, he devoted himself to social work. After serving in the elected council (zemstvo) of Tula he led in organizing voluntary relief work in the far east during the Russo-Japanese War. During World War I, as president of the All-Russian Union of Zemstvos, he performed the same tasks on a more extensive scale and with considerable success, but obstruction from official quarters made him increasingly critical of the tsarist regime. Already in 1906, as a member of the first *duma,* he had been put forward by liberal leaders as a candidate for ministerial office, and his reputation now stood higher than ever. The emperor Nicholas II on the day of his abdication (March 15, 1917) approved Lvov's nomination as prime minister.

Lvov, however, was psychologically unsuited to hold such a responsible post. He had an almost Tolstoyan disdain for the realities of political power and regarded the Revolution through rose-coloured spectacles. In an effort to maintain his popular standing he drifted far to the left. After the "July days" he belatedly realized the need for firmer measures, but being loath to apply them himself resigned in favour of A. F. Kerenski (July 21). In 1918 he emigrated to Paris, where he died on March 6, 1925.

See T. I. Polner, *Zhiznenny put knyazya G. E. Lvova* (1932). (J. L. H. K.)

LVOV (Ukrainian LVIV), an *oblast* in the Ukrainian Soviet Socialist Republic of the U.S.S.R., formed in 1939 after the Soviet occupation of eastern Poland from parts of the Polish provinces of Lwow and Tarnopol (Ternopol). Covering 8,378 sq.mi. it lies in the western Ukraine adjacent to the present Polish frontier and extends from the crest line of the Carpathian mountains in the southwest, across the foothills and the upper Dniester valley, over the Roztoche watershed (the western end of the Volyno-Podolsk upland) and into the upper basin of the Western Bug. The southern half of the *oblast* was the separate Drogobych *oblast* until May 21, 1959. The varying relief gives rise to great variation in soil and vegetation. The northern half, in the Bug-Pripyat (Pripet) basin, lies in the southern mixed-forest zone, dominated by oak, hornbeam and other hardwoods on podsol soils, with pine in sandy areas. Much of the forest has been cleared. The upland area round the town of Lvov is forest-steppe on degraded chernozem soils. The Dniester valley has meadows along the river and the original light forest cover has largely been removed. The Carpathian slopes are densely forested, by beech lower down on brown earths, and conifers higher up on podsols. Summits, which are gently rounded, are in open alpine meadows, called *poloniny*, much used for pasture. The climate is moderately continental (Lvov city has a January average temperature of −4° C. [25° F.] and a July average of 18° C. [64° F.]), but there is a great local variation with relief. Precipitation is fairly high, 24–28 in. a year and rising to 40 in. in the mountains.

The population (1959 census) was 2,107,858. Of these, 837,930 (40%) were urban dwellers, half of them living in the administrative centre of Lvov (410,678). There are in all 35 towns and as many urban districts, all of small size. The rural population is concentrated most densely in the neighbourhood of Lvov and in the Dniester valley. The southern part of the *oblast* has a small but important oil field, centred on Borislav and Truskavets. In association with the field are large deposits of natural gas, which are being developed. Dashava is the main centre for natural gas and from there pipelines run to Lvov, Kiev and as far as Moscow, while a line to Leningrad was under construction in 1961. Potassium salts are also obtained in this area. Manufacturing is chiefly concentrated in Lvov, with Drogobych, Stry and Sambor as minor centres. In the Carpathians timber working is highly developed. Furniture making is widespread and at Zhidachov is the largest paper mill in the Ukraine. All the *oblast*, except the Carpathians, is under intensive agriculture. Rye is the chief crop, followed by wheat, maize (corn) and sugar beet. Stock-breeding, especially of cattle and sheep, is important in the mountains. (R. A. F.)

LVOV (Ukrainian LVIV; Polish Lwow), a town and *oblast* administrative centre of the Ukrainian Soviet Socialist Republic, U.S.S.R., lies in the western Ukraine on the Roztoche watershed between the Dniester and Western Bug basins, near the source of the Bug, 250 mi. W.S.W. of Kiev. Pop. (1959) 410,678. Founded in 1256 by the Galician prince Danilo (Daniel) Romanovich, the town has always been the chief centre of Galicia (*q.v.*). Its key strategic position on the great east-west route along the northern flank of the Carpathian mountains, controlling the low passes through the mountains into the Hungarian plain, has given Lvov a stormy history. Captured by the Poles in 1340, it remained in their hands until the first partition of Poland in 1772, when it passed to the Austrian empire and was renamed Lemberg. It returned to Poland in Nov. 1918. In Sept. 1939 the Soviet army occupied Lvov under terms of the Molotov-Ribbentrop treaty. It was later occupied by the Germans, but its possession by the U.S.S.R. was confirmed in 1945, when Lvov was created an *oblast* centre of the Ukraine. Industry has developed rapidly and the town manufactures omnibuses, loading machinery, agricultural implements, bicycles, electric lamps, telecommunications equipment, glass, textiles, foodstuffs, furniture, veneer, cardboard, paints and perfumery. Lvov is excellently served by the nine railways converging on the town (a reflection of its nodal position), which link it to all parts of the Ukraine, to Belorussia, Moldavia, Hungary, Czechoslovakia and Poland.

Lvov has always been an important centre of Ukrainian culture, which flourished there in tsarist times, when Ukrainian national feeling and language were suppressed in the Russian Ukraine. Its cultural significance still remains, and in this respect the city is probably second only to Kiev in the Ukraine. There is the Ivan Franko State university, founded in 1661, 11 other higher educational establishments, 28 special and technical schools and 70 general schools. Lvov has an opera house and five theatres and is a publishing centre. (R. A. F.)

LYALLPUR, a canal-colony town in the Sandal bar (Rechna Doab upland) and headquarters of Lyallpur district in the Sargodha division of West Pakistan. Pop. (1961) 425,248. Named after Sir James Lyall, lieutenant governor of Punjab, it was founded in 1892 as a market town and became the headquarters of the Lower Chenab colony, dependent on irrigation from the Lower Chenab canal. Eight main roads or bazaars radiate from the town's centre, where stands a clock tower, and terminate on the road which encircles the main town. In between the circular road and the clock tower is the Ring road (Gol bazaar), the main wholesale market for cloth, grains and ghee (clarified butter). With the increase in population after independence (1947), several new satellite towns sprang up. Situated in the midst of a cotton and wheat producing area, Lyallpur has grown into an important centre for the textile, hosiery and flour milling industries. Other chief products are vegetable oil, soap and sugar. Lyallpur is an important educational and cultural centre with six colleges affiliated to the University of the Panjab besides many schools. The well-known Panjab agricultural college became a university in 1961. There is a public park known as the Company Bagh and a separate enclosed park for women.

LYALLPUR DISTRICT was formed in 1904 of the lands in the Rechna Doab, carved out of the neighbouring districts of Jhang, Sheikhupura, Montgomery and Multan. Area 3,516 sq.mi.; pop. (1961) 2,683,838. It consists of a fertile plain, irrigated by the Lower Chenab canal. Cotton, wheat and sugar cane are the chief crops. Formerly in Multan division it now forms part of the new Sargodha division. (K. S. AD.)

LYAUTEY, LOUIS HUBERT GONZALVE (1854–1934), French marshal, a firm believer in the civilizing virtue of colonialism and the real builder of the protectorate over Morocco, was born at Nancy on Nov. 17, 1854. As a child he suffered a spinal injury but nevertheless did well at school and entered St. Cyr in 1873. The routine there disappointed him, but an army officer, Albert de Mun, aroused his enthusiasm for social reform; and by the time of his entry into the Staff college he was already helping the Catholic workingmen's clubs.

After service with a cavalry regiment at Châteaudun and six months' sick leave, Lyautey went to Algeria in 1880. He returned to France in 1882 and was made captain the next year. He expressed his royalist convictions to the comte de Chambord on a visit to Austria and was profoundly distressed when Pope Leo XIII, at an interview in Rome, showed himself well disposed to the French republican regime. As a strong Legitimist, however, he felt no sympathy for the Orleanists and so became readier to serve the republic after the comte de Chambord's death (Aug. 1883).

In command of a corps at St. Germain (1887), Lyautey paid special attention to his men's welfare. He also made a name for himself in literary circles and wrote an article for the *Revue des Deux Mondes* on the social role of the officer under universal military service; but after further posts at Gray and at Meaux, he found himself longing for action.

In Aug. 1894 Lyautey was sent to Indochina. At Tongking he met Joseph Galliéni, whose idea of conquest as a means of civilization he adopted and from whose experience he profited. When Galliéni summoned him to Madagascar, Lyautey went immediately, despite his liking for Tongking. With the rank of lieutenant colonel, he was given the task of pacifying one-third of the island. Colonel and commander of the forces in the south in 1900, Lyautey took only two years to conquer all that area.

Lyautey returned to France in 1902 and took command of the 4th hussars at Alençon. Then, in 1904, Célestin Jonnart, governor general of Algeria, obtained for him the post of commandant of the subdivision of Aïn-Sefra. Now general of brigade, Lyautey did not hesitate to encroach on Moroccan territory in order to round the frontier off. Jonnart protected him when Morocco protested to France, and Lyautey reduced the frontier tribes to obedience. Commandant of Oran from 1906, he continued insidiously pushing the frontier westward.

At the end of 1910 Lyautey was recalled to France to be commandant of the army corps at Rennes; but in April 1912 he was appointed resident general in Morocco, over which the French protectorate had just been proclaimed. Besieged in Fès by insurgent tribes, he extricated himself and then replaced the sultan Maulay Hafid by his more reliable brother Maulay Yusuf. He had now before him the task of conquering and pacifying the whole country; and in this he showed respect for local institutions. He had a sense of grandeur that appealed to the Arabs and showed discernment in his choice of assistants.

In July 1914, on the eve of World War I, the French government ordered Lyautey to withdraw from the interior of Morocco to the ports and thus release numbers of the occupying troops for service in France. Though he at once sent home the forces required of him, he yet was able to hold the whole country. Recalled to France to be minister of war (Dec. 1916–17), he then returned to Morocco. A member of the Académie Française from 1912, he was made a marshal of France in 1921.

Lyautey's achievement in Morocco was characterized by vitality and realism, but yet resulted in an "aristocratic" type of colonization. His reliance on the traditional structure of the administration and on Islam tended to preserve the old Morocco, while his imaginative policy of exploiting the country's economic resources, building roads and towns and developing the port of Casablanca was creating a new Morocco in contradiction with it.

After a long sick leave in 1923, Lyautey thought of leaving Morocco in 1924, when the parties of the left won the elections in France. Staying to face the revolt of Abd-el-Krim, he received little consideration from Marshal Pétain, whom Paul Painlevé's government sent out to command operations; and on Sept. 24, 1925, he resigned. Thereafter he lived at Thorey (Meurthe-et-Moselle), concerning himself with work for young people. His last public service was to organize the Colonial exhibition of 1931. Lyautey died at Thorey on July 21, 1934.

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LYCANTHROPY, a psychiatric state in which the patient believes he is a wolf or some other nonhuman animal (Gr. *lykos* "wolf" + *anthropos* "man"). Undoubtedly stimulated by the once widespread superstition that lycanthropy is a supernatural condition in which men actually assume the physical form of other animals, the delusion has been most likely to occur among people who believe in reincarnation and the transmigration of souls (*see* METEMPSYCHOSIS). Usually a person is deemed to take the form of the most dangerous beast of prey of the region: the wolf or bear in Europe and northern Asia, the hyena or leopard in Africa and the tiger in India, China, Japan and elsewhere in Asia; but other animals are mentioned too. Both the superstition and the psychiatric disorder are linked with belief in animal guardian spirits, vampires, totemism, witches and werewolves. The folklore, fairy tales and legends of many nations and peoples show evidence of lycanthropic belief.

Stories of men turning into beasts go back to antiquity. In parts of ancient Greece werewolf myths, presumably stemming from prehistoric times, became linked with the Olympian religion. In Arcadia, a region plagued by wolves, there was a cult of the Wolf-Zeus. Mt. Lycaeus was the scene of a yearly gathering at which the priests were said to prepare a sacrificial feast that included meat mixed with human parts. According to legend, whoever tasted it became a wolf, and could not turn back into a man unless he abstained from human flesh for nine years (*see* LYCAON).

The Romans also knew this superstition. Anyone who was supposed to have been turned into a wolf by means of magic spells or herbs was called *versipellis* ("turnskin") by the Romans.

Stories about the werewolf (in French, *loup garou*) were widely believed in Europe during the middle ages. Outlaws and bandits played on these superstitions by sometimes wearing wolfskins over their armour. At that time people were unusually prone to develop the delusion that they themselves were wolves; suspected lycanthropists were burned alive if convicted. Only rarely was their condition recognized as a psychological disturbance. Although the superstition no longer is common in the 1960s, traces still linger. *See* also WITCHCRAFT.

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LYCAON, a mythical king of Arcadia. At Mt. Lycaeus a very extraordinary ceremony, the Lycaea, in honour of Zeus Lycaeus took place; it is alleged (Plato, *Republic*, viii) that a man was sacrificed and his entrails put with those of more usual victims; that anyone who tasted them became a wolf (*lykos*); later authors add that the man thus transformed belonged to a particular clan, and that he remained a wolf for nine years (a sacred number), after which he might become a man once more if in that time he had not tasted human flesh again. The whole story is suggestive of the Lion and Leopard societies of Africa.

In explanation the following story was told (Ovid, *Metamorphoses*, i, 209–243): Lycaon, in early days, was an impious and cruel king. Having occasion to entertain Zeus, he, or his sons, set before the god human flesh (in some versions, the flesh of Lycaon's own son, Nyctimus). The god was not deceived, and in wrath caused the deluge which in Deucalion's time devastated the earth (*see* DEUCALION). It has been suggested that behind the figure of Lycaon is concealed some ancient local god, afterward identified with Zeus; the theory is in no way impossible, but it leads little further, since there is no agreement as to the nature of the supposed god. *See* also LYCANTHROPY.

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LYCAONIA, an ancient region in the interior of Asia Minor, north of the Taurus mountains, corresponding to the south central part of modern Turkey, bounded on the east by Cappadocia, on the north by Galatia, on the west by Phrygia and Pisidia, and on the south by Cilicia Tracheia. Iconium (Konya), which according to Xenophon was the last city of Phrygia visited by Cyrus on his eastward march, became chief city of Lycaonia in Seleucid times, and capital of the tetrarchy of Lycaonia in the 1st century B.C. In the 1st century A.D. the Roman administration distinguished between the eastern part of Lycaonia, which was governed by King Antiochus IV, and that part which formed a region of the province of Galatia. The words of Acts xiv, 6, where Paul is said to have fled from Iconium "to Lystra and Derbe, cities of Lycaonia," imply that while Iconium was considered to be in the Phrygian region of the province of Galatia, Lystra and Derbe lay in the Lycaonian region of that province.

Lycaonia is described by Strabo as a cold region of high plains, affording pasture to wild asses and to sheep. Amyntas, king of Galatia, to whom the district was for a time subject, maintained there not less than 300 flocks. It forms part of the interior tableland of Asia Minor, and has an elevation of more than 3,000 ft. The plain is interrupted by some minor groups of mountains, of volcanic character, of which the Kara Dagh in the south rises above 7,000 ft. Experiencing great extremes of temperature and only a moderate rainfall, it is still largely ranching country. But extensive irrigation works have rendered fertile districts near Konya and Eregli, where both surface and subterranean water seeps down from the Taurus range.

The Lycaonians were to a great extent independent of the Persian empire, and were, like their neighbours, the Isaurians, wild and lawless freebooters; but their country was traversed by one of the great high roads through Asia Minor, from Ephesus to the Cilician Gates, and a few considerable towns grew up along or near this line, notably Iconium, Laodicea Combusta (Ladik) and Laranda (Karaman). Derbe and Lystra, which appear from the Acts of the Apostles to have been considerable towns, were between Iconium and Laranda, Lystra being about 1 mi. N.W. of modern Hatunsaray; the site of Derbe is disputed. Lycaonia was Christianized very early, and its ecclesiastical system was more completely organized during the 4th century than that of any other region of Asia Minor. Its administration and grouping changed often under the Romans, and in the early Christian era it was largely included in the province of Galatia; St. Paul's Epistle to the Galatians was, in the opinion of some scholars, addressed to the churches of southern Lycaonia. About A.D. 371 Lycaonia was formed into a separate province.

The Lycaonians appear to have retained a distinct nationality in the time of Strabo, and were probably one of the aboriginal peoples of Asia Minor. The mention of the Lycaonian language in the Acts of the Apostles (xiv, 11) shows that the native language was spoken by the common people at Lystra as late as A.D. 50.

(WM. C. B.)

LYCÉE (FRANCE), a state-maintained secondary school in the French educational system; municipally maintained secondary schools are known as *collèges*. *See* SECONDARY EDUCATION; EDUCATION, HISTORY OF; FRANCE: *Administration and Social Conditions: Education.*

LYCEUMS AND CHAUTAUQUAS. The first lyceum in the United States was founded in 1826 in Millbury, Mass., by Josiah Holbrook, a teacher and lecturer. Named from the place where Aristotle lectured to the youth of ancient Greece, the lyceums were voluntary local associations that gave the people an opportunity to hear debates and lectures on topics of current interest. Thus they constituted an early form of organized adult education in the United States. The lyceums multiplied rapidly after 1826, chiefly in New England, New York and the middle west. By 1834 there were nearly 3,000 local groups, many of which were organized in a national association known as the American Lyceum. One of the major topics discussed at lyceum meetings in the early years was the establishment of public schools.

At first the lyceums were local ventures with speakers supplied by the community. By 1840 the lyceums had become professionalized institutions with outside lecturers to whom fees were paid. Among the well-known speakers who traveled from state to state addressing local lyceums were Ralph Waldo Emerson, Henry David Thoreau, Daniel Webster, Henry Ward Beecher, Nathaniel Hawthorne and Susan B. Anthony. A number of Emerson's essays were originally written as lyceum lectures. The local lyceums continued to flourish until the Civil War. Musicians, elocutionists, readers and other entertainers were added to the lyceum programs. After the Civil War the lyceum movement came under the management of bureaus founded as commercial enterprises. One of the largest of these organizations was the Boston Lyceum bureau, later known as the Redpath Lyceum Bureau, founded in 1868 by James Redpath.

A parallel movement arose after the Civil War in the chautauqua, which originated at Fair Point on Chautauqua lake in New York state. In 1874 the Rev. John H. Vincent, aided by Lewis Miller of Akron, O., organized an assembly for the training of Sunday school teachers and church workers at Fair Point. This first assembly developed into an annual affair, and the name of the meeting place was known after 1876 as Chautauqua. At first the annual assemblies were entirely religious in nature, but gradually the program was broadened to include general education and popular entertainments. In the beginning the Chautauqua programs were organized to enable teachers and church workers to advance their education during the summer vacation months. In later years the summer lectures and classes were supplemented by a program of directed home reading and correspondence study. William Rainey Harper, later president of The University of Chicago, became educational director in 1883 and attracted outstanding speakers. By 1900 the Chautauqua assembly included a school of theology, a correspondence school and a publishing house. William Jennings Bryan went there year after year to deliver his "Cross of Gold" speech. Tents were used for many years to house the people who attended the annual sessions, but by 1900 a number of hotels and permanent homes had been constructed. Dramatic performances were frowned upon until 1911 when Shakespearean plays were performed for the first time.

The success of the Chautauqua, N.Y., assembly led to the founding of many "chautauquas" throughout the United States pat-

terned after the original institution. By 1900 there were over 400 such local assemblies. The lyceum booking agents entered the chautauqua field, supplying the lecturers and musicians who traveled from one community to another. In the peak year of 1924 the traveling chautauquas visited approximately 10,000 communities and were attended by over 40,000,000 persons.

The circuit chautauquas declined after 1925, and by 1932 less than 300 U.S. communities were visited by them. The decline of the chautauqua has been attributed to: (1) motion pictures and radio, which supplied competing entertainment; (2) automobile transportation, which enabled people to travel to larger centres; (3) the greater sophistication of the public; and (4) the service and luncheon clubs, women's clubs and similar groups that absorbed the time and interest formerly devoted to the chautauqua. The original institution at Chautauqua remained in existence, however, offering a diversified program that included symphony concerts, operas, plays, university summer school courses and outstanding lecturers.

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LYCHNIS, a genus of plants of the pink family (Caryophyllaceae; *q.v.*), including numerous species, several of which are cultivated and are called campion or catchfly. The Maltese cross (*L. chalcedonica*), three feet high, has dense heads of bright scarlet flowers, both single and double. The crown campion (*L. coronata*), one to two feet high, has clusters of scarlet, crimson, pink and white flowers.

Other garden species are *L. fulgens* and *L. haageana*. *L. flos-cuculi* is the ragged robin or cuckoo flower. Several species are native to western North America, including *L. drummondi*, found from Manitoba to Nebraska and west to the Pacific coast. All are hardy herbaceous perennials.

LYCIA, an ancient district in southwestern Asia Minor, occupying the coast between Caria and Pamphylia, and extending inland as far as the ridge of Mt. Taurus. At present, most of Lycia forms part of the Turkish *il* of Antalya. It is a rugged, mountainous country and the coast is indented by a succession of bays, the most marked of which is the Gulf of Fethiye in the extreme west. A number of smaller bays and broken, rocky headlands, with a few small islets, constitute the coastline thence to the southeast promontory of Lycia, modern Gelidonya Burnu. Though the mountain ranges of Lycia are all offshoots of Mt. Taurus, in ancient times several of them were distinguished by separate names. Such were Daedala in the west, adjoining the Gulf of Fethiye; Cragus on the seacoast, west of the valley of the Xanthus; Massicytus (10,000 ft.), nearly in the centre of the region; and Solyma in the extreme east above Phaselis (7,800 ft.). The steep and rugged pass between Solyma and the sea, called the Climax ("ladder"), was the only direct communication between Lycia and Pamphylia. The only considerable rivers are the Xanthus, which descends from the central mass of Mt. Taurus, and flows through a narrow valley till it reaches the city of Xanthus, below which it forms a plain of some extent before reaching the sea, and the Limyrus, which flows into the Gulf of Finike. The small alluvial plains at the mouths of these rivers are the only level ground in Lycia, but the hills that rise thence toward the mountains are covered with thick scrub and pine forests. The upper valleys and mountainsides afford good pasture for sheep, and the main Taurus range encloses several extensive upland basin-shaped valleys (*yailas*). (*See* Asia Minor.)

According to Artemidorus (*c.* 100 B.C.), 23 towns made up the Lycian league; but Pliny states that Lycia once possessed 70 towns, of which only 26 remained in his day (1st century A.D.). Recent researches have confirmed that the coast and the valleys were studded with towns. On the Gulf of Fethiye stood Telmessus, while a short distance inland were the small towns of Daedala and Tadyanda. At the entrance of the valley of the Xanthus were Patara, Xanthus (*q.v.*) itself, and, a little higher up, Pinara on the west and Tlos on the east side of the valley. Myra (*q.v.*), one of the most important cities of Lycia, occupied the entrance of the Andriacus valley; on the coast between this and the mouth of the Xanthus stood Antiphellus, while in the interior, at a short distance, were Phellus, Cyaneae and Candyba. In the alluvial plain formed by the Arycandus and Limyrus rivers stood Limyra. Arycanda commanded the upper Arycandus valley. On the east coast stood Olympus, one of the cities of the league, while Phaselis, a little farther north, which was a much more important place, never belonged to the Lycian league and appears always to have been independent.

History.—According to Greek tradition, apparently derived from Hecataeus (*c.* 500 B.C.), the builders of the monumental walls and galleries of Tiryns had been Cyclopes from Lycia, sent together with an army by the king of the Lycians to secure Tiryns for his daughter, several generations before the Trojan War. This queen also appears in the story of Bellerophon (*q.v.*), who was sent from Tiryns to Lycia bearing a letter containing the "sinister script." The story is told in Homer's *Iliad*, where the Lycian army and its leaders Glaucus and Sarpedon play a prominent part in the Trojan War.

These early Lycians are frequently mentioned in Egyptian, Hittite and Ugaritic records of the 14th and 13th centuries B.C. According to the Amarna tablets the Lycian fleet conducted yearly raids on Cyprus; in the inscription of Ramses II the Lycians form an important part of the Hittite army at the battle of Kadesh; the archives of Ugarit indicate Lycian sea raiders, while one record says the whole Ugaritic fleet is off the Lycian coast. The Hittite documents show the Lycians well established on the west coast of Asia Minor and name a number of Lycian cities situated between the Hittite power and the encroaching Achaeans (Ahhiyawa; *see* Hittites: *History*). The Lycians are described as Hittite vassals, but their cities often seem to contain pro-Achaean factions and are governed not by kings but by city elders. The role played by the Lycians in the final collapse of the Hittite empire is uncertain.

When written records appear again in the Aegean area, the Greeks have strung their colonies along the west coast of Asia Minor, and the Lycians are confined to Lycia proper. Both Phrygians and Lydians failed to subdue Lycia, but after the fall of the Lydian kingdom under Croesus (*c.* 546 B.C.) the Lycian cities were conquered by Harpagus, the general of Cyrus, after a heroic resistance described by Herodotus. But while acknowledging the suzerainty of Persia, the Lycians contrived to remain practically independent and for a time even joined the Delian league. They were later incorporated into the empire of Alexander the Great. Even after their conquest by the Romans, however, they enjoyed a relative freedom and preserved their federal institutions as late as the time of Augustus. Under Claudius, Lycia was annexed (A.D. 43) to the Roman empire and united with Pamphylia as a province; it became a separate province in the 4th century.

Archaeology.—Numerous large mounds (*hüyük*) on the high plateau of inner Lycia reveal a settled population early in the Bronze Age. They are offshoots of cultures farther north, decreasing and disappearing when within reach of the coast. American excavations at Elmali began in 1963. The coastal areas of Lycia were not settled in the Bronze Age, as shown by excavations at Xanthus and Antiphellus. The occupation of the country by the Lycians is of somewhat later date and, since the Lycian inscriptions are not found far inland, it may be concluded that they entered the country from the sea. The alphabet of Lycia was derived from the Doric alphabet of Rhodes, with an admixture of Anatolian characters, some of which seem to have retained their syllabic values. The Lycian language has now been proved beyond doubt to belong to the Luvian group. (*See* Anatolian Languages.)

Monuments discovered in Lycia during the 19th century were transported to the British museum, and include examples of a very distinct native architecture. Its characteristic features are displayed in the various types of sepulchral structures, such as the pillar-tombs where the burial chamber is at the top of a tall, square tower, surrounded by reliefs, or the large sarcophagi with pointed arches, often sculptured and, like many façades of rock-

cut tombs, closely imitating wooden structures. This is indeed the most striking aspect of Lycia: the innumerable tombs and funerary monuments strewn over the whole countryside, particularly in the coastal areas, and always placed in conspicuous positions. But the temples and theatres found in almost every town, some of them very large, are sufficient to attest the influence of Greek civilization; and this is confirmed by the sculptures which are for the most part Greek in style.

Among the distinctive social customs of the Lycians, as described by Herodotus and confirmed by evidence from inscriptions, is their stress on matrilineal descent and the special status of the sister's son. Their political institutions are based on federal organization. The focal points of their religion were the cults of Apollo and Artemis, whose birthplace was considered to be the Letoon, between Xanthus and Patara. French excavations began in 1950 at Xanthus and in 1963 at the Letoon.

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(F. J. Tr.)

LYCOPHRON (3rd century B.C.), of Chalcis in Euboea, Greek poet and scholar, is best known because of the attribution to him of the extant poem *Alexandra*. He was invited to work on the comedies in the Alexandrian library (*c.* 285 B.C.) and wrote a treatise on comedy. He also wrote numerous tragedies, of which only a few fragments survive. The *Alexandra* is in form a messenger's speech in tragic iambics in which the prophecies of Cassandra are reported. The poem carries the cult of erudition and obscurity to extremes; the material is recondite; the vocabulary is exotic; the style is affected; and the names of gods and men are disguised by cult-title or riddling periphrasis. Considerable historical interest attaches to the references to Rome and the West, which have been thought to be more in keeping with the historical situation in 197 B.C. than with that a century earlier. On this ground it has been forcibly argued that the *Alexandra* is by a later author than the tragedian Lycophron.

See edition with Eng. trans. by A. W. Mair, *Callimachus and Lycophron* (1921), in the "Loeb Series." *See* also K. Ziegler in Pauly-Wissowa *Real-Encyclopädie der classischen Altertums wissenschaft*, vol. 13, col. 2316–81 (1927). (Ar. Ca.)

LYCOPODIUM, a genus of mosslike near-herbs, commonly called ground pine or club moss. It is one of two living genera of the Lycopodiaceae, a family of the Lycopsida, a subdivision of the vascular plants comprising the club mosses and their allies, fossil and living. Probably 200 or more species exist, nearly cosmopolitan in distribution, but most abundant in the tropics. The 13 species found in North America occur most abundantly in the cool, wooded regions of the eastern United States and Canada. The Pacific coastal states and adjacent parts of Canada have only nine of these species. Great Britain has five, chiefly in mountainous districts.

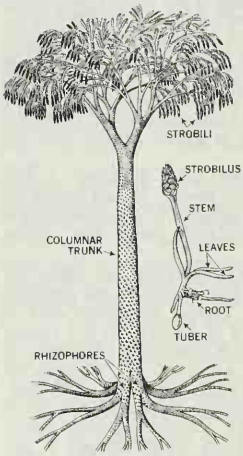
The lycopods are spore bearers; their stems, covered with small, simple leaves, more or less spirally arranged, may be erect, prostrate, creeping, or epiphytic and pendent. No lycopod stem has a cambium. The fertile leaves (sporophylls) may be somewhat similar to the vegetative leaves, in which case they are present in alternating zones on the stem, or they may be aggregated in conical strobili at the tips of branches. In this case, the sporophylls may differ markedly in size and shape from the vegetative leaves. Each sporophyll bears on its upper surface a single, kidney-shaped spore case (sporangium) which produces large numbers of thick-walled, cutinized spores. Very few of these spores appear to germinate in nature. The evidence suggests an inability to absorb water. Scarifying the spore wall or centrifuging the spores in water at considerable speed causes many more to germinate.

When grown on a sugar-mineral salt nutrient medium, the germinated spores grow well and all species tried produce green, much-branched, rhizoid-bearing, hermaphroditic prothallia. By contrast, in the limited number of cases described from nature since the mid-19th century, the prothallia are green and branched if on the surface of the ground or somewhat colourless and fleshy if below. The prothallia of all species described prove to have an endophytic fungus in symbiotic relation, possibly obligate.

The small size of the spores of *Lycopodium* and their high content of finely divided oil droplets make for inflammability. They have been used, as lycopodium powder, in fireworks and in flashlight photography.

See also Paleobotany. (R. H. We.)

LYCOPSIDA, a class (or subphylum) of spore-bearing vascular plants comprising the club mosses and their allies, living and fossil. Present-day lycopsids are grouped into four genera and 900–1,000 species of wide distribution but especially numerous in the tropics: *Lycopodium*, the club mosses or "ground pines"; *Selaginella*, little club mosses or spike mosses; the small, fleshy unique plant *Phylloglossum;* and *Isoetes*, the quillworts. These genera include diminutive creeping or shrubby plants. Representative extinct genera are *Lepidodendron* and *Sigillaria*, the tree lycopods, and *Protolepidodendron*, a herbaceous *Lycopodium*-like plant. Lycopsids are known from rocks of Silurian Age (about 350,000,000 years ago) of the Paleozoic era. The remains of *Lepidodendron* and other extinct lycopods form most of the great coal beds of the world.



FROM A. FOSTER AND E. GIFFORD, "COMPARATIVE MORPHOLOGY OF VASCULAR PLANTS," W. H. FREEMAN AND CO., SAN FRANCISCO, 1959

FIG. 1.—LEPIDODENDRON, LARGEST EXTINCT LYCOPSID, WHOSE COLUMNAR TRUNK ROSE 100 FT. OR MORE, AND PHYLLOGLOSSUM, SMALLEST LIVING LYCOPSID, AN HERBACEOUS PLANT ONLY A FEW INCHES HIGH

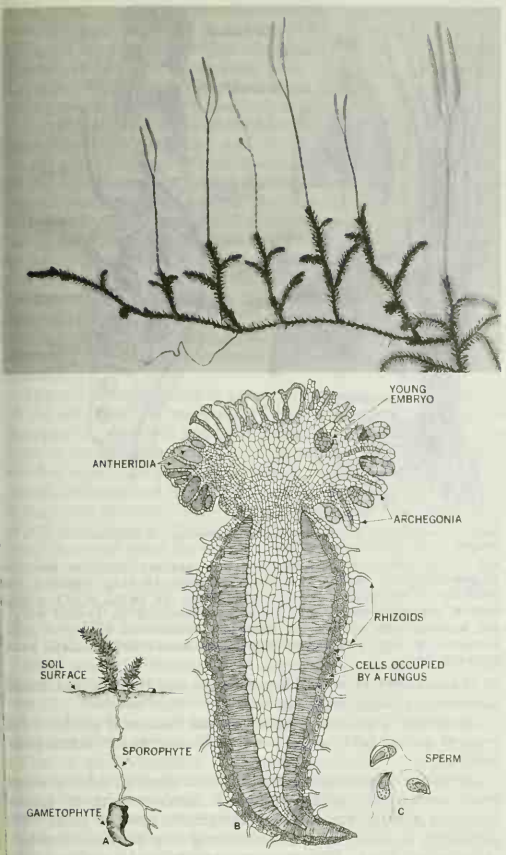
General Features.—All members of the class share certain morphological characteristics. Branching is fundamentally dichotomous, that is, the shoot tip forks repeatedly. The two branches that result may become equal in length or one may become longer than the other. The leaves are generally small, although they did achieve the length of one metre in the giant lycopod, *Lepidodendron*. Generally each leaf is narrow and has an unbranched midvein, the type of leaf referred to as a microphyll, in contrast to the megaphyll of the ferns and seed plants (Pteropsida), which generally has branched venation. The sporangia occur singly on the upper side facing the stem (adaxial side) of the leaf (sporophyll).

The Lycopsida in general are characterized by the occurrence of strobili. A strobilus is an aggregation of sporophylls usually tightly appressed, forming a definite conelike structure. The vascular tissue in the stem may occupy the centre of the axis (protostele) or form a cylinder around a central pith (siphonostele). There are no interruptions in the vascular cylinder where vascular strands diverge to leaves, as is true for the Pteropsida.

There are variations in the Lycopsida in the occurrence of secondary growth, types of spores produced, types of gametophytes (the inconspicuous sexual stages) and other details. The following discussion pertains mainly to orders with living members.

Survey.—*Lycopodiales.*—This is an order of one family, consisting of two living genera (*Lycopodium* and *Phylloglossum*) and one extinct form known from cones only and perhaps referable to *Lycopodium* (*Lycopodites*). The club mosses (*Lycopodium*) include about 200 species, most of which occur in the tropics. They prefer acid conditions and open, semi-shady locations associated with forests. *Phylloglossum*, a highly specialized plant that dies down at each dry season and cannot be found until the next wet season, is restricted to Australia; an individual plant may be only three to five centimetres tall, and consists of only a few leaves and a strobilus.

In growth habit the sporophytes (the conspicuous asexual



OTTOM REDRAWN FROM "A TEXTBOOK OF GENERAL BOTANY," FIFTH EDITION, BY GILBERT M WITH ET AL., BY PERMISSION OF THE PUBLISHER. COPYRIGHT 1953 BY THE MACMILLAN COMPANY

IG. 2.—LYCOPODIUM CLAVATUM. (TOP) GROWTH HABIT OF SPOROPHYTE, HOWING RHIZOPHORES AND UPRIGHT BRANCHES WITH STROBILI ARISING ROM PROSTRATE STEM; (BOTTOM) UNDERGROUND GAMETOPHYTE; (A) EN- IRE VIEW; (B) SECTION ENLARGED; (C) SPERM PRODUCED BY ANTHERIDIA

tages) of species of *Lycopodium* may arise erect from a rhizome ystem or creep in habit. Many are epiphytes; *i.e.*, they grow ttached to tree branches or other supports. Branching is funda- ientally dichotomous, but in species with well-developed rhizomes, ne branch of a dichotomy usually becomes much longer and rger than the other one and remains close to the substrate. The horter one may undergo several limited dichotomies and the ltimate upright branches terminate in strobili. The leaves may e spirally arranged or grouped in four vertical rows along the hoot. Each leaf, from two millimetres to almost three centi- ietres in length, has a single unbranched midvein (microphyll). dventitious roots, initiated near the shoot tip, may grow vertically ithin the stem cortex for some distance before emerging. The ots branch dichotomously but no extensive root system is rmed. In terrestrial species the roots have root hairs that func- on for a long time.

The stem is protostelic (without a central pith), but there is eat variety in the disposition of xylem and phloem in the central scular cylinder. Sporophylls may be aggregated into definite robili or there may be simply "fertile" and "sterile" regions ong a stem, the sporophylls resembling vegetative leaves. Often e sporophylls of compact strobili are quite different from the vegetative leaves of the same plant. The kidney-shaped sporangia are yellow or orange and have short stalks. Reduction division (meiosis) occurs in the sporangium; thus the small tetrahedral spores have the haploid chromosome number. Spore morphology has become important in delimiting subgroups in the genus. (*See* also LYCOPODIUM.)

Although gametophytes are rarely found in nature, enough is known about them to recognize two types, based principally upon the mode of growth and nutrition. In some species the gametophyte, which develops from a spore, becomes a small, green plant growing on the surface of the soil; the time interval between spore germination and sexual maturity of the gametophyte may be eight months to one year. In other species, including nearly all those of the north temperate zone, the gametophyte is slower growing, and is dependent upon an associated fungus for continued growth. The plant may become carrot shaped or disc shaped (one to two centimetres in length or width); it is yellow to brown, but apparently can develop chlorophyll if the plant is growing near the soil surface where light can reach it. Generally a gametophyte of this type remains subterranean, and five or more years are required before it becomes sexually mature. Gametophytes are monoecious (the sperm-producing antheridia and the egg-producing archegonia occur on the same plant). Fertilization is accomplished by the biflagellate sperm (antherozoid) swimming to the archegonium. The embryo, or young sporophyte, consists of a shoot, root and haustorial "foot." One gametophyte may "support" more than one sporophyte for a period of time; but ultimately the sporophyte becomes physiologically independent of the gametophyte, and the latter dies.

Some information has accumulated on chromosome numbers in *Lycopodium*. In two species the sporophyte chromosome numbers are 28 and 156. For one species, *L. selago*, the large number of 260 has been reported. *Phylloglossum*, the very small, reduced plant, is reported to have 502 to 510 in each nucleus. Only a few ferns have higher numbers of chromosomes for vascular plants. (Large chromosome numbers are often considered to reflect the great antiquity of a group.)

Selaginellales.—One family and two genera (one fossil, one extant) constitute the order. In such a monotypic group the characteristics of the order, family and genus are the same. The living species are in the genus *Selaginella*, and the fossils are assigned to the genus *Selaginellites*. *Selaginella*, the small club mosses, with about 700 species, is of greatest diversity in the tropics. Whereas species of *Lycopodium* prefer acid soils, *Selaginella* may be found in alkaline situations; a few species, called resurrection plants, survive the rigours of desert habitats. The foliage leaves, only a few millimetres long, may be dark green or bluish and in some species are iridescent. As in *Lycopodium*, branching is fundamentally dichotomous. The sporophyte may consist of several upright branches from a rhizome, prostrate branches creeping along the surface of the soil or large, flat, erect frondlike side branches from strong rhizome systems. The entire branch system is often considered to be just a leaf upon casual observation by the untrained observer.

One of the distinctive features of *Selaginella* is the rhizophore, a proplike structure that originates at points of branching and that

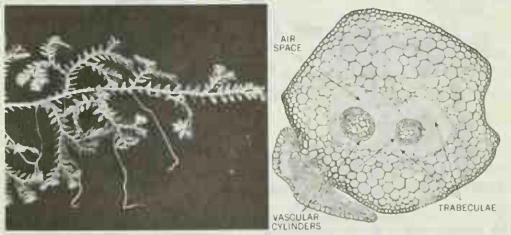


FIG. 3.—SELAGINELLA KRAUSSIANA. (LEFT) CREEPING HABIT, WITH PROSTRATE STEM GIVING RISE TO RHIZOPHORES AND LEAFY BRANCHES; (RIGHT) CROSS SECTION OF STEM SHOWING PROTOSTELIC CONDITION OF VASCULAR SYSTEM

forms roots upon contacting the soil or a hard surface. Rhizophores are most readily seen in scrambling or scandent species. Morphologically the rhizophore is a leafless stem that in its early stages of development can give rise to leafy branches if the normally leafy branches of a dichotomy are cut off. The leaves are arranged as in *Lycopodium*, the occurrence of four vertical rows being common. Anisophylly (the occurrence of two sizes of leaves) is common in creeping and strongly rhizomatous species. As the rhizophore is a distinctive feature for *Selaginella*, so is the presence of an unusual structure on the adaxial side of a leaf. This is the ligule, a peculiar tonguelike outgrowth from the leaf surface near the leaf base. Leaves of *Lycopodium* and *Selaginella* can be distinguished on this basis. The structure can be observed in young leaves with a moderately good hand lens. The ligule appears very early in the development of a leaf. At maturity it is a surprisingly complex structure. The evolutionary origin and homology of the ligule are obscure. Functionally, it is believed that they are secretory organs that, by exuding water and possibly mucilage, serve to keep young leaves and sporangia moist. They are short-lived structures, becoming shrunken and inconspicuous in older leaves.

The protostele is the prevailing type of vascular cylinder with only a few species being siphonostelic. In protostelic types there may be two or more vascular cylinders at a given level in the stem. However, these seemingly independent vascular strands are interconnected at points of branching of the stem. The vascular cylinders are usually supported in an air space by trabeculae—elongated endodermal cells or strands of cortical cells.

Definite strobili are formed in *Selaginella*, and the sporophylls generally differ from the vegetative leaves, but not as much as in the species of *Lycopodium* that form definite strobili. There are two types of sporangia, termed microsporangia and megasporangia, and the sporophylls associated with them are termed microsporophylls and megasporophylls. A mature microsporangium may be red, yellow or brown, from the colour of the microspores within the sporangium. Megasporangia are usually a pale green or whitish. Numerous microspores are produced, and cell division within the microspore wall initiates male gametophyte development. These divisions may occur before the spores are shed from the microsporangium. Final development of the "male" gametophyte, or microgametophyte, usually occurs on the soil prior to the release of biflagellate sperms. Usually only four large megaspores are produced in a megasporangium because meiosis occurs in only one functional spore-mother-cell. Development of the "female" gametophyte, or megagametophyte, may also begin while the megaspore is still within the megasporangium: free nuclear divisions (without wall formation) occur for a time, but ultimately walls appear and the megagametophyte ruptures the megaspore wall. These final stages in development usually occur on the soil after the megaspore with the enclosed female gametophyte is shed from the megasporangium. Fertilization occurs when a biflagellate sperm swims to an archegonium. The young sporophyte remains

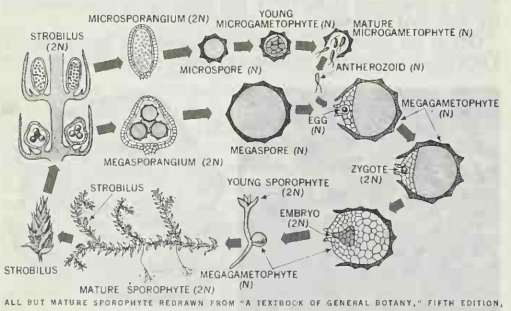


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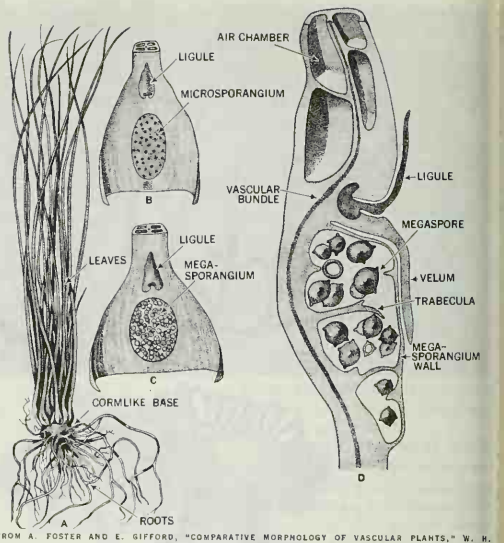
FIG. 4.—LIFE CYCLE OF SELAGINELLA. CHROMOSOME COMPLEMENT INDICATED AS DIPLOID (2N) OR HAPLOID (N)



FROM A. FOSTER AND E. GIFFORD, "COMPARATIVE MORPHOLOGY OF VASCULAR PLANTS," W. H. FREEMAN AND CO., SAN FRANCISCO, 1959

FIG. 5.—ISOETES: (A) SPOROPHYTE; (B) ADAXIAL VIEW OF BASE OF MICROSPOROPHYLL SHOWING MICROSPORANGIUM AS SEEN THROUGH THE OPENING IN THE VELUM (SPORES ARE SHOWN AS SMALL BLACK SPECKS WITHIN THE SPORANGIUM, THE ENDS OF TRABECULAE AS LARGER DOTS); (C) ADAXIAL VIEW OF BASE OF MEGASPOROPHYLL WITH ATTACHED MEGASPORANGIUM; (D) LONGITUDINAL SECTION OF MEGASPOROPHYLL AND MEGASPORANGIUM

in physical contact with the megaspore and the enclosed female gametophyte tissue for some time.

Selaginella is said to be heterosporous because it produces two types of spores that give rise to two different types of sexual gametophytes.

Isoetales.—This order consists of one family and the extant genus *Isoetes*, the quillworts, which number about 65 species. *Isoetes* is a most interesting and enigmatic vascular plant. The plant body is relatively small, consisting of a short axis and tufts of leaves and roots. Many species are mistaken for certain aquatic grasses, which are seed plants. The majority of species occur in the cooler climates of the world and are usually immersed continually in water. Each leaf is in reality a sporophyll, bearing either a microsporangium or a megasporangium at its base on the adaxial side. Each leaf also has a ligule, a morphological feature similar to *Selaginella*. *Isoetes* differs from both *Selaginella* and *Lycopodium* in the occurrence of secondary growth in the stem and in the possession of a definite root-producing meristem that gives rise to sets of roots in a definite sequence. Annual top growth rises from a cormlike base that persists from one growing season to the next. The general processes of sexual reproduction are very similar to those in *Selaginella*, except that many more spores are formed per sporangium. In fact, the microsporangia of some species are the largest in vascular plants and produce immense numbers of spores.

A discussion of the extinct order Lepidodendrales can be found in PALEOBOTANY.

See A. S. Foster and E. M. Gifford, Jr., *Comparative Morphology of Vascular Plants* (1959); K. Esau, *Anatomy of Seed Plants* (1960); T. Delevoryas, *Morphology and Evolution of Fossil Plants* (1962).

(E. M. GI.)

LYCURGUS, the lawgiver traditionally responsible for most of the institutions of ancient Sparta. For the institutions, *see* SPARTA; the primary problem about Lycurgus is the extent to which he can be regarded as a historical person and about the use that was made of his name.

The 7th-century Spartan poet Tyrtaeus, though he paraphrased

a document later associated with Lycurgus, certainly did not mention his name (he would have been quoted if he had, in view of the great interest later writers took in the lawgiver). Herodotus repeats an oracle of unknown date, ostensibly addressed to Lycurgus, which shows Delphi in doubt whether to treat him as god or man but inclining to the former: when this oracle was given, there can have been little definite historical information about him. Simonides (*c.* 556–468/467 B.C.) knew the tradition that he belonged to the Eurypontid royal house, but Herodotus in the middle of the 5th century was told at Sparta that he was an Agiad, and regent for his nephew Leobotes (a very early king). He was also told that Lycurgus brought most of his institutions from Crete, but he had heard elsewhere that they were brought from Delphi. In the next generation Thucydides, without naming Lycurgus, said that the Spartan constitution had not been altered since a date in the late 9th century; whereas Hellanicus seems to have ascribed Sparta's institutions to the legendary Dorian founders Eurysthenes and Procles. Later Xenophon, ascribing everything to Lycurgus, apparently thought him contemporary with the original Dorian foundation.

Thereafter the authorities are more consistent. By the middle of the 4th century it was accepted that Lycurgus belonged to the Eurypontid house and had been regent for Charillus, some steps lower in the genealogy than Leobotes, and on this basis hellenistic scholars dated him to the 9th century. This date held the field, though Aristotle had found his name on an inscription purporting to guarantee the truce for the Olympic games, traditionally founded in 776, and Timaeus (3rd century) took refuge in the thesis that there were two great figures named Lycurgus, at different dates. The story of the 9th-century reformer was further elaborated, and when Plutarch (1st–2nd century A.D.) came to write his life there was plenty of material, including his journeys to Egypt and elsewhere, and his bringing of the poems of Homer to Sparta. The bulk of the *Life* is naturally devoted to his reforms.

Some modern historians have accepted the ascription of most Spartan institutions to a reformer named Lycurgus in the 9th century. But the confident dates and details given by the later sources may reasonably be suspected, in the light of the variety and uncertainty of writers before 400 B.C. The Greeks found it easiest to discuss political and social institutions in terms of the personal intentions of a single founder—the peculiarity of Spartan institutions gave a special interest to the discussion of Lycurgus' intentions—and their ascription of particular institutions to particular founders is not always to be trusted. Thus it is asserted with equal confidence that Lycurgus instituted the office of ephor (*q.v.*), and that it was set up many years after his death: Xenophon ascribed to Lycurgus an organization of the army which almost certainly belongs to the 5th century: and it seems that the 3rd century reformers Agis IV and Cleomenes III used his name freely to sanction in detail their plans for redistribution of land. Even the admittedly archaic institutions are not necessarily all of the same date. Many scholars believe that an important group of reforms was carried out in the 7th century. If these reforms were, as seems likely, attributed to a Lycurgus at the time, this will be the Lycurgus of Herodotus' oracle, a shadowy figure of the past whose name was used to give authority to the reforms.

Herodotus reports that there was a shrine and cult of Lycurgus at Sparta in his day, as there was also later, and it has been supposed that he was originally a local god or hero, either a light-god or a wolf-god according to the derivation given to his name. The supposition, though possible, is not necessary: but there seems to be little advantage in arguing the question whether there was an actual person called Lycurgus or not.

See the ancient authorities referred to above, especially Plutarch's *Life;* and articles GREECE: *History* and SPARTA.

(A. As.)

LYCURGUS (*c.* 390–324 B.C.), Athenian statesman and orator, was noted for his efficient financial administration and his rigorous prosecutions of public malefactors. He came from the ancient family of the Eteobutadae. He supported Demosthenes (*q.v.*) in opposing Macedonian expansion, but first became prominent in 338. During the 12 years which followed the Athenian defeat at Chaeronea (338–326) he controlled the state finances either directly or through his nominees. He is said to have increased the annual public revenues from 600 to 1,200 talents. His other activities included reforming the constitution of the army, remodeling the fleet, repairing dockyards and finishing the arsenal designed by the architect Philo. He carried out an extensive building program, prominent in which was the reconstruction in stone of the Dionysiac theatre (*see* ATHENS). An interesting item of his legislation was a measure to make and preserve official copies of the plays of the three great tragedians, Aeschylus, Sophocles and Euripides.

Lycurgus looked beyond the material improvement of Athens. He was inspired by a mission to raise the level of public and private morals. Himself an austerely pious man, he relentlessly demanded the same standards from others. Apart from fostering religious cults and traditions, he brought numerous prosecutions against those who had failed in their duty toward god or state.

Fifteen of his speeches existed in ancient times. Apart from minor fragments, only one, *Against Leocrates,* has survived. Leocrates had fled from Athens during the panic which followed the battle of Chaeronea, and on his return about six years later was prosecuted by Lycurgus for treason. The speech is an impersonal homily on patriotism, rather than an argument on specific legal points. There are historical digressions and long poetical quotations. Stylistically it shows traces of Isocrates' influence, but sentence structure is careless and haphazard. Even so the vigour and obvious sincerity of the speaker command attention.

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(H. L. H.-W.)

LYCURGUS, the name of a number of Greek mythological personages, the most famous a king who opposed the god Dionysus. Homer describes how Lycurgus chased Dionysus' nurses on Mt. Nysa and drove him to take refuge with Thetis in the sea. Other authors made Lycurgus king of Thebes (or, after Aeschylus, usually of Thrace); for his impiety he was driven mad and first killed his family and finally hacked off his own limbs in mistake for vine branches.

(H. W. PA.)

LYDD, a municipal borough (1885) of Kent, Eng., 72 mi. E.S.E. of London by road and rail, comprises the old town of Lydd and the coastal districts of Dungeness (*q.v.*), Lydd-on-Sea and Greatstone. It has 9½ mi. of coast line and is the most southerly town in Kent. Pop. (1961) 2,685.

Adjacent to the High street are the Guild hall and the parish church of All Saints, which incorporates a portion of a stone Saxon church and has a Perpendicular tower with rich vaulting within; the tower is a widely known landmark. Cardinal Wolsey was once vicar there. On and adjacent to land known as the Rypes, granted to the barons of Lydd in the 8th century as a reward for their valour in repelling the Danes, are a large military camp with artillery, rifle and mortar ranges (the town gave its name to the shell explosive lyddite, first tested there), and an extensive housing estate. Close to the northeastern approach to the town is Lydd (Ferryfield) airport with a 20-minute car ferry service to the continent. The inland portion of the borough is mainly agricultural, and there are extensive beach quarrying and crushing plants. The coastal area attracts a great many summer visitors.

Lydd is a corporate member of the Confederation of the Cinque Ports, being a limb of Romney. The liberties and customs of the Cinque Ports were granted to Lydd in 1155. Until the early 14th century the town was an island, but it is now three miles from the sea.

(CL. L. W.)

LYDDA: *see* LOD.

LYDGATE, JOHN (*c.* 1370–*c.* 1450), English poet, known principally for long moralistic and devotional works of greater fertility than genius, was born at Lidgate in Suffolk. In his *Testament* he says that while still a boy he became a novice in the Benedictine abbey of Bury St. Edmunds but until the age of 15 was idle and heedless of his duties. He was professed a monk there, and became a priest also in 1397. He must have spent some time in London, and seems to have been in Paris about 1421; but

from 1415 he was apparently mainly at Bury, except for the years from 1421 to 1432, when he was prior of Hatfield Broad Oak in Essex. The date of his death is uncertain, but it may well have been in the autumn of 1449.

Lydgate's most conspicuous quality is his sheer productiveness: no fewer than 145,000 lines of his verse survive. (His only prose work, *The Serpent of Division*, 1422, an account of Julius Caesar, is brief.) His poems vary enormously in matter and treatment, from vast narratives such as *The Troy Book* and *The Fall of Princes* to occasional poems of a few lines. Of the longer poems the most attractive is the allegory *Reason and Sensuality*, a comparatively early work (*c.* 1408) on the theme of chastity, translated from the French. It contains some fresh and charming descriptions of nature, in well-handled octosyllabic couplets. *The Troy Book*, begun in 1412 at the command of the prince of Wales, later Henry V, but not finished until 1421, is a verbose and pedestrian rendering, in decasyllabic couplets, of Guido delle Colonne's *Historia troiana*. It was closely followed by *The Siege of Thebes*, in which the main story is drawn from a lost French romance but embellished by features from Boccaccio; and the preface looks directly to Chaucer, Lydgate presenting himself as a Canterbury pilgrim invited by the Host of the Tabard inn to join the famous company and to tell his tale. In 1426 Lydgate undertook a translation of Guillaume de Deguilleville's *Le Pèlerinage de la vie humaine* as *The Pilgrimage of the Life of Man*, a stern and disagreeable allegory, again of excessive length, and between 1431 and 1438 he was occupied with *The Fall of Princes*, translated into rhyme royal from a French version of Boccaccio's *De Casibus virorum illustrium*. In addition to these major works he wrote love allegories such as *The Complaint of the Black Knight* and *The Temple of Glass*, saints' lives, versions of Aesop's fables, a great many poems commissioned for special occasions such as Henry VI's entry into London and "mummings" at various places, and lyrics both religious and secular.

So great a volume of work is naturally uneven in quality, and it must be admitted that the proportion of good poetry is small. Lydgate's pervasive faults are prolixity and lack of precision. He uses innumerable tags and clichés and repeats himself endlessly. His diction is often overladen with "aureate" neologisms from French and Latin, and his lines so often stumble, if read according to normal scansion, that they have come to be regarded as based on a distinct "broken-backed" rhythm having affinities with the alliterative metre. Yet with all his faults Lydgate can at his best write graceful and telling lines. His reputation long equaled Chaucer's, and he exercised immense influence on succeeding poets for nearly a century.

See also ENGLISH LITERATURE: *From Chaucer to the Renaissance.*

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LYDIA, the land of the Lydians (Gr. *Ludoi*), an inland people of western Asia Minor, briefly prominent in near eastern history in the 7th and 6th centuries B.C. Their capital was at Sardis (*q.v.*), with its almost impregnable citadel (now much eroded) at the source of the Pactolus torrent, a tributary of the Hermus (Gediz) and a source of wealth to the city and country from its alluvial gold-bearing sands.

The Lydian name does not appear in Homer; in the list of Trojan allies, their central district under Mt. Tmolos (Boz Dag) and round the Gygaean lake (Marmara Golu) is assigned to the Maeonians (*Iliad*, ii, 864–866). The relations of the two peoples were discussed in ancient times, "some saying that they were the same, and some different" (Strabo, xii, p. 572); Herodotus (i, 7) considered that they were the same, but had changed their name. It seems not unlikely that, while the main body of the people may have been of old Anatolian stock, the Lydian name may have been introduced by Early Iron Age conquerors. The language, scantily known from glosses and from inscriptions in an alphabetic script akin to eastern Greek archaic alphabets, has been thought to be Indo-European, but dubiously. Connections with Caucasian languages remain possible (*see* ANATOLIAN LANGUAGES).

The first appearance of Lydians in historical records is in a famous tablet of Ashurbanipal of Assyria, which recounts, about 660 B.C., how "Gugu, king of Luddi, a far land at the crossing of the sea, of which the kings my fathers had not heard the name," accepted (it is alleged) Assyrian overlordship and concerted operations against barbarian invaders, the Gimirri (Cimmerians, *q.v.*). Gugu captured and sent in chains to Assyria two Cimmerian chiefs; later, however, he broke off the alliance and sent troops to the aid of the refractory Psamtik I (Psammetichus) of Egypt (*q.v.*); Ashurbanipal ascribes to the answering of his prayers for vengeance Gugu's subsequent defeat and death (about 648) and relates that his son and successor returned to his allegiance.

Gugu is undoubtedly Gyges (*q.v.*) of Lydia. The fact that the name of his people was new to the Assyrians is a precious piece of information; for it was the same Cimmerian invaders who had lately destroyed the Phrygian empire of Midas (*q.v.*), with whom the previous Assyrian kings had had dealings. It may well have been the breaking of this power which enabled the Lydians, dwelling south and west of Phrygia and so less (though not much less) exposed to Cimmerian depredations, to rise from obscurity. Lydia had had its own earlier dynasties, according to Herodotus (i, 7 ff.) and to the 5th-century native historian Xanthus, whose work, in Greek, is known only through quotations: the Heraclid dynasty (perhaps a dynasty claiming descent from the lion-taming god Sandon) and, still earlier and more obscure, an alleged dynasty descended from Atys, in whose time, according to Herodotus' famous and unrefuted assertion (i, 94), an expedition, in time of famine, sailed to colonize Etruria (*see* ETRUSCANS). But neither history nor archaeology has shed much more light on these dynasties. Essentially, the Lydian kingdom so well known to the eastern Greeks was born in the crisis of the 7th century. Under its new, military dynasty, the Mermnadae or "House of the Hawk," Lydia emerged as a warlike power. The "Ludim, that handle and bend the bow," are known even to the gentle Hebrew Jeremiah, among the mercenaries of Egypt (Jer. xlvi, 9).

To the Ionians on the coast, Lydia was formidable. The kings, like the dynasty of Phrygian Midas before them, were well aware of the existence of lands to the west, and had dealings with the oracle at Delphi (Herodotus, i, 13 ff., 46 ff., etc.). Great traders, though no sailors themselves, the Lydians coveted not only the lands of Ionia, but the harbours. Gyges, in an interval between Cimmerian invasions, overthrew with his powerful cavalry the knights of Colophon, hitherto the strongest Ionian power on land; the poet Mimnermus of Colophon (*c.* 630), remembering these wars, gives the first extant Greek mention of the Lydians by name. Ardys, Gyges' son, captured the small port of Priene. Priene's neighbour, the wealthy Miletus, sustained bloody defeats; but its seafaring economy proved too tough to be broken by the raiding of its farms, and it was admitted to alliance. It may well be that the great outpouring of Ionian colonists to the Black sea just at this time was stimulated in part through the cutting short of Ionia's lands by Lydia.

Alyattes, son of King Sadyattes the son of Ardys, was the most successful of the five Mermnad kings and had the longest reign (*c.* 617–560 traditionally). He drove the last Cimmerians far to the east; and he captured Smyrna, using not only cavalry raiding tactics, but the siegecraft of the east. The remains of the huge mound, engulfing olive yards in its way, which he threw up against the walls, have been discovered during the Turco-British excava-

tions, and fragments of 7th-century pottery therein provide valuable dating evidence. But in his time new dangers also began to appear. Cyaxares the Mede, the destroyer of Assyria, threatened his eastern frontier. Alyattes held his ground in a severe war, the course of which Thales (*q.v.*) the Milesian is said to have influenced by predicting an eclipse (585 or 582?). Peace was made through the mediation of the kings of Babylon and Cilicia (*c.* 580?), and under Alyattes' son, the wealthy Croesus (*q.v.*), the kingdom seemed destined to reach even greater heights of power and prosperity. Croesus gained unprecedented successes against Ionia, capturing Ephesus and ultimately nearly all the mainland cities. But in Iran, meanwhile, supremacy was gained by the formidable Persians. Croesus, whose sister had been married to the last king of the Medes, made alliance with Babylon, Egypt and Sparta; but he was outstripped by the military genius of the great Cyrus (*q.v.*); and the fall of his citadel before Persian rock-climbing enterprise brought the Lydian monarchy to a final and dramatic end (*c.* 546 or 540).

Little more is heard of the Lydians as a people, and nothing more, once they were disarmed after the early revolt of Paktyas (Herodotus, i, 153 ff.), of their military qualities; a curious fact, suggesting that Lydian conquests were the work of an aristocracy (the *Ludoi* proper?) which had already been bled white by war. Never again was their name that of an independent state; and by the beginning of our era (if we may judge by a somewhat corrupt passage of Strabo, xiii, p. 631) their language had disappeared from the lowlands. The personal names, Lydos, Lydia, survived in Greek (originally for Lydian slaves) and the feminine form, through St. Paul's convert from Thyateira (Acts xvi, 14), has entered the Christian repertoire.

On Lydian manners and customs, archaeology has shed little light: the American excavation of Sardis (*q.v.*) discovered less of the thatched huts of the Lydian bazaar-city than of the Hellenistic and Roman epochs. In essence, we are still dependent on Herodotus, whose summary (i, 94) is that "their customs are like those of the Greeks, except that their girls engage in prostitution." The prostitution, by which they earned their dowries, had no doubt, as in Babylon, a religious sanction. Herodotus adds that they were the first men known to strike and use coins of gold and silver; and they were the first *kapeloi* ("retailers"; *i.e.*, permanent shops were something which the Greeks first saw in commercial Sardis). From their trade between east and west arose the important step which their kings took, in stamping small ingots of gold, silver or (most frequently) of the mixture "pale gold" or electrum; a guarantee, originally, of the quality rather than of the weight, since the primitive coins were of irregular shape and could be, and were, often clipped. It was an invention, made probably in the mid-7th century or later, rather than about 700 as was formerly believed, which the Greeks were quick to adopt, and which played an important part as a catalyst in the commercial revolution that transformed Greek civilization in the course of the next 150 years (*see* NUMISMATICS).

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LYE, the name given to the solution of alkaline salts obtained by leaching or lixiviating wood ashes with water; to solutions of a caustic alkali (sodium or potassium hydroxide); or, more generally to any strong alkaline solution or solid, especially one used as a detergent.

In the United States it is the common name for sodium hydroxide. *See* ALKALI; ALKALI MANUFACTURE.

LYELL, SIR CHARLES (1797–1875), British geologist, author of *Elements of Geology,* a standard work on stratigraphical and paleontological geology, was born on Nov. 14, 1797, on the family estate of Kinnordy, Forfarshire, Scotland. His father, Charles Lyell (1767–1849), was known both as a botanist and as the translator of the *Vita Nuova* and the *Convivio* of Dante: the plant *Lyellia* was named after him. As a boy Lyell had a strong inclination for natural history, especially entomology. In 1816 he entered Exeter college, Oxford, where the lectures of William Buckland first attracted him to geology. After graduating he entered Lincoln's Inn, London, and in 1825 he was called to the bar and went on the western circuit for two years. In 1819 he had been elected a fellow of the Linnean and Geological societies; in 1823 he went to France with introductions to Georges Cuvier and other scientists and in 1824 made a geological tour in Scotland in company with Buckland. In 1826 he was elected fellow of the Royal society (F.R.S.) and in 1827 he finally abandoned law for geology.

He had already begun to plan his chief work, *The Principles of Geology* (3 vol., 1830–33). With Sir Roderick Murchison he wrote joint papers on the volcanic district of Auvergne and the Tertiary formations of Aix-en-Provence. He then studied the marine remains of the Italian Tertiary strata and conceived the idea of dividing the geological system into three or four groups, characterized by the proportion of recent to extinct species of shells. To these groups he gave the names later universally adopted—Eocene (*dawn of recent*), Miocene (*less of recent*) and Pliocene (*more of recent*)—and with the assistance of G. P. Deshayes he drew up a table of shells in illustration of this classification. Between 1830 and 1876 12 editions of *The Principles of Geology* were published, each so much enriched as to form a complete history of the progress of geology during that interval.

In 1838 Lyell published the *Elements of Geology,* which became a standard work on stratigraphical and paleontological geology. This book, which was based on lectures, went through six editions in Lyell's lifetime. In his third great work, *The Antiquity of Man* (1863), he gave a general survey of the arguments for man's early appearance on the earth, derived from the discoveries of flint implements in post-Pliocene strata in the Somme valley and elsewhere; he discussed also the deposits of the Glacial epoch, and in the same volume he expressed his support of Charles Darwin's theory of the origin of species.

In 1834 Lyell went to Denmark and Sweden, the result of which was his Bakerian lecture to the Royal society "On the Proofs of the gradual Rising of Land in certain Parts of Sweden." He also brought before the Geological Society of London a paper "On the Cretaceous and Tertiary Strata of Seeland and Möen." In 1835 he became president of the Geological society. In 1837 he was again in Norway and Denmark, and in 1841 traveled through the United States, Canada and Nova Scotia. This last journey, together with a second one to America in 1845, resulted not only in papers, but also in two works not exclusively geological, *Travels in North America* (1845) and *A Second Visit to the United States* (1849). He estimated the rate of recession of the falls of Niagara, the annual average accumulation of alluvial matter in the delta of the Mississippi, and studied those vegetable accumulations in the "Great Dismal Swamp" of Virginia, which he afterward used in illustrating the formation of beds of coal. He also studied the coal formations in Nova Scotia and discovered, in company with Sir John W. Dawson of Montreal, the earliest known land shell, *Pupa vetusta,* in the hollow stem of a fossil tree club moss, *Sigillaria.*

On a visit to Madeira and Tenerife he accumulated evidence on the age and deposition of lava beds and the formation of volcanic cones. He revisited Sicily in 1858, and his observations upon the structure of Etna refuted the theory of "craters of elevation" upheld by Christian von Buch and Jean Élie de Beaumont.

Lyell was knighted in 1848 and created a baronet in 1864, in which year he was president of the British association at Bath. He died in London on Feb. 22, 1875, and was buried in Westminster abbey. The Lyell Medal was established in 1875 under the will of Sir Charles Lyell, to be awarded annually (or from time to time) by the council of the Geological society.

See *Life, Letters and Journals of Sir Charles Lyell, Bart.*, ed. by his sister-in-law, Mrs. Lyell, 2 vol. (1881); T. G. Bonney, *Charles Lyell and Modern Geology* (1895).

LYLE OF WESTBOURNE, CHARLES ERNEST LEONARD LYLE, 1ST BARON (1882–1954), British industrialist and member of parliament, was born at Highgate, London, on

July 22, 1882, the son of Charles and grandson of Abram Lyle, the founder of the sugar refining firm of Abram Lyle and Sons, Ltd. Educated at Harrow and Trinity hall, Cambridge, he joined the family business in 1903. He became managing director of the amalgamated Tate and Lyle, Ltd., in 1921, chairman in 1923 and president in 1937. He was also greatly concerned with the humanizing and efficient running of hospitals, being chairman of Queen Mary's hospital at Stratford, London, from 1915 to 1931 and deputy president from 1932.

In 1918 he was elected as Coalition Unionist member of parliament for the Stratford division of West Ham, holding this seat until 1922. He was a member for Epping in 1923–24 and for Bournemouth in 1940–45. His public work was recognized in 1923 by a knighthood, and in 1932 he was created a baronet. In 1945 he was raised to the peerage. At sport he represented England at lawn tennis and he also became president of the Professional Golfers' association. He died at Bournemouth, Hampshire, on March 6, 1954. (X.)

LYLY, JOHN (1554?–1606), English author most famous for his novel, *Euphues,* was born in Kent in 1553 or 1554. After leaving Oxford, he apparently entered the service of Lord De La Warr, and in 1580 that of Edward de Vere, earl of Oxford. In 1578 he soared to fame through the publication of *Euphues, or the Anatomy of Wit. Euphues and His England* appeared in 1580. The most fashionable English writer in the 1580s, Lyly was praised as the creator of "a new English," and as Edward Blount, his first editor, reported in 1632 (in the *Sixe Court Comedies*), "that Beautie in Court, which could not Parley, *Euphueisme,* was as little regarded; as shee which now there, speakes not French."

After the publication of *Euphues,* Lyly abandoned the novel and devoted himself almost entirely to playwriting. It is known that *c.* June 1583, through Oxford's influence, he gained control of the first Blackfriars theatre and dabbled in theatrical ventures that led, a year later, to brief imprisonment for debt. In this theatre his earliest plays, *Campaspe* and *Sapho and Phao,* were produced by a company called Oxford's boys, perhaps a short-lived amalgamation of Paul's boys and the children of the Chapel. That Lyly ever served as vice-master of Paul's (a nonexistent post), as has been alleged, seems rather implausible. All that remains certain is that all Lyly's plays, except *The Woman in the Moon,* were presented by Paul's boys, either alone or with the Chapel children.

Pappe With an Hatchet (1589) was a tract in defense of the bishops in the Marprelate controversy. About the same time (probably in 1588) Lyly presumably received at least a promise of the reversion of the mastership of the Revels whenever Edmund Tylney (appointed 1579) should retire. After the inhibition of Paul's boys (*c.* 1590), however, Lyly's fortunes rapidly declined. Though a member of parliament during the 1590s, he apparently suffered from both a meagre income and a disastrously waning popularity caused by the rise of Thomas Kyd, Robert Greene, Christopher Marlowe and Shakespeare. Nor was the mastership of the Revels any nearer; Tylney held the post till 1610. In despair Lyly finally addressed to Elizabeth I two bitter petitions, dated conjecturally 1598 and 1601. In the first he complained of having wasted ten years hanging about the court in hope of preferment; his increasing despondency may be gauged from the singularly reckless tone of the second. "Thirteene yeeres your Highnes servant: but yet nothinge. Twenty frendes, that though they saye they will be suer, I finde them suer to be slowe. A thousand hopes, but all nothinge, a hundred promises, but yet nothinge. Thus castinge up the Inventorye of my frendes, hopes, prommisses and tyme: the *summa totalis* amounteth in all to just nothinge." Blount says vaguely that Elizabeth "graced, and rewarded" him, but of this there is little evidence, though he may have received something out of the Essex forfeitures. He was buried in London on Nov. 30, 1606. He had married in 1583 Beatrice Browne of Mexborough, Yorkshire, by whom he had several children.

Comedies.—The dating of Lyly's plays remains conjectural, though scholarly opinion has settled upon the following dates of probable composition: *Campaspe* and *Sapho and Phao* (1583, in this sequence); *Gallathea* (1584); *Endimion* (1586–87); *Love's Metamorphosis* and *Midas* (1589, in this sequence); *Mother Bombie* (1589–90); and *The Woman in the Moon* (1594–95). Of these all but the last are in prose. During the 1590s Lyly also wrote a number of entertainments for aristocratic audiences. Lyly's comedies mark an enormous advance upon those of his predecessors and give him a secure place among the playwrights who distinguished the last two decades of Elizabeth's reign. His skill in acclimatizing to England Italianate pastoral and Latinate comedy of intrigue; his ability to bring together into a cohesive plot fanciful and mythological characters and characters from the lower ranks of English life; his delicate analysis by allegorical means (both topical and philosophical) of the nature of love, as the Renaissance understood it; and the grace and charm of his witty dialogue set aesthetic standards that younger, more gifted dramatists dared not ignore. How these standards were met and surpassed by Shakespeare can be seen in such plays as *A Midsummer Night's Dream* and *As You Like It.* Lyly's classical and pastoral plots and characters, and his lapses into Renaissance pedantry, may seem anemic to modern readers; nevertheless his finest play, *Endimion,* precious though it be, remains a masterpiece. Francis Meres in *Palladis Tamia* (1598) cites Lyly as among "the best for comedy," and Ben Jonson lists him among the foremost rivals whom Shakespeare outsung.

Euphues.—It was as the author of *Euphues,* however, that Lyly made his most enduring impression upon the Elizabethan world. This essentially Renaissance "novel" introduced a new sense of form into English prose style. Lyly's preoccupation with the exact arrangement and selection of words, with balance, antithesis and alliteration, demonstrated that the English language could be disciplined into a flexible vehicle capable of competing on equal terms with Latin and Greek. Lyly was not the first to experiment with the artificialities of euphuism (*q.v.*), but he brought the style to its highest point and through his very exaggerations conferred a lasting benefit upon English prose. Euphuism served as one model for the malleable prose of Shakespeare, who paid Lyly the final compliment of parodying the style in *1 Henry IV* (II, iv), where Hal and Falstaff in the famous "play extempore" burlesque King Henry's euphuistic grandiloquence.

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(W. N. Kg.)

LYME REGIS, a municipal borough and seaside town in the West Dorset parliamentary division of Dorsetshire, Eng., 25 mi. W. of Dorchester by road, is situated at the mouth of a narrow valley opening upon a fine coast line of almost vertical cliffs made of horizontal layers of blue-gray limestones and shales which contain many fossils. Pop. (1961) 3,533. The beach is shingle with sand at low tide and there is a small harbour between the jetty, on the east, and the massive curved wall known as the Cobb, which also forms a pier. The picturesque town, built on a steep hill, contains many Georgian houses and the church of St. Michael the Archangel, which is mainly Perpendicular with a Norman tower. The chief industry is the tourist trade. A Royal Air Force marine craft unit base was established in 1938.

Three manors of Lyme are mentioned in 1086 and the town was first known as Lyme Regis in 1316. It was a port in 1234 and was granted a charter by Edward I in 1284, making it a free borough with a merchant guild. At that date it was trading with France and by 1311 it was an important port. Further charters were granted by Elizabeth I (1591), James I, Charles II and

William III. Lyme returned two members to parliament from 1295 to 1832 when the membership was reduced to one; it was disfranchised in 1867. Fairs were granted in 1553 for Feb. 1 and Sept. 20, but are no longer held. In 1685, before the battle of Sedgemoor, James, duke of Monmouth, landed at the Cobb which is also associated with Jane Austen's *Persuasion*. Sir George Somers (1554–1610), who first settled the Bermudas, Thomas Coram (1668–1751), who started the London Foundling hospital, and Mary Anning (1799–1847), who in 1811 found the fossilized remains of an ichthyosaurus (now in the British Museum [Natural History], South Kensington, London), were natives of Lyme.

LYMINGTON, a municipal borough and seaport in the New Forest parliamentary division of the county of Southampton (geographical Hampshire), Eng., on the river Lymington where it flows into the Solent, and 18 mi. S.W. of Southampton by road. It is bordered on the north by the New forest (*q.v.*). Pop. (1961) 28,642. Stone Age flint instruments and a Bronze Age burial urn have been found in the district and nearby was a Roman camp. In Domesday Book, Lymington is called Lentune and its first charter, one of the earliest in England, was granted by Baldwin de Redvers, 2nd earl of Devon, in 1150 and celebrated in 1950 by a week's festivities. The 6th earl granted another charter extending the borough (called old and new boroughs) to contain about 105 ac.; this remained unaltered until 1888 when Old and New Lymington were formed. The charter of Isabella de Fortibus, in 1270, gave almost complete freedom to the burgesses. These charters were later confirmed but no alteration has ever been made by the crown. The charter of 1605, formally incorporating the borough, remained in force until 1835 when, under the Municipal Corporations act, the government of the town (by a mayor and burgesses) was reformed. In 1932 the borough was extended to include Milford-on-Sea, New Milton (a holiday resort), Barton-on-Sea (famous for fossils), Hordle, Pennington (where there is a bird sanctuary on the marshes) and part of Sway. From 1584 until 1867, when the number was reduced to one, two members were returned to parliament; in 1885 the representation was merged in that of the county. Two fairs were granted in the 13th century and were for centuries important events in May and October. The present Saturday market is also ancient but declined in magnitude with the coming of the railways.

The first mention of salt works, later very important, is in a grant of tithes to Quarr abbey in 1147. The old borough was made a port in Henry I's reign and rivaled Southampton in prosperity, chiefly because of the salt industry. By 1845 the salt pans, or salterns, were worked out and the industry came to an end. Yachting and the building of yachts and other craft have been carried on since the early 19th century and the other main industry (established in 1919) is the making of piston rings. Regular passenger and car ferries serve Yarmouth in the Isle of Wight.

LYMPH AND LYMPHATIC SYSTEM. The lymphatic system consists of two main components: (1) a system of closed tubes, the lymphatics, containing a fluid, the lymph; and (2) the lymphoid complex, an aggregate of different types of lymphoid tissue containing varying combinations of cells, among which lymphocytes predominate. Scattered lymphocytes also occur in large numbers throughout the body. Though the two main components of the lymphatic system are closely associated, they are best considered separately for descriptive purposes.

This article is divided into the following sections:

I. Lymph and Lymphatics
  1. Structure and Arrangement of Lymphatic Vessels
  2. Composition of Lymph
  3. Amount of Lymph
  4. Relation of Lymph to Lymphoid Tissue
  5. Formed Elements in Lymph
  6. Mode of Production of Lymph
  7. Structure and Properties of Blood Capillary Endothelium
  8. Propulsion of Lymph
  9. Pressure in Tissue Spaces
II. Lymphoid Complex, Lymphoid Organs and Lymphoid Tissues
  1. Total Amount of Lymphoid Tissue
  2. Age Changes
  3. Relation Between Different Members of the Lymphoid Complex
  4. Lymph Nodes
  5. Subepithelial Lymphoid Tissues
  6. Lymphoid Tissue in the Spleen
  7. Thymus
  8. Hemolymph Nodes
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I. LYMPH AND LYMPHATICS

In the higher animals the blood vessels form, with one or two possible exceptions, a closed system in which the most numerous vessels are the thin-walled capillaries. Through the capillary walls materials pass from the blood to the tissue fluid, which surrounds the individual cells and is in close contact with them. The term "tissue fluid" is a convenient one, but it must be emphasized that under normal circumstances it contains little if any free fluid. It consists of a gelatinous material, through which fluid can readily pass, but is not normally "free" in the sense that it forms localized accumulations. The water is associated with the colloid gel which forms the ground substance of the connective tissue, consisting in the main of mucopolysaccharide protein complexes, in which are embedded in varying proportions collagen and elastic fibres. It is probable that fluid moves through the connective tissues in thin films, between and around the fibres, by the action of surface forces. P. D. McMaster and R. J. Parsons (1939) refer to these as "captured" films. It is only when there is inflammatory or other edema that the accumulation of free fluid in pools may be observed, because of hydration of the colloid gel beyond a certain point.

The tissue fluid acts as a middleman in the transport of substances between the blood and the tissue cells (*see* also Circulation of Blood). Water and crystalloids can diffuse freely and rapidly in and out of the blood through the endothelium of the blood capillary. In addition, the hydrostatic pressure in the capillary causes fluid to filter out into the tissues. The extent and speed of the movement of water and crystalloids has been shown very clearly by the use of heavy water (G. Hevesy and C. F. Jacobsen, 1940) and radioactive isotopes. L. B. Flexner and his colleagues showed that in man 105% of plasma water and 78% of plasma sodium are exchanged per minute, while in the guinea pig the water exchange is even greater (140%). The absolute figures in man may be gauged from the fact that in the human adult the total blood volume is about 5 l., and of this approximately 3 l. are plasma, separated by the capillary endothelium from 10–12 l. of extravascular tissue fluid. Rapid fluid movements are essential if the composition of the tissue fluid is to remain reasonably constant.

Though the capillary endothelium so readily permits the free passage of water and crystalloids, it holds back most of the blood proteins. However, possibly as a result of the relatively high pressure of blood within the capillary, protein molecules do occasionally escape into the tissues. Over a 24-hour period something like 50% or more of the total plasma proteins leave the blood, the smaller albumin molecules escaping more frequently than the larger molecules such as globulin. Furthermore, in some parts of the body, protein leaves the blood stream more freely than in others. Once the protein molecules have passed out of the blood capillaries they cannot be directly reabsorbed into the blood. Some of this extravascular protein may be used by the tissue cells, but most of it can be removed only via the lymphatic capillaries. The prime purpose of the lymphatic system is thus to

drain away from the tissues any excess protein which has escaped from the blood vessels and ultimately to return it to the blood by the main lymph ducts entering the veins. It would follow from this that wherever there are blood capillaries, lymphatic capillaries must also be present. In general this is true, and exceptions, such as the central nervous system, the bone marrow, the splenic pulp and possibly the skeletal muscle bundles, are due to local circulatory peculiarities which render the presence of lymphatics unnecessary.

1. Structure and Arrangement of Lymphatic Vessels.—The lymphatics begin as a network of capillaries with blind extremities; like the blood capillaries they are separated from the tissue fluid by a continuous layer of thin cells called endothelium (*see* fig. 1). Though this endothelium looks very like that of the blood capillary, it is much more freely permeable to large molecules such as protein and even to particulate matter, which therefore readily enters the lymphatics after injection into the tissue spaces. It was at one time thought that the lymphatics communicated directly with the tissue spaces, through small openings or stomata, but it is now believed that the lymphatic system is completely closed. From the network of lymphatic capillaries there emerge plexuses of larger vessels with thicker walls, but unlike the veins these do not undergo progressive increase in calibre as they near their destination. The smallest lymph capillaries consist of a single layer of flattened endothelial cells, but the larger vessels resemble veins in having an inner coat of endothelium, a middle unstriped muscle coat and an external fibrous coat.

Valves are numerous, even in vessels of very small calibre, though they are not present in the capillaries. They usually consist of two cusps, set so as to prevent flow toward the periphery. When the vessels are engorged the sites of the valves are marked by constrictions, producing a beaded appearance. The lymph plexuses of the organs and tissues are drained by the lymphatic trunks, which usually course with the main blood vessels of the part. The main trunks from the hind limbs and abdominal organs are united into one large vessel, the cisterna chyli, from which the thoracic duct passes up on the left side of the esophagus to drain into the commencement of the left innominate vein. A smaller duct, the right lymph duct, drains the right side of the head and neck and the right upper limb, entering the commencement of the right innominate vein (fig. 2). In addition, a number of other lymphatico-venous communications may occur irregularly in the thorax and abdomen. Lymph vessels coming from organs or limbs pass at some part of their course through one or more lymph nodes, and it must be rarely, if ever, that lymph reaches the venous system without passing through at least one node.

In certain fishes are seen vessels—venous lymphatics—which contain blood and lymph in varying proportions. In these animals

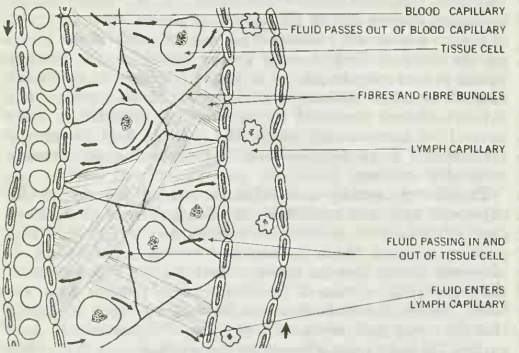
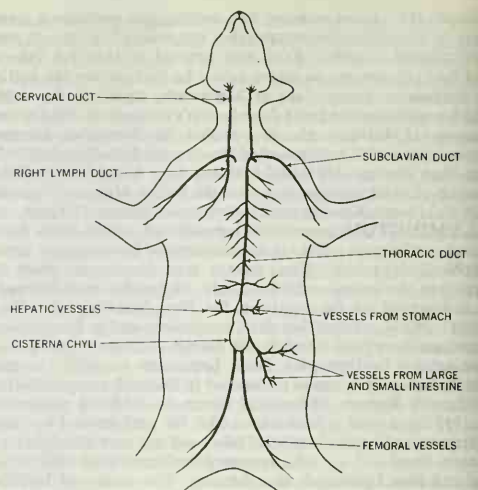


FIG. 1.—DIAGRAM SHOWING FLUID EXCHANGES TAKING PLACE IN ACTIVE TISSUE.

Arrows indicate the direction of flow of the fluid as it comes from the blood vessels and passes between the tissue cells into the lymph capillary, where it forms lymph. Arrows also indicate fluid exchange between the cells and surrounding tissue fluid



FROM YOFFEY AND COURTICE, "LYMPHATICS, LYMPH AND LYMPHOID TISSUES"; REPRODUCED BY PERMISSION OF EDWARD ARNOLD (PUBLISHERS) LTD.

FIG. 2.—SCHEME OF THE MAIN LYMPH VESSELS IN MAMMALS

the lymph vessels do not possess valves, and fluid is driven through them by contractile lymph hearts. In amphibia and reptiles lymph is no longer mixed with blood; lymphatic valves have not yet appeared, but functional lymph hearts are present, to effect a sluggish but direct flow of lymph to the blood. In most birds the lymph hearts disappear after embryonic life and the lymph vessels contain valves, just as do those of mammals.

2. Composition of Lymph.—Lymph is the colourless or yellowish fluid, containing formed elements, salts and varying amounts of protein and fat, which fills the lymphatic vessels. There is general agreement that the crystalloids of lymph are substantially identical with those of the tissue fluid. Like it, they consist chiefly of the cations: sodium, potassium, calcium and magnesium; and the anions: chloride, bicarbonate and phosphate. C. K. Drinker and his associates brought forward considerable evidence that this identity with the tissue fluid extends to the protein content also; *i.e.*, that peripheral lymph can fairly be regarded as the counterpart of tissue fluid, which undergoes little if any modification as it crosses the extremely permeable lymphatic endothelium.

Lymph derived from the intestine differs from lymph in other situations, since it is intimately associated with the absorption of several substances. If the animal has been fed some time previously with a fatty meal, the lymph has a milky appearance, which is due to the presence of innumerable fine droplets of fat (chylomicrons) about 0.5μ–0.75μ in diameter. The fat is absorbed by the lymphatics of the small intestine, which because of their white appearance during digestion are called lacteals. Among other substances known to be absorbed from the intestine via the lymphatics are vitamin K and certain sterols.

3. Amount of Lymph.—No precise data are available on the total lymph flow. Most of the information is based on thoracic duct lymph flow in anesthetized animals, and from this it would appear that the flow is about 2 ml. per kilogram per hour in nonruminants, and rather more than this in ruminants. The flow of lymph in all the other ducts combined is about 50% of the thoracic duct flow. Direct measurements had not been made in man, except for a few diseased persons in whom the flow ranged from 0.3 l. to 2.8 l. a day. The total volume of all the lymph in the lymphatics and lymphoid tissues at any given time cannot be accurately determined.

4. Relation of Lymph to Lymphoid Tissue.—In the lymph glands the lymphoid tissue is traversed by a lymph stream which reaches the glands by afferent lymph vessels and leaves them by efferent vessels. The subepithelial lymphoid tissue (naso-

pharyngeal and intestinal, as also the thymus) possesses efferent but not afferent vessels. The lymphoid tissue of the spleen is related to the blood stream and possesses neither afferent nor efferent lymph vessels. In the case of lymph glands, lymph which has not yet traversed a gland is known as peripheral lymph. If it has passed through one gland but still has to flow through another, it is intermediate lymph, while if it is on its way to the blood without further glandular interruption it is central lymph.

5. Formed Elements in Lymph.—The majority of the white cells in central lymph are lymphocytes, of which about 95% are small or medium lymphocytes and 5% large basophilic cells, capable of mitosis (*i.e.*, cell division). A few monocytes and granulocytes may be present. Most studies of central lymph have been made on lymph from the thoracic duct. The actual number of cells present at any time is quite variable, both in the same and in different species. In general, the smaller the animal, the greater the concentration of lymphocytes. In the dog and cat J. M. Yoffey and C. K. Drinker found that peripheral lymph contained a mean lymphocyte count of 280 and 370 per cubic millimetre, while thoracic duct lymph contained 7,800 and 12,000 lymphocytes per cubic millimetre, respectively. The lymphocyte count in thoracic duct lymph may on occasion greatly exceed this figure. Peripheral lymph contains small numbers of red and white cells, while central and intermediate lymph contain large numbers of white cells, almost entirely lymphocytes, which are being carried in the lymph to the blood stream.

6. Mode of Production of Lymph.—The forces subserving the transference of substances through the blood capillary wall to the lymphatic vessels appear to be of a physical character, though the capillary endothelium, being composed of living cells, is capable of altering its degree of permeability. It appears to be at all times freely permeable to dissolved salts, but its permeability to protein is variable. The physiological conditions under which this permeability alters are not known, but under various pathological conditions the proteins are able to pass freely through the injured epithelium, as also are the formed elements of the blood in lesser degree.

It is now considered that there are three forces producing a transference of fluid and dissolved substances from the interior of the capillary to the tissue spaces; they are blood pressure, diffusion and osmosis. The excess hydrostatic pressure existing in a blood capillary over that in the extravascular tissue spaces causes a filtration through the endothelial wall of fluid with the same composition in salts as blood but varying in protein content. At the same time diffusible substances at a greater concentration in the blood tend to pass to a region of lesser concentration in the tissues. The third force, that of osmosis, depends on the fact that water passes through the capillary more quickly than salts and even more quickly in relation to the plasma proteins. Thus if a hypertonic solution of sodium chloride is injected intravenously there is a passage of water from the tissues to the blood, which becomes greatly increased in volume, with a concomitant desiccation of the tissues. At the same time salt passes more slowly from the blood into the tissues until a new equilibrium is reached. In the reverse direction similar changes would follow an increased molecular concentration in the tissues. These factors would be sufficient to account for the major part of the exchange of water and dissolved substances between blood and tissues.

Osmotic pressure of the plasma proteins, however (as first clearly pointed out by E. H. Starling in 1896), is essential for maintaining the full balance of fluid exchange through the capillary membrane. According to what is now known as the Starling hypothesis, the endothelium of the blood capillary functions as a semipermeable membrane in relation to the plasma proteins. At any given time the amount of plasma protein which leaks through the capillary wall is small in relation to that which does not, and the protein within the capillary exerts an osmotic pressure of about 30–40 mm. Hg (mercury). There are thus two opposed forces. The capillary pressure causes water to pass out of the capillary into the tissues, while the osmotic pressure of the plasma proteins causes it to be absorbed from the tissues into the capillary. The most important of the plasma proteins for this purpose is the albumin, which has a molecular weight of 69,000. "Whereas capillary pressure determines transudations the osmotic pressure of the proteids of the serum determines absorption." The truth of Starling's hypothesis was confirmed by direct measurement of the pressure changes in individual capillaries in the frog's mesentery (E. M. Landis, 1927). Later J. R. Pappenheimer and A. Soto-Rivera (1948), using an isolated mammalian hindleg preparation, showed that the same was true for mammalian capillaries and that, in respect of the absolute figures for the capillary pressure and the osmotic pressure of the plasma proteins, the rate of fluid transfer depended on the net difference between these two forces.

A number of additional factors, though they do not affect the essential validity of Starling's view, call for consideration. Thus there is some protein in the tissue fluid and it exerts an osmotic pressure in the opposite direction to the plasma proteins. The effective osmotic pressure of the plasma proteins is therefore lessened by this amount. Furthermore, Landis showed by direct measurement that there is a fall in pressure from the arterial to the venous end of the capillary, with corresponding differences in the final fluid exchange. It is estimated that at the arterial end of the capillary the hydrostatic pressure is greater than the osmotic, whereas at the venous end it is lower. At the arterial end, therefore, the excess of hydrostatic pressure causes fluid to flow from the capillary to the tissue spaces. At the venous end the excess of osmotic pressure produces the reverse phenomenon and fluid passes from the tissue spaces into the capillary. The difference between the two ends may be diminished, however, by the fact that, as first suggested by F. P. Rous, the permeability of the blood capillary is not the same throughout its length, but exhibits a gradient, increasing from the arterial to the venous end.

The balance between the forces controlling fluid exchange is very nicely regulated, and it is possible that if it were not for the leakage of protein, lymphatics would be quite unnecessary. There are regions of the body in which, when at rest, the lymphatic system plays very little part, so that a constant interchange between blood and tissue fluid can take place without the production of a single drop of lymph. If a cannula is inserted into the main lymph trunk of a limb at rest almost no lymph can be obtained. If, however, the limb is thrown into action, the arterioles and capillaries of the part dilate and the hydrostatic pressure in them consequently increases; that is to say, the length of the capillary in which resorption can occur, by virtue of the excess of osmotic over hydrostatic pressure, is lessened so that fluid tends to accumulate in the tissue spaces. That it does not normally accumulate there is due to the fact that it is taken away by the lymphatics. It must be emphasized, however, that the lymphatic vessels cannot deal with large quantities of fluid and if there is more than a moderate increase in the escape of fluid from the blood capillaries, it accumulates in the tissues, which become waterlogged and edematous.

7. Structure and Properties of Blood Capillary Endothelium.—The formation and drainage of lymph involve the passage of fluid first through the endothelium of the blood capillary and second through that of the lymphatic capillary. The lymphatic capillaries appear to consist solely of cells joined by intercellular cement. The blood capillary has the same essential structure, but in addition there is usually a pericapillary sheath of fine connective tissue, while on the inner surface of the endothelium there may be a noncellular lining derived from the plasma proteins (R. Chambers and B. W. Zweifach, 1947). The intercellular cement is readily demonstrated in most capillaries by the reduction of silver nitrate. It may well be that the cement lines constitute areas of increased permeability. Electron microscope studies suggest that true capillary pores may in fact exist in certain situations.

The distinctive feature of lymphatic endothelium is its great permeability. Not only large protein molecules but even solid particles such as india ink, bacteria and cells pass through it readily. This fact is the basis of the classical method of demonstrating lymphatics, namely, interstitial injection—the injection of a particulate suspension into the tissue spaces or interstices, whence the particles readily enter the adjacent capillaries. This

property can readily be demonstrated in the lymphatics of the peritoneal surface of the diaphragm. If a suspension of graphite is injected into the peritoneal cavity of a rabbit, the subperitoneal lymphatics can be seen filled with the black material. Red cells, too, can be removed by this route from the peritoneal cavity in considerable numbers; and F. C. Courtice, J. Harding and A. W. Steinbeck showed that they reach the blood stream through the right lymph duct. There appears to be a slow steady movement of cells from the blood stream through the tissues and into the lymphatics. The precise significance of this is not clear.

The high degree of permeability of the lymphatic endothelium has a further consequence in that substances of low molecular weight which have been absorbed by lymph capillaries may, during their passage along these channels, diffuse out again into the surrounding tissue fluid to be reabsorbed by the blood vessels or by other lymphatics. An interesting observation on the permeability of lymphatic vessels to diffusible substances was made by M. R. Lewis. If histamine or adrenaline is inserted into the skin by puncture, some of the substance is taken up into the lymphatics, but leakage out again into the tissue fluid occurs during passage up the lymphatics, as is shown by the occurrence of a reddish line of dilated capillaries and venules in the case of histamine, and a white line due to the contraction of these vessels in the case of adrenaline.

8. Propulsion of Lymph.—Lymph hearts (that is, organs for pumping lymph through the lymphatic vessels) are not present in mammals. Rhythmical contraction of lymphatic vessels has occasionally been noted (*e.g.*, in the mesenteric lymph vessels of the rat and guinea pig), but, in the main, the propulsion of lymph in mammals is due to extrinsic and not intrinsic forces. In the first place, the slight tissue pressure helps to drive fluid from the tissue spaces into the lymphatic capillaries. Though the head of pressure is not great (in the mouse's ear 1.9 cm. of water outside the lymphatic capillary, 1.2 cm. in its lumen), it exerts a continual effect, augmented by movement. All the larger and most of the smaller lymphatic trunks are liberally supplied with valves, which consist usually of two cusps and which permit the flow of lymph in one direction only, namely toward the heart. In the limbs, movement and muscular contraction are the main propelling agents. If a cannula is inserted into a lymph trunk in a limb, no lymph flows if the limb is at rest, but there is considerable flow if it is either massaged or made to move, whether actively or passively. In the intestine, contraction squeezes out lymph very effectively into the cisterna chyli and the thoracic duct. This can be shown readily by observing the great increase in thoracic duct lymph flow after the administration of drugs such as pilocarpine which stimulate peristalsis. Once lymph has found its way into the cisterna chyli (*see* fig. 2), the pressure changes associated with each inspiration—namely, increased intra-abdominal pressure expelling it from the abdomen, and negative intrathoracic pressure sucking it into the thorax and great veins—form the final link in the chain of extrinsic propelling agents.

In some situations, an additional aid to lymph flow may be the transmitted pulsation from adjacent arteries; *e.g.*, the aorta and the thoracic duct. Occasionally, the lymph vessels may even form plexuses around the arteries.

9. Pressure in Tissue Spaces.—The relation between the tissue pressure and that within the lymphatic capillaries raises the problem of the patency of these vessels, which might be expected to collapse if the pressure of the fluid outside them were greater than that inside. This might conceivably be an even more difficult problem when the tissue pressure is increased as in cases of edema. It was long ago observed, however, by W. A. Gaskell that fibres passed from the walls of the lymphatic vessels into the surrounding tissues in the epiglottis, so that if the tissues became swollen with fluid, these fibres were pulled on and helped to keep open the lumen of the vessel to which they were attached. These observations later were confirmed by B. D. Pullinger and H. W. Florey in experimentally induced edema in the ear of the mouse, in which fine argyrophilic connective tissue fibres could be demonstrated passing from the walls of widely patent lymph capillaries into the surrounding edematous tissues.

II. LYMPHOID COMPLEX, LYMPHOID ORGANS AND LYMPHOID TISSUES

The second great component of the lymphatic system consists of the lymphoid complex, a group of organs and tissues formed by: (1) lymph nodes; (2) subepithelial lymphoid tissues, lying under the mucous membrane of the alimentary canal; (3) the spleen; (4) the thymus; and (5) hemolymph nodes. In addition, there are large numbers of lymphocytes scattered throughout the connective tissues, especially abundant in the bone marrow.

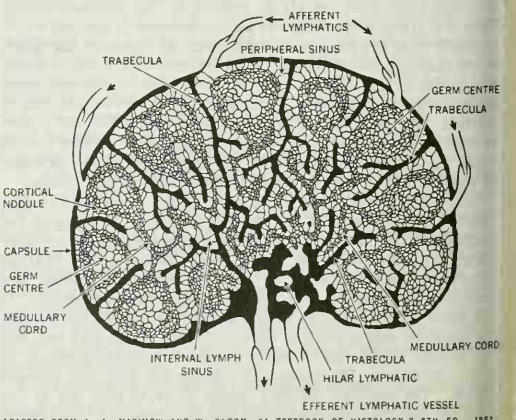
1. Total Amount of Lymphoid Tissue.—It is difficult to assess the total amount of lymphoid tissue in the body, and the method which has been employed, namely the careful dissection and weighing of all the scattered lymphoid masses, is far from ideal. E. Andreasen estimated that in young adult rats the total amount of lymphoid tissue, including the thymus, is 0.5%–1% of the body weight.

2. Age Changes.—Lymphoid tissue undergoes age changes. Well developed until puberty, when it reaches its maximum, it then undergoes atrophy. In old age the thymus and subepithelial lymphoid tissues have for the most part disappeared, but the spleen and lymph nodes persist.

3. Relation Between Different Members of the Lymphoid Complex.—Though all members of the lymphoid complex are referred to as lymphoid tissue, there are marked points of difference. In the case of the thymus, it has been questioned whether it really is a lymphoid organ, and it has been suggested that though the thymic cells bear a superficial resemblance to lymphocytes they do in fact form a distinct cell species. However, thymocytes and lymphocytes both have the same characteristic movement, the nucleus forming a rounded head, the cytoplasm a short stumpy tail.

There are significant differences between the members of the lymphoid complex in the ability to form antibodies. The spleen can, when required, produce large amounts of antibody, the thymus none, while the lymph nodes are intermediate in this respect.

4. Lymph Nodes.—Lymph nodes or lymph glands are the most numerous of all the lymphoid organs. They are pink bodies situated on the course of the lymphatics and they therefore possess both entering (afferent) and draining (efferent) lymph vessels. They are rounded or bean-shaped (*see* fig. 3) and vary in size from small nodules to flattened masses perhaps two inches long, large nodes being commonest in the groin. Each node has a fibrous capsule from which trabeculae pass toward the interior, where they break up and interlace to form a network, the intervals being filled by lymph sinuses and cell columns. Beneath the capsule of the node is a peripheral lymph sinus into which the afferent lymphatic vessels enter, usually from the convexity of the node. Subsidiary lymph sinuses traverse the node from the peripheral sinus



ADAPTED FROM A. A. MAXIMOW AND W. BLOOM, "A TEXTBOOK OF HISTOLOGY," 8TH ED., 1952. BY COURTESY OF W. B. SAUNDERS AND CO.

FIG. 3.—LYMPH NODE

and are collected together at the hilus (where the blood vessels enter) as one or more efferent lymphatic trunks. The node is subdivided by the internal lymph sinuses and trabeculae into rounded nodules of lymphoid tissue in the cortical region and elongated cords in the medullary region. In the centre of each cortical nodule there may be a lighter area of large cells, the germ centre, while considerable regions may be occupied by diffuse lymphoid tissue without any nodules. The complete endothelial lining of the entering lymphatic vessels is not continued to line the sinuses of the node, which are rather spaces in the reticular tissue, often traversed by fine bridgelike strands of reticulum, to which adhere many large, flattened, reticulo-endothelial cells. These latter cells, in contrast to the lymphocytes, are highly phagocytic and readily take up foreign particles which enter by the lymph. Thus the thoracic nodes of city dwellers are black from carbon strained off in its passage from the lungs. In a similar way, invading bacteria which have been taken up by the lymphatics tend to be arrested in the nodes draining the affected region.

The exact position of the various groups of lymph nodes is very important from a medical point of view. The tendency for an infection to spread to the draining lymph nodes just mentioned is a case in point. Another is the tendency of malignant tumours to spread and involve the lymph nodes. It is not possible here to describe in detail the positions of the nodes and groups of nodes. Full descriptions are given in treatises on anatomy.

Besides being adapted to filtering off foreign particles, the slow seepage of the lymph through the node permits easy entry of cells from the node into the lymph. Indeed, lymphocytes that are formed in the node and then enter the lymph as it traverses the node are an important source of the free lymphocytes of the blood. Lymphocyte formation can occur in diffuse lymphoid tissue even in the absence of germinal centres, but the latter seem to develop whenever maximal production of lymphocytes is required.

Lymph nodes reach their highest development in mammals. Simpler nodes are present in marsupials. Among the birds only certain aquatic species possess them, but they are of very simple structure and are present only in certain situations; viz., a pair at the thoracic inlet and a similar pair in the abdomen. In some birds there are quite appreciable accumulations of lymphoid tissue in the walls of blood vessels. In fishes and amphibia lymphoid tissue does not occur by itself, but is found in the lympho-myeloid organs, where it is closely associated with tissue which forms myelocytes, granulocytes and erythrocytes.

5. Subepithelial Lymphoid Tissues.—The subepithelial lymphoid tissues lie under, and in close association with, the mucous membrane of certain parts of the alimentary canal. At the upper end are situated the palatine tonsils, the nasopharyngeal tonsils (known as adenoids when enlarged) and the lingual tonsil, which lies posteriorly on the dorsum of the tongue. These three sets of tonsils thus form a group surrounding the entrance to the pharynx. Throughout the intestine there occur solitary nodules, but they are most numerous in the small intestine, in the terminal part of which they also form large aggregations known as Peyer's patches. The submucosa of the appendix is closely packed with lymphoid tissue. The subepithelial lymphoid tissues have a simpler type of organization than lymph nodes. As they have no afferent lymph vessels and therefore no lymph sinuses traversing them, the subepithelial lymphoid tissues consist of lymphoid nodules with germ centres and a variable amount of diffuse lymphoid tissue, surrounded by a network of lymphatic capillaries.

6. Lymphoid Tissue in the Spleen.—The spleen is enclosed in a capsule which is muscular and contractile in many animals, but in man is mainly fibroelastic. From the capsule trabeculae ramify throughout the organ, forming a framework the meshes of which are occupied by the splenic pulp. The latter is of two types, the white pulp, which is composed of lymphoid tissue as described above, and the red pulp. This consists of venous sinuses among which are a spongy network of cells, the splenic cords, containing lymphocytes and numerous macrophages, either free or arranged as a network (the pulp reticulum). On the cut surface of the organ the white pulp is visible as rounded or elongated gray areas up to one millimetre in diameter, sometimes known as the Malpighian bodies, and usually surrounding the arteries. No lymphatic channels are present in the pulp, which possesses instead a highly specialized blood vascular arrangement which allows intimate contact of the cellular and fluid elements of the blood with the lymphoid and reticulo-endothelial cells of the pulp. This permits the spleen, quite apart from its reservoir function, to entrap foreign particles circulating in the blood stream in the same fashion as a lymph node arrests particles in the lymph stream. (*See* also SPLEEN.)

7. Thymus.—The thymus, situated in man behind the upper end of the sternum, consists of a dense mass of round cells embedded in a reticular framework. Draining lymphatics are present, but entering lymphatics are not. Besides the small round cells or thymocytes, groups of epitheliallike cells (Hassall's corpuscles) are present. Controversy still exists as to whether the thymus is a true lymphoid organ, for in some ways it reacts differently from lymphoid tissues elsewhere, though the differences are usually of degree rather than of kind. On the whole, the available evidence appears to favour the view that the thymocyte and the small lymphocyte are identical; in tissue culture they both show the same type of distinctive movement. The thymocytes tend to be the smallest of the small lymphocytes, with a bare minimum of cytoplasm, resembling most closely the small lymphocytes in bone marrow. The evidence suggests that the thymus is the most vigorous cell producer of all the lymphoid organs, being four to six times as active as lymph node tissue. (*See* also THYMUS.)

8. Hemolymph Nodes.—These bodies are similar to simple lymph nodes but their sinuses contain blood. They are most conspicuous in ruminants such as the sheep. In man they are found only within the abdomen and are of very small size and minor physiological importance. They are in all probability lymph nodes whose afferent lymph vessels have contained an abnormally large number of erythrocytes, which then accumulate in the sinuses of the nodes.

9. Lymphoid Tissue in Bone Marrow.—Certain aspects of this question are considered in the discussion below on the fate of the lymphocyte. Here it need only be noted that mammalian bone marrow does not normally contain organized lymphoid tissue of the type associated with lymphocyte production in all other situations. It may contain scattered small lymphocytic aggregates, and it usually has a large number of small lymphocytes, which seem not to have been formed in the marrow but to have entered it from the blood.

10. Functions of Lymphoid Tissue.—Two main functions have been assigned to lymphoid tissue: (1) defense and (2) lymphocyte formation. The defense theory was originated by R. Virchow, who maintained that noxious particles entering the lymph stream were held up in the sinuses of the nodes. This simple barrier theory was later extended to include antibody production. The view that lymphocyte production is an important function of lymphoid tissue received a strong impetus from the observation by W. Flemming (1885) that the germinal centres contained abundant mitoses.

III. LYMPHOCYTES

Lymphocytes are often described in terms of size as large, medium or small, though there are other differences associated with these size relationships. The most numerous cell type—and also still the centre of acute controversy—is the small lymphocyte. In fresh wet preparations of blood or lymph the small lymphocytes are rounded cells, usually about eight microns in diameter. The nucleus almost fills the cell and is round, oval or bean-shaped. If kept at body temperature the lymphocytes move about rapidly for short periods, and then round off to a resting state in which small pseudopodia may form and retract. The movement is distinctive, since the nucleus forms a rounded head and the cytoplasm the tail. The number of moving cells increases from the first to the ninth hour, by which time most of the cells are moving. This is in contrast to the behaviour of the polymorphs, which are most active initially but are almost rounded and inactive after six hours.

The cytoplasm of the lymphocyte is clear, and mitochondria can be seen in unstained cells. In fixed preparations treated with

Romanowsky stains the nucleus of the lymphocyte is coloured an intense dark purple, while the cytoplasm is a clear pale blue, though in the large lymphocytes it may be much more basophilic. Ultraviolet absorption studies indicate that the nucleus of the small lymphocyte contains the diploid number of chromosomes.

1. Genetic Relations of Lymphocytes.—Lymphocytes develop either from other lymphocytes or from nonlymphocytic precursors in the various lymphoid tissues, but the details of their origin and development are matters of dispute, as part of the larger question of the origin and interrelationships of blood cells generally. M. M. Wintrobe (1946) emphasized that one of the main points of disagreement between the proponents of the various general theories of blood formation is in regard to what constitutes a lymphocyte. With regard to developmental potentialities, the question has been most acute in relation to the small lymphocyte.

It has been maintained on the one hand that the small lymphocyte is totipotential, capable of developing into all the other cells of the blood and connective tissue, and on the other hand, that it is incapable of further development; intermediate views have been held. If the small lymphocyte is totipotential, then it must be regarded as a specialized form of the primitive mesenchymal cell, reduced to the smallest possible size to facilitate rapid mobilization and transport through the blood stream from one part of the body to another.

2. Production of Lymphocytes and Entry Into Blood.—The study of lymphocyte production is beset with many difficulties. Newly formed lymphocytes may enter the blood indirectly, by first entering the lymph stream, or directly, by passing through the walls of the blood capillaries in lymphoid tissue. The indirect entry lymphocytes reach the blood by the thoracic duct, the right lymph duct or other and irregular lymphatico-venous communications. In the past, it was assumed that most of the lymphocytes enter the blood by way of the thoracic duct, and numerous quantitative studies have been based upon this assumption. In a typical experiment, samples of lymph are collected at intervals from the thoracic duct over a period of several hours. Then from the total volume of lymph flow, and the number of lymphocytes per unit volume, it can readily be calculated that the number of lymphocytes entering the blood stream a day by this route alone is considerably in excess of the total number of lymphocytes in the blood. Since there is no clear evidence that lymphocytes are destroyed while in the blood, it must be assumed either that there is a continuous circulation of lymphocytes between blood and lymph, or that the lymphocytes leave the blood stream and are continually replaced by the newly formed cells which are entering it. J. M. Yoffey (1936) estimated that in the dog the blood lymphocytes were replaced about $2\frac{1}{2}$ times a day, and termed this the daily replacement factor (D.R.F.). A. G. Sanders, H. W. Florey and J. M. Barnes found in the rabbit a D.R.F. of about five; and in general, the smaller the animal the higher the D.R.F. Studies of cell multiplication in the lymphoid tissues themselves suggest that lymphocyte formation may be considerably more active than the thoracic duct data indicate. As to the relative contribution of the different members of the lymphoid complex, it is probable that the thymus is the most active of all the lymphocytopoietic tissues and that the intestinal and mesenteric lymphoid masses rank next in importance.

3. Fate of the Lymphocytes.—H. S. Sjövall (1936) maintained that the lymphocytes continually recirculated between blood and lymph, and experiments involving prolonged drainage of thoracic duct lymphocytes have been interpreted as supporting this view. It is, however, difficult to reconcile this with the active synthesis of deoxyribonucleic acids (DNA) in lymphoid tissues. The existence of a very rapid turnover for lymphocytes poses acutely the question of the fate of these cells. It is unlikely that lymphocytes undergo degeneration on any considerable scale while in the blood stream. It is also improbable that there are large numbers of lymphocytes lost to the body by migration through the epithelium of the intestine, though a certain number may be.

Lymphocytes are constantly migrating into the connective tissues, but there is no evidence to prove that this extravascular migration occurs on a sufficiently large scale to account for the "disappearance" of the lymphocytes. Another suggestion is that the lymphocytes are filtered out of the blood into the bone marrow. This concept would fit in admirably with the view that lymphocytes are totipotential and capable of developing into the other blood cells, but on this point there is no general measure of agreement. From a quantitative point of view, it is significant that very large numbers of lymphocytes occur in normal marrow, and all the evidence points to their reaching the marrow from the blood. The number of lymphocytes present in the marrow is more than adequate to account for the numbers daily disappearing from the blood.

The question of the transformation of lymphocytes into other cells has been extensively investigated not only in the tissues of the organism but also in living organisms by the technique of tissue culture. Some observers have claimed that starting with pure cultures of lymphocytes they have noted the subsequent appearance of monocytes, macrophages, fibroblasts, granulocytes and erythroid cells. But their claims have not met with general acceptance.

4. Function of the Lymphocyte.—It has long been widely held that the lymphocyte plays a part in the defense mechanisms of the body. Many familiar observations form the basis for this belief, among them the increase in the blood lymphocytes in many infectious diseases; the accumulation of lymphocytes around areas of subacute or chronic inflammation, especially when due to organisms such as those of syphilis and tuberculosis; the mantle of lymphocytes around an invading tumour; and the collections of lymphocytes in parts subjected to mechanical or chemical irritation. The anatomical arrangement of the masses of lymphoid tissue has been advanced as support for the protective role of the lymphocyte. Thus the tonsillar ring of lymphoid tissue is often described as guarding the gateway to the alimentary canal from the entry of organisms; a similar protective function is assigned to the lymphoid nodules of the intestine, while the disposition of lymph nodes as filters along the course of the lymph stream has given further support to these views.

Direct factual evidence has become available about the role of the lymphocyte in these defense processes. The small lymphocyte lacks phagocytic powers and is incapable of producing antibodies to bacteria or foreign proteins. In 1935 P. D. McMaster and S. Hudack, following up earlier work, demonstrated specific agglutinins in the lymph nodes draining an infected area, though they were unable to show which cells were responsible. W. E. Ehrich and T. N. Harris (1942) found that the injection of antigen into the pad of a rabbit's foot was followed by a hyperplasia of the popliteal node, with an increase in the cell count and the antibody content of the lymph issuing from a cannula inserted into the efferent lymphatic. But subsequent work led Ehrich and his collaborators to the view put forward by A. Fagraeus (1948) and others, that it was the plasma cell which was in the main responsible for antibody formation, not the lymphocyte. A. Coons and his co-workers applied an ingenious technique involving the use of fluorescent antigen and antibody, as a result of which they showed not only that it is not the small lymphocyte in lymph nodes which is responsible for antibody formation, but that the plasma cells which are responsible are derived from the primitive reticular cells and large lymphocytes from which small lymphocytes also arise.

The part played by the reticulo-endothelial cells is not altogether clear. F. R. Sabin (1939) used a coloured antigen to study antibody production, and suggested that this process occurred in the phagocytic cells of the reticulo-endothelial system which ingested the antigen. It was later shown that antigen was indeed retained for 11 weeks and longer in the macrophages of lymphoid organs, even though these cells were not in themselves responsible for antibody formation. It would appear, therefore, that when antigen reaches a lymph node it is taken up mainly by the reticulo-endothelial cells, and that subsequently the node reacts by producing increased numbers of both plasma cells and lymphocytes. The plasma cells remain in the node and are a source of antibody; the lymphocytes are discharged in the efferent lymph and enter the blood. When the antigenic stimulation is at an end the formation

of plasma cells ceases and lymphocytopoiesis becomes once again the dominant activity. Antibody formation proceeds most actively in the spleen, to a lesser extent in lymph nodes, and seems to be completely absent in the thymus. (*See* IMMUNITY AND IMMUNIZATION.)

5. Lymphoid Tissue and Virus Infections.—In the case of virus infections, lymph nodes may constitute a mechanism for the dissemination of virus particles. Viruses are cytotropic, and when from a focus of infection they enter the lymphatics and come to the regional lymph nodes, they obtain access to the various cells, including the lymphocytes. When virus-containing lymphocytes leave the node they take virus with them to the blood stream, and so it becomes rapidly disseminated through the body. This mechanism of virus transport was first shown in the case of vaccinia. Viruses such as those of poliomyelitis were long thought to be exclusively neurotropic in their spread, but there is an increasing body of evidence to suggest that even with these viruses the lymphoid mode of dissemination may occur.

6. Lymphoid Tissue and the Endocrine System.—There exists only scanty information about the mechanisms by which the growth of lymphoid tissue is controlled. A good deal of attention has been directed toward the possibility of lymphoid tissue's being controlled through the endocrine system, more especially the adrenal glands. From the time when Thomas Addison (1855) first noted a lymphoid tissue hyperplasia in one of the 11 cases on which he based his description of the disease named after him, evidence has steadily accumulated to indicate a close connection between lymphoid tissue and the adrenal cortex. H. Selye (1937), in his first account of the adaptation syndrome, emphasized the role of the pituitary in stimulating the secretion of the adrenal cortex with resultant atrophy of the thymus. T. F. Dougherty and A. White in 1944 attributed an important role to the pituitary adrenotropic hormone in the regulation not only of the lymphocytes but also of the other cellular elements of the blood.

IV. DISEASES OF THE LYMPHATIC SYSTEM

A distinction must be drawn between, on the one hand, those conditions which primarily affect the lymphatic system, and, on the other, the reactions of the lymphatic system to disease of some other system or systems. Important in the latter connection is the role of the lymphatic system in edema and in the dissemination of tumours or bacteria. For information on these topics *see* CANCER; EDEMA; etc.

1. Lymphadenitis.—This disease, an inflammatory infection of lymph nodes, is characterized by hyperemia of, and exudation into, the lymph node, which becomes firmer, redder and enlarged. Three varieties may be distinguished: simple, suppurative and tuberculous. The cause is the arrest in the node of toxic or infective material, usually of viral or bacterial origin. This may occur in several of the acute infectious diseases, notably scarlet fever, diphtheria and German measles; and the infectious material may reach the lymph nodes either through the lymphatic vessels or from the blood stream. The lymph nodes of the neck are often enlarged, especially in children when chronic infection is present in the tonsils. In chronic infectious diseases such as syphilis and typhoid fever, many groups of nodes may be involved. Simple lymphadenitis usually subsides of its own accord if viral in origin, but it may progress to suppuration if the causal agent is pyogenic.

2. Tuberculous Lymphadenitis.—This is due to infection of the lymph nodes with the tubercle bacillus. Involvement of the draining nodes in this way is apt to follow tuberculous disease in any situation, as there is a particular tendency for the organisms to spread by the lymphatics. Thus, in pulmonary tuberculosis, the bronchial and mediastinal nodes are commonly involved in the process. Especially in young children, these nodes may become massively enlarged, even when the primary focus in the lung itself is small. In the neck there may be extensive involvement of many nodes with no obvious primary focus. In this case, although the matter has been considerably disputed, there is a good deal of evidence pointing to the tonsil as a common portal of entry.

Tuberculous disease is also not uncommon in the mesenteric lymph nodes. In this instance, the infection is from swallowed organisms. A sufferer from pulmonary tuberculosis may swallow some of his infected sputum instead of expectorating it, and so set up an intestinal and mesenteric infection. More important, however, is the abdominal tuberculosis resulting as a primary infection in children from the ingestion of milk from tuberculous cows.

The earliest manifestations of tuberculous lymphadenitis are an enlargement of the node and the formation within it of minute tubercles. It is possible in this stage for spontaneous healing to occur, but the disease often progresses to caseation, in which death of the tissue occurs and is followed by conversion of the dead material into a cheesy mass. This latter stage may end in calcification, but often the caseous material softens, so that the node may become a single abscess cavity. If left to itself, the "cold abscess" (as it is called) sooner or later penetrates the capsule of the node into the surrounding connective tissues, where it may track for some distance. In disease of the cervical nodes, the abscess may penetrate the skin at one or several points, through which the caseous contents are discharged. In diseases of internal nodes such as the mediastinal, the abscess may ulcerate into a blood vessel, with a resulting general dissemination of the disease. (*See* also TUBERCULOSIS.)

3. Lymphangitis.—In cases where an infective agent such as a hemolytic streptococcus is very virulent, there may be seen thin red lines in the skin tracking from the focus of infection (which may be quite trivial) toward the nearest group of lymph nodes. These lines indicate the spread of the organisms up the superficial lymphatics. The draining node may arrest the process, but in very severe cases localization of the infection may not occur, and organisms will then enter the blood stream.

4. Filarial Infestation: Elephantiasis.—A chronic lymphangitis occurs in filarial infestation. The adult worms, both male and female, live in the lymphatics, commonly those of the lower abdomen, pelvis or groin. The young microfilariae pass into the blood stream. The presence of the adult parasites in the lymphatic trunks causes obstruction, peripheral dilatation and irritation of the vessels. In certain cases the condition of elephantiasis may then supervene, possibly as a result of superadded infection. In the majority of such cases a lower limb is the part affected. (*See* also FILARIASIS.)

5. Reticuloses.—Mention has already been made of the diverse types of cells which are present in lymphoid tissue. It is not surprising therefore that primary diseases of this tissue should present, as in fact they do present, a bewildering variety of appearances and behaviour. Particularly is this the case in the hyperplastic conditions, and especially so in neoplastic (tumorous) conditions, where there is often a marked tendency for the cells of the tumour to revert to more primitive types. In such a confusing group of diseases classification is difficult and at the best only provisional. Where knowledge is scanty, definite opinions cannot be expressed. Nevertheless, the term reticulosis, or reticulo-endotheliosis, has been introduced by pathologists to include any systematized overgrowth of lympho-reticular tissue, whether neoplastic or nonneoplastic. Included in this category are Hodgkin's disease (lymphadenoma), lymphosarcoma, reticulosarcoma, leukemia, the generalized lipoidoses, as well as the systematized lymphadenitis seen in syphilis, kala azar, malaria and typhoid fever.

6. Hodgkin's Disease (Lymphadenoma).—This disease, fully described by Thomas Hodgkin in 1832, is characterized by a progressive enlargement of the lymph nodes all over the body, generally starting in the nodes of the neck. The majority of cases occur in young adult males. The first sign is usually the enlargement of a node in the neck, followed by progressive growth of the nodes in the submaxillary region and axilla. The inguinal group is early involved, and the abdominal nodes later. The swellings are at first painless, but in the later stages of the disease symptoms occur as a result of pressure on surrounding organs. When the disease starts in the deeper groups of nodes, the first symptom may be pain in the chest and cough, or pain in the abdomen, or pain and edema in the legs. For a long time the nodes remain dis-

crete and rubbery, but in the latter stages of the disease they may become matted together. In the majority of cases the spleen enlarges. Secondary anemia is common, slight irregular fever may be present; and eventually a great and progressive emaciation takes place.

The course of the disease advances slowly and is ultimately fatal. In the early stages, treatment may cause rapid decrease in the size of the masses, but when the nodes have become fibrotic there is little response.

Microscopic examination of the nodes shows a gradual replacement of the normal architecture of the lymphoid tissue by larger cells of various types, including giant cells with several nuclei. Areas of necrosis often occur. There is a marked and characteristic increase of reticulum (shown by silver staining) and, in the later stages of the disease, of dense fibrous tissue, which may almost obliterate the proliferating cells. (*See* also HODGKIN'S DISEASE.)

7. Reticulo-Sarcoma.—This group comprises frankly malignant tumours of various types, including (among many others) those formerly classed as "lymphosarcoma" and the so-called "Hodgkin's sarcoma." They are, in general, more rapidly fatal than is Hodgkin's disease, and present a great variety of appearances and behaviour, in keeping with the multiple potentialities of the cell of origin (a relatively undifferentiated reticulo-endothelial cell) and the higher degree of malignancy. Although rare exceptions have been reported, overflow of the malignant cells from the lymphoid tissues into the blood stream does not occur, a feature which serves to distinguish these affections from leukemia.

8. Leukemia.—There are two main types of leukemia, namely, lymphatic and myelogenous. Lymphatic leukemia affects the lymph nodes most obviously, though it has been suggested that it may begin in the thymus. Myeloid leukemia is primarily a disease of the bone marrow, in which the enlargement of the lymph nodes is a secondary phenomenon due to the infiltration of the nodes by the proliferating myeloid cells. In chronic lymphatic leukemia the lymph nodes, liver and spleen become greatly enlarged, owing to the accumulation of great numbers of lymphocytes. In contradistinction to Hodgkin's disease, the nodes do not remain discrete, but soon become matted together. In addition, there is usually a great increase in the circulating lymphocytes of the blood, a phenomenon which does not occur in Hodgkin's disease or reticulo-sarcoma. More rarely the condition is acute, and in these cases the primitive lymphoblasts may be present in the blood, although the lymph nodes are only slightly enlarged. Death may occur in a few weeks in such cases.

The outcome of leukemia is inevitably fatal, after a long or short course, depending mainly on the acuteness of the process. Treatment directed to the bone marrow and lymphoid organs may arrest the process for a time.

See BLOOD; LEUKEMIA; SPLEEN, DISEASES OF; THYMUS, DISEASES OF; *see* also references under "Lymph and Lymphatic System" in the Index.

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LYMPHOGRANULOMA VENEREUM, a venereally acquired virus infection of lymph channels and nodes which may be manifested by ulcerations, rectal strictures and enlargement of lymph nodes and the genitalia. *See* VENEREAL DISEASES.

LYNBROOK, a village in Nassau county, on Long Island, N.Y., U.S., about 2 mi. E. of the New York city line. Primarily a residential community, Lynbrook also has light industry including electronic supplies, plastic buttons, hats, laboratory supplies and several mail order houses. The village was incorporated in 1911. For comparative population figures *see* table in NEW YORK: *Population*. (M. H. LE.)

LYNCH, BENITO (1885–1951), Argentinean novelist and short-story writer, whose works examine the psychology of uncomplicated persons at everyday activities, was born in Buenos Aires in 1885, of Irish ancestry. From his second until his tenth year he lived on a cattle ranch in the province of Buenos Aires, gaining an intimate knowledge of rural life. Being of independent means, he preferred later to live quietly and do his writing in La Plata. He died in Buenos Aires on Dec. 23, 1951.

Lynch's first important novel, *Los caranchos de la Florida* (1916), although somewhat melodramatic, opened a modern phase of the gaucho novel in Argentina. In the major novels *Raquela* (1918), *El inglés de los güesos* (1924)—generally considered his best work—and *El romance de un gaucho* (1933), he gives a unique interpretation of country folk in Argentina, diverging from the usual dramatic or sensational myth of the gaucho and using a simple, ironic style. His art is intuitive rather than intellectual, and his general approach is that of realism. Lynch's skill in shorter forms is best shown in the novelette *El antojo de la patrona* (1925) and the stories in *De los campos porteños* (1931).

See Arturo Torres-Rioseco, *Grandes novelistas de la América Hispana*, vol. i (1941). (A. CR.)

LYNCHBURG, a city adjacent to but independent of, Campbell county in central Virginia, U.S., is located on the James river in the foothills of the Blue Ridge, 50 mi. E.N.E. of Roanoke. It was settled largely by Quakers in 1757 at a ferry established by John Lynch, after whom it was named. Despite its steep hills, it became a tobacco market of importance. Hogsheads of tobacco were rolled in from surrounding fields, lowered by ropes to the river below, and poled in flatboats to the tidewater at Richmond. Strict attention to grading made Lynchburg famous for its dark-leaf tobacco, which, flavoured with licorice, became a favourite chewing tobacco throughout the south.

The village was incorporated as a town in 1805, and by 1829 had grown into a bustling place of 4,630 inhabitants, with warehouses and stores. The importance of Lynchburg was enhanced by the construction of the James river canal in 1840 which enabled horse-drawn barges and packets loaded with freight and passengers to move between the town and Richmond. Canal traffic was gradually replaced by railroad transport in the 1850s. The town was incorporated as a city in 1852.

During the American Civil War it was an important Confederate supply base and link in communication between besieged Richmond and the west. After the war Lynchburg boomed. It acquired additional railroad connections and increased in population to 19,000 by the end of the 19th century. The city developed into a shoe and iron manufacturing centre and, although the change in smoking taste from dark to bright tobacco in the form of cigarettes shifted the centre of tobacco growing away from the red clay soils surrounding Lynchburg, the city continued to grow moderately, acquiring textile mills, garment factories and tool shops. Manufactures include drugs and cosmetics, hosiery, batteries, machine gears and steel products. Lynchburg was the home of Jubal Anderson Early, famous Confederate general, and John W. Daniel, orator and senator, and was the birthplace of Carter Glass, Samuel Untermyer and Robert L. Owen, authors of the Federal Reserve act (1913). It is the seat of Lynchburg college (affiliated with Christian Church and chartered 1903 as Virginia Christian college); Randolph-Macon Woman's college (Methodist, 1891) and Virginia Theological seminary and college (Negro, 1888). Sweet Briar college for women (private, 1901) is 11 mi. N.N.E. *Etude*, the music publication, was founded there by Theodore Presser in 1883. The Lynchburg Little Theatre dates from 1920.

The city adopted the council-manager form of municipal government in 1920. Pop. (1960) 54,790; standard metropolitan statistical area (Lynchburg city and Amherst and Campbell counties), 110,701. For comparative population figures *see* table in VIRGINIA: *Population*. (F. B. S.)

LYNCHING AND LYNCH LAW are terms loosely used to designate various forms of mob violence peculiar to the United States from the middle of the 18th century. The mob executes the offender, often also torturing him and mutilating his body, without

trial and regardless of existing courts of law, under the pretense of administering justice. The origin of the terms is uncertain, but the commonly accepted explanation is that they derive from Charles Lynch, a Virginia farmer and patriot, who, during the American Revolution, headed an irregular organization formed to punish thieves, outlaws and Tories. (*See* Thomas Walker Page, "The Real Judge Lynch," in *Atlantic Monthly*, vol. lxxxviii [Dec. 1901].) The legal definition of lynching varies from state to state, but it includes the execution, without due process of law by three or more persons, of an individual suspected or convicted of a crime, or accused of an offense contrary to prevailing custom. Some states require that the lynch victim must have been in the hands of a peace officer before being seized by the mob.

The summary killing of an individual by a mob as a penalty for real or supposed crime has been practiced in all countries where unsettled conditions prevailed; and informal organizations of people have attempted to supplement or replace legal procedure by dealing with criminals outside the law. Hence American lynching is sometimes compared to such historic forms of private administration of criminal justice as the *Vehmgericht* in medieval Germany, the gibbet law and Cowper justice of border districts in England, the Jedburgh justice in Scotland, and the *Santa Hermandad* in Spain. Likewise the pogroms of Russia and Poland, and the treatment of Jews in Germany under Hitler in more modern times, are somewhat similar to lynching practices.

The English colonists in America were not slow to follow the old world practice of taking the law into their own hands, and mob law prevailed in the colonies prior to the Revolution. Examples are to be found in the extralegal organizations to punish Indian scalpers in New England; in the Rangers of Pennsylvania; in the Regulators of New York and North Carolina; and in the popular tribunals organized during the Revolution to mete out speedy punishment to robbers, bandits and Loyalists. Development of civil institutions did not keep pace with the westward expansion of population after independence had been gained, and the frontiersmen established agencies outside the law to deal with horse thieves, gamblers, murderers and others who violated generally accepted standards of conduct. The region beyond the Appalachian mountains furnished many examples of lynch law. Frontiersmen demanded immediate and personal justice. They were impatient of legal forms and technicalities, and they chose to take the law in their own hands. The extralegal governments of the state of Franklin and the Oconee republic, and the extralegal organizations of Squatters associations in the midwest and vigilantes of California and the Rocky Mountain frontier played an important role in the development of the great west. But the disregard of law and order fostered by frontier conditions carried over into mob violence and lynching long after the frontier stage of society had ended.

Conditions in the southern states also fostered a lawless spirit. Frontier conditions persisted until after the Civil War, but far more significant was the prevalence of slavery and a growing sectional bitterness over the institution. Southerners exercised their absolute control over slave property by flogging even to death their refractory slaves. Later they resorted to mob violence with increasing frequency and severity against persons accused of tampering with slavery. Vigilance committees flogged, tarred and feathered and hanged abolition agitators and persons accused of aiding fugitive slaves. After the Civil War, southerners organized the Ku Klux Klan, the Order of the White Camellia and similar bodies which molested and frightened the former slaves out of the exercise of their civil rights and lynched untold numbers of Negroes. These practices carried over into the later south as did frontier practices in the west. But the south and the west held no monopoly on lynching. Only Massachusetts, New Hampshire, Rhode Island and Vermont have a clean record in this respect.

The victims of western lynchings were largely white men, although a few Negroes were lynched, and the major offenses with which they were charged were murder and crimes against property. In the south lynching crystallized into a traditional method of summarily punishing Negroes accused of offenses, chiefly murder and rape, against whites. Some few whites were lynched in the south, and occasionally Negroes lynched white men.

Fairly reliable data on lynchings are available since 1882. Compiled largely at Tuskegee institute in Alabama and published in the annual *Negro Year Book*, these data show that, between 1882 and 1951, 4,730 persons were lynched in the United States. Of these 1,293 were whites and 3,437 were Negroes. The crimes charged against the victims were: homicide 41%, rape and attempted rape 25.3%, robbery and theft 4.9%, felonious assault 4.3%, insult to whites 1.8%, and all others 22.7%. Between 1882 and 1901 the largest number lynched in any one year was 230, the smallest number 96; and between 1902 and 1935 the largest number lynched in any one year was 99, the smallest number was 8.

After 1935 the number of lynchings drastically declined. During the 1950s and early 1960s the average stood at less than one per year. Some years saw no lynchings at all. The character of lynch mobs also changed: mobs became more secretive; there were few spectacular man hunts; and mob leaders no longer boasted that they served race, tradition and justice.

Chief among the agencies effecting the decline were the National Association for the Advancement of Colored People, the Southern Commission on Interracial Cooperation, the Association of Southern Women for the Prevention of Lynching, and the Southern Regional Council. Individual journalists and educational and religious leaders, both white and Negro, also played a prominent role in the movement. They worked to elevate the economic and social position of the Negro and to improve relations between whites and Negroes. They emphasized the harmful consequences of lynching in debasing the reputation of the south, in brutalizing those who participate in lynchings, and in the general disrespect for law, order and human rights which lynchings tend to develop. All the southern states as well as several in the north and west enacted legislation looking toward the punishment of those who participate in mob violence and lynchings.

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(F. M. G.)

LYNDHURST, JOHN SINGLETON COPLEY, 1st Baron (1772–1863), lord chancellor of England, was born at Boston, Mass., on May 21, 1772, the son of John Singleton Copley, the painter. He was educated at an English private school and at Cambridge university, where he was second wrangler and fellow of Trinity college. Called to the bar at Lincoln's Inn in 1804, he gained a considerable practice and was raised to the dignity of serjeant-at-law in 1813. As one of the counsel for James Watson, tried in 1817 for his share in the Spa Fields riot, he so distinguished himself as to attract the attention of the Tory government, under whose patronage he entered parliament as member for Yarmouth, Isle of Wight. Later he sat for Ashburton (1818–26) and for Cambridge university (1826–27). He was appointed king's serjeant and chief justice of Chester in 1818, solicitor general in 1819 (with a knighthood), attorney general in 1824, master of the rolls in 1826, and lord chancellor in April 1827 (in George Canning's ministry), with the title of Lord Lyndhurst. In this latter capacity he was particularly acceptable to George IV on account of his anti-Catholic views; but in 1829 he supported the government's Catholic relief bill.

During this period it was unusual for the lord chancellor to retire on a change of government, unless it was a "total" change, as in 1806 and 1830. Lord Lyndhurst, the supremely successful careerist of his time, would have welcomed an invitation to remain in office under Lord Grey in Nov. 1830. However, political necessity compelled the Whigs to appoint Henry Brougham, and although Lyndhurst was made lord chief baron of the exchequer (1831–34), this did not prevent him from vigorously opposing the Whig reform bill. He was again lord chancellor in Sir Robert

Peel's brief administration of 1834–35. During Lord Melbourne's ministry (1835–41) he figured conspicuously as an obstructionist in the house of lords. In these years it was a frequent practice with him, before each prorogation of parliament, to entertain the house with a "review of the session," in which he mercilessly attacked the Whig government. His former adversary Lord Brougham, disgusted at his treatment by the Whig leaders, soon became his most powerful ally in opposition, and the two dominated the house of lords. In the Peel administration of 1841–46 he resumed the office of lord chancellor for the last time. As Peel never had much confidence in Lord Lyndhurst, the latter did not exert so great an influence in the cabinet as his position and experience entitled him to do. But he continued a loyal member of the Tory party. He died in London on Oct. 12, 1863.

Of Lord Lyndhurst as a judge opinions have differed; there is authority, including Lord Selborne himself, for the view that he was not a just chancery judge. His heart was not in the business. But the qualities of a just chancellor in those days were of a very special order, and in the house of lords he was more at home, though the estimate must stand that he was "a judge for the parties rather than a judge for the lawyers." His greatest moment in the house of lords was his success in averting what would have been a disastrous precedent—the attempt of lay members to vote in an appeal to the house of lords, theoretically permissible but a violation of a strict constitutional understanding (Daniel O'Connell's case, Sept. 4, 1844).

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(A. AL.)

LYNDSAY, SIR DAVID (*c.* 1485–*c.* 1555), Scottish poet and author of *Ane Satyre of the Thrie Estaits*, the only surviving Scots morality play, was the son of David Lyndsay of the Mount, near Cupar (*q.v.*), Fife, and of Garmylton in East Lothian. He may have been at St. Andrews *c.* 1508. Entering the service of James IV, he became usher to the infant prince born in 1512, and married Janet Douglas, a court seamstress, *c.* 1522. Dismissed from court in 1524, when his charge, now James V, fell under the control of the Douglas faction, he returned to the king's service four years later. He acted as chief herald from *c.* 1530, and became Lyon king of arms in 1542. His duties took him on several missions overseas. In 1531 he accompanied a Scottish ambassador to Flanders, in 1536 he went with the royal envoys to France to negotiate a marriage alliance and after James's death in 1542 he went to the courts of Henry VIII, Charles V and Francis I. to return orders conferred on his master. Little is known of his last years. Most of his verse, with a work on heraldry, was written during his prosperous years at court. It survives as follows:

1. *The Dreme;* 1,134 ll. (?1528) is a vision of John Commonwealth and the ill-condition of Scotland, written in an old tradition, with a delightfully personal epistle to the king. This is his earliest surviving, though probably not his first, work in verse; he reminds James of the many stories he had "done discryve" for him in the nursery.

2. *The Testament and Complaynt of Our Soverane Lordis Papyngo* (completed Dec. 1530; stanzaic, 1,185 ll.) is a mixture of satire, comedy and moral instruction. The king's parrot, dying, gives advice to king and court and makes its testament. This poem again illustrates Lyndsay's preoccupation with mutability and with the corruption of the commonweal. The prologue contains a valuable catalogue of Scots poets.

3. *An Answer quhilk Schir David Lyndsay maid to the Kingis Flyting* (?1536) is a short and ribald example of the satirical *genre* best illustrated by William Dunbar and Walter Kennedy (*qq.v.*) and apparently popular at court. James V's contribution has not survived.

4. *The Complaynt and Publict Confessioun of the Kingis Auld Hound callit Bagsche* (*c.* 1536) is a short didactic piece, satirizing court life through the mouth of the dog—a device used by Dunbar and others and revived by Robert Burns.

5. *The Deploratioun of the Deith of Quene Magdalene* (1537).

6. *The Justing betuix James Watsoun and Jhone Barbour Servitouris to King James the Fyft* is a burlesque description of a jousting said to have been part of James's wedding celebration in 1538, again in a traditional mode.

7. *Kitteis Confessioun* and (8) *Ane Supplicatioun directit to the Kingis Grace in Contemptioun of Syde Taillis*, both of uncertain date, are short satires in couplets. The first is an attack, in a comic framework, on the confessional; the second calls for the abolition of the absurdly long trains then in fashion among women.

9. *The Tragedie of the Cardinall* (1547) is a rather tedious piece of moralizing on the pattern of Boccaccio's *De casibus virorum illustrium* (434 ll.).

10. *The Historie of Ane Nobill and Vailyeand Squyer, William Meldrum* (written after 1550) is a vigorous tale of love and war, celebrating, in the romance tradition, the heroic life of a Fifeshire laird (1,594 ll. in 8-syllable couplets), with a pendant fictitious testament (36 stanzas). This is the liveliest and most nearly nondidactic of Lyndsay's poems, and the last and most original of Scottish romances.

11. *Ane Dialog betuix Experience and ane Courteour of the Miserabyll Estait of the World* (?1553; 6,333 ll.), commonly known as the *Monarche*, is a universal history from the Creation to the fifth (papal) empire, with a view of the last judgment, in four books. Stanzaic complaints are inset in the couplet narrative. The matter of the poem is drawn mainly from such authors as Josephus and Orosius, and is its only attraction. The style is flat, and the solemnity of tone is seldom relieved.

12. *Ane Satyre of the Thrie Estaits* is the only complete Scots morality play to survive. It began as an interlude of "the mysdemeanours of Busshops Religious persones and preists within the Realme," written for the feast of the Epiphany at Linlithgow palace in 1540. Enlarged, with a deal of coarse comedy, it was performed at Cupar, Fife, on June 7, 1552; and again on the slopes of the Calton hill, Edinburgh, on Aug. 12, 1552, before the queen regent "and ane greit part of the Nobilitie . . . fra .ix. houris afoir none, till .vi. houris at euin." It is a dramatic representation of the crucial issues of the mid-century in religion, government and social life, with all Scotland crowded on the stage. Some of the long didactic speeches are nobly rhetorical; the comic passages are written in a strong, colloquial Scots. There is something here for every class of society; each is mirrored, admonished and entertained. Lyndsay draws freely from a range of poetic genres: sermon, farce, debate, satirical "character," and song. The perennial interest and power of the *Satyre* was revealed by the brilliant revival at the Edinburgh festival of 1948.

BIBLIOGRAPHY.—*Manuscripts: Ane Dialog* survives in a manuscript at Lambeth palace, London; the Bannatyne manuscript (1568), in the National Library of Scotland, contains the "banns" and the "mirry Interludis" of the version of the *Satyre* performed at Cupar; *The Register of Arms* (1542; published 1821, 1878), an authoritative document on Scottish heraldry, in the National Library of Scotland.

Editions: Most minor pieces were included in the Paris (1558) or Edinburgh (1559, 1568) editions; the *Papyngo* was first published in London in 1538 (there may have been an earlier edition), *Ane Dialog* at St. Andrews (1554), *The Historie of Squyer Meldrum* at Edinburgh (1582; earliest surviving edition, 1592) and *Ane Satyre* at Edinburgh (1602); H. Charteris published a collected edition at Edinburgh (1569). The first critical editions are by F. Hall, J. Small and J. A. H. Murray, for the Early English Text Society, 5 parts (1865–71), and by D. Laing, 2 vol. (1871); 3 vol. (1879). The standard edition is by D. Hamer, for the Scottish Text Society, 4 vol. (1931–36). Modern editions of single works are *Ane Satyre of the Thrie Estaits*, by J. Kinsley (1954), with a critical discussion by A. M. Mackenzie and an account of the 1948 revival by I. Brown; *The Historie of Squyer Meldrum*, by J. Kinsley (1959), with critical discussions.

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(J. KY.)

LYNEDOCH, THOMAS GRAHAM, 1ST BARON (1748–1843), British soldier who fought throughout the French Revolutionary and Napoleonic wars and became second-in-command to the duke of Wellington in Spain. He was born on Oct. 19, 1748, the son of Thomas Graham, laird of Balgowan. Until the outbreak of war with France in 1793 he lived the life of a country gentleman, traveling much on the continent, partly for the health of his wife, the beautiful Mrs. Graham of Gainsborough's famous portrait. While her body was being shipped home for burial after her death at sea off France in 1792, a revolutionary mob insisted on opening the coffin in search of hidden arms. In his resentment Graham became an inveterate foe of France. He served as a volunteer in Admiral Hood's fleet at the siege of Toulon (1793) and returned home to raise a Perthshire battalion, the 90th Foot. He saw service in the Quiberon expedition (1795), and as British military commissioner with the Austrian army in Italy (1796) he made a daring escape from Mantua to inform the relieving force of the critical position of its Austrian garrison. He returned to England after the peace of Amiens (1802) to take up his parliamentary duties as member for Perthshire.

On the renewal of war Graham rejoined the army. He served on Sir John Moore's staff in Sweden (1808) and in the Corunna campaign (1808–09), where he was present at Moore's death and burial. Graham was then promoted major general (1810) and given command of a force in southern Spain, where he won a brilliant but barren victory at Barossa near Cádiz (1811). He then joined Wellington's army as commander of the 1st division. He commanded the left wing of the army in the advance to Vitoria and in Wellington's decisive victory there (1813). He then conducted the siege of San Sebastian. In 1814 he was transferred to command the British forces in Holland, but failed in an attempt to surprise the fortress of Bergen op Zoom, the last episode of his military career. He was created Baron Lynedoch in May 1814 and died in London on Dec. 18, 1843.

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LYNEN, FEODOR (1911–), German biochemist who was awarded the 1964 Nobel Prize for Medicine jointly with Konrad Bloch (*q.v.*) for work on the metabolism of cholesterol and fatty acids, was born in Munich on April 6, 1911. He obtained his doctorate at the University of Munich in 1937 and qualified as university lecturer in 1941. In 1947 he became professor of biochemistry at Munich and in 1954 was named director of the Max Planck Institute of Biochemistry there.

Lynen was the first to isolate activated acetate, from which both cholesterol (*q.v.*) and fatty acids (*see* CARBOXYLIC ACIDS) are formed. With collaborators he unraveled the mechanism of fatty acid degradation in the so-called fatty acid cycle; and elucidated the pathway of biosynthesis of polyisoprenoid compounds including cholesterol, squalene, the terpenes, and natural rubber. While working on the mechanism of fatty acid synthesis from malonylcoenzyme A, he isolated fatty acid synthetase, a multi-enzyme complex concerned with the key reactions of this process. He further found that biotin, an essential co-factor of this enzyme complex, binds carbon dioxide to form activated CO_2, which he identified as 1-N-carboxybiotin. Lynen's team worked also on the biosynthesis of the amino acid cystine, and the formation of acetoacetic acid in liver. (W. W. Z.)

LYNN, a city of Essex County, Mass., U.S., on the northern shore of Massachusetts Bay, 11 mi. NE of Boston. Established in 1629 as Saugus, it was organized as a village in 1631, and in 1637 was renamed after Lynn Regis in England. It was incorporated as a city in 1850. The first smelting works in America was built there in 1643, several tanneries were established and shoemaking, beginning in 1635, had by the middle of the 18th century brought prominence and prosperity to the town. A century later, the introduction of the sewing machine and steam power led to the development of the factory system, an influx of immigrant workmen, and Lynn's emergence as the foremost shoe centre in the country.

During the 1930s shoe manufacture declined in importance and by the second half of the 20th century electrical machinery and transportation equipment had become the principal manufactures. Pop. (1960) 94,478. For comparative population figures *see* table in MASSACHUSETTS. (L. G. BA.)

LYNTON and LYNMOUTH, seaside villages in the Lynton urban district (pop. [1961] 1,918) of Devon, Eng., lie on the Bristol channel about 17 mi. N.E. of Barnstaple. Lynmouth, at the mouth of the East and West Lyn rivers, and Lynton, on the cliff top 500 ft. above, are linked by a steep road, and a cliff railway 900 ft. long, which was cut through the woods and opened in 1890. In August 1952 the East and West Lyn rivers, swollen by a cloudburst of tropical intensity, ravaged Lynmouth, killing 31 persons. Lynmouth has a small harbour with a Rhenish tower, reconstructed since the flood havoc; and a public hall built in memory of the flood victims. Lynton has quaint old streets and houses but with a modern section, and a fine half-timbered town hall. Both are summer resorts situated in the Exmoor National Park. *See* EXMOOR.

LYNX, the generic and common name of several medium-sized cats having short tails, long legs, large paws, tufted ears and broad, short heads. Each upper jaw has only two premolar teeth whereas typical cats have three. There are two distinct types: the northern lynx (*L. lynx* of Eurasia; *L. canadensis* of North America) and the bay lynx or bobcat (*L. rufus* of North America). The northern lynx is a forest dwelling cat with unusually large paws and hairy soles, a somewhat mottled tawny to cream coat and a black-tipped tail. In winter the fur is dense and soft, the hairs up to 4 in. long, and is sought for trimming garments. The Eurasian species occurs southward to central Europe, Turkistan and Tibet. It is the largest wild felid of Europe. The Canadian lynx formerly extended southward into the northern tier of the United States and farther in the Rockies, where it is now rare. It feeds on small mammals, even young deer, subsisting mainly on the snowshoe rabbit. Breeding takes place in March, and the one

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CANADIAN LYNX (LYNX CANADENSIS)

to four young are born two months later. They are nocturnal and extremely shy.

The bobcat occurs from southern Canada to the Isthmus of Tehuantepec. It differs from the northern lynx in having shorter ear tufts and being generally smaller bodied. The colour and thickness of the coat are variable according to the habitat. The pelt is of less commercial value than that of the northern lynx, being somewhat brittle. The bobcat is equally at home in forests or deserts and, unlike its northern relative, is much less inclined to climb trees. (K. R. Kn.)

LYON, MARY (MASON) (1797–1849), U.S. educator and pioneer in the field of higher education for women, was born on Feb. 28, 1797, on a farm near Buckland, Mass. She began to teach when she was 17, and in 1817, with earnings from spinning and weaving, she went to Sanderson academy, Ashfield, where she was distinguished by her extraordinary mental quickness. She supported herself there and at the other academies she attended by teaching, her desire to acquire and impart learning seeming insatiable. Her success as a teacher and administrator and the demand for the young women she trained led to her plan for "a permanent institution consecrated to the training of young women for usefulness . . . designed to furnish every advantage which the state of education in this country will allow . . . to put within reach of students of moderate means such opportunities that none can find better." She was aided in this effort by Edward Hitchcock, the geologist, with whom she had studied. This assistance, reinforced by her own enthusiasm and practical common sense, secured for her plan the necessary financial support. In 1835 a site was selected near the village of South Hadley. The school was incorporated in 1836 as Mount Holyoke Female seminary; and on Nov. 8, 1837, it opened with Mary Lyon as principal and Eunice Caldwell, afterward well known as Mrs. J. P. Cowles of Ipswich academy, as assistant. Miss Lyon died at Holyoke on March 5, 1849, having served nearly 12 years as principal of the seminary. Her work at Mount Holyoke represented an important step in the higher education of women.

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LYON, NATHANIEL (1818–1861), U.S. soldier during the early phase of the American Civil War, was born in Ashford, Conn., July 14, 1818. After graduating from the U.S. Military academy in 1841 he was assigned to fighting the Seminole Indians in Florida. He served in the Mexican War, and after spending several years in California was sent to "Bleeding Kansas" in 1854. He joined the Republican party and wrote several articles for the *Manhattan* (Kan.) *Express* attacking Buchanan and Douglas and supporting Abraham Lincoln. Lyon was transferred to St. Louis on Feb. 6, 1861. He immediately got in touch with Francis P. Blair, Jr., and other leading Unionists in that city. After Blair's intercession, Lyon was placed in command in eastern Missouri. He seized the Confederate base at Camp Jackson on May 10, 1861, and began the arming of Union volunteers. He took part in a final attempt at compromise, meeting with Blair, Maj. Gen. Sterling Price and the secessionist governor, Claiborne F. Jackson, at the Planters hotel. The attempt failed and Lyon commented upon its conclusion, "This means war." On June 13, Lyon moved up the Missouri river with 2,000 regulars, capturing the Missouri capital at Jefferson City, June 15, and Boonville, June 17. He followed the Confederate forces into southwestern Missouri, finally bringing them into battle at Wilson's creek, Aug. 10. Although Lyon himself was killed and his forces defeated, his prompt actions in eastern and central Missouri were a large factor in saving that state for the Union. *See* also Missouri: *History*. (J. M. Wo.)

LYONIA, a genus of evergreen or deciduous shrubs of North America and Asia belonging to the heath family (Ericaceae). They have alternate, short-petioled leaves and white or pinkish flowers in dense axillary or terminal clusters. Three species common in the eastern United States are grown as ornamentals: the swamp or privet andromeda, male berry or he-huckleberry (*L. ligustrina*), a deciduous shrub to 12 ft., bearing oval leathery leaves, occurring from Maine to Florida; the fetterbush (*L. lucida*), an evergreen to 6 ft. high, with lustrous leaves, found from Virginia to Florida; and the staggerbush or wicopy (*L. mariana*), a deciduous shrub to 6 ft., found from Rhode Island to Florida. (J. M. Bl.)

LYONNAIS, a French province or *gouvernement* of the *ancien régime*, bounded on the north by Burgundy, on the east by Dombes, Bresse and Dauphiné, on the south by Languedoc and on the west by Auvergne and Bourbonnais. It was formed in the 16th century when Beaujolais (*see* Beaujeu) and Forez (*q.v.*) were merged with the older Lyonnais. This older Lyonnais comprised the territory dependent on Lyons west of the Saône and Rhône rivers as far as the Monts du Lyonnais; east of the Rhône in the immediate vicinity of Lyons; and east of the Saône north of Lyons, where the country round Vimy (Neufville-sur-Saône) had the right to vote its own taxes and so was called the Franc-Lyonnais. Converted into the *département* of Rhône-et-Loire in 1790, it was divided into those of Rhône and Loire in 1793.

LYONNESSE (Lyonesse, Lennoys or Leonais), a mythical lost land supposed to have once connected Cornwall, Eng., with the Scilly Isles. That such a land could really have existed within historical memory is of course impossible. The name Lyonnesse first appears in Sir Thomas Malory's *Morte Darthur*, where it is the native land of the hero Tristan (*q.v.*). In the 12th-century French *Tristan* poem by Béroul the hero is called Tristan de Loenois, a name already used by Wace to translate Geoffrey of Monmouth's Lodonesia, *i.e.*, Lothian in Scotland. In the 13th-century French prose *Tristan*, the name sometimes appears as Leonois, probably by identification with the region round St. Pol-de-Léon in Brittany, and this form is the source of Malory's Lyonnesse. Following the prose *Tristan*, Malory assumes that Cornwall and Lyonnesse are contiguous kingdoms, both in Great Britain.

The earliest reference to a drowned land, containing 140 parishes and extending from St. Michael's Mount to the Scilly Isles, occurs in the 15th-century Latin prose work, the *Itinerary of William of Worcester*. A tradition concerning a submerged forest near Avranches was known to the monks of Mont-Saint-Michel in Normandy in the 13th century. As the monastic traditions of Mont-Saint-Michel were freely borrowed by the daughter house of St. Michael's Mount, the account in the *Itinerary* may reflect the French inundation story as modified by the Cornish monks. William Camden in his *Britannia* (1586) refers to the drowned land as Lyonnesse, but it was really the Cornish antiquary, Richard Carew of East Antony (1555–1620), who was responsible for giving the land this name, which he drew from Malory's account of Tristan's kingdom. Carew's *Survey of Cornwall* was first printed in 1602, but Camden is known to have had access to the work while it was still in manuscript. This learned fabrication has since been widely and uncritically accepted as genuine Cornish folklore.

See A. D. H. Bivar, "Lyonnesse: The Evolution of a Fable," *Modern Philology* (Feb. 1953). (F. Wh.)

LYONNET, PIERRE (1707–1789), Dutch naturalist and insect anatomist, was born at Maastricht, Holland, on July 22, 1707, and after being trained as a lawyer, devoted most of his time to engraving objects of natural history. He made the drawings for Lesser's *Theology of Insects* (1742) and for A. Trembley's treatise on hydra, *Mémoires pour servir à l'histoire d'un genre de Polypes d'eau douce* (1744). Finally he produced a monograph on insect anatomy published in 1760 under the title *Traité anatomique de la Chenille qui ronge le bois de Saule*. He engraved his own figures on copper, and his drawings are remarkable not only for their skill but also for the extraordinary amount of detail shown. He distinguished no fewer than 4,041 separate muscles in the caterpillar of the goat moth and showed the nerves and tracheae in a manner never previously attempted. The extraordinary character of these drawings caused a sensation, and Lyonnet was accused of embellishing reality with fanciful detail. In a second edition, published in 1762, Lyonnet answered his critics by giving drawings of his instruments and a description of his methods. His monograph remains one of the most beautiful accounts of insect anatomy ever published. He died at The Hague on Oct. 10, 1789. Notes and drawings intended for a *Recueil historique*, illustrated by 54 plates dealing with various insects, were published

in the *Mémoires du Musée d'Histoire naturelle* (1829–32).
(Ed. He.)

LYONS, SIR JOSEPH (1848–1917), British businessman, was born in London on Sept. 29, 1848, and educated at a Jewish school. In early life he studied painting and exhibited at the Royal institute, but by 1886 he had turned to business enterprises, in conjunction with the brothers Isidore and Montague Gluckstein. This led to the foundation of the catering firm of J. Lyons and Co., Ltd., of which he became chairman. He began by catering at public exhibitions, and next opened teashops in London, the first in 1894. Twenty years later these numbered more than 200 and provided inexpensive food for the large numbers of clerical workers and junior members of professions. Later he opened several restaurants of a more ambitious nature, as well as hotels, on the no-tipping principle. He was knighted in 1911, and died in London on June 22, 1917.

LYONS, RICHARD BICKERTON PEMELL LYONS, Viscount (1817–1887), British ambassador at Paris for 20 years, was born at Lymington, Hampshire, on April 26, 1817, the elder son of Edmund, Baron Lyons, who commanded the British fleet in the Crimean War. He was educated at Winchester and Christ Church, Oxford, and entered the diplomatic service (1839) as attaché to his father, who was then British minister at Athens. He served in turn at Dresden, Rome and Florence, and was at Washington, D.C., as British minister from 1859 to 1865. During the American Civil War his tact helped to prevent Anglo-American hostilities arising from the arrest of Confederate envoys on the British mail steamer "Trent." After a brief period at Constantinople he became ambassador at Paris in 1867. He continued in this post until 1887.

An exceptionally able and judicious public servant, Lyons had the rare gift of making no enemies, and enjoyed the full confidence of successive governments in London and Paris alike, even when French opinion was as intensely inflamed against Great Britain as it was during the early days of the British occupation of Egypt. He refused an offer from Lord Salisbury of the foreign secretaryship in 1886, as his health was giving way. He had succeeded his father in the barony in 1858, and was created Viscount Lyons of Christchurch on Nov. 24, 1881. After his retirement from office in Oct. 1887, he was to have received an earldom, but he died, in London, on Dec. 5, 1887, before the honour was conferred. As he had never married, and his brother had been killed in the Crimea, the viscountcy became extinct.

See Lord Newton, *Lord Lyons,* 2 vol. (1913). (M. R. D. F.)

LYONS (Lyon), the chief town of the *département* of the Rhône, France, the seat of an archbishop and the headquarters of a military region, lies 472 km. (293 mi.) S.E. of Paris and 328 km. (204 mi.) N. of Marseilles by road. Sheltered by the foothills of the Massif Central to the west and by the southern heights of the Jura mountains to the northeast, Lyons is situated at the confluence of the Rhône and Saône, on the narrow peninsula between the rivers and on their opposite banks. Pop. (1962) 524,834.

The contrasting heights of the hills on which the city is built, varying from 450 to over 1,000 ft., give Lyons an unusually picturesque appearance. The summit of Fourvière on the right bank of the Saône is reached by funicular railway and offers the best view of the whole town—of its rivers, its bridges and its roofs of pinkish tile. At Fourvière (Forum Vetus) excavations begun in 1933 revealed a theatre of the Greco-Roman type and an odeum (for musical contests) of the 1st and 2nd centuries A.D. The hill, covered with convents and hospitals, is dominated by the church of Notre Dame de Fourvière. This modern basilica (1894), with its elaborate marble and mosaic decoration, is a place of pilgrimage. Close by, a metal tower 262.5 ft. high, built in 1893, supports television aerials. Bordering the right bank of the Saône, "Old Lyons," grouped around the cathedral, is an extraordinary accumulation of medieval and Renaissance buildings having great windows and inner courtyards with galleries and turrets. The cathedral, dedicated to St. John the Baptist, was built between the 12th and 15th centuries. Its apse is a masterpiece of Lyonnais Romanesque; the Gothic nave dates from the 13th and 14th centuries as does the fine stained glass in the choir; there is some remarkable carving on the west front. Farther north, along the same bank of the Saône, is the church of St. Paul with its octagonal lantern tower dating from the 12th century. The exchange (by J. G. Soufflot), now a Protestant church, and the archbishop's palace (since 1911 housing the municipal library) are both 18th-century buildings. The ponderous law courts are of the following century. On the peninsula, among buildings of diverse styles, traces of the old medieval city can be seen here and there. The Romanesque porch of St. Pierre-des-Terreaux and the oldest church in Lyons, St. Martin d'Ainay (1107), are examples. The straight roads running from north to south on the peninsula, Rue Victor Hugo, Rue de la République and Rue de l'Hôtel de Ville (renamed Rue Président Herriot in 1958), which carry much of the business traffic, were constructed in the latter half of the 19th century. To the north is the hill of Croix Rousse with the tall houses of the silk weavers, and at its summit the baroque church of St. Bruno-des-Chartreux. The 17th-century group of buildings around the Place des Terreaux is particularly beautiful, especially the *hôtel de ville*, one of the masterpieces of French civic architecture, begun in 1646 by the Lyonnais Simon Maupin, and the palace of St. Pierre, formerly a Benedictine abbey, built between 1659 and 1685 in the Italian baroque style. In front of the *hôtel de ville* is a fountain designed by the 19th-century sculptor F. A. Bartholdi. The churches of St. Nizier and St. Bonaventure are Gothic buildings of little interest. The opera house, the Bourse and the Théâtre des Célestins, built in the 19th century, are also in this district. Facing the Rhône between the Wilson bridge and the La Guillotière bridge is the 17th-century Hôtel Dieu for which Soufflot designed the façade in the following century. The Bellecour quarter is characterized by elegant 18th-century hotels and buildings. From the Place de Bellecour, with its equestrian statue of Louis XIV, the Rue Victor Hugo leads via the Place Carnot to the Perrache quarter with its docks, hostels and warehouses. This district, at the southern tip of the peninsula, was named after the most famous of the 18th-century engineers who worked to extend the confluence farther south.

On the left bank of the Rhône are the new districts of Lyons with busy streets and broad shady embankments. There are the university and the prefecture, and also the wealthy residential quarter built around the large park of La Tête d'Or, containing a lake, a zoological collection and fine botanical gardens. Farther east are industrial suburbs, with the medical university, the Édouard Herriot hospital and the new municipal stadium. Around the town, especially to the northwest and east, are many populous communes, the most important being Villeurbaune. The industrial outskirts are constantly expanding into the plain of Dauphiné. The university (1896) is the most important in France, after Paris; it has a veterinary school founded by C. Bourgelat in 1762 (the oldest in the world). Mention should also be made of the Central School of Lyons (1857), the dental school, the Institute of Industrial Chemistry (1883), the Military Medical school and the National Institute of Applied Science (1957). In addition to the university library, there is the municipal library possessing a fine collection of books, manuscripts, incunabula, prints and engravings. The most important of the city's 21 museums are: the museum of fine arts in the Palais St. Pierre, where Perugino's altarpiece, works of the 19th-century Lyonnais school and a fine picture of the Tahiti period by Gauguin are among the chief treasures; the museum of textiles and the museum of decorative arts in the 18th-century houses of the Rue de la Charité, where the history of the weaving industry is illustrated; the historical museum in the old Hôtel de Gadagne, which contains an international collection of marionettes; the Guimet museum (natural history); and the museum of printing in the former medieval town hall.

Transport and Communications.—Situated on the banks of two rivers and guarded by the surrounding hills, Lyons naturally commands a number of routes: to Paris by the valley of the Saône, across Burgundy to the Rhine, to Switzerland and Italy by the upper Rhône, westward through the valley of St. Étienne and to the Mediterranean by the corridor of the lower Rhône. Since the beginning of its history, Lyons has owed much of its prosperity to river traffic. In spite of the junction of road and rail routes,

three harbours are in use, and shipping in these doubled between 1926 and 1955. The Saône is connected by canal with the basins of the Loire, Seine and Rhône. Roads from east to west across the peninsula are connected by no fewer than 27 bridges. The problem of traffic in this direction was made easier by the tunnel of the Croix Rousse, the longest road tunnel in France (5,748 ft.), connecting the Delattre de Tassigny bridge on the Rhône to the Clemenceau bridge on the Saône.

The first railway in France to use a steam engine was built between St. Étienne and Lyons (1826–33), and the great Paris-Lyons-Mediterranean line was built in 1850. Since the electrification of the line, some of the fastest trains in the world run between Paris and Lyons, which is also a main-line station for Switzerland and Italy. Other lines connect Lyons with Brittany, Alsace-Lorraine and Languedoc.

Air services operate from the airport at Bron, one of the first in France. It was destroyed in World War II but was later reconstructed and steadily improved thereafter.

Industries.—Since the 16th century Lyons has been the centre of a silk industry originally derived from Italy. The first Lyons silk weavers were Piedmontese workers that the town council secured by privilege in 1536. Under the patronage of succeeding kings the silk trade developed enormously and grew into the *Grande Fabrique*, unrivaled in the 18th century. It remained the chief source of the city's prosperity until the end of the 19th century. The designs were made by local artists such as Philippe de la Salle, and the work was done by the local weavers in the town and surrounding countryside. The invention of the weaving loom by J. M. Jacquard (1752–1834) gave a new impetus to the industry. In the mid-19th century more and more silk-weaving factories were established in the southeast; nevertheless, Lyons remained the controlling centre for the silk trade of the world. The manufacture of chemicals, dyes and synthetic fibres has developed largely to meet the industry's requirements, and Lyons' chemical industries are second in importance in France only to those of the Paris region. Allied industries produce mineral and vegetable colouring matters, gelatin, glue, fertilizers and pharmaceutical and plastic products. The metal industry, including mechanical construction and motor and electrical engineering, has surpassed textiles in importance, however, and is the largest employer in the Rhône *département*. The electric cables of Lyons are world famous and there are sheet-iron works, foundries and wire mills.

History.—The earliest Gallic people who occupied the territory at the river confluence were Segusians. In Oct. 43 B.C. Lucius Munatius Plancus, a former lieutenant of Caesar's, founded a colony, Lugdunum (*q.v.*), on the hill above the confluence. The importance of the site as a node of communications had turned Lyons into a political centre by the 2nd century. Five great roads radiated from it, toward Aquitaine, the Atlantic, the Rhine, Italy and the Mediterranean; three towns surrounded it, the Roman Fourvière, the Gallic Condate on the slopes of the Croix Rousse and the settlement of boatmen and merchants on the Isle of Ainay.

Augustus and Caligula lived at Lugdunum and the emperors Claudius, who gave Roman citizenship to the Lyonese, and Caracalla were born there. In the 2nd century Christianity reached Lyons. In 177 its Christian community was persecuted by Marcus Aurelius, and in 197 the city was burned and ravaged by Lucius Septimius Severus, so that by the 5th century it was no more than the chief town of a province of Gaul.

The barbarian invasions preceded the coming of the peace-loving Burgundians who made Lyons their capital in 470. Under the Franks, churches and monasteries were built by the bishops. In 1032 Lyons was incorporated into the Holy Roman empire under Conrad II, having previously been the chief town of the kingdom of Provence and then of part of Burgundy. The real power lay with the archbishops and under their authority two ecumenical councils were held there, one in 1245 when Innocent IV deposed the emperor Frederick II, and one in 1274 when Gregory X proclaimed the reunion of the Greek and Latin churches (*see* Council). In 1305 Clement V, the first pope of Avignon, and in 1316 John XXII, both Frenchmen, were crowned popes at Lyons. The Lyonese, having revolted against their prince-archbishop, appealed to Philip the Fair who, in 1312, annexed the town to the French crown. From then on it was administered by elected consuls.

Lyons remained faithful to the king during the Hundred Years' War. Louis XI granted it the privilege of four annual fairs in 1463 and in the 16th century it entered into its most prosperous period. During the wars with Italy, Lyons was the seat of the court and the government; the wealth of its merchants, bankers and printers and the work of its writers and poets, such as Louise Labé and Maurice Scève (*q.v.*), made it, in fact, the political and literary capital of France and the largest commercial and financial centre. This prosperity was lost during the wars of religion, the Protestant occupation of 1562 and the Lyonese massacres of St. Bartholomew of 1572. Held in check by the absolute monarchy, Lyons once again became no more than the chief town of the united province of Lyons, Beaujolais and Forez.

At the time of the Revolution the town was suffering from an economic crisis. As a supporter of moderate and royalist factions, it was besieged by the army under Gen. F. C. Kellermann from Aug. 8 to Oct. 9, 1793, and was forced to surrender to the republicans. It was condemned to partial destruction and to the loss of its name for that of "*commune-affranchie*," and 2,000 of its citizens were guillotined or shot. Under the first empire its prosperity returned. The wretched condition of the working classes provoked risings in 1831, 1834 and 1849.

The 20th century saw the steady urban and industrial expansion of the city. An annual international sample fair was first staged in 1916 by Édouard Herriot, the city's most illustrious mayor (from 1905 to 1957), who became prime minister and president of the national assembly. Under German occupation (1940–44) in World War II, Lyons was the headquarters of the French resistance movement and, in its region alone, 5,000 people were executed by the Gestapo.

See also references under "Lyons" in the Index. (Hy. J.)

LYOT, BERNARD FERDINAND (1897–1952), French astronomer, inventor of the solar coronagraph, which makes possible the observation of the solar corona when the sun is not in eclipse, was born in Paris on Feb. 27, 1897. He started his astronomical researches in the 1920s with measurement of polarization of light from the moon and planets, using a new sensitive polarimeter constructed by himself. He showed that the moon's surface behaves as though covered with a layer of dust, that Mercury can have at most a very tenuous atmosphere, that polarization from Mars is sometimes affected by haze or dust and that there are irregularities over the Martian south polar cap, attributable to the formation of clouds. Venus was found to be covered by a continuous cloud layer composed of droplets of diameter about 2μ and of refractive index near that of water.

In 1931 Lyot successfully observed the solar corona in broad daylight, an achievement at that time generally regarded as impossible, using a new form of telescope, much of which he carried on skis to the summit of the Pic du Midi in the Pyrenees. Two years later he perfected a polarizing filter, of the type now known by his name, permitting single exposure monochromatic photography of the whole sun in a band width about one Ångström. During the 1930s he measured day-to-day changes in the solar corona, particularly in the light of the 5303 and 6374 Å lines, and also added much to our knowledge of the coronal spectrum (*see* Corona). His pioneer motion-picture films, showing movement in solar prominences in the light of the red hydrogen Hα line, were unsurpassed in quality for many years and added new and unexpected knowledge in this field. At the Pic du Midi he also made some of the finest planetary photographs obtained until that time. He showed that if the moon has an atmosphere the density cannot exceed one hundred millionth of that of the earth's atmosphere.

Lyot relied greatly on apparatus with virtually flawless optical surfaces and therefore invented new and sensitive methods of examining very small defects of glass structure or of surface polish. He designed a large new spectrograph for examining the light of the night sky. One of his last achievements was the construction of electronic apparatus allowing observations of the solar corona from places near sea level.

Lyot's work, consistently of the finest quality, was character-

ized by great originality and elegance. He was awarded the gold medal of the Royal Astronomical society in 1939 and the Bruce medal of the Astronomical Society of the Pacific in 1946. He died on a train between Cairo and Helwan, Egy., April 2, 1952.

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LYRA (the Harp) is a constellation seen in the northern hemisphere. It contains Vega (α Lyrae), one of the brightest stars in the sky, whose name is a remnant of an Arabic phrase meaning "falling eagle." The double star β Lyrae is an eclipsing variable with a period of 12.92 days; the system presents some abnormal features, perhaps owing to the very low densities of the two components. The star ϵ Lyrae is a double double; a binocular or even the unaided eye shows two stars, and a small telescope resolves each of these into two components. The Ring nebula in Lyra (Messier 57) is the brightest example of this class of nebula.

LYRE, a type of stringed musical instrument that was widespread in the ancient Mediterranean world and near east and is still used in Arabia and parts of Africa. It is characterized by a sound box from which project two arms joined by a yoke; the shape of the sound box varies between instruments. The strings run from the sound box over a bridge to the yoke, where they are tuned by means of twisted thongs or pegs; they are plucked with the fingers or with a plectrum.

The lyre is known in Mesopotamia from the Sumerian period onward; it was introduced into Egypt not later than the 19th century B.C. Size, construction and the number of strings vary greatly. Splendid specimens have survived from Ur (25th century B.C.). These are about 3 ft. 6 in. high. Giant lyres that stand on the ground and are played by a seated player are seen on Mesopotamian reliefs from the 3rd millennium and later in Egypt (Amarna period). Smaller, portable instruments (Babylonia, Egypt, Syria, Assyria) were held horizontally or lying in the arms; their construction was often asymmetrical. The Hebrew *kinnor* was probably a lyre.

In Greek lands there is evidence of lyre-type instruments with seven or more strings—probably related to Asiatic types—during the Minoan-Mycenaean civilizations. Vase paintings of the 8th century B.C. show a simple variety with from three to five strings that can be identified with the phorminx of Homer. From the 7th century B.C., probably under renewed Asiatic influence, the main classical varieties became established, with seven strings at first. The lyra had a sound box made of tortoise shell (later wood) and slender curved arms. This was the instrument of the schoolboy and the amateur; players are generally shown seated with the lyre resting on the left hip. The barbiton, a subtype of the lyra, had longer strings and lower pitch.

The instrument of the professional was the cithara, which was larger and more solidly built, the hollow arms forming a substantial prolongation of the sound box. The citharoedus (singer to the cithara) stood on a small platform, his decorative instrument resting against his body and supported in position by a band attached to his left wrist.

There were two main varieties of cithara: the first, an elaborately constructed instrument with a flat base; the second, a much simpler instrument with a rounded base that was favoured by less pretentious players.

With both the lyra and the cithara, the left hand was spread over the strings, while the right hand held a plectrum. The precise function of the two hands is still uncertain. Though strings numbering up to 12 were added to the cithara by virtuosos of the late 5th century B.C., the number 7 was canonical in the classical period. It is debated whether each string provided one note only or whether it was possible to obtain notes of higher pitch by stopping.

During the Roman period new varieties of cithara emerged. The lyre of medieval Europe (rote) tended to depart from the type by the addition of a finger board and the use of a bow; *e.g.*, the Welsh *crwth* (*q.v.*), which was still played in the early 19th century. A similar instrument, the kantele, is still played in Finland and Estonia.

In Africa, *e.g.*, Sudan, Ethiopia, Uganda, the lyre survives in a form not unlike that of the ancient world and is used, as in Homer's day, to provide an accompaniment for the professional singer.

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FROM M. WEGNER, "DAS MUSIKLEBEN DER GRIECHEN" (W. DE GRUYTER AND CO., BERLIN, 1949)

INSTRUCTOR AND PUPIL PLAYING THE LYRE BENEATH HANGING CITHARA AS DEPICTED IN SCHOOL SCENE ON ATHENIAN VASE, 5TH CENTURY B.C.

LYREBIRD, the name for Australian birds of the genus *Menura*, which resemble in some respects the scrubbirds (*q.v.*). Somewhat smaller than a pheasant, the lyrebird is the largest of the perching birds. The common superb lyrebird (*M. superba*), of the woodlands of eastern Australia, is the best known. The male is remarkable not only for his tail feathers, which when displayed bring to mind an ancient lyre, but also for his vocalizing, which is sometimes musical, sometimes uncannily imitative of a wide range of sounds. The female has a fowllike tail and apparently lacks the vocal ability of the male. Both sexes have brownish body feathers. The cock's tail feathers number 16: the outermost on either side, broad, curved and more than two feet long, are whitish with prominent brown marks; the central plumes are delicate and lacelike. Contrary to popular belief, the tail displayed in a vertical attitude is rarely seen; it is a fleeting position passed through as the tail is fanned forward and over the body, concealing the bird under a lacy canopy.

Lyrebirds are very shy, inhabiting the thickest underbrush. The cock builds small mounds within his territory on which he displays and sings. The food consists of insects and other small invertebrates. A domed nest, on or near the ground, is closely woven of roots and fibres and lined with feathers. A single purplish-gray egg, darkly blotched, is incubated by the hen for about six weeks; the chick, naked at hatching, quickly becomes covered with dark down.

Another species, Albert's lyrebird (*M. alberti*), named for Queen Victoria's consort, is more rust coloured and has less prominent tail feathers than the superb lyrebird. (HT. FN.)

LYSANDER (d. 395 B.C.), son of Aristocritus, won the final victory for Sparta in the Peloponnesian War and wielded great power at its close.

Nothing is known of his early career (stories of his humble birth must be discounted). His first year as admiral (407) was spent mainly in negotiation with the Persian viceroy, Cyrus the Younger, in preparation and in political activity, the only recorded action being his victory at Notium (early 406). His partisans made great difficulties for his successor Callicratidas, and when the latter was killed at Arginusae in August 406 they joined with Cyrus in demanding Lysander's reappointment. Spartan law forbade a second term, so he went out nominally as second-in-command early in 405. His victory at Aegospotami in September closed the corn route

through the Hellespont, starving Athens into surrender (April 404). Some time after the formal surrender he returned to Athens and helped to set up the oligarchy of the Thirty Tyrants, after which he returned in triumph to Sparta.

Lysander had used his period of power to support narrow oligarchies everywhere: many cities were ruled by a board of ten (decarchy) of his partisans, and some had garrisons under a Spartan commander (harmost). He aimed at a Spartan empire, wider than the Athenian and under strict control, but the attempt failed. The record for 403 is confused and partly fictional, but it is certain that Lysander was sent to support the Thirty at Athens against Thrasybulus' democratic revolt, and was nearly successful when King Pausanias secured the support of a majority of the five ephors for his own intervention. The eventual settlement, which allowed the restoration of democracy at Athens, was a defeat for Lysander, confirmed by the acquittal of Pausanias at his subsequent trial. The decarchies were probably abolished, though some scholars maintain they survived till 397 and deny that Lysander suffered a political eclipse.

On the death of Agis II, probably in 400, he helped Agesilaus II to the throne, and he headed the 30 Spartan officers who accompanied Agesilaus to Asia in 396. At first he engrossed all the expedition's business, but Agesilaus, by rejecting all requests backed by Lysander, undermined his authority. Eventually he was allowed to go off on a separate mission, and in 395 he returned home. In the summer war broke out with Thebes, and Lysander led an army of Sparta's northern allies into Boeotia from the west, won over Orchomenus and marched to Haliartus to meet Pausanias and the Spartan army. Lysander arrived first, attacked the town alone and was killed under the walls. He was buried at Panopeus in Phocis and Pausanias after a second trial went into exile.

A very able soldier and politician, Lysander was wholly ruthless in pursuit of his own and Sparta's ambitions and made many enemies. He was credited with plans to alter the constitution to an elective monarchy, and though this theme has been embroidered it may have a basis of truth.

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(A. As.)

LYSENKO, TROFIM DENISOVICH (1898–), a Soviet agronomist, graduate of the Kiev Agricultural Institute, who rejected orthodox genetics in favour of "Michurinism" (named for the Russian horticulturist I. V. Michurin). Michurinism, widely regarded as a form of Lamarckism (*q.v.*), more properly should be compared with the school of Luther Burbank (*q.v.*). It was begun by an uneducated plant breeder fashioning explanations of his hybrid fruit creations. After Michurin's death in 1935, Lysenko led the movement and transformed it into an assault on orthodox genetics.

It is historically true that Lysenko's Michurinism was buttressed by the Stalinist version of Marxism. The Soviet chiefs began to support Lysenko during the agricultural crisis of the 1930s. On the basis of rather crude and unsubstantiated experiments, Lysenko promised greater, more rapid and less costly increases in crop yields than other biologists believed possible. By 1948, when education and research in standard genetics were virtually outlawed, some geneticists had suffered secret arrest and death of undisclosed causes. After Stalin's death, in 1953, some of Lysenko's agricultural programs were abandoned but not entirely discredited; orthodox geneticists won limited freedom of teaching, research and publication; and some condemned biologists were posthumously reinstated.

It is misleading to regard the inheritance of acquired characters as the primary issue in Lysenko's clash with orthodox geneticists, who, since the 1920s, have been making their own studies, precise and controlled, of environmentally induced changes in heredity. Lysenko rejects the basic concepts and methods of these experiments. He disregards the statistically justified distinction between genotype and phenotype. He insists that all parts of the organism are equally involved in heredity (which recalls Darwin's early doctrine of pangenesis), that chromosomes play no special role, that genes do not exist. His own "theories" are too vague or too question-begging to be taken seriously by most geneticists. His central principle, "the unity of the organism with its environment," can mean anything he chooses it to mean. His "directed changes in heredity" neglects the statistical rigour and the initial purity of stock required by standard genetical concepts (these he rejects in advance). His school has also been charged with falsifying data.

Lysenko's doctrines and claims have varied with the amount of power he has held. Between 1948 and 1953, when he was the total autocrat of Soviet biology, he claimed that wheat plants raised in the appropriate environment produce seeds of rye, which is equivalent to saying that dogs living in the wild give birth to foxes. His fundamental, continuing argument is that theoretical biology must be fused with Soviet agricultural practice. Since Stalin's death, this principle has caused Lysenko some embarrassment, for efforts to improve Soviet agriculture have brought the abandonment of measures to which his name and fame were tied. For example, the "grassland" system of crop rotation was abandoned in favour of intensive cultivation with heavy use of mineral fertilizers, and a hybrid corn program based on the American example has been energetically pursued (Lysenko put a halt to such a program in the mid-1930s, for he was opposed to the inbreeding with which it must begin). After the political demise of N. S. Khrushchev in the autumn of 1964, Lysenko's doctrines were discredited and efforts made toward the reestablishment of orthodox genetics in the U.S.S.R. *See* also GENETICS: *Soviet Genetics.*

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(D. Jo.)

LYSIAS (*c.* 445–after 380), a Greek professional speech writer at Athens, noted for the charm and purity of his prose. His father, Cephalus, was a native of Syracuse who was said to have settled in Athens at the invitation of Pericles. Plato, who seems to have known the family well, gives a charming picture of Cephalus and his sons at the beginning of the *Republic*. After his father's death Lysias, then aged 15, went with his brother Polemarchus to Thurii in southern Italy where, according to an ancient source, he studied rhetoric under the Syracusan rhetorician Tisias. In 412 an anti-Athenian reaction at Thurii, which followed the Athenian disaster in Sicily, compelled the two brothers to return to Athens where they settled as *isoteleis* (a specially favoured class of aliens). They derived a substantial income from a shield factory in Piraeus and had a good social position. A statement ascribed to Aristotle that Lysias taught rhetoric may refer to this period of his life.

The fortunes of the brothers changed after the fall of Athens in 404 when the Thirty Tyrants attacked the persons and property of resident aliens. Polemarchus was killed. Lysias himself was arrested, but escaped to Megara, and from there he helped the cause of the exiled democrats. On the restoration of democracy in 403 a decree was passed in the ecclesia conferring citizenship on Lysias, but it was later declared invalid owing to some technical irregularity. He spent the rest of his life at Athens as a professional writer of speeches for litigants. The only occasion on which he appeared personally in the courts was in 403 when he prosecuted Eratosthenes, one of the Thirty. Little is known of his other activities. Dionysius of Halicarnassus has preserved the fragment of a speech supposed to have been delivered by Lysias at the Olympic festival of 388. His latest extant speech is dated *c.* 380.

Of the large number of speeches ascribed to Lysias by antiquity 34 have survived. Some of these are incomplete and some are probably spurious. Small fragments of others have been preserved and their number has been increased by modern papyrological discoveries. There is also a rhetorical trifle in Plato's *Phaedrus* which purports to be the work of Lysias. It pleads the case of a suitor who is not in love with a boy. Some think it was in fact written by Lysias, but it is more commonly regarded as a pastiche by Plato.

The most interesting of the nonlegal speeches is the *Olympiacus* (xxxiii), which Lysias is said to have delivered at Olympia in 388. In it he appeals to the Greeks to unite against the tyranny of Dionysius the Elder of Syracuse. The ornate style, which is char

acteristic of epideictic, or ceremonial, oratory, is in contrast with the unpretentious simplicity of Lysias' legal speeches. The *Epitaphius* (ii), written in honour of Athenians killed during the Corinthian War (395–386), is probably spurious. There is a substantial fragment of a political speech (xxxiv), ostensibly delivered in the ecclesia, which is directed against a proposal to limit the ancient democratic constitution after the fall of the Thirty in 403.

The other extant speeches are all legal and on these Lysias' fame rests. Most of them were written for public cases. The longest and most famous is that "Against Eratosthenes" (xii; *Kata Eratosthenous*) in which Lysias denounces one of the Thirty, whom he held responsible for the murder of his brother, for the part he played in the reign of terror which followed the collapse of Athens. "Against Agoratus" (xiii; *Kata Agoratou*) also gives interesting information about the activities of the Thirty. Other speeches concern various crimes against the state; *e.g.*, murder (i), malicious wounding (iii and iv), sacrilege (v and vii) and taking bribes (xxi). One is in prosecution of the public corn dealers for overcharging (xxii), and a particularly delightful speech defends a cripple's right to a state pension (xxiv). Three concern the scrutiny of persons elected to public offices (xvi, xxvi, xxxi). A few of the extant speeches were written for private suits, such as x in which a man is accused of slander. The most interesting of the papyrus fragments come from a speech in which the point at issue is apparently the recovery of Lysias' property which had been confiscated by the Thirty.

In contrast with the self-conscious artistry of Antiphon, Lysias' style in his legal speeches is unpretentious and achieves its effect by its apparent artlessness. This was in keeping with the trends of his time. About the end of the 5th century there was a reaction, at least as regards practical oratory, against the artificial embellishments of Gorgias and his imitators. Juries were inclined to suspect the sincerity of an elaborately composed speech. No speech writer was more successful than Lysias in disarming such suspicions. His language reflects the simple speech of everyday life. Rare and poetical words, colourful metaphors, striking phrases are all avoided. Of the so-called "figures of speech," antithesis is the only one commonly found, and even this he uses in moderation and with regard to the appropriateness of the context. The structure of his sentences is remarkably supple and varied; he ranges with complete mastery from the short, uncompounded sentence to one complex, rounded period. His arrangement of subject matter is clear and precise. Speeches are normally divided into introduction, narrative of facts, proofs and epilogue. His characteristic qualities are best seen in the narrative. Introduction and epilogue are inevitably to some extent conventional, but he shows great skill in varying them so that each is appropriate to the particular speech.

What contributed as much as anything else to Lysias' success as a speech writer was his unrivaled genius for making his speeches reflect the character of the speakers. Notable examples are the speeches written for the ingenuous young knight Mantitheus (xvi) and the humorous, but unscrupulous, cripple (xxiv). "Against Eratosthenes" shows that Lysias was capable of impassioned oratory when he himself was the speaker and his own feelings were deeply involved, but in his professional writing for the courts the tone is quiet and there is little appeal to the emotions.

Lysias' influence on subsequent Greek prose was considerable. With later antiquity he became the model for the plain style of Attic Greek.

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LYSIMACHUS (*c.* 355–281 B.C.), Macedonian general, satrap and king, was one of the "Successors" (Diadochi) of Alexander the Great. He played an important role in the wars which followed Alexander's death and in the political transformation of the Macedonian empire thereby effected.

During Alexander's conquest of the Persian empire Lysimachus was one of the king's bodyguard. He distinguished himself in the Indian campaign. In the distribution of satrapies at Babylon after Alexander's death (323) he was given Thrace to govern. For many years he was fully occupied in wars against the native peoples there and so prevented from taking an active part in the struggles in Greece and Asia between the other Successors, though in 316 he joined with Cassander, Ptolemy and Seleucus in the coalition against Antigonus I. It was not until 302, on the occasion of the second alliance of the enemies of Antigonus, that he emerged as a power of the first rank. Then, reinforced by troops given him by Cassander, he entered the dominions of Antigonus in Asia Minor and bore the brunt of the campaign which ended in the overthrow of Antigonus at the battle of Ipsus (301; *q.v.*). The division of Antigonus' kingdom resulted in Lysimachus' acquiring the greater part of Asia Minor. This, with his European possessions, gave him a position of great strategic strength: his territory at its greatest extent embraced about 160,000 sq.mi. He had taken the title of king at the same time as the other Successors in 306/305, having already built himself a new capital, Lysimachia, in the Thracian Chersonese (Gallipoli peninsula) near the older city of Cardia (309).

After 301 Lysimachus consolidated his power in both Asia and Europe in wars against Demetrius Poliorcetes. Only in 294 did he conclude peace, having by then annexed the cities in Ionia and Caria which Demetrius had retained after Ipsus. An attempt to carry his power beyond the Danube ended in failure, but in 288 he joined hands with Pyrrhus, the king of Epirus, to drive Demetrius from Macedonia. Pyrrhus was at first allowed to remain in possession of half of Macedonia with the title of king, but in 285 Lysimachus seized the whole country for himself.

The last years of his life were darkened by dissension and intrigue within the ranks of his family. He had married as his third wife Arsinoe, the daughter of Ptolemy I Soter, the king of Egypt. This ambitious and ruthless woman, in order to gain the succession for her own sons (and probably at the instigation of her half brother Ptolemy Ceraunus, who had left Egypt to seek his fortune with Lysimachus), persuaded her husband to execute his eldest son Agathocles on a charge of treasonable conspiracy with Seleucus I, the Syrian king (284). This unjustified act caused revulsion among the courtiers and throughout the kingdom. Agathocles' widow fled to Seleucus, who, seeing the prevailing discontent, took advantage of the opportunity to invade the territory of Lysimachus in Asia Minor, where many of the Greek cities had already revolted. Lysimachus crossed the Hellespont into Asia, and in 281 a decisive battle was fought at Corupedium in Lydia in which Lysimachus was defeated and killed.

Lysimachus was an able and energetic ruler. In generalship and statesmanship he was fully the equal of the other Successors. Over the Greek cities in his realm he exercised a strict control, taxing them heavily. One aspect of the close attention he gave to the financial organization of his kingdom may be seen in the extremely fine coinage bearing the head of Alexander which he issued and which served as a model to be copied by other kings long after his death.

See F. Geyer in Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, vol. xiv, 1–31 (1928). (R. H. Sr.)

LYSIPPUS (fl. late 4th century B.C.), Greek sculptor, was head of the school of Argos and Sicyon in the time of Philip and Alexander of Macedon. He worked in bronze and was said to have produced some 1,500 works, several of them colossal. He modified the canon of Polyclitus toward a more slender type, and introduced an element of impressionism. Lysippus represented the acme of lifelike naturalism. Pliny and other writers mentioned many of his statues. Among the gods he seems to have produced new and striking types of Zeus, Poseidon, the sun-god Helios and others. He made several statues of Hercules, stressing the motif of weariness exemplified in the later Farnese Hercules.

Lysippus made many portraits of Alexander the Great and became the court sculptor of the king, from whom and from whose generals he received many commissions. The extant portraits of Alexander vary greatly and it is impossible to determine which among them go back to Lysippus.

As head of the great athletic school of the Peloponnese, Lysippus sculptured many athletes; a figure by him of a man scraping himself with a strigil (skin scraper) was a great favourite of the Romans in the time of Tiberius; and this has been usually regarded as the original copied in the Apoxyomenus of the Vatican. More than 40 ancient copies of his "Eros" exist. His "Kairos," a personification of opportunity, has often been imitated. He also did drunken flute players and dancing satyrs.

See F. P. Johnson, *Lysippos* (1928); M. Bieber, *The Sculpture of the Hellenistic Age*, pp. 38–39 (1955). (P. G.; D. M. R.)

LYSIS OF TARENTUM (*fl. c.* 400 B.C.), Greek philosopher, a member of the Pythagorean community in southern Italy, is said to have escaped from a massacre there to Thebes, where he became the teacher of Epaminondas. A letter of his, whose genuineness is doubtful, is given in Iamblichus, *Life of Pythagoras*, 75–78.

LYTE, HENRY FRANCIS (1793–1847), English clergyman and hymn writer, was born near Kelso on June 1, 1793, and was educated at Enniskillen school and at Trinity college, Dublin. He took orders in 1815, and eventually settled, in 1823, in the parish of Brixham. He died at Nice on Nov. 20, 1847.

Lyte is remembered for his *Poems, chiefly Religious* (1833) and *The Spirit of the Psalms* (1834). His best-known hymns are "Abide with me!"; "Jesus, I my cross have taken"; and "Praise, my soul, the King of Heaven."

LYTHAM ST. ANNES, a municipal borough (1922) and popular seaside resort of Lancashire, Eng., is situated on the northern side of the Ribble estuary, 12 mi. W. of Preston and adjoining the southern boundary of Blackpool. Pop. (1961) 36,222. There are five public parks, extensive floral promenades and 6½ mi. of beach. Four 18-hole golf courses include the Royal Lytham and St. Annes Golf club, venue of national and international golfing events. Squire's Gate airport, between Lytham St. Annes and Blackpool, has services to the European continent, Jersey and the Isle of Man. A Benedictine cell was founded at Lytham in the 12th century by Richard Fitz-Roger, lord of the manor.

(T. J. H.)

LYTHRACEAE, the loosestrife family of flowering plants, consisting of about 23 genera and 475 species of dicotyledonous herbs, shrubs or trees, widely distributed but abundant in the American tropics. They have mostly opposite, entire leaves, with stipules minute or lacking; and flowers bisexual, mostly axillary, solitary or in clusters, generally symmetrical, with the calyx free from the ovary and petals sometimes wanting. Among the best-known ornamental members are crape myrtle (*Lagerstroemia*), spiked or purple loosestrife (*Lythrum*), cigar flower (*Cuphea*) and henna (*Lawsonia*). *See* LOOSESTRIFE; HENNA. (J. M. BL.)

LYTTON, EDWARD GEORGE EARLE LYTTON, BULWER-LYTTON, 1ST BARON (1803–1873), prolific and versatile English novelist and politician, was born in London on May 25, 1803, the youngest son of Gen. William Bulwer and Elizabeth Lytton, the heiress of Knebworth, Hertfordshire. His father died when he was four, and Bulwer was educated at various private schools and at Trinity college and Trinity hall, Cambridge. While still at school he published *Ismael, an Oriental Tale* (1820), a volume of youthful Byronic verses, and was deeply affected when the young girl with whom he had fallen in love was abruptly removed by her father. Their brief romance and her subsequent death profoundly influenced Bulwer's attitude to love in his novels. While at Cambridge he was awarded the Chancellor's medal for his poem *Sculpture* (1825), and was drawn into a flirtation with Lady Caroline Lamb, Byron's former mistress. He then visited Paris and Versailles, and on his return to England met Rosina Doyle Wheeler, an Irish beauty, whom he married in 1827. His mother disapproved of the match and as a final protest withdrew his allowance.

Bulwer was thus forced to find some means of earning a living. He had already published *Falkland* (1827), an unpopular novel heavily influenced by Jean Jacques Rousseau and Mrs. Ann Radcliffe, but *Pelham* (1828), the adventures of a young dandy in the fashionable world, was a great success and inaugurated his career as a fluent popular novelist. His extravagant style of living necessitated feverish industry and the strain made Bulwer an irritable and negligent husband. Rosina became jealous of his work, and after a series of increasingly violent quarrels, they were legally separated in 1836. But Rosina's hysterical passion was not appeased, and she was a constant source of embarrassment to Bulwer for the rest of his life.

In 1831 Bulwer entered parliament as Liberal member for St. Ives and in 1832 became member for Lincoln. He advocated legislation on behalf of literature and the arts, including a reduction in the newspaper tax and the creation of dramatic copyright, attacked censorship, and recommended state subsidies for the theatre. His pamphlet in support of Lord Melbourne in 1834 was said to have been instrumental in returning a Whig government. As a reward he was offered a minor post which he refused in favour of his literary career, and in 1841 he retired in protest against the repeal of the corn laws. This, together with his growing friendship with Disraeli, converted Bulwer into a Tory, and in 1852 he returned to the house as member for Hertfordshire. He was created a baronet in 1838, added Lytton to his surname when he inherited Knebworth in 1843, and was raised to the peerage as Baron Lytton of Knebworth in 1866. He was not active in the house of lords. He died at Torquay on Jan. 18, 1873.

Bulwer's interest in the theatre was not confined to legislation. His own theatrical ventures were the result of his friendship with William Macready (*q.v.*), the celebrated actor-manager, who, together with John Forster (*q.v.*), Bulwer's staunchest literary friend, shaped his plays by encouragement and criticism. His first production, *The Duchess de la Vallière* (1836), was a failure, but *The Lady of Lyons* (1838), a romantic comedy, and *Richelieu* (1839), a historical comedy with Macready in the title role, were great successes. *Money* (1840), a social comedy and Bulwer's most enduring play, was to be his last, for the theatre was not really profitable, and despite his many plans nothing else was completed.

Bulwer's versatility was also shown in several volumes of poetry including *The New Timon* (1846), a satirical verse novel which contained an unworthy attack on Tennyson, and *King Arthur* (1848), an ambitious and unsuccessful long epic. He also edited the *New Monthly* (1831–33), wrote *England and the English* (1833), an acute piece of social criticism, and a history of Athens, but his literary reputation rests primarily on his novels. His immense popularity during his lifetime was largely due to his skill in anticipating and satisfying the various changes in public taste. Thus he started in the "Silver Fork" tradition with *Pelham*, which combined Gothic romance with the setting of the fashionable world; in *Devereux* (1829) he began a series of historical novels which included the spectacularly successful *The Last Days of Pompeii* (1834), *The Last of the Barons* (1845), and *Harold, the Last of the Saxon Kings* (1845); and in *Paul Clifford* (1830) and *Eugene Aram* (1832) he made use of the current interest in criminals and the underworld. Bulwer's own interest in the occult produced *Zanoni* (1842) and *A Strange Story* (1862); he presented his Utopia in *The Coming Race* (1871), and turned to realism and the portrayal of English society in *The Caxtons* (1849) and *My Novel* (1853).

In the 20th century Bulwer-Lytton's reputation has declined as sharply as the critics (including Thackeray) who persecuted him in *Fraser's Magazine* could have wished. He was influenced by the romanticism of Byron and Goethe, the melodrama of the Gothic novel, and by such novelists as Samuel Richardson, Henry Fielding and William Godwin. His plots are elaborate and involved and his characterization is exaggerated and unreal. Thus his heroines are all purity and sweetness and his villains as unsubtle as they are unscrupulous. His historical novels tend to be weighed down with meticulous detail, and his style is grandiose and ornate. Without the instinctive genius of a Dickens or a Thackeray which could triumph over the sentimental ideals of the period, he is an inescapably dated writer, although a gifted storyteller who remains immensely readable. In his best novels such as *Ernest Maltravers* (1837) and its sequel *Alice* (1838), the strong autobiographical element provides a convincing and revealing portrait of society life and the political arena. His personal experience of society and politics gives Bulwer's work historical interest: his standing is that of a talented novelist in the great age of the novel.

BIBLIOGRAPHY.—*The Life of Edward Bulwer* by his grandson, 2 vol.

(1913); M. Jaffeir, *Bulwer and his Wife, a Panorama*, 1903–4 (1903); *Bulwer and Macready*, correspondence ed. by C. H. Shattuck (1958).

LYTTON, (EDWARD) ROBERT BULWER-LYTTON, 1st Earl of (pseudonym, Owen Meredith) (1831–1891), English diplomat, and a notable viceroy of India (1876–80), who also achieved a considerable contemporary reputation as a poet. The only son of the first Lord Lytton (q.v.), he was born in London on Nov. 8, 1831. Although he wished to become a poet, his father insisted that he should enter the diplomatic service. After three years at Harrow (1846–49), and a year with a tutor in Bonn, in 1850 he was appointed unpaid attaché to his uncle, Sir Henry Bulwer (later Lord Dalling, q.v.), then minister at Washington, D.C. He rose steadily in the service, his first paid appointment being at Vienna (1858), and in 1874 was appointed minister at Lisbon. In 1864 he had married Edith Villiers, niece of the earl of Clarendon, and in 1877 had succeeded to the barony.

In Nov. 1875 Disraeli asked him to succeed Lord Northbrook as governor-general of India. Relations with Afghanistan were in a delicate state; Russian influence there was growing, and Lytton took with him orders either to counteract it or to secure a stronger frontier by force. Eleven months of negotiations had produced no result when he abruptly suspended them in March 1878, his actions led to war with Afghanistan in November. The British forces won a quick victory. The amir, Sher Ali Khan, fled and his son Yakub Khan was installed in his place. The treaty of Kandahar (May 16, 1879) established a more defensible "scientific" frontier with India as well as a British residency at Kabul to control Afghan foreign policy. (See AFGHANISTAN, *History*.) But on Sept. 3 the resident, Sir Pierre Louis Cavagnari, and his staff were murdered and war began again. Lytton immediately dispatched Gen. Sir Frederick (later Field Marshal Earl) Roberts on a successful campaign, which was still being pursued when the governor-general resigned, with the Conservative government, in the spring of 1880. His successor, Lord Ripon, disapproved and revised his "forward" Afghan policy. Though Afghanistan received most attention in Great Britain during Lytton's viceroyalty, and his conduct there was criticized, he had done much for Indian administration; he supervised effective measures for famine relief, abolished internal customs barriers, decentralized the financial system, proclaimed the queen empress of India at a splendid durbar at Delhi (Jan. 1, 1877) and reserved one-sixth of civil service vacancies for Indians.

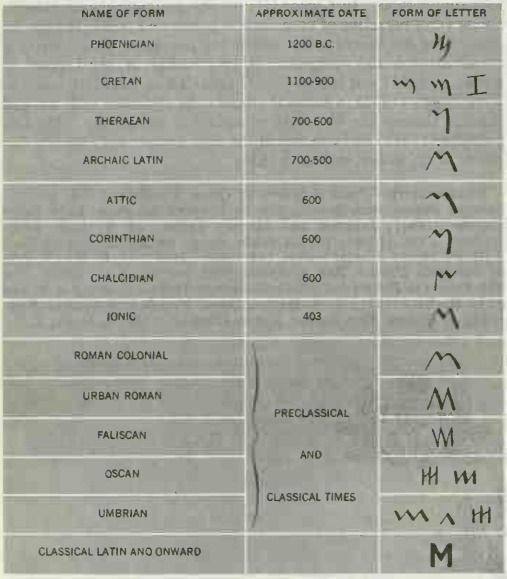
In returning from India, Lytton received an earldom, and in 1887 was appointed ambassador in Paris, where his winning personality did much to improve Anglo-French relations. He died there, very suddenly, on Nov. 24, 1891, and was succeeded by his elder surviving son, Victor (1876–1947), under-secretary of state for India (1920) and governor of Bengal (1922–27). In his death the title passed to his brother Neville Stephen (1879–1951), who was succeeded by his son, Noel Anthony Scawen (1900–).

To his contemporaries, Robert Lytton was better-known as a poet than as a diplomat, and his first collections—*Clytemnestra ... and Other Poems* (1855), verse narrative imitative of Browning; *The Wanderer* (1858), autobiographical lyrics—were well received, as was *Lucile* (1860), a witty and romantic novel in verse. His undoubted talents were encouraged by the Browning, whom he met in Florence (1852), by his father's friend, John Forster, and by Charles Dickens. They suffered, however, from his inability to give writing his undivided attention, and success as a diplomat prevented his poetic development. The failure of *Chronicles and Characters* (1867), an ambitious attempt to express poetically the ideas of the past, depressed him deeply and, when he returned from India, he found that his creative energies had been exhausted by long suppression. In *Genoveffa, or the Metamorphoses* (1885), a long verse narrative of considerable power and poetic beauty, he dramatized the inner conflict which had prevented his achieving a consistent style and viewpoint. *After Paradise, or the Legends of Exile* (1887) and *Marah* (1892) collected his later lyrics, and in *King Poppy* (1892), a satirical allegory, he criticized with wit and delicate fantasy the Victorian materialistic philosophy. He also published (1883) two volumes of the *Life, Letters and Literary Remains* of his father, ending in 1883.

BIBLIOGRAPHY.—*Poetical Works of Owen Meredith*, 2 vol. (1867); *Selected Poems*, with introduction by Lytton's daughter, Lady Betty Balfour (1894); *Personal and Literary Letters*, ed. by Lady Betty Balfour, 2 vol. (1906); for his public career, see her *History of Lord Lytton's Indian Administration* (1877–80) (1899); K. D. Buckle, *Life of Benjamin Disraeli, Earl of Beaconsfield*, vol. 5 and 6 (1920). See also *Letters to Robert and Elizabeth Barrett Browning*, ed. by A. B. and J. L. Harlan (1937); A. B. Harlan, *Owen Meredith: a Critical Biography of Robert, First Earl of Lytton* (1946). [A. R. D. E., X.]

THE letter M corresponds to the Semitic 𐤌 (*mem*) and to the Greek Μ (*mu*). The Semitic form may derive from an earlier sign representing waves of water. Early Greek forms from Thera, Attica and Corinth closely resemble the early North Semitic 𐤌, Μ. The Lydian alphabet also had the form 𐤌. These forms differ only in the direction of the writing. The Etruscan form was similar, but with an additional stroke, 𐤌. The Ionic alphabet had the form Μ. Since this form is rare in Etruscan, the Latin form M may have been borrowed directly from the Chalcidian.

Curious forms occurred in the various Italic alphabets. Umbrian had 𐤌 or Λ, Oscan 𐤌, Faliscan 𐤌. The rounded form appeared in the uncial writing of the 5th or 6th centuries, ϻ. The cursive hands of the 6th century showed ϻ and on this was based the Carolingian ɯ. The modern minuscule does not differ essentially from the majuscule letter. The sound represented by



THE DEVELOPMENT OF THE LETTER "M" FROM THE PHOENICIAN THROUGH CLASSICAL LATIN TO THE PRESENT FORM

the letter has been from the beginning the labial nasal. The nasals of all sounds are least liable to change, a fact that is reflected in the consistent history of the letter. *See* also ALPHABET. (B. F. C. A.; J. W. P.)

MA'AN, a town of southern Jordan, administrative centre of the *liwa'* (district) of that name. Pop. (1961) 6,643. It lies on a plateau at the fringe of the desert and is the trading and shopping centre for the Bedouin who are the principal inhabitants of the area. The town, built almost entirely of mud brick, is linked by road and rail to Amman and by road to the port of Aqaba. There is a landing strip east of the town. Ancient Petra (*q.v.*) lies 25 mi. W., and from Ra's an Naqb on the south there is one of the most sensational views in the country.

MA'AN LIWA' includes the subdistricts of Aqaba and Ma'an. Area 266 sq.mi. Pop. (1961) 27,051. Much of the district is a high plateau. It is sparsely cultivated. (G. W. L. H.)

MAAS, NICOLAS: *see* MAES, NICOLAES.

MAASTRICHT, the capital of Limburg province, the Netherlands, on the left bank of the Maas (Meuse), 32 km. (20 mi.) N.N.E. of Liège, Belg., by road. Pop. (1962 est.) 92,371. Maastricht, the site of a Roman settlement, was the seat of a bishop from *c.* 382 to 721. After 1204 the duke of Brabant held the town in fief from Philip of Swabia; in 1284 it came under the joint sovereignty of Liège and Brabant and in 1632 of Liège and the Dutch states-general. In 1579 it was taken and plundered by the Spaniards under the duke of Parma. It became a strategic fortress and was besieged by the French in 1673, 1748 and 1794. Parts of the old fortifications—Hellgate (1229), fort of St. Peter and 16th–18th-century bastions—remain.

The suburb of Wijk lies on the right bank of the river. A stone bridge, St. Servaasbrug, connecting the two sections, replaced a wooden structure as early as 1280 and was rebuilt in 1683; the Wilhelminabrug was completed in 1934. The town hall (1659–64) contains paintings and Gobelins. The Dinghuis, or former courthouse, is a 15th-century Gothic building. The church of St. Servatius (St. Gervase), founded by Bishop Monulphus in the 6th century, is the oldest church in Holland; according to one account it was rebuilt and enlarged from the 11th to the 15th century. The late Romanesque basilica of St. Mary (Onze-Lieve-Vrouwekerk) has two ancient crypts and a 12th-century choir. The Protestant St. Janskerk, a Gothic building of the 13th and 15th centuries, with a fine tower, formerly served as the parish church for the cathedral of St. Servatius. There are also many fine houses in regional Renaissance and French styles. Maastricht is a noted art and cultural centre with a music conservatory, symphony orchestra, men's choir, academies of drama and plastic arts, and museums of antiquities and natural history.

An early trade was carried on in cloth, leather, hardware and building materials. The town did not reap the full advantages of its central position between the mining and industrial cities of Heerlen, Aix-la-Chapelle, Liège and Kempen till the opening of the railways after 1853. There are now manufactures of pottery, glass and crystal, as well as cement, paper, tobacco and cigar factories. Steel and chemicals are produced and art-printing is significant. There is a trade in grain and butter.

A short distance south of Maastricht are the marl quarries of Pietersberg, which were worked from Roman times till the end of the 19th century, resulting in more than 200 mi. of subterranean labyrinths, now partly leveled by the cement industry. In the time of the Spanish wars these underground passages served to hide the peasants and their cattle, and during World War II famous art treasures were stored there. The Renaissance castles of Neubourg and Mheer, the baroque castle of Amstenrade and the late-17th-century castle of Neercanne are nearby. Maastricht was assaulted by the Germans on May 10, 1940—the first day of the invasion of the Low Countries—and was liberated Sept. 13–14, 1944. (J. G. J. K.)

MABILLON, JEAN (1632–1707), Benedictine monk and scholar of the Congregation of St. Maur, was born on Nov. 23, 1632, the son of a peasant living near Reims, France. In 1653 he entered the abbey of St. Remi at Reims and in 1664 was placed at St. Germain-des-Prés in Paris, the great literary workshop of the Maurists. There he lived and worked for 20 years, at first under Luc d'Achéry, with whom he edited the nine folio volumes of *Acta* of the Benedictine saints (1668–1701). In Mabillon's prefaces (reprinted separately) these lives were for the first time made to illustrate the ecclesiastical and civil history of the early middle ages.

Several journeys—in Flanders, Lorraine, Burgundy, southern Germany and Switzerland—proved exceptionally fruitful. Many of Mabillon's discoveries were promptly published in his *Veterum Analecta* (4 vol., 1675–85). Prompted by the excessive skepticism

of the Jesuit Daniel Papebroch, who in his *Propylaeum antiquarium circa veri ac falsi discrimen in vetustis membranis* (1675) had declared that nearly all Merovingian documents were spurious and that no authentic charters existed for the period before 700, Mabillon with the help of several of his confrères produced a classic work, his *De re diplomatica* (1681; supplement, 1704), in which were first laid down the principles for determining the authenticity and date of medieval charters and manuscripts. It practically created the science of Latin paleography. Work on the Lectionary of Luxeuil, discovered in the early days of the *Iter Germanicum* (1683), stimulated him to write the *De liturgia Gallicana* (1685), and the most profitable journey of all, that in Italy, led to the publication of the *Museum Italicum* (1687–89), which included not only the famous Missal of Bobbio but also the precious *Ordines Romani*. These important texts have been splendidly reedited since, but for more than two centuries they were the only resource available to scholars. On his return to Paris from Italy Mabillon was called upon to defend against the Trappist abbot A. J. le B. de Rancé, the legitimacy for monks of the kind of studies to which the Maurists devoted themselves. This called forth Mabillon's *Traité des études monastiques* and his *Réflexions sur la réponse de M. l'abbé de la Trappe* (1691–92), works embodying the ideas and program of the Maurists for ecclesiastical studies.

Mabillon produced in all about 20 folio volumes and as many of lesser size, nearly all works of monumental erudition. He died in Paris on Dec. 27, 1707, in the midst of the production of the colossal Benedictine *Annales* (4 vol., 1703–07; vol. 5, posthumously, 1713; vol. 6, the work of other authors, 1739). *See* also DIPLOMATIC.

BIBLIOGRAPHY.—The chief authority for Mabillon's life is the *Abrégé de la vie de D. J. M.* (also in Latin), by T. Ruinart (1709), reprinted (1933) under the title *Mabillon* (Collection *Pax*, xxxv). *See* also R. P. Tassin, *Histoire littéraire de la congregation de St. Maur* (1770). Excellent introductions to the study of Mabillon's career are the articles by J. Baudot in *Dictionnaire de Théologie catholique*, vol. ix, and by H. Leclercq in *Dictionnaire d'Archéologie chrétienne et de Liturgie*, vol. x. The modern biographies include those of E. de Broglie, 2 vol. (1888), S. Bäumer (1892) and Henri Leclercq, 2 vol. (1953–57), this last work in many respects the most valuable of all. Especially useful is J. U. Bergkamp's dissertation, *Dom Jean Mabillon and the Benedictine Historical School of Saint-Maur* (1928).

(E. C. B.; AM. S.)

MABINOGION, THE, the title of a collection of 11 medieval Welsh tales. *The White Book of Rhydderch* (*c.* 1300–25) is the first manuscript extant to contain any considerable number of them; *The Red Book of Hergest* (*c.* 1375–1425) the first to contain them all. The form *mabinogion* was long regarded incorrectly as a plural of *mabinogi*, which meant, first "youth," then a tale of youth" and lastly "a tale." The stories of the *Mabinogion* are (1) "The Four Branches of the *Mabinogi*," consisting of "Pwyll Prince of Dyfed," "Branwen daughter of Llŷr," "Manawydan son of Llŷr" and "Math son of Mathonwy"; (2) the native Arthurian tales "Culhwch and Olwen" and "The Dream of Rhonabwy"; (3) "The Dream of Macsen Wledig" and "The Adventure of Lludd and Llefelys"; and (4) the French Arthurian romances "Owain and Luned" (or "The Lady of the Fountain"), "Geraint and Enid" and "Peredur son of Efrawg." These anonymous tales, taken from oral stories, are based on mythology, folklore, heroic traditions and etiological elements and range from the second half of the 11th century to the close of the 13th century.

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(T. Js.)

MABUSE (MALBODIUS), **JAN** (JAN GOSSAERT or JENNI GOSSART) (*c.* 1478–1532), was the name adopted (from Maubeuge in northern France, where he or his family originally came from) by the Flemish painter Jan Gossaert. He is most likely to be identified with the Jennyn van Hennegouwe who registered as master of the guild of St. Luke at Antwerp in 1503. His most important early work extant is the "Adoration of the Kings" in the National Gallery, London, which is signed by him. There he throws together some 30 figures on an architectural background, carefully elaborated and Romanesque in style. He surprises us by pompous costume. His figures, like pieces on a chessboard, are often rigid and conventional. The landscape which shows through the ruined architecture is adorned with towers and steeples in minute fashion. This picture, probably painted for the abbey of St. Adrian, Grammont, is the work of a man trained in the old Flemish traditions.

That he was an admirer of Jan van Eyck is shown by his picture in Madrid of "Jesus, the Virgin and the Baptist," in Gothic framework. One of Mabuse's most distinguished works, the little triptych at Palermo was probably also painted at this early period. Jean Carondelet, who was Mabuse's patron, was archbishop of Palermo and chancellor of Flanders, and he probably transferred the picture to Sicily. It is a wonderful piece of pictorial elaboration, containing features taken from Dürer. Another early work is the moonlight scene representing "The Agony in the Garden," in the Berlin museum.

After living for a few years at Antwerp, Mabuse took service with Philip, bastard of Philip the Good, at that time lord of Somerdyk and admiral of Zeeland. One of his pictures had already become celebrated—a "Descent From the Cross" with 50 figures, ordered by Philip of Burgundy for the high altar of the church of Middelburg; and the value which was then set on the picture is apparent from the fact that in 1521 Dürer came expressly to Middelburg to see it, noting in his diary that it was not so good in design as in execution. In 1568 the altarpiece perished by fire. A smaller "Descent From the Cross," seen by Van Mander at Delft, is probably the one now in the Hermitage at Leningrad. In 1508 Mabuse accompanied Philip of Burgundy on his Italian mission, and this led to an important revolution in the art of the Netherlands. Mabuse not only brought home a new style, but also introduced the fashion of traveling to Italy; and from that time until the age of Rubens and Van Dyck it was considered proper that all Flemish painters should visit the peninsula.

In the summer of 1509 Philip returned to the Netherlands, and, retiring to his seat of Suytburg in Zeeland, surrendered himself to the pleasures of planning decorations for his castle and ordering pictures from Mabuse and Jacopo de Barbari. Being in constant communication with the court of Margaret of Austria at Malines, he gave the artists in his employ fair chances of promotion. Barbari was made court painter to the regent, while Mabuse received less important commissions. Records prove that Mabuse painted a portrait of Leonora of Portugal, and other small pieces, for Charles V in 1516. But his only signed pictures of this period are the "Neptune and Amphitrite" of 1516 at Berlin, the composition of which is taken from Dürer's famous engraving, and the Madonna, with a portrait of Carondelet of 1517, at the Louvre. In these last two we clearly discern that Giorgio Vasari only spoke by hearsay of the progress made by Mabuse in "the true method of producing pictures full of nude figures and poesies," for the types are ugly, though drawn delicately and modeled elaborately. Of similar type is the "Hercules and Deianira," dated 1517, in the Barber institute, Birmingham. In later forms of the same subject—the "Adam and Eve" at Hampton court, or the other version at Berlin—we observe more nudity, combined with realism.

Mabuse's "St. Luke Painting the Portrait of the Virgin" in the Narodni Galerie at Prague, and a variety of the same subject in the Vienna museum, prove that travel had left many of Mabuse's fundamental peculiarities unaltered. His figures still retain the character of stone; his architecture, now in Italian Renaissance style, is as rich and varied; his tones are as strong as ever. But bright contrasts of gaudy tints are replaced by soberer grays, and a cold haze pervades the surfaces. In this form the Madonnas of Munich (1527) and Vienna, in the collections of Max Wassermann in Paris, and E. Simon in Berlin, are fair specimens of his skill.

As early as 1523, when Christian II of Denmark came to Belgium, he asked Mabuse to paint the likenesses of his dwarfs. In 1528 he requested the artist to suppress the design for his Queen Isabella's tomb and epitaph in the Abbey of St. Pierre near Ghent. It was no doubt at this time that Mabuse completed the portraits of John, Dorothy and Christine, children of Christian II, of which replicas are at Hampton court, at Wilton house and at Longford castle, Wiltshire. It is as a portrait painter that Mabuse can be

seen to the best advantage. His portraits of Carondelet in the collection of M. von Guttmann in Vienna and L. Hirsch in London; of Marquise de Vere in the Gardner museum at Boston, Mass., and others in the galleries of Copenhagen, London, Paris, Berlin, and in the Pratt collection, New York city, are remarkable for their strength and plasticity. In his later portraits the rendering of the hands becomes remarkably expressive of the sitter's personality. Carondelet's portrait in Vienna formed part of a diptych. The opposite wing is now in the Tournai museum and carries a half-length of St. Donatian. This diptych is one of the most powerful works of Mabuse.

When Philip of Burgundy became bishop of Utrecht, and settled at Duerstede, near Wyck, in 1517, he was accompanied by Mabuse, who helped to decorate the new palace of his master. At Philip's death, in 1524, Mabuse retired to Middelburg, where he took service with Philip's nephew, Adolph, lord of Veeren. He died at Breda in 1532.

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MAC (Scottish and Irish Gaelic *mac* = "son") is a surname prefix equivalent to the Anglo-Norman and Hiberno-Norman *Fitz* and the Welsh *Ap* (formerly *Map*). Just as the latter has become initial *P*, as in the modern names Price, Pritchard, etc., *Mac* has in some names become initial *C* and even *K; e.g.,* Cody, Costigan, Keegan.

The Gaelic countries were among the earliest to adopt hereditary surnames, their introduction in Ireland dating from the 11th century (with a few early ones in the 10th). A cursory examination of early medieval Gaelic records gives the impression that surnames in the modern sense were in use much earlier, because such personal names as *Domhnall Mac Gormain* occur continually; this name, however, does not in fact imply the existence of the surname MacGorman in the 9th century but merely indicates that this *Domhnall* (Donnell) was the son of a man whose Christian name was Gorman. Similarly, Dermot O'Tierney was simply Dermot the grandson of a man called Tierney (*Ua*, later shortened to *O*, means grandson or, more loosely, descendant).

Most names in *Mac* are formed from a Christian name, as is *Mac Aonghusa* (modern MacAinsb or MacGuinness, which both derive from the forename now anglicized as Angus). Many have been still farther removed from their original form by the substitution of the terminal *–son* for the prefix *Mac; e.g.,* Ferguson. Several of the best known *Mac* names embody Norse forenames, *e.g.,* the Scottish MacCorquadale, the Irish MacManus, or Irish MacLoughlin (MacLachlan in Scotland). Later, Norman names were likewise incorporated, *e.g.,* MacCostello; and in more recent times, especially in Scotland, surnames like MacDicken and MacRitchie have been formed from modern Christian names.

Most English surnames are formed from trades, personal attributes and places. The first two categories occur also in the Gaelic system, though less frequently. Instances are: MacDuff; Duffie (and even MacPhie, all from *dubh,* "black"); and Macateer (*mac an t-saoir,* "son of the carpenter," often translated to give Carpenter). Place names, naturally, do not combine readily with *Mac.*

In Gaelic Scotland there are now no *O* names. Ogilvie is a toponym (*i.e.,* a place-name derivation). Usually *-Gil-* here is *giolla,* "follower" or "devotee" (usually associated with Christ or with the name of some saint, *e.g.,* Gilchrist). It is rare with *O* but frequent with *Mac,* as, for example, in MacElroy, MacIlwaine, MacLennan, MacClellan. There are numerous modern, anglicized forms of names beginning in Gaelic with *mac giolla; e.g., Mac Giolla Riabhaigh,* which gives MacGillreavy, MacGilrea, MacElreavy, MacIlrea, MacAreavy, MacIlravy, MacElreath, MacIlwraith, Gallery, occasionally Kilgray and even Gray, as well as other minor variants. Indeed, some of the more corrupt forms of such names bear little resemblance to their original: it is hard to recognize *Mac Giolla Bhrighde* ("son of the devotee of St. Brigid") in Mucklebreed (a synonym of MacBride in County Armagh). Meikleham for MacIlquham is a Scottish example of this.

MacAinsh, mentioned above, is an anglicized form approximating phonetically to the original Gaelic *Mac Aonghusa;* but in Scotland it has also become MacInnes, MacNeish and MacQuinness, while in Ireland it is MacGuinness.

This last name illustrates a tendency, particularly in Ulster, whereby *Mac* names followed by an initial *G* are contracted; thus MacGuinness (also written MacGennis) becomes Magennis, MacGuire becomes Maguire and MacGee, Magee.

In Ulster the *Mac* names outnumber the *O*'s, largely on account of the number of families of Scottish stock which settled there from the time of the plantation of Ulster early in the 17th century. Elsewhere in Ireland *O*'s outnumber *Mac*'s, although in one western county (County Clare) the two most numerous names are MacMahon and Macnamara.

A Macnamara in that locality is invariably known colloquially as Mac, and children of Macnamara families were sometimes formerly registered as Mack. The same abbreviation occurs to a lesser extent in other counties for different *Mac* names.

In Scotland the *Mac* prefix has been generally retained, but in Ireland, as a result of the Gaelic submergence in the 18th century, it was widely discarded, as was the cognate *O:* thus Carthy was used for MacCarthy, Keogh for MacKeogh, and so on. It is interesting to note that since the 1890s these prefixes have been resumed to a considerable extent.

If the popular illusion that the bearer of a *Mac* name is Scottish no longer exists (it is hard to know how it ever arose with names like MacMahon, MacCarthy and MacDermot so common), another fallacy dies slower; *i.e.,* that the *Mc* form is Scottish and the *Mac* form Irish (sometimes the reverse is asserted). This is entirely without foundation. Both forms are used indiscriminately, *Mc* being, of course, simply an abbreviation of *Mac,* as also is *M'* (now nearly obsolete but once widely used). Most well-constructed modern indexes and directories list *Mac, Mc* and *M'* together.

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MACÁ (formerly called ENIMAGÁ or ENI-MACÁ), a South American Indian tribe probably belonging to a Macá-Matacoan linguistic stock. The Macá, who number at least 1,000, live on the plains between the Negro and upper Confuso rivers in the Gran Chaco, where they subsist by means of wild-food gathering, agriculture, hunting and fishing.

In the 18th century the Macá gained a reputation as fierce warriors, fighting against such tribes as the Mbayá and Guaná. At mid-20th century, aboriginal Macá culture was disappearing rapidly under the impact of white occupation of their territory.

Many Macá still live in long beehivelike communal houses covered with palm or grass thatch. The typical native dress was a deer or rhea-skin skirt for women and a dyed woolen blanket for men. Both garments were held in place by woolen belts woven in geometric designs.

Macá society characteristically consisted of small bands which joined seasonally to form larger communities at fishing spots and at locations where large quantities of algarroba pods could be harvested.

See Alfred Métraux, "Ethnography of the Chaco," Bureau of American Ethnology, *Bulletin* 143, vol. 1, pp. 197–370 (1946). (M. J. H.)

MACABRE: *see* DANCE OF DEATH.

McADAM, JOHN LOUDON (1756–1836), engineer who developed the macadam road, was born at Ayr, Scot., Sept. 21, 1756. In 1770 he went to New York city, entering the countinghouse of a merchant uncle. He returned to Scotland with a considerable fortune in 1783, and purchased an estate at Sauhrie, Ayrshire. The local highways were in poor condition, and McAdam, who was a road trustee in his district, began at his own expense a series of experiments in road making. In 1798 he moved to

Falmouth, where he continued his experiments under a government appointment. He recommended that roads should be raised above the adjacent ground for good drainage and covered with a surface of clean, graded stones. In 1815, having been appointed surveyor general of the Bristol roads, he was able to put his theories into practice. In 1819 he published a *Practical Essay on the Scientific Repair and Preservation of Roads*, followed, in 1820, by the *Present State of Road-making*. In 1827 he was appointed general surveyor of roads in Great Britain. McAdam died at Moffat, Dumfriesshire, on Nov. 26, 1836.

MACADAMIA, the generic and common name for the edible seeds of two closely related trees of the silk-oak family (Proteaceae) native to Queensland and New South Wales. Other names for the delicately flavoured, rich kernels are Queensland nut and Australian nut. *Macadamia ternifolia* has stiff oblong-lanceolate leaves four to eight inches in length, with coarsely serrate margins; *M. integrifolia* has similar leaves, but with smooth margins. Under favourable conditions of growth (a climate about like that for the orange) and rather moist rich soil, the trees ultimately attain a height up to 60 ft. (18 m.) and are highly ornamental in appearance.

Hard-shelled, shiny round nuts, covered by thick husks and following the small white flowers, are abundantly produced on racemes six to eight inches long. The husks split open and release the nuts when the latter are fully ripe. The kernels, used almost exclusively as dessert nuts, bring high prices in food-specialty markets.

Propagation is commonly by seed, but superior varieties (of which a number have been established in Hawaii and Australia) must be propagated vegetatively. Grafting is commercially feasible but rather difficult. Because of their eventual large size, trees in orchards are planted 35 to 40 ft. (11 to 12 m.) apart. There are numerous small commercial orchards in Hawaii and Australia, many trees in California and Florida and occasional ones in other tropical and subtropical regions. (W. Po.)

McADOO, WILLIAM GIBBS (1863–1941), U.S. lawyer and railroad executive who served as secretary of the treasury and director-general of U.S. railroads during World War I, was born near Marietta, Ga., Oct. 31, 1863. He briefly attended the University of Tennessee, became deputy clerk in the U.S. circuit court at Chattanooga in 1882, and was admitted to the bar three years later. In 1892, disappointed with his law practice and the losses resulting from his efforts to modernize the Knoxville street railway system, he moved to New York city. There his main interest became transportation, and he organized and headed two companies (later consolidated as the Hudson and Manhattan Railway company) that built tunnels under the Hudson river and operated the railways connected with them.

McAdoo's abundant energy, his aptitude for politics, and a chance meeting with Woodrow Wilson led to his early participation in the movement to make Wilson president. His conspicuous part in the campaign and Wilson's confidence in him brought about his nomination as secretary of the treasury. In the cabinet he was one of the leading figures in the Wilson administration, gaining special recognition for his work connected with the federal reserve board, of which he was chairman, and for his service as director-general of U.S. railroads during the period of government operation (1917–19). Under his direction four successful Liberty bond drives were conducted. In 1919 he resumed the practice of law, first in New York and later in Los Angeles, Calif. Meanwhile, his first wife having died in 1912, McAdoo married Eleanor Randolph Wilson, daughter of the president, in a White House ceremony on May 7, 1914.

McAdoo emerged from public service as the acknowledged leader of a large segment of the Democratic party. He made a strong showing as a candidate for the presidential nomination at the party convention in San Francisco in 1920. His candidacy in New York in 1924, where a near majority of the delegates supported him, precipitated the famous deadlocked convention. He represented California in the U.S. senate from 1933 until his resignation in 1938.

He died Feb. 1, 1941. His career is well-documented by the large collection of his personal papers in the Library of Congress. His autobiography, *Crowded Years*, appeared in 1931. (J. C. V.)

MACAIRE, the title chosen by two successive editors, A. Mussafia and F. Guessard, for a French medieval epic romance, belonging to the Carolingian cycle, of which the only known manuscript is from the 14th century (Venice, Bibl. S. Marc, ms. fr. XIII). The title is derived from one of the chief characters in the romance, which relates what happens to Blanchefleur, wife of the old and infirm Charlemagne, when, having repulsed the advances of Macaire, she is accused of infidelity and condemned to death—a sentence commuted to perpetual exile. During this exile she is attended by the faithful Auberi de Mondidier who is assassinated by Macaire. He is avenged by his dog who, after savaging Macaire in the midst of the royal court, discovers Auberi's corpse, engages in single combat with the murderer and kills him. Meanwhile Blanchefleur has reached Hungary, where she gives birth to Louis, Charlemagne's son; she then takes refuge with her father, the emperor of Constantinople. The emperor decides to avenge his daughter's honour and summons a powerful army to attack Charlemagne. The war ends with a single combat between Ogier the Dane (*q.v.*) and Varocher, the queen's protector; during the fight Varocher proves to Ogier that Blanchefleur is innocent, and Charlemagne, learning the truth, seeks and obtains his wife's pardon.

This story is also developed in another *chanson de geste* called *La Reine Sebile*, though details (the name of the queen, among others) differ. The manuscript of this, which runs to 500 lines, has been reconstructed from 13th-century fragments, discovered in England, at Mons, Belg., and at Sion in Switzerland. The poem also is known in a remarkably faithful Spanish translation, the manuscript of which (end of the 14th or beginning of the 15th century) is preserved in the Escorial, Madrid. This formed the basis of a Spanish prose romance, the *Historia de la Reyna Sebilla*, and of a book popular in the Netherlands, printed at Antwerp at the beginning of the 16th century; the story was already known there in the 14th century.

The existence of an epic romance on this subject was attested in France at least as early as the first half of the 13th century. Criticism remains in doubt as to whether *La Reine Sebile*, composed in dodecasyllabic verse, is earlier than *Macaire*, written in decasyllables; but it is generally admitted that these two romance poems developed almost identical stories independently. Whatever the facts of their origin, both are concerned with themes belonging to folklore: a queen unjustly suspected of infidelity and a dog who avenges his master's death. The first (*see* GENEVIÈVE) is found, for instance, in the *Thousand and One Nights*, in Vincent de Beauvais's *Speculum majus*, and in a German poem of the 14th century, in which the queen is named Hildegarde. The second, already with many of the details to be found in *Macaire*, is told in Plutarch's *Opera Moralia*, and the duel between Macaire and the dog is interpolated by Giraldus Cambrensis in a manuscript of the *Hexameron* of St. Ambrose. The name *"chien de Montargis"* is mentioned for the first time in the *Histoires prodigieuses* (1580) of François de Belleforest (1530–83), which asserts that the episode was depicted in a painting in the castle of Montargis. The story itself, again worked over by Gaston Phoebus in about 1390 and in the *Menagier de Paris* (1393), was thus already separated from its Carolingian context; Jean de la Taille, in his *Discours notable des duels* (1607), placed it in the reign of Charles V. *See* also CHANSONS DE GESTE; CHARLEMAGNE LEGENDS.

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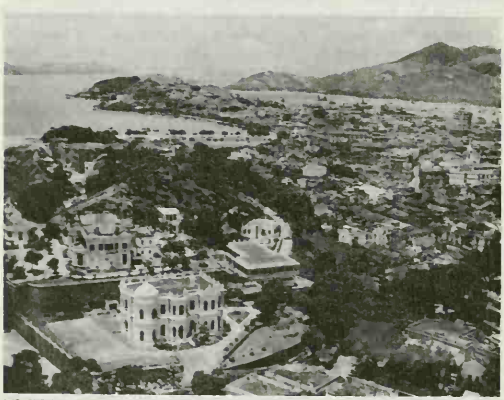
McALLEN, a city of Hidalgo county, in southeastern Texas, U.S., about 50 mi. W.N.W. of Brownsville and 7 mi. from the International bridge over the Rio Grande at Reynosa, Mex. It was founded in 1905, incorporated in 1911 and named for John McAllen, a Scottish settler from whose ranch the townsite was

carved. McAllen is a leading winter resort. It is the centre of oil-field operations in the Lower Rio Grande valley. McAllen is also a packing and shipping centre for an irrigated district devoted to citrus culture and vegetables, and a port of entry for trade with Mexico. Manufactures include clothing, food processing and petroleum products. For comparative population figures *see* table in TEXAS: *Population*. (O. Mo.)

MACALPINE (or MACCABEUS), **JOHN** (d. 1557), Scottish reformer and theologian, was from 1532 to 1534 prior of the Dominican convent of Perth; but having in the latter year been summoned with Alexander Ales and others to answer for heresy before the bishop of Ross, he fled to England, where he was granted letters of denization on April 7, 1537, and married Agnes Macheson, a fellow exile for religion; her sister Elizabeth became the wife of Miles Coverdale. The reaction of 1539 made England a doubtful refuge, and on Nov. 25, 1540, Macalpine matriculated at the University of Wittenberg, Ger. In 1542, having assumed the name of Maccabeus or Machabeus, he became professor of theology at the University of Copenhagen. There he took a prominent part in building up the Lutheran Church of Denmark. A joint exposure by Peter Plade and Macalpine of Andreas Osiander's errors was published in 1552 and reprinted at Leipzig and Copenhagen in 1768; and Macalpine was one of the four translators of Luther's German Bible into Danish. He died at Copenhagen on Dec. 6, 1557.

MACAO (Portuguese MACAU), a Portuguese overseas province on the coast of southern China, lies on the western side of the entrance to the Hsi Chiang (Si Kiang) river, opposite to and about 35 mi. from Hong Kong. It comprises the peninsula of Macao and three islets nearby, the two Taipa islands and Colôane, the area of the whole being about 6 sq.mi. On the peninsula, which is about 3 mi. long and 1 mi. broad, is situated the picturesque city of Macao, extending up a hillside to overlook a fine bay on the west. Its multicoloured buildings reveal an interesting combination of oriental and European features. Many fine buildings remain from early Portuguese times. The famous promenade, Praia Grande, is 1½ mi. long. The tropical climate is relieved by southwest sea breezes.

Direct trade by sea between Europe and China began through Portuguese enterprise as early as 1516. Macao, the oldest European outpost in the trade with China, was established in 1557. It was an early centre of Jesuit missionary activity and in 1580 the bishopric of Macao was created. In 1680 the first governor was appointed, but the Portuguese remained largely under the control of the Chinese with whom there were constant disputes concerning the extent of Portuguese jurisdiction. A rental was paid for the peninsula until 1849, when the Portuguese abolished the Chinese customshouse and declared the independence of the port. It was not, however, until 1887 that China formally recognized Portuguese sovereign rights in a treaty whereby China confirmed the perpetual occupation and government of Macao and its dependencies by Portugal, which in turn undertook never to alienate Macao and its dependencies without the consent of China, and to co-operate in the work of the opium revenue service. This did not put an end to disputes, and the delimitation of Macao's boundaries remained an unsettled question.



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PANORAMIC VIEW OF MACAO

During the 18th century Macao was the chief centre in the Sino-European trade, but the rapid development of Hong Kong (ceded to Great Britain in 1842) was responsible for its decline, as also were the shallowness and silting of Macao harbour. In 1920 a plan for harbour improvement was launched and a contract placed with the Netherlands Harbour Works. The construction of an artificial deepwater harbour began in 1923; and this entailed the dredging of a 4-mi. channel to the open sea. These harbour works, completed in 1926 at a cost of $10,000,000 (U.S.), led to the reclamation of 130 ac. of land on the eastern side of the peninsula, but the area remained largely unused. As a free port Macao remained a distribution centre for rice, fish, lumber, silk, piece goods and oil; but it also had a reputation for opium smuggling and gambling. The League of Nations' efforts reduced its opium trade value from $1,500,000 (U.S.) to about $200,000 (U.S.) before 1939. In that year, after the capture of Canton and the closure of the Hong Kong–Kowloon border, Macao enjoyed briefly the available import and export trade of southern China. Between 1938 and 1939 the total foreign trade leaped from $2,300,000 (U.S.) to $5,600,000 (U.S.). From 1940 until the end of World War II Macao was subject to considerable pressure from the Japanese but it was never occupied.

The population, which rose from 83,894 in 1920 to 374,737 in 1940, and was swollen by refugees from Hong Kong in 1941, had fallen by 1960 to 169,299, including 7,974 Portuguese. Included in the population are about 7,700 who dwell on boats. Many refugees have come from Communist China. The city comprises Chinese and non-Chinese wards under separate administration.

Macao has an important fishing industry, much of the fish being salted or dried and exported, especially to China. The chief manufactures are textiles and apparel and firecrackers; there is also some metalworking.

See L. G. Gomes, *Efemérides da história de Macau* (1954).

(L. D. S.)

MACAQUE, a name for monkeys of the large genus *Macaca*, mainly Asiatic in distribution, with the exception of a single species, the barbary ape (*Macaca sylvana*), of north Africa and the Rock of Gibraltar. The Asiatic range extends from western India to Japan and from northern China to the southernmost Indonesian islands. Macaques are robustly built with prominent muzzles recalling those of baboons but differing in the rounded profile, the nostrils being located on the upper surface. They are for the most part ill-tempered, though possessing a high degree of intelligence and learning capacity. They live in troops of varying size in much the same way as baboons; most species are somewhat more arboreal than baboons, however, but are equally at home on the ground or in rocky terrain. They are omnivorous feeders and breed all the year round, having a single young.

The numerous species differ greatly in the length of the tail. A few, *e.g.*, the south Indian bonnet monkey (*Macaca radiata*) and its Ceylonese relative, the toque monkey (*M. sinica*), as well as the Malayan crab-eater (*M. irus*), are long-tailed. Most, like the rhesus (*M. mulatta*), have tails of moderate length. Several, including *M. speciosa* of Thailand, are stump-tailed, while *M. sylvana* is completely tailless.

Remarkable for its educability is the pigtailed macaque (*M. nemestrina*), which is taught by the Malays to pick, at a command, only ripe coconuts. The Japanese macaque (*M. fusca*) has long been a subject for local artists. *See* also PRIMATES: *Old World Monkeys (Catarrhines): Macaques;* MONKEY.

(W. C. O. H.)

MACARONI, a preparation of a glutenous wheat originally peculiar to Italy, where it is an article of food of national importance. The Italian form of the word is *maccheroni*. The same substance in different forms is also known as vermicelli,

spaghetti, *taglioni, fanti,* etc.; general terms for these foods are alimentary pastes, *pasta* and Italian pastes. They are prepared from the hard, semitranslucent varieties of wheat which are cultivated in the south of Europe, Algeria and other warm regions and in the northwestern area of the American Great Plains, particularly northeastern North Dakota. They are distinguished by the Italians as *grano duro* or *grano da semolino.* Their preparations are more easily preserved than those of softer or more tender wheats of other regions. Common forms are fine thin threads (vermicelli), thin sticks and pipes (spaghetti, macaroni), small lozenges, stars, disks, ellipses, etc. (pastes). These different forms are prepared in a uniform manner from a granular product of hard wheat, which is distributed commercially under the name of semolina or middlings.

The semolina is thoroughly mixed with warm water and is kneaded into a stiff paste or dough in a kneading machine, such as is used in bakeries. Modern macaroni products manufacture is done by continuous mixing, kneading and extrusion rather than the batch procedures formerly used. The continuous press is equipped with feeders which furnish a constant flow of semolina and water at a rate of 200 to 1,500 lb. of semolina per hour. The continuous mixers push the product on while the dough is being mixed until at the end of the mixer the dough enters a tightly sealed auger. This moves the dough forward while compacting and further mixing it. The plastic dough is fed into a chamber or series of tubes behind a die. Vacuum often is employed during processing, which improves the colour of the finished product.

The pressure of 1,500 to 2,000 lb. per square inch built up in the dough forces it through the die, forming it into the desired shape. The soft, wet product is then dried from approximately 31% to 12% moisture content. For proper drying the air circulation, temperature and humidity must be strictly regulated; too rapid drying causes checking or cracking while slow drying may allow the product to stretch on the drying sticks or permit souring and mold growth. The drying rate is determined by the shape of the product; the drying air temperature, humidity and velocity; and the moisture content of the macaroni.

True macaroni can be distinguished by observing within the end of the tubes the flattened mark of the rod over which it has been dried; it has a soft yellowish colour, is rough in texture, elastic and hard, and breaks with a smooth glassy fracture. In boiling it swells up to double its original size without becoming pasty or adhesive. It can be kept any length of time without alteration or deterioration. (R. H. H.)

MACARONICS, burlesque Latin verses into which vernacular words are introduced with appropriate but absurd Latin endings. The inventor of the form was Teofilo Folengo (*q.v.*), a dissolute Benedictine who lived by his rhyming, and his *Baldus* (1517) is a burlesque epic of chivalry: ridiculous, squalid and satirical by turns. Its author described the macaronic as the literary equivalent of the Italian dish, in its 16th-century form a rustic mixture of flour, butter and cheese. The *Baldus* found many imitators in Italy and in France, and some macaronics were also written in mock-Greek. The outstanding British poem in this form is the *Polemo-Middinia inter Vitarvam et Nebernam,* an account of a battle between two Fifeshire villages by the 17th-century Scottish poet William Drummond (*q.v.*), in which occur the lines:

> Whistlavere viri, workhorsosque ordine swieros
> Drivavere foras, donec iterumque iterumque
> Fartavere omnes, et sic turba horrida mustrat.

A derivative of the macaronic has been developed in England which pokes insular fun at the cumbrous grammatical complexities of the foreign tongues taught in school. Verses of this kind, though often composed by the teacher, are clearly intended for the learner. An early example is the *Polka Lyric* of Barclay Phillips, who invites his partner in two languages:

> Polkam jungere, Virgo, vis,
> Will you join the polka, miss?

Better known is A. D. Godley's declension of the *Motor Bus,* which includes in the accusative plural:

> Domine defende nos
> Contra hos Motores Bos,

and F. Sidgwick's celebration of a coster bank holiday with its Virgilian opening in *Some Verse* published by Sidgwick and Jackson (1915):

> Charmer virumque I sing, Jack plumigeramque Arabellam.

The German-American medleys of C. G. Leland (*q.v.*) in his *Hans Breitmann's Ballads* (1871) are also examples of the modern macaronic, in particular his warning *To a Friend Studying German:*

> "Will'st dou learn die deutsche Sprache?" (Jo. M. C.)

MacARTHUR, ARTHUR (1845–1912), U.S. army officer, was born at Chicopee Falls, Mass., June 2, 1845. He served throughout the American Civil War in the 24th Wisconsin volunteer infantry, being advanced through the ranks from lieutenant to colonel of the regiment when but 20 years of age. His regiment gained fame in Gen. Philip Sheridan's division of the Army of the Cumberland where he was affectionately known as the "Boy Colonel of the West." He was wounded three times, brevetted four times, and cited for "gallant and meritorious service" in the battles of Perryville, Stones River, Missionary Ridge, Resaca, Dalton, Jonesboro, Kenesaw Mountain, Atlanta and Franklin. He was awarded the medal of honor for seizing the colours of his regiment at a critical moment and planting them on the captured works on the crest of Missionary Ridge. At the close of the war he entered the regular army and from 1866 to 1886 participated in Indian campaigns in the southwest. At the outbreak of the Spanish-American War (1898) he was appointed a brigadier general and assigned to the Philippine command. His brigade captured the town of Malate and thus prepared the way for the taking of Manila. He was cited by Gen. Wesley Merritt for gallantry and conspicuous service and appointed a major general to command the 2nd division. When the insurrection under Gen. Emilio Aguinaldo broke out in February of 1899 he commanded the main column which defeated the insurgents. He succeeded Gen. E. S. Otis in command of the 8th corps, the army of the Philippines, and as the military governor. In the latter capacity (1900–01) he helped to lay the foundations for a free and independent Philippine republic, introducing the writ of habeas corpus, revising the Spanish law and establishing the free public school system and other democratic concepts. During the Russo-Japanese War he was detailed as a special observer with the Japanese army. In 1906 he was appointed a lieutenant general and became the senior ranking officer of the U.S. army. He retired from the army in 1909 and died Sept. 5, 1912, at Milwaukee, Wis. (D. MacA.)

MacARTHUR, DOUGLAS (1880–1964), U.S. army officer who commanded Allied forces in the Pacific during World War II, served as supreme commander of occupation forces in Japan and of United Nations forces during the first nine months of the Korean War, was born on Jan. 26, 1880, at Little Rock barracks, Ark., the son of Arthur MacArthur (*q.v.*). In 1903 he graduated from the U.S. Military academy at West Point, first in his class and senior officer in the corps of cadets. He served with the military survey in the Philippines and on a study of colonial lands in the far east, including Korea (1905). He took part in the Veracruz (Mexico) expedition (1914), and in World War I rose to command the 42nd (Rainbow) division. After the war he was put in charge of the U.S. occupation sector along the Rhine. He served as superintendent of the U.S. Military academy (1919–22) and in 1925 was a member of the court-martial that tried aviation advocate Col. William ("Billy") Mitchell (*q.v.*). Although MacArthur is popularly believed to have voted for acquittal at this famous trial, the actual voting of the court members was, according to standard army procedure, not revealed. He served as department commander in the Philippines (1928–30) and as U.S. army chief of staff (1930–35). In preparation for Philippine independence, MacArthur, in 1935, was appointed military adviser to organize the islands' defenses. He was made a field marshal in the Philippine commonwealth army the following year, and continued to serve in the islands after his retirement from the U.S. army on Dec. 31, 1937.

World War II.—With tension mounting in the Pacific, MacArthur was recalled to active duty on July 26, 1941, to command U.S. and Philippine troops. When the Japanese attack came in

December, his outnumbered forces made a heroic stand on Luzon, falling back to the Bataan peninsula and the island of Corregidor where they were forced to capitulate during April and May 1942. For this gallant defense MacArthur was awarded the medal of honor, the same decoration his father had received more than 50 years before. Ordered by Pres. Franklin D. Roosevelt to leave the Philippines before the surrender, MacArthur arrived in Australia on March 17, 1942, after a daring 3,000-mi. dash through enemy-controlled seas. He opened his offensive campaign in the fall of 1942 with the invasion of New Guinea, and began to retake the areas conquered by Japan in the war's initial stages. Approaching the Philippines in 1944, he was ordered to bypass and neutralize them as he had many other Japanese strong points during the preceding two years. His arguments in favour of a Philippine invasion, however, persuaded President Roosevelt to allow him to retake the islands. Landings were made at Leyte in Oct. 1944, and by the following July the Philippines were again in Allied hands. Two months later, on Sept. 2, 1945, MacArthur, who had been appointed to the newly created rank of general of the army, accepted the Japanese surrender on board the U.S.S. "Missouri" in Tokyo bay. During the next five years, as supreme commander allied powers, he supervised the reconstruction of Japan and the establishment there of a democratic form of government.

Korean War.—When North Korean Communist troops crossed the 38th parallel and invaded South Korea in June 1950, MacArthur was put in charge of UN forces. Despite heavy odds against him, he was finally able to stop the Communist advance near the port of Pusan and, with the arrival of fresh UN units, plan his offensive, a surprise landing by amphibious troops at Inchon, far to the enemy rear. Subordinates and other high military officials at first opposed the plan but MacArthur was able to convince them of its feasibility and on Sept. 15, 1950, U.S. marine and army units landed at Inchon. At the same time UN forces to the south broke out of the Pusan perimeter and rolled north to effect a juncture with the amphibious forces. During the next two months the North Korean army was routed and all but destroyed. The intervention of the Chinese Communists late in November precipitated what MacArthur called a "new war" and UN forces were forced to withdraw south of the 38th parallel. By March 1951 MacArthur, having stopped the Chinese advance, was able to resume the offensive. Contrary to the policy of Pres. Harry S. Truman (*q.v.*), with whom he had conferred in Oct. 1950 at Wake Island, MacArthur urged the bombing of Communist bases in Manchuria, the blockade of the Chinese coast and the employment of Nationalist Chinese forces based on Formosa. This conflict of views led to his being relieved of his command on April 11, 1951.

Returning to the U.S., MacArthur addressed both houses of congress in a memorable speech, outlining, explaining and defending his policies in the far east. Thereafter, having been placed on the active list for life as general of the army, he retired to private life. The following year he delivered the keynote address at the Republican national convention, and in 1963 he wrote a volume of memoirs entitled *Reminiscences*. MacArthur died at Walter Reed army medical centre, Washington, D.C., on April 5, 1964, and was buried at Norfolk, Va.

See World War II; Korean War; *see* also references under "MacArthur, Douglas" in the Index.

MACAULAY, THOMAS BABINGTON MACAULAY, Baron (1800–1859), English historian, essayist and politician, best known for his *History of England,* was born at Rothley Temple, Leicestershire, the seat of an uncle, on Oct. 25, 1800. His father, Zachary Macaulay, the son of a Hebridean minister, had been governor of Sierra Leone; an ardent philanthropist and ally of William Wilberforce the abolitionist, he was a man of severe Evangelical piety. His mother, a Quaker, was the daughter of a Bristol bookseller and an old pupil of Hannah More, who took a warm interest in her children. Before Thomas was eight years old he had written a *Compendium of Universal History* and a poem, *The Battle of Cheviot,* in the style of Sir Walter Scott; these were soon followed by other voluminous works. The boy was sent to a good private school, and in Oct. 1818, went up to Trinity college, Cambridge, where he later became a fellow, and which held second place to his home in his affection throughout life. He gained in 1824 a college prize for an essay on the character of William III. He also won a Craven scholarship and wrote the English prize poems of 1819 and 1821, but failed to appear in the Tripos list through weakness in mathematics.

In 1826 Macaulay was called to the bar and joined the northern circuit. But he spent many more hours under the gallery of the house of commons than in the court. Meanwhile commercial disaster had fallen on the house of Babington and Macaulay, and the son saw himself faced with the necessity of earning money for his parents and their children as well as for himself, a burden which he accepted cheerfully and carried with complete success. He was never happier than when he was at home, and his deepest affection was reserved for two of his sisters, Margaret and Hannah. Meanwhile, in Aug. 1825, he had leapt to fame overnight with the first of his essays, that on Milton, published in the *Edinburgh Review,* which then, under the editorship of Francis Jeffrey, was the arbiter of literary fame and taste to the English-speaking world. It may seem surprising that social success should have been the consequence of a single article, but the writer was also a brilliant talker. At the university Macaulay had been pre-eminent for inexhaustible talk and genial companionship among a circle of such brilliant young men as Charles Austin, John Romilly, W. M. Praed and Charles Villiers. He now displayed these gifts on a larger stage. He was courted and admired by the most distinguished personages of the day. He was admitted at Holland house, where the formidable Lady Holland listened to him with deference and scolded him with a circumspection which was in itself a compliment. Samuel Rogers, the poet, spoke of him with friendliness and to him with affection.

Macaulay now began to aspire to a political career. His Trinity fellowship expired in 1831, and he could make at most £200 a year by writing, but he received a commissionership of bankruptcy from Lord Lyndhurst in 1828, and in Feb. 1830 he entered the house of commons for the "pocket borough" of Calne, offered him by Lord Lansdowne. Macaulay made his maiden speech on April 5, 1830, on the second reading of the bill for the removal of Jewish disabilities. On March 1, 1831, the Reform bill was introduced, and on the second night of the debate Macaulay made the first of his reform speeches, of which Sir Robert Peel said that "portions were as beautiful as anything I have ever heard or read." On the passing of the Reform act in June 1832, Macaulay, whose eloquence had signalized every stage of the conflict, became one of the commissioners and later secretary of the board of control, which represented the crown vis-à-vis the East India company. Giving his days to India and his nights to the house of commons, he could only devote a few hours to literary composition by rising at five in the morning. Between Sept. 1831 and Dec. 1833 he furnished the *Edinburgh Review* with eight important articles, besides writing his ballad *The Armada.*

In the first Reform parliament, Jan. 1833, Macaulay took his seat as one of the two members for the new borough of Leeds, and in July he defended the Government of India bill in a speech of great power. When the abolition of slavery came before the house as a practical question, Macaulay had the prospect of having to surrender office or of voting for a modified abolition proposed by the ministry, but condemned by the abolitionists. He placed his resignation in Lord Althorp's hands, and spoke against the ministerial proposal; the sense of the house compelled the ministry to give way, and Macaulay remained at the board of control. He then (1834) accepted a seat in the supreme council of India, created by the new India act. The salary of the office was fixed at £10,000, out of which he calculated to be able to save £30,000 in five years. His sister Margaret was now married; he took Hannah with him to India.

Macaulay's appointment to India occurred at the critical moment when the government of the company was being superseded by government by the crown. The part he took has been described as "the application of sound liberal principles to a government which till then had been jealous, close and repressive." He vindicated the liberty of the press; he maintained the equality of

Europeans and Indians before the law; and as president of the committee of public instruction he inaugurated the system of national education, and secured that this should be western in character. He was appointed also president of a commission to inquire into Indian jurisprudence, and the draft of a penal code which he submitted became in time the basis of the Indian criminal code. Meanwhile his life had been clouded with private sorrow. His sister Margaret died, and Hannah early in 1835 married a promising young servant of the company, Charles Trevelyan. The twofold blow was perhaps the severest suffering of his life.

In 1838 he returned to England and at once entered parliament as member for Edinburgh. In 1839 he became secretary for war, with a seat in the cabinet in Lord Melbourne's ministry. This diverted him for a time from prosecuting the plan he had already formed of a great historical work, but when in less than two years the Melbourne ministry fell, he published his *Lays of Ancient Rome* (1842) and in the next year a collection of his *Essays*. These he had never intended to reprint, but large unauthorized editions were selling in America. He returned to office in 1846, in Lord John Russell's administration, as paymaster general. In the sessions of 1846–47 he spoke only five times, and at the general election of 1847 he lost his seat for Edinburgh, where his cavalier treatment of regional interests and doctrinaire Whig principles had alienated public opinion.

He had in fact lost much of his interest in the political scene, and retired into private life with a sense of relief. Henceforward he abandoned general society for the intimacy of his own close relatives and one or two old friends of whom T. F. Ellis, his faithful correspondent, was chief, and for reunions with a group of sympathetic minds such as Samuel Rogers, Henry Hallam, Sydney Smith, Lord Carlisle, Lord Stanhope, Charles Grenville, Dean Milman and Sir Anthony Panizzi. He talked brilliantly, unceasingly and somewhat overbearingly. As his biographer G. O. Trevelyan remarks: "To get at his meaning people never had the need to think twice, and they certainly had seldom the time."

In these years he was working with unflagging industry upon his *History of England*, which was intended to run from the Revolution of 1688 to the death of George IV. His composition was slow, his corrections both of matter and of style endless; he spared no pains to ascertain the facts. He sacrificed to the prosecution of his task political career, house of commons fame, the allurements of society. The first two volumes appeared in Dec. 1848. The success was in every way complete beyond expectation. The sale of edition after edition, both in England and the United States, was enormous.

In 1852, when his party returned to office, he refused a seat in the cabinet, but the city of Edinburgh in contrite mood returned him unasked at the head of the poll at the general election that year. He had hardly accepted the summons to return to parliamentary life before his heart developed a fatal weakness; he wrote that he grew 20 years older in a day, and from this time forward his strength continued gradually to sink. His interventions in debate, though effective, were rare and costly.

In Nov. 1855 vol. iii and iv of the *History* appeared and attained a vast circulation. Within a generation of its first appearance more than 140,000 copies of the *History* were sold in the United Kingdom, and sales in the United States were on a correspondingly large scale. The work was translated into German, Polish, Danish, Swedish, Hungarian, Russian, Bohemian, Italian, French, Dutch and Spanish. He received many marks of respect from foreign academies, and his pecuniary profits were correspondingly large: the check received from his publisher, Longmans, for £20,000 has become a landmark in literary history. It may be safely said that no serious historical work on a comparable scale has ever been so widely diffused over the reading public both of the English-speaking world and of western Europe.

In May 1856 Macaulay quitted the Albany after 15 happy years and went to live at Holly Lodge, Campden Hill, surrounded by lawns and trees. In the following year he was raised to the peerage with the title of Baron Macaulay of Rothley. His health was now visibly failing every year; he never spoke in the house of lords, and gradually acquiesced in the conviction that he would scarcely live to complete the reign of William III. He died on Dec. 28, 1859, and was buried in Westminster abbey.

Macaulay never married. His great capacity for affection found its satisfaction in the attachment and close sympathy of his sisters, and in particular of Hannah, later Lady Trevelyan, who remained in almost daily contact with him even after her marriage, and whose children were to him as his own. He was a steadfast friend, pure in morals throughout life, and no act inconsistent with the strictest honour and integrity was ever imputed to him. When a poor man, he twice resigned office rather than make compliances for which he would not have been severely blamed. He had a keen relish for the good things of life, and desired fortune as the means of obtaining them for himself and others; but there was nothing mercenary or selfish in his nature; it may be mentioned that in 1857 he wrote for the 8th edition of the *Encyclopædia Britannica* a series of five articles including those on Dr. Johnson and William Pitt, which have been judged the finest examples of his mature manner, for which he refused to accept any payment. When affluent, he gave away with an open hand, often rashly, and his last act was to dictate a letter to a poor curate and sign a check for £25.

The life of Macaulay was, as he repeatedly acknowledged, eminently happy. His exceptional gifts of mind were never, as they have been for so many men of genius, a source of calamity or mental anguish. Had he wished, he could have risen to high political place, perhaps to the highest; instead, he chose to live for literature and devoted his powers to the portrayal of the past of England. The feats of his memory, which was capacious and retentive to an extraordinary degree, have become proverbial. His command of literature was imperial. The literature and history of Greece and Rome were familiar from his college days to the end of his life, and few classical scholars had a wider sweep. To this he added the literature of his own country, of France, of Italy, of Spain and of Germany. He had his limitations. In later life he never gave expression to any religious conviction, and had no appreciation of spiritual, as distinct from ethical, excellence. All religious and philosophic speculation was alien to his mind, and he showed no interest in the marvellous discoveries of science which were succeeding each other day by day. A large part of ecclesiastical history lay outside his historical view. Of art he confessed himself ignorant, and to music he was completely deaf. At games, sports and physical skills—even that of tying a cravat —his incompetence was absolute.

His reputation, which during the last decade of his life was immense, fell steadily in the half-century that followed. His undisguised political partisanship, his superficial cast of mind, his easy and arrogant assumption that English bourgeois standards of comfort and progress were to be forever the norm for less favoured nations, the materialism, not to say vulgarity, of his judgments of value and taste, all came under heavy fire from Thomas Carlyle, Matthew Arnold and John Ruskin, while in the realm of historical studies a revolution, already accomplished in Germany during his lifetime but never appreciated by Macaulay, soon affected English historiography. The standards and interests of William Stubbs, of Lord Acton and of F. W. Maitland were very different from his. Wide as was Macaulay's reading, great as were the pains he took to acquire his information, his method and approach were entirely uncritical in the academic sense of that word, and he knew nothing of the austere and exigent standards of the best German and French work of his day. When he was describing the merits of friends and the faults of political enemies, even those of an earlier age, his pen knew no moderation. He had a constant tendency to glaring colours; he was not merely exuberant, but excessive; there was an overweening confidence about his tone; his propositions had no qualifications. Whereas the ordinary reader is reassured by this self-confidence, the more critical reader may be alienated by Macaulay's categorical affirmations about matters which our own experience of life teaches us to be of a more uncertain nature. We inevitably think of a saying attributed to Lord Melbourne: "I wish I were as cocksure of any one thing as Macaulay is of everything."

His mind was the mind of the advocate, not of the historian.

Yet his greatness remains. In the grasp and range of his knowledge, in his powers of vivid and sustained narrative and in the marshalling of his topics to serve a great design he is unsurpassed among English historians, except perhaps by Edward Gibbon. As for his style, which drove out the heavy classical periods, as well as the formless narrative, of the current history and journalism of his early years, it has become in its main features, such as its clarity, its tricks of emphasis and its use of the paragraph as the self-contained unit of expression, the characteristic English style for all purposes of exposition and persuasion, from the leading articles of higher journalism to the minutes of government departments. It is a forensic style, with no undertones or overtones of passion or poetry, and lacks the idiomatic flavour of a Dryden, as well as the sensitive, almost invisible matching of word with thought of a Newman, but for the purpose of effective exposition to be grasped by every reader it is unrivaled. His greatest gift is that of communicating to the reader, and especially to the young reader, his own vivid sense of the variety and human appeal of the past. Although his *Essays* were in origin no more than brilliant improvisations, and have proved vulnerable to criticism, they have done more than any other work to kindle enthusiasm for historical reading and in particular for English history of the 17th and 18th centuries. Macaulay had the rare gift of awakening in others his own intense mental delight in the spectacle of the past and the treasures of its literature. While his verse rarely, if ever, becomes poetry, and he had no ear for the purity of tone in Blake or Wordsworth, his glimpses of English landscape and wild life, both in the *History* and the ballads, reveal him as the contemporary of Thomas Bewick and John Sell Cotman.

The striking portrait by J. Partridge in the National Portrait gallery, London, shows him in the full vigour of manhood; his relatives considered the daguerreotype, reproduced in G. O. Trevelyan's *Life*, an excellent likeness from his later years. There is a statue in the ante-chapel of Trinity college, Cambridge.

Bibliography.—The standard ed. of Macaulay's complete works is that in 12 vol. (1898). *The Life and Letters of Lord Macaulay*, 2 vol. (1876; enlarged ed. 1908, 1959 with full index), by his nephew, Sir George Otto Trevelyan, is acknowledged as one of the best biographies in the English language. Its excellence, and the absence of any complexity in Macaulay's life and character, have rendered it unnecessary and impossible to replace, and judgments on Macaulay's work, its excellences and faults, have likewise been singularly unanimous. His long correspondence with T. F. Ellis and his voluminous diaries, both used to good effect by Trevelyan, are in the possession of Trinity college, Cambridge, but they have no secrets to reveal, except that Macaulay could use a conversational idiom and make outspoken and summary judgments on his contemporaries. *See* also J. A. C. Morison, *Macaulay* (1882); Sir Arthur Bryant, *Macaulay* (1932); Sir C. H. Firth, *A Commentary on Macaulay's History of England* (1938).
(M. PA.; M. D. K.)

McAULEY, CATHERINE ELIZABETH (1787–1841), founder of the Sisters of Mercy, was born in County Dublin, Ire., Sept. 29, 1787. The McAuley children, orphaned at an early age, were entirely dependent on Protestant relatives, but Catherine could not be induced to join in Protestant worship. Left a small fortune, she invested it in a large building on Lower Baggot street, Dublin, and on Sept. 24, 1827, opened it as an institution for destitute women, orphans and the poor in need of schools.

At first there was no intention of forming a religious institute, but the work and way of life of Catherine McAuley's group soon led authorities to desire that they join the newly formed Irish Sisters of Charity. This situation was solved by the founding of a new congregation which was to combine the silence and prayer of the Carmelites with the active labours of the Sisters of Charity. The first novices were invested with the habit of the Sisters of Mercy on Dec. 12, 1831. At this same time Catherine McAuley was named superior, an office she held for the remainder of her life. She died in Dublin on Nov. 11, 1841. Her cause for beatification has been handicapped by the lack of authenticated miracles and primary documents. *See* also Mercy, Sisters of.

Bibliography.—M. Teresa Austin Carroll, *Life of Catherine McAuley* (1866); Roland Burke Savage, *Catherine McAuley, the First Sister of Mercy* (1949); Sister M. Bertrand Degnan, *Mercy Unto Thousands* (1957). (E. R. V.)

McAULIFFE, ANTHONY CLEMENT (1898–), U.S. army officer in the European theatre during World War II, was born in Washington, D.C., July 2, 1898. He graduated from the United States Military academy at West Point in 1919 and was commissioned in the field artillery. After routine service and school appointments during peacetime, McAuliffe served with airborne troops in World War II. He was acting commander of the 101st air-borne division in Dec. 1944 during the "battle of the bulge," and in this post his stout defense of Bastogne checked the German drive in the Ardennes and contributed to the ultimate German defeat. His terse reply to a German summons to surrender Bastogne—"Nuts!"—became a classic of World War II. During the postwar period, McAuliffe held various command and staff appointments, ending his military career as commanding general of the 7th army in Germany in 1953–55 and as U.S. army commander in Europe in 1955–56. He retired with the rank of general on May 31, 1956, to enter industry. (W. R. E.)

MACAW: *see* Parrot.

MACBETH, king of Scots from 1040 to 1057, the legend of whose life formed the basis of Shakespeare's *Macbeth*, was probably a grandson of Kenneth II and was married to Gruoch, a descendant (possibly the granddaughter) of Kenneth III. He was *mormaer* (provincial ruler) of Moray, a position previously held by his father, and had probably attained the office by 1031. Macbeth established himself on the throne in 1040 when he killed Duncan I in battle near Elgin—not, as Shakespeare has it, by murdering him in bed. Both Duncan and Macbeth derived their right to the throne through their respective mothers and there was no rule of succession among Kenneth I's descendants that gave one a better claim than the other. The defeat of rebels, perhaps led by Crinan, father of Duncan, in a battle near Dunkeld in 1045 may account for the later story of Birnam wood. Earl Siward of Northumbria attempted, unsuccessfully, to dethrone Macbeth in 1046 in favour of Malcolm (afterward Malcolm III), the son of Duncan, but by 1050 Macbeth was secure enough to go on a pilgrimage to Rome. Nevertheless he was apparently forced by Siward to hand over part of southern Scotland to Malcolm in 1054 and was slain by Malcolm in battle at Lumphanan, in Mar, in 1057. Macbeth was buried at Iona, which was regarded as the resting place of kings but not of usurpers.

Macbeth's stepson, Lulach, who had established himself as king, perhaps in Moray, was slain in 1058. (A. A. M. D.)

McBRIDE, SIR RICHARD (1870–1917), Canadian politician, premier of British Columbia, 1903–15, established a record in that province for long tenure of office. Born at New Westminster, B.C., on Dec. 15, 1870, he was educated there and at Dalhousie university, Halifax, Nova Scotia. He entered the British Columbian legislature in 1898, became minister of mines in 1900, leader of the opposition in 1902 and premier in 1903, at the age of 32. He introduced the two-party system into the province's politics.

McBride's term of office coincided with the first great boom in the province. Population doubled; British, French and German capital poured into land, fisheries and mines; two transcontinental railways extended lines to British Columbia; and a network of railways was built within the province. His government founded the University of British Columbia and a provincial archives and library. In Aug. 1914, alarmed about the lack of security on the Pacific coast, he used provincial funds to purchase two submarines in Seattle, Wash.; later he turned them over to the Canadian navy.

Discouraged by the collapse of the real-estate boom and by failing health, he resigned in 1915 to become the province's agent-general in London. He died there on Aug. 6, 1917.

See Margaret A. Ormsby, *British Columbia: a History* (1958).
(M. A. O.)

MACCABEES, the name (in the plural) of a distinguished Jewish family dominant in Jerusalem in the 2nd century B.C., effective in preventing the destruction of Judaism by Hellenism. According to I Macc. ii, 4, the name Maccabee, or Maccabaeus, was originally the distinctive surname of Judas, third son of the Jewish priest Mattathias, who struck the first blow for religious liberty during the persecution under Antiochus IV Epiphanes.

Subsequently, however, it obtained a wider significance, having been applied first to the kinsmen of Judas, then to his adherents, and ultimately to all champions of religion in the Greek period. It is now customary to apply it only to the sons and descendants of Mattathias. As, however, according to Josephus, this brave priest's great-great-grandfather was called Hasmon, the family is more correctly designated by the name of HASMONAEANS or ASMONEANS. If Maccabee is the original form of the name, it is derived from a Hebrew word which is generally believed to be *maqqabi*, "the hammerer"; hence Judas Maccabaeus is "Judas the Hammerer," with reference to his beating down the enemies of the Jewish nation. But as Judas was surnamed "the Maccabee" before his military exploits, it is perhaps more probable that the name is derived, as A. Bevan suggested, from the verb *maqab*, "to designate," "to appoint"; hence "the one appointed [by Yahweh]."

The Maccabaean revolt was caused by the attempt of Antiochus IV Epiphanes, king of Syria, to force Hellenism upon Judaea (*see* ANTIOCHUS). In Dec. 168 sacrifice was offered to Zeus upon an idol altar erected over the great altar of burnt offering in the Temple. The issue of an edict ordaining the erection of heathen altars in every township of Palestine, and the appointment of officers to deal with recusants, brought matters to a crisis. At Modein, Mattathias, an aged priest, not only refused to offer the first sacrifice but slew an apostate Jew who was about to step into the breach. Having thus given the signal for rebellion, he then with his five sons took to the mountains. Many, including the *Hasidim* ("the pious"), who had constituted themselves champions of the Law, flocked to his standard, and set themselves to revive Jewish rites and to uproot paganism. In 166 Mattathias died, after nominating Judas as their leader.

The military genius of Judas made this the most stirring chapter in Israelite history. In quick succession he overthrew the Syrian generals Apollonius, Seron and Gorgias, and after the regent Lysias had shared the same fate at his hands he restored the Temple worship (165). These exploits dismayed his opponents and kindled the enthusiasm of his friends. When, however, Lysias returned in force to renew the contest, Judas had to fall back upon the Temple mount, and escaped defeat only because the Syrian leader was obliged to hasten back to Antioch in order to prevent a rival from seizing the regency. Under these circumstances Lysias unexpectedly guaranteed to the Jews their religious freedom (163). But though they had thus gained their end, the struggle did not cease. The *Hasidim* indeed were satisfied, and declined to fight longer, but the Maccabees determined not to desist until their nation was politically as well as religiously free.

In 161 Judas defeated Nicanor at Beth-horon, but within a few weeks thereafter, in a heroic struggle against superior numbers under Bacchides at Elasa, he was himself cut off. If in his brother Jonathan the cause which Judas had espoused did not possess so brilliant a soldier, it had in him an astute diplomatist who knew how to exploit the internal troubles of Syria. With all his cunning, Jonathan walked into a trap at Ptolemais, was made prisoner and ultimately slain (143). The leadership now devolved upon Simon, the last survivor of the sons of Mattathias, who succeeded in negotiating a treaty whereby the political independence of Judaea was at length secured in May 142. In the following year he was by popular decree invested with absolute powers, being appointed leader, high priest and ethnarch. As these offices were declared hereditary in his family, he became the founder of the Hasmonaean dynasty. The first year of his reign (143–142 B.C.) was made the beginning of a new era; issue of a Jewish coinage betokened the independence of his sovereignty. Under Simon's administration the country enjoyed prosperity, but in 135 he and two of his sons were murdered by Ptolemy, his son-in-law, who had an eye on the supreme power. Simon's third son, John Hyrcanus I, warned in time, asserted his rights as hereditary head of the state.

After the death of Antiochus VII Sidetes in 129 left him a free hand, John Hyrcanus (135–104) soon carved out for himself a large and prosperous kingdom, which, however, was rent by internal discord owing to the antagonism developed between the rival parties of the Pharisees and Sadducees. Hyrcanus was succeeded by his son Aristobulus, whose reign of but one year was followed by that of his brother, the warlike Alexander Jannaeus (103–76). The new king's Sadducean proclivities rendered him odious to the populace, which rose in revolt, but only to bring upon itself a savage revenge. The accession of his widow, Salome Alexandra (76–67), witnessed a complete reversal of the policy pursued by Jannaeus, for she chose to rule in accordance with the ideals of the Pharisees. (For the differing views of Sadducees and Pharisees, *see* JEWISH SECTS DURING THE SECOND COMMONWEALTH.) Her elder son, John Hyrcanus II, a pliable weakling, was appointed high priest; her younger son, the energetic Aristobulus, who chafed at his exclusion from office, seized 20 strongholds and with an army bore down on Jerusalem. At this crisis Alexandra died, and Hyrcanus had to retire in favour of his brother (*see* also HYRCANUS).

A new and disturbing element now entered into Jewish politics in the person of the Idumaean Antipater, who for selfish ends deliberately made mischief between the brothers. An appeal to M. Aemilius Scaurus, who in 65 came into Syria as the legate of Pompey, led to the interference of the Romans, the siege of Jerusalem by Pompey and the vassalage of the Jews. Repeated but fruitless attempts were made by the Hasmonaeans and their patriotic supporters to throw off the Roman yoke. At length, in 40, the Parthians set up as king Antigonus, sole surviving son of Aristobulus. Through the execution of Antigonus by Mark Antony in 37 B.C. the Hasmonaean dynasty became extinct. (*See* also JEWS: *Greek and Roman Conquests;* PALESTINE: *Prehistory and History;* SELEUCID DYNASTY.)

Another set of brothers, also called Maccabees (though not so named in II Macc. vii, where their story is given), who were executed because they refused to break the commands of the Jewish Law, were regarded as examples of martyrdom in the early Christian period and are celebrated as saints on Aug. 1 in both the eastern and western churches. *See* also MACCABEES, BOOKS OF.

BIBLIOGRAPHY.—I and II Macc. and Josephus are the main sources for the Maccabaean history. *See* also Madden, *Coins of the Jews* (1881); E. Beurlier in F. Vigouroux (ed.), *Dictionnaire de la Bible*, vol. iv, cols. 479–488 (1908); C. C. Torrey in T. K. Cheyne and J. S. Black (eds.), *Encyclopaedia Biblica*, vol. iii, cols. 2850–58 (1902); H. Weiss, *Judas Makkabäus* (1897); A. W. Streane, *The Age of the Maccabees* (1898); E. Schürer, *Geschichte des judischen Volkes im Zeitalter Jesu Christi*, 4th ed., vol. i (1901); E. Bickermann, *The Maccabees*, trans. by M. Hadas (1947), *Der Gott der Makkabäer* (1937). (W. F.; X.)

MACCABEES, BOOKS OF. All four books of Maccabees, none of which is in the Hebrew Bible, appear in some manuscripts of the Septuagint; the first two only are part of canonical Scripture in the Septuagint and the Vulgate (hence are canonical to Roman Catholicism and Eastern Orthodoxy) and are included in the Protestant Apocrypha (*see* APOCRYPHA, OLD TESTAMENT).

I Maccabees.—The first Book of Maccabees, of which the Hebrew original (seen by Jerome) is lost, is a history of the Maccabees (*q.v.*) from the attempts of Antiochus IV Epiphanes of Syria to root out the Jewish religion until the death of Simon Maccabaeus (175–135 B.C.). The first chapter sets the scene, with an account of the natural pressure on the Jews since the time of Alexander the Great to conform to the customs of their Hellenistic neighbours and the active measures of Antiochus in forbidding Jewish practices and defiling the Temple. (*See* JEWS.) The book then describes the revolt of the priest Mattathias, who refused to obey Antiochus' commands and together with his five sons and other followers fought for the defense and reinstatement of Judaism (ch. ii). On his death his son Judas Maccabaeus took over the command of the Jewish forces and won a series of victories, after which the Temple was purified and reconsecrated at a dedication festival lasting eight days (ch. iii–iv). There was further fighting, but before Judas was finally killed in battle he had made a treaty with the Romans (v–ix. 22). His brother Jonathan, who succeeded to the command, was finally recognized as the Jewish ruler, being made high priest (ix. 23–xii). After Jonathan was killed by the Syrians at Ptolemais his brother Simon succeeded in ejecting the Syrian garrison from Jerusalem and inaugurated a period of prosperity; he was made ruler and high priest, but was murdered after a short reign (xiii–xvi).

The first Book of Maccabees was perhaps written toward the end

of the 2nd century B.C., after the death of Simon's son, John Hyrcanus, who is referred to in the last two verses. The author, a reliable historian whose theme is that Hellenism is the root of all evil, was a Palestinian Jew utterly devoted to the national cause and quite possibly a Sadducee, for he is not against the profanation of the sabbath. The work is characterized by a religious reticence which never refers directly to God or mentions the messianic hope.

II Maccabees.—The second Book of Maccabees, which was probably written originally in Greek, is the work of a preacher rather than of a historian. In the prefatory letters (ch. i–ii) addressed to the Jews of Alexandria by the Jews of Jerusalem it claims to be the epitome in one book of a lost five-volume history by Jason of Cyrene covering the period 176–161 B.C. The book then tells of the heavenly apparition sent by God to preserve the Temple from desecration (ch. iii) and of various other attempts to Hellenize the Jews, including the martyrdom of the priest Eleazar and the seven brothers who refused to break the law by eating forbidden food (ch. iv–vii). The climax comes with the victories of Judas Maccabaeus, the subsequent purification and rededication of the Temple and the independence of Jerusalem from foreign control (ch. viii–xiii). The aim of the book is to uphold the Jewish faith by stressing God's mighty power shown clearly in heavenly apparitions (v, 1–4; x, 29–31; xi, 8; etc.), by relating examples of steadfastness in obeying the Law (*e.g.,* sabbath observance, vi, 11; viii, 25 ff.; xii, 38; xv, 1) and by urging the celebration of national festivals (i, 9; x, 5 ff.; xv, 36). The book, which probably dates from the 1st century B.C., refers to the resurrection of the dead and to prayers for the dead, which it says would be pointless if there were no resurrection (xii, 43–45). The prophet Jeremiah is also said to pray for the Jewish people and for the holy city (xv, 14).

III Maccabees.—The third Book of Maccabees, which is without historical foundation, tells the story of a persecution against the Jews said to have been attempted by Ptolemy IV Philopator (221–204). Incensed at being miraculously prevented from entering the Temple in Jerusalem, Ptolemy commanded that the Jews of Alexandria should be trampled underfoot by 500 drunk elephants, but a further miracle diverted this fate from the Jews to the Egyptians. The purpose of the writer was evidently to encourage the Jews of Alexandria during persecution, but there is no clear allusion to dates. The book must, however, have been written after the Maccabaean period and before the fall of Jerusalem in A.D. 70. A somewhat similar event is related by the Jewish historian Josephus as taking place in the reign of Ptolemy VII Euergetes II (170–164 and 145–117). Greek was the original language of III Maccabees, which probably owes its title to being placed after I–II Maccabees in manuscripts. The book is also found in the Syriac Peshitta and in an Armenian translation.

IV Maccabees.—The fourth Book of Maccabees is a philosophical discourse on the supremacy of religious reason over the passions. It shows how the four cardinal virtues can be practised by obeying the Jewish Law. Its title is probably due to the fact that it is largely devoted to retelling the story, also related in II Maccabees, of how the priest Eleazar and the seven brothers were martyred for their determination to obey the Law. It has been suggested that the book was composed for delivery at an annual commemoration of these Maccabaean martyrs, possibly in Antioch where later tradition located their tomb. This suggestion is supported by the fact that the book was later so used by the church; it is found in many manuscripts of Greek service books as an appropriate homily for Aug. 1, the day when the Maccabees are remembered in the Christian calendar. In some manuscripts and in certain editions the book appears among the works of Josephus, to whom it is also attributed by various Church Fathers, but it differs greatly in outlook, method and vocabulary from Josephus' authentic writings. The author of the book, who wrote in Greek, was an unknown Hellenistic Jew who had studied Greek philosophy and probably lived in the 1st century B.C. There is a Syriac version of the book in the Peshitta and a Latin paraphrase entitled *Passio SS. Machabaeorum.* The book was popular among Christian preachers (*e.g.,* Gregory of Nazianzus and John Chrysostom) as providing a superlative example of steadfastness, for the Maccabees could have no faith in Christ to sustain them in their martyrdom. *See* also BIBLE.

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McCARTHY, JOSEPH RAYMOND (1908–1957), U.S. senator who gained prominence with anti-Communist charges during the 1950s, was born on a Grand Chute farm near Appleton, Wis., on Nov. 14, 1908. He worked his way through Marquette university, Milwaukee, Wis., and received a law degree in 1935. He then began to practise law and entered politics, first as a Democrat and then as a Republican. Elected circuit judge in 1939, he left the bench three years later to enlist in the U.S. marine corps where he served during World War II as an enlisted man and as an officer. After returning home he won a striking victory over Sen. Robert M. La Follette, Jr., in the Wisconsin Republican primary election in 1946, and defeated the Democratic candidate in the fall. He made his home in Appleton and was re-elected to the senate in 1952.

Senator McCarthy became nationally prominent after he took up the Communist issue in 1950. Working alone and through senate committees, he charged that Communists and fellow travelers had infiltrated the U.S. department of state and other government offices. He drove some persons out of their jobs and brought popular condemnation on others. His accusations, always colourful and cleverly presented, won him widespread support as a crusader against Communism. Many Americans and Europeans, however, denounced McCarthy as a demagogue whose reckless charges did disservice to the anti-Communist cause. To them, "McCarthyism" meant accusation without proof.

During Pres. Dwight D. Eisenhower's administration McCarthy broke with leaders in his own party. Though he had built his strength on congressional investigations, he lost influence in 1954 as a result of the sensational, nationally televised hearing on McCarthy's charges against army officers and civilian officials. When the Republicans lost control of the senate as a result of the autumn elections of 1954 McCarthy lost his chairmanship of the investigating committee and soon thereafter, on Dec. 2, 1954, was formally condemned by the senate, 67–22, for conduct "contrary to Senate traditions." He had not regained his former power when he died at Bethesda, Md., on May 2, 1957.

See William F. Buckley, Jr., and L. Brent Bozell, *McCarthy and His Enemies* (1954) for a favourable estimate; *see* Richard H. Rovere, *Senator Joe McCarthy* (1959) for a critical view. (F. H. Hn.)

M'CARTHY, JUSTIN (1830–1912), Irish politician, historian and novelist, best known for his *History of Our Own Times* and his *Reminiscences* (1899), was born in Cork on Nov. 22, 1830, and educated there. He entered journalism as a reporter on the *Cork Examiner* and in 1854 joined the *Northern Daily Times* in Liverpool. He subsequently became foreign editor of the *Morning Star* and its editor till 1868. Having made his name as a novelist with such successes as *Dear Lady Disdain* (1875) and *Miss Misanthrope* (1878), he published his *History of Our Own Times* (1879–97), which won general recognition. In 1879 he entered Irish politics as member for County Longford, and became vice-chairman of the new Home Rule party under Charles Stewart Parnell (*q.v.*). In 1886 he won Londonderry city for Parnell; but when conflict arose over Parnell's leadership, M'Carthy became chairman of the anti-Parnellites. At the general election of 1892 his party won an overwhelming majority, but M'Carthy had no political ambitions and in 1896 resigned in favour of John Dillon. His health soon broke down with almost total blindness, but he continued writing by dictation. He died at Folkestone, Eng., on April 24, 1912. (D. G.)

McCLELLAN, GEORGE BRINTON (1826–1885), the most controversial Union general of the American Civil War, was

born in Philadelphia, Pa., on Dec. 3, 1826. He was educated at the University of Pennsylvania preparatory school and at the age of 15, with special permission, was admitted to the United States Military academy at West Point, graduating second in his class in 1846. The newly commissioned officer was detailed as a military engineer with Gen. Winfield Scott's expedition in the Mexican War and was breveted twice for distinguished conduct under fire. From 1848 to 1851 he was an instructor at West Point.

McClellan was directed to explore the Red river in Arkansas in 1852 and the following year he was in command of an expedition to survey a route for a railway across the Cascade mountains. In 1854 he was sent on a secret mission to Santo Domingo to examine facilities for a possible U.S. naval base there. The war department then ordered him to the Crimea where he observed European methods of conducting warfare and gained valuable experience. At this time he also designed a new type of saddle, afterward known as the McClellan saddle, for the cavalry.

McClellan resigned his captain's commission in 1857 to become chief engineer with the Illinois Central railroad, and in 1860 he was appointed president of the Ohio and Mississippi railroad with offices in Cincinnati. On May 22, 1860, he married Ellen Mary Marcy, who was to bear him a son and a daughter.

Although a states' rights Democrat, McClellan was a staunch Unionist, and in April 1861, at the outbreak of the Civil War, he accepted appointment as major general of the Ohio volunteers. The following month he was commissioned in the regular army and was placed in command of the department of the Ohio; he assumed responsibility for holding western Virginia for the Union. By July 13 the Confederate forces in this area had been defeated, and McClellan had established a reputation as the "Young Napoleon of the West" because of his issuance of bombastic manifestoes to soldiers under his command.

After the Union reverse at Bull Run in July 1861, McClellan was called to Washington and placed in command of the department (later army) of the Potomac; he was charged with the defense of the capital and with the destruction of the enemy's forces in northern and eastern Virginia. Upon the retirement of the aged General Scott as general-in-chief of the army in Nov. 1861, McClellan assumed this office, a position he was to hold only until March 1862.

McClellan's organizing abilities and logistical understanding brought order out of the chaos of defeat and he was brilliantly successful in whipping his army into a fighting unit with high morale, an efficient staff and effective supporting services. Yet he refused to take the offensive against the enemy in the fall of 1861, claiming that the army was not prepared to move. President Lincoln, disturbed with McClellan's inactivity, issued his famed General War Order No. 1 calling for the forward movement of all armies on Feb. 22, 1862, as a means of prodding his numerous reluctant generals. "Little Mac" was able to convince the president that a postponement of two months was desirable. He also succeeded in persuading Lincoln that the army of the Potomac should take the offensive against the enemy capital at Richmond from the peninsula between the York and James rivers rather than by the overland north-south route.

The Peninsula campaign continued in May 1862 after a one-month siege of Yorktown, and although McClellan was never really defeated by the enemy and actually won several victories, notably at Malvern hill, he was cautious and always failed to press his advantage. Coming to within a few miles of Richmond, he consistently miscalculated the number of enemy troops opposing him. Disappointed with Lincoln's action in withholding McDowell's corps from his control for the protection of Washington, McClellan was forced to make a strategic withdrawal to the James river because his army was now divided by the Chickahominy river. Although the Confederate forces under Gen. Robert E. Lee began an all-out attempt to destroy McClellan's army in the Seven Days' battle (June 26 to July 2), the Union troops retreated successfully to a new base of operations at Harrison's Landing. Lincoln's discouragement over McClellan's failure to take Richmond or to defeat the enemy decisively led to the withdrawal of the army of the Potomac from the peninsula.

McClellan returned to Washington just as the news of the demoralizing setback for Federal troops at Second Bull Run (Aug. 29–30, 1862) was received, and he was requested to take command of the army for the defense of the capital. Again exercising his organizing capacity, he was able to rejuvenate the Union forces. When Lee moved north into Maryland, McClellan's army met the Confederates at the battle of Antietam (Sept. 17, 1862), where a Union victory prevented any extension of the invasion. McClellan once again failed to move rapidly to destroy Lee's army, and the exasperated Lincoln removed him from his command in Nov. 1862.

In 1864 McClellan was nominated for the presidency by the Democratic party on a platform that denounced the war as a failure; he repudiated this position but accepted the nomination. On election day McClellan resigned his commission in the army and later sailed for Europe. He returned in 1868, and after declining the presidencies of the new University of California and Union college, he became chief engineer of the department of docks in New York city from 1870 to 1873. In 1871 he also served as one of three trustees to reorganize the Atlantic and Great Western railroad and became its president in 1872. Elected governor of New Jersey on the Democratic ticket in 1877, McClellan served one term and spent the remaining years of his life in traveling and writing his memoirs. He died suddenly on Oct. 29, 1885, at Mayfield, Orange, N.J.

As a general, McClellan was a superior organizer, had an excellent grasp of military strategy, and was well liked by the men who served under him, but he was overly cautious and insufferably egocentric in his dealings with civilian superiors. Most important, he lacked the ability to view the Civil War as more than the clash of opposing armed forces.

See also references under "McClellan, George Brinton" in the Index.

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(J. R. Co.)

McCLERNAND, JOHN ALEXANDER (1812–1900), U.S. politician and Civil War general, was born near Hardinsburg, Ky., May 30, 1812. The family soon moved to Illinois, and in 1832 McClernand was admitted to the bar in Shawneetown, Ill. He served in the Black Hawk War, was active in militia affairs and later edited a local newspaper. He served as a Democrat in the U.S. house of representatives from 1843 to 1851 and again from 1859 to 1861. Upon the outbreak of the Civil War he resigned from congress and returned to Illinois to raise troops.

McClernand was commissioned brigadier general of volunteers on May 17, 1861. At Belmont, at Ft. Henry and Ft. Donelson, and at Shiloh he was one of the senior commanders and was promoted to major general on March 21, 1862. Thereafter his tactless behaviour made for increasing conflict and misunderstanding with Ulysses S. Grant. Following his unauthorized capture of Arkansas Post on Jan. 11, 1863, General Grant recalled him, and throughout the rest of the Vicksburg campaign the schism between the two officers widened. Grant accused McClernand of tardiness at Champion Hill and Grand Gulf, and blamed him for unwarranted casualties. McClernand meanwhile issued a congratulatory order virtually claiming victory for his own division. This order angered Grant, who relieved him in June 1863, but Pres. Abraham Lincoln, unwilling to anger the War Democrats, reinstated him in Feb. 1864. Lack of military success and ill health caused McClernand to resign Nov. 30, 1864. He continued to be a power in the Democratic party in Illinois after the war, holding elective and appointive offices. He died at Springfield, Ill., Sept. 20, 1900.

(C. C. W.)

MACCLESFIELD, EARLS OF. The earldom of Macclesfield was created in 1679 for Charles Gerard (*c.* 1618–94) who had supported Charles I in the Civil War, commanding a brigade at Edgehill and distinguishing himself at Newbury (1643) and Newark (1644). He was given the command in south Wales where his severity made him unpopular, and was also lieutenant general of the King's horse. Created Lord Gerard of Brandon in 1645, he retired to the continent in 1646 after Oxford had fallen

to the parliamentarians. Gerard returned in 1660 with Charles II., his estates were restored and he received a pension. He was created earl of Macclesfield and Viscount Brandon in 1679, but his sympathies with the duke of Monmouth led to his temporary arrest in 1685. Macclesfield escaped abroad, to return with William III in 1688 as commander of his bodyguard. He was made privy councillor and president of the council in the Welsh marches in 1689. Macclesfield died on Jan. 7 1694. CHARLES (c. 1676–1702), 2nd earl, was also involved in Monmouth's intrigues. He was sentenced to death in 1685 for complicity in the Rye House plot, but was later pardoned. He divorced his first wife, Anne, by act of parliament, thus creating legal precedent since no previous decree had been obtained in an ecclesiastical court. The poet, Richard Savage, claimed to be the youngest of two illegitimate children of Anne by Richard Savage, Earl Rivers. Charles was succeeded, briefly, by his brother, FITTON (c. 1666–1702), 3rd earl, on whose death the title became extinct.

The title was revived in 1721 for THOMAS PARKER (1667–1732), a lawyer who took part in the proceedings against Dr. Henry Sacheverell. He was appointed lord chief justice in 1710 and lord chancellor in 1718. Impeached for corruption in 1725 he was found guilty and fined heavily. GEORGE (1697–1764), 2nd earl of this creation, was a celebrated astronomer who was prominent in introducing the new style of dates in 1752. He was president of the Royal society and died on March 17 1764. GEORGE (1755–1842), 4th earl, was president of the board of agriculture from 1796 to 1818. GEORGE (1888–), 7th earl, succeeded to the title in 1906.

MACCLESFIELD, a municipal borough and market and manufacturing town in the Macclesfield parliamentary division of Cheshire, Eng., 18 mi. S.S.E. of Manchester by road. Pop. (1961) 37,573. It stands on the Bollin river in a deep gorge with heights up to 1,500 ft. on the east where the bleak upland country retains its ancient name of Macclesfield forest. Steps and terraces connect the low lying Waters Green near the river, where the Barnaby and May fairs are held, with the upper part of the town with its many steep, cobbled streets. The church and town hall crown the hill where gardens are now laid out. St. Michael's church was founded in 1278 by Queen Eleanor and was once connected with the two private chapels of the Savage and Legh families. The Savage chapel, belonging to a college of secular priests founded in 1508 by Thomas Savage. A Unitarian chapel, built in 1884, stands behind a fine wrought iron gate. The King's school was founded in 1502 as a free grammar school and refounded in 1552. There are also a technical school and a school of art. The museum was built in 1898. The most important industry is silk manufacture; cork, paper, shirts, shoes and electrical appliances are also produced. Stone is quarried locally.

Before 1066 Macclesfield was held by Edwin, earl of Mercia; the Domesday Book records it in the lands of the earl of Chester where it remained until 1344 when it lapsed to the crown. The forest remained a royal forest until after the Restoration, but by the 18th century it had been enclosed and cultivated. In 1261 John de Macclesfield obtained permission to fortify his mansion; it was later owned by the duke of Buckingham and then by the earl of Derby; it was destroyed in the Civil War when the town walls also were demolished. The names Jordangate, Chestergate and Waligate bear witness to the ancient fortifications. The earliest of many charters was granted by Ranulf (or Randulph), earl of Chester, in 1260; in 1261 another, granted by Edward, prince of Wales, constituted Macclesfield a free borough with a merchant guild. In 1684 Charles II issued the last charter which continued until 1835. The markets, first mentioned in 1261, are still flourishing. The charter of Elizabeth I (1564) granted an annual fair in June, and Charles II granted fairs in April and September. The present fairs are held in May and October. Macclesfield first sent two members to parliament in 1295; in 1885 it was disfranchised and in 1918 it was merged in the county division of Macclesfield.

The manufacture of silk-covered buttons began in the 16th century and flourished until the early 18th. Charles Roe, who came to Macclesfield in 1743, introduced silk throwing in 1756, when the first silk mill was erected, and fostered the silk and metal-working industries. By 1790 silk manufacture was being carried on on a large scale and in 1831 the Macclesfield canal, between the Trent and Mersey canal and the Peak Forest canal, was opened. In 1845 the railway connected Macclesfield with Stockport.

McCLINTOCK, SIR FRANCIS LEOPOLD (1819–1907), British naval officer and arctic explorer, who made known the fate of Sir John Franklin's expedition, was born at Dundalk, Ire., on July 8 1819. He went to sea at the age of 19 and served in several ships of the Royal Navy before joining the Franklin search expedition of 1848–49 under Sir James Clark Ross, as second lieutenant of the "Enterprise." During his second arctic season (1850–51) as first lieutenant of the "Assistance" and during his third (1852–54) when he commanded the "Intrepid," he improved on Ross's sledging methods and equipment, and initiated a system of depot laying which resulted in some great man hauling journeys. McClintock's party in the spring of 1853 travelled 1,398 mi. in 105 days, and sledge journeys of comparable length were made in 1854 and during his last searching expedition of 1857–59. Much new coast line was explored, but no traces found of Sir John Franklin (q.v.). After many fruitless expeditions, news of the fate of the lost party was obtained in 1854 by John Rae from the Eskimo of Boothia peninsula. The government refused to equip another expedition, so Lady Franklin sent McClintock in the "Fox" to King William Island, off which Franklin's ships, the "Erebus" and "Terror," had been beset. Through him the fate of the expedition was made known and many relics discovered, including a record left on the island. These relics and McClintock's own papers are in the National Maritime museum. He died in Nov. 17, 1907.

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McCLINTOCK, JOHN (1814–1870), U.S. Methodist Episcopal theologian and educator, an able preacher, orator and teacher, and a versatile scholar, was born in Philadelphia, Pa., on Oct. 27 1814. After his graduation from the University of Pennsylvania in 1832 he taught in Dickinson college for 12 years. He edited the *Methodist Quarterly Review* (1848–52) and in 1867 at the wish of Daniel Drew became president of the newly established Drew Theological seminary at Madison, N.J., where he died on March 4 1870.

McClintock by his editorial and educational work probably did more than any other man to raise the intellectual level of American Methodism. He put into practice the scholarly methods of the new German theology of the day, not alone by his translation with Charles E. Blumenthal of Neander's *Life of Christ* (1847), and of Bunsener's *History of the Church of Trent* (1853), but by his own noteworthy project, McClintock and Strong's *Cyclopaedia of Biblical, Theological and Ecclesiastical Literature* (1867–81; supplement, 1885–87). Among McClintock's other publications are *Sketches of Eminent Methodist Ministers* (1853), *Living Words* (1871) and *Lectures on Theological Encyclopaedia and Methodology* (1873).

See G. R. Crooks, *Life and Letters of the Rev. Dr. John McClintock* (1876).

McCLOSKEY, JOHN (1810–1885), U.S. Roman Catholic archbishop of New York, the first U.S. cardinal, was born in Brooklyn, N.Y., March 10 1810. Educated at Mount St. Mary's college, Emmitsburg, Md., he was ordained a priest in 1834, spent two years in graduate study at the Gregorian university in Rome, and returned to New York city in 1837 as rector of St. Joseph's church. In 1841 he organized and became first president of St. John's college (later Fordham university). After serving from 1844 to 1847 as bishop coadjutor to Bishop John Hughes of New York, he became first ordinary of the newly created see of Albany, N.Y. Succeeding to the archbishopric of New York in 1864, he renewed construction of St. Patrick's cathedral, suspended during the Civil War, and dedicated the edifice on May 25 1879. Elevated to the cardinalate in 1875, he journeyed to Rome in 1878 but arrived too late to attend the conclave that elected Pope Leo XIII. He died in New York on Oct. 10 1885.

See J. M. Farley, *The Life of John Cardinal McCloskey* (1918). (J. A. Rs.)

McCLURE, SIR ROBERT JOHN LE MESURIER (1807–1873), British arctic explorer who commanded the first expedition to complete the Northwest passage, though Sir John Franklin was later credited with its discovery, was born at Wexford, Ire., on Jan. 28, 1807. He joined Sir George Back's arctic expedition of 1836–37, and the Franklin search expedition of 1848–49 under Sir James Clark Ross. In 1850, McClure, commanding H.M.S. "Investigator," accompanied Sir R. Collinson, in H.M.S. "Enterprise," to search again for Franklin's lost expedition. "Investigator" preceded "Enterprise" through Bering strait and discovered a northwest passage, finding one route through Prince of Wales strait and another round Banks Island. Having abandoned ship off Banks Island, the expedition joined the "Resolute" and "Intrepid" of the search expedition commanded by Horatio Austin, at Melville Island. These ships were in turn abandoned, and McClure's party went on foot to Beechey Island and thence home by ship in 1854. (*See* also ARCTIC, THE.) McClure died in London on Oct. 17, 1873.

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McCONNELL, FRANCIS JOHN (1871–1955), U.S. Methodist bishop, was born at Trinway, Ohio, Aug. 18, 1871. He graduated at Ohio Wesleyan university and later studied at Boston university. In 1894 he entered the Methodist ministry and was pastor successively at Chelmsford, Newton, Ipswich and Cambridge, all in Massachusetts, and in 1908–09 at the New York Avenue Methodist church in Brooklyn. From 1909 to 1912 he was president of De Pauw university. He was elected bishop in 1912 and served for a number of years in Mexico and afterward in the Pittsburgh, Pa., district. In the latter region he entered actively into a study of industrial conditions and problems. As chairman of the Commission of Inquiry appointed by the Interchurch World Movement organization he pushed the investigation resulting in the *Report on the Steel Strike of 1919* which was influential in abolishing the 12-hour day and seven-day week in the steel industry. He wrote many books, among which are *Personal Christianity* (1914); *Christianity and Coercion* (1933); *John Wesley* (1939); and *Evangelicals, Revolutionists and Idealists* (1942). Bishop McConnell retired in 1944 and died at Lucasville, Ohio, on Aug. 18, 1955.

McCOOK, ALEXANDER McDOWELL (1831–1903), U.S. army officer, was born in Columbiana county, O., April 22, 1831, and graduated from the United States Military academy at West Point in 1852. He did garrison duty in the west and served as an instructor at West Point prior to the American Civil War, in which he and seven of his brothers, known as the "fighting McCooks," served. In April 1861 he became a colonel of Ohio volunteers, fought in the first battle of Bull Run and commanded a brigade in Kentucky. He next led a division in the army of the Ohio, fighting at Corinth, Nashville and Shiloh. He fought with the army of the Cumberland at Chickamauga, was blamed for the Union defeat and relieved of his command. A board of inquiry exonerated him and he returned to duty. At the end of the war, having risen to the rank of major general of volunteers, he resumed his rank of lieutenant colonel in the regular army, serving in several infantry regiments. He was aide-de-camp to Gen. William T. Sherman from 1875 to 1880. He became a brigadier general in 1890 and a major general in 1894, and retired the next year. He later served on the commission which investigated the conduct of the war department in the Spanish-American War. He died in Dayton, O., on June 12, 1903. (C. W. Tr.)

McCORMACK, JOHN (1884–1945), Irish-U.S. operatic and concert tenor, was born at Athlone, Ireland, on June 14, 1884. He won the prize at the *Feis Ceoil* in Dublin in 1902 and later studied in Italy under Sabatini. He made his operatic debut at Covent Garden in *Cavalleria Rusticana* in 1907 and appeared at the Manhattan opera house, New York, in *Traviata* in 1909. He afterward sang with the Chicago and Boston opera companies and the Metropolitan opera company. In 1911 he toured Australia with Melba in Italian opera. After two further operatic seasons, he turned to the concert stage, where he achieved an extraordinary popularity confirmed in many fine phonograph records. He became a U.S. citizen in 1919 and was made a count in the papal peerage in 1928. McCormack died Sept. 16, 1945, near Dublin.

See L. A. G. Strong, *John McCormack* (1949).

McCORMICK, CYRUS HALL (1809–1884), U.S. inventor of the reaper, was born in Rockbridge county, Va., on Feb. 15, 1809. He was the eldest son of Robert McCormick, an inventor of farm machinery and a major factor in the early development of the reaper. In 1831 Cyrus demonstrated a successful reaper, the principles of which have been essential to all subsequent grain-cutting machines. He obtained a patent on his invention in 1834 and in 1847 established his factory in Chicago. McCormick expanded the business and defended its patent rights, charging his brothers, Leander J. and William S., with management of the concern. In 1858 Cyrus married Nettie Fowler, who became his constant consultant and, upon his death, the first American woman to assume leadership of a major business. His brothers became partners in the firm, and Cyrus turned his attention to the building of a world market. He became active in the Presbyterian Church, establishing McCormick Theological seminary, and also in the Democratic party. His other interests included philanthropy, railroading, mining and Chicago real estate. McCormick died in Chicago on May 13, 1884. In 1902 the McCormick Harvesting Machine company joined with the Deering Harvester company and others to form International Harvester company, with McCormick's son, Cyrus Jr., becoming its first president.

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McCORMICK, ROBERT RUTHERFORD (1880–1955), U.S. publisher, editor and soldier, was born in Chicago, Ill., July 30, 1880. His father was a U.S. diplomat, his mother a daughter of Joseph Medill, editor and proprietor of the *Chicago Tribune*.

A graduate of Yale university (1905) and Northwestern university law school, Chicago (1906), McCormick was admitted to the bar in 1908. He served as a Chicago alderman, 1904, and president of the Sanitary District board, 1905–10. As a staff and combat officer with the American expeditionary force (1917–18) McCormick was awarded the U.S. distinguished service medal.

McCormick was named president of the Tribune company in 1911, and with his cousin, Joseph Medill Patterson (q.v.), shared the functions of publisher and editor of the *Chicago Tribune* from 1914 until 1925 when he became sole editor and publisher. Under his direction the *Tribune* came to lead the U.S. in standard-size newspaper circulation and the world in newspaper advertising revenue. He built Tribune enterprises to include forest lands, paper mills, hydroelectric installations and shipping companies as well as major publishing, radio and television facilities. Tribune editorial policies voiced outspoken opposition to Prohibition, the Roosevelt and Truman administrations and U.S. political involvement in overseas conflicts. From 1925 until his death April 1, 1955, at Wheaton, Ill., McCormick was among the most powerful and controversial figures in U.S. journalism. A staunch advocate of constitutional liberties, McCormick was the author of historical works, numerous pamphlets, and public and radio addresses. (F. C. Cx.)

McCOY, SIR FREDERICK (1823–1899), British paleontologist, who established and directed the National Museum of Natural History and Geology in Melbourne, Austr., was born the son of Simon McCoy, a physician, in Dublin, Ire., in 1823 and was educated for the medical profession. In collaboration with the geologist Adam Sedgwick, he prepared *A Synopsis of the Classification of the British Palaeozoic Rocks, With a Systematic Description of the British Palaeozoic Fossils in the Geological Museum of the University of Cambridge* (1855). After four years in Belfast, N.Ire., he became professor of natural science in the University of Melbourne, where he lectured for about 30 years. While he directed the National museum he became associated with the geological survey of Victoria as paleontologist and issued, at

intervals during a 30-year span, a series of decades (works in ten parts) entitled *Prodromus of the Palaeontology of Victoria*. He also issued the *Prodromus of the Zoology of Victoria*. McCoy was elected fellow of the Royal society in 1880 and was made Companion (in 1886) and Knight Commander (in 1891) (of the Order) of St. Michael and St. George. He died near Melbourne on May 13, 1899.

McCULLOCH, HUGH (1808–1895), U.S. financier, comptroller of the currency, and secretary of the treasury, was born at Kennebunk, Me., Dec. 7, 1808. After two years at Bowdoin college, Brunswick, Me., he taught school, studied law in Boston, and began practising law in 1833 at Fort Wayne, Ind. He was cashier and manager of the Fort Wayne branch of the old state bank of Indiana from 1835 to 1856, and president of the new state bank from 1857 to 1863. Even though he had opposed, on behalf of the state banks, the proposed national banking legislation, he was appointed comptroller of the currency and successfully put the new National Bank act of 1863 into operation. In March 1865 he was appointed secretary of the treasury by Pres. Abraham Lincoln and continued in that office under Pres. Andrew Johnson until March 1869. Following a suggestion made by McCulloch, congress passed an act on March 12, 1866, that provided for a slow withdrawal from circulation of greenbacks (paper money issued during the Civil War). Strong opposition developed, however, and the legislation was repealed on Feb. 4, 1868, after only $48,000,000 had been withdrawn. After leaving the cabinet McCulloch spent six years (1870–76) in England as a member of the banking house of Jay Cooke, McCulloch and Co. (after 1873, McCulloch and Co.). He was again briefly secretary of the treasury under Pres. Chester A. Arthur (Oct. 1884–March 1885). He lived in retirement near Washington, D.C., and died there May 24, 1895. His reminiscences, *Men and Measures of Half a Century*, was published in 1888. (Jo. F. S.)

McCULLOCH, SIR JAMES (1819–1893), prime minister of Victoria, Austr., 1863–66, 1866–68, 1868–69 and 1875–77, was born in Glasgow, Scot. After a primary education he was employed by a firm of merchants and on becoming a junior partner was sent to Melbourne in 1853 to organize an Australian branch. He was nominated a member of the legislative council in 1854 and was elected to the legislative assembly in 1856 for Wimmera. He was asked by Gov. Sir Henry Barkly to form a ministry in April 1857 but failed and became minister of trade and customs under W. C. Haines. McCulloch was treasurer in 1859 and formed in 1863 the most stable ministry in Victoria up to that time. This term of office was taken up in the struggle to give expression to the wishes of the electorate for protective tariffs, against the resistance of the legislative council. McCulloch not only eventually succeeded in establishing protection but also demonstrated the essential nature of the problems of the constitution. Gov. Sir Charles Darling made decisions indicating that the views of the vast majority who supported McCulloch's ministry in the elections should prevail, and was recalled to England. A long and bitter struggle took place between the assembly and the council over the proposed grant of £20,000 to Lady Darling. McCulloch's resignation in 1869 was followed by the award of a knighthood. Between 1871 and 1873 he was in London as agent general for Victoria; he was made a Knight Commander of St. Michael and St. George (K.C.M.G.) in 1874 and returned to Victoria, forming his fourth ministry in 1875. Defeated in 1877, McCulloch retired in 1878 and returned to England where he died at Ewell on Jan. 31, 1893. (J. F. C.)

McCULLOCH, JOHN RAMSAY (1789–1864), Scottish economist and statistician who, with the historian James Mill, helped to propagate the economic ideas of David Ricardo, was born at Whithorn, Wigtownshire, on March 1, 1789. From 1818 he edited the *Scotsman* for a while and also exercised much influence through his contributions on political economy to the *Edinburgh Review*. In 1825 he published his *Principles of Political Economy* and occupied the chair of political economy at the new University college, London, from 1828 until 1832. In 1838 he became comptroller of the stationery office. His *Dictionary . . . of Commerce and Commercial Navigation* (1832) and his *Statistical Account of the British Empire* (2 vol., 1837) are monumental works and his *Literature of Political Economy* (1845), though showing his earlier prejudices, is a valuable pioneer bibliography. McCulloch died in London on Nov. 11, 1864. (T. W. H.)

MacCUNN, HAMISH (1868–1916), Scottish composer and conductor, baptized John MacCunn, was born at Greenock on March 22, 1868. A pupil of Sir Hubert Parry and Sir Charles Stanford at the Royal College of Music, London, he made his name with the overture *The Land of the Mountain and Flood* (1887) and the opera *Jeanie Deans* (1894). His other operas and stage works include *Diarmid* (1897), *The Masque of War and Peace* (1900) and *The Golden Girl* (1905). He was professor at the Royal College of Music (1888–94), conductor of the Carl Rosa opera company, the Moody-Manners company and Quinlan's opera company, and assisted Sir Thomas Beecham at Covent Garden and His Majesty's theatre (1910–11). His unpublished autobiography is in the Glasgow university library. He died in London on Aug. 2, 1916.

MACDIARMID, HUGH (pseudonym of CHRISTOPHER MURRAY GRIEVE) (1892–), the greatest Scottish poet of the first half of the 20th century, was born in Langholm, Dumfriesshire, on Aug. 11, 1892, the son of a postman, and educated at Langholm academy and Edinburgh university. After service in World War I he became a journalist in Montrose, where he edited three issues of the first postwar Scottish verse anthology, *Northern Numbers* (1921–23). In 1922 he founded the monthly *Scottish Chapbook*, in which he advocated a Scottish literary revival (or "Renaissance") and published the lyrics of "Hugh Macdiarmid," later collected as *Sangschaw* (1925) and *Penny Wheep* (1926). Rejecting English as a medium for Scottish poetry, Grieve wrote in "synthetic" Scots, an amalgam of elements from various dialects and literary sources, and he achieved notable success both in his lyrics and in *A Drunk Man Looks at the Thistle* (1926), an extended rhapsody ranging from investigation of his own personality to exploration of the mysteries of space and time. Later, as he became increasingly involved in metaphysical speculation and accepted the philosophy of dialectical materialism, he found it difficult to express his themes adequately in modern Scots, which has lost most of its intellectual terms, and after writing Scotticized English in *To Circumjack Cencrastus* (1930) and archaic Scots in *Scots Unbound* (1932) he returned to "King's English" and sought to produce "a poetry of fact" in *Stony Limits* (1934) and *Second Hymn to Lenin* (1935), where his treatment of Scottish scenes and social circumstances has all the verve and penetration, though less of the ironic humour and the formal dexterity, of his earlier work in Scots. His later volumes, *A Kist of Whistles* (1948) and *In Memoriam James Joyce* (1955), suffer from his attempt to achieve "a variety great enough to express all the world's," the verse being so crammed with detail that the content distorts the form.

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MACDONALD, FLORA (1722–1790), Scottish Jacobite heroine who helped the Young Pretender to escape from Scotland after his defeat at Culloden, was the daughter of Ranald Macdonald of Milton, in the island of South Uist (Hebrides). Prince Charles Edward (*q.v.*) took refuge in June 1746 in Benbecula in the Hebrides where Flora was staying on a visit and his companion Capt. Felix O'Neal, sought her help. She obtained a passport for herself and party, which included Charles disguised as Betty Burke "an Irish spinning maid." They landed in Skye where Flora and the prince separated. The boatsmen's talk later brought suspicion on Flora and she was arrested and imprisoned in the Tower of London. She was later allowed to live outside under the guard of a jailer and after the Act of Indemnity (1747) she was freed. She married Allan Macdonald of Kingsburgh in 1750 and they emigrated to North Carolina in 1774. Macdonald served the British during the American Revolution and was taken prisoner. His wife returned to Scotland in 1779 and died at Kingsburgh on March 5, 1790.

See A. MacGregor, *The Life of Flora Macdonald* (1882). The so-called *Autobiography* (1870) of Flora Macdonald is spurious.

MACDONALD, GEORGE (1824–1905), Scottish novelist and poet, best known as a writer of Christian allegories and fairy stories, was born on Dec. 10, 1824, at Huntly, Aberdeenshire, the son of a farmer. He was educated at Aberdeen university and Highbury theological college, was Congregational minister at Arundel for a few years, and then a free-lance preacher and lecturer in Manchester and Liverpool. From 1856 when he published his first book, *Within and Without*, a poetic tragedy, he made literature his profession, writing poetry, novels of Scottish life, sermons, allegories and children's books. He died on Sept. 18, 1905, at Ashtead, Surrey.

As a writer for adults he is remembered for *Phantastes: A Faerie Romance* (1858) and *Lilith* (1895), both unresolved allegories of man's pilgrimage back to God, and for his three series of *Unspoken Sermons* (1867–89). But Macdonald's greatest claim to immortality is as a writer of allegorical fairy stories which have continued to delight children and their elders. His short fairy tales such as "The Light Princess" were first collected in *Dealings with the Fairies* (1867); his most famous book is *At the Back of the North Wind* (1870); his greatest and most enduring are *The Princess and the Goblin* (1871) and its even better sequel *The Princess and Curdie* (1882).

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(R. L. Gr.)

MACDONALD, JACQUES ÉTIENNE JOSEPH ALEXANDRE, Duc de Tarente (1765–1840), French army officer, one of Napoleon's marshals, was born at Sedan on Nov. 17, 1765, the son of Jacobite exiles from the Hebrides. In 1784 he joined an "Irish" regiment in the French service. When the French Revolutionary Wars (*q.v.*) broke out, he was promoted colonel. He was made a general after a success near Lille in Aug. 1793; and after the harder fighting near Tourcoing and Ypres he stood out as second only to J. V. Moreau in the army of the north which conquered Holland.

In May 1798 Macdonald was sent to Italy. Under J. E. Championnet he expelled the Neapolitan army from Rome. Then, after an interval of intrigue, he ousted Championnet from the command at Naples (March 1799) but was ordered north to help the defeated French army of Italy. He took the risk of leading his 30,000 men straight to the Po to relieve Mantua and was cut off by A. V. Suvorov's larger Russian army. In the battle on the Trebbia (June 17–19, 1799) he was wounded, and the army escaped with heavy loss.

Treated as a corps commander by Napoleon Bonaparte in 1800, Macdonald won fame by his winter crossing of the Splügen pass from Switzerland into Lombardy; but after Moreau's disgrace in 1804 Macdonald's enthusiasm for Napoleon was questioned, and he was not given a command again until 1809. Then the "talents and verve" which Napoleon recognized in him brought vigour to the army of Italy in its march to the Danube (*see* Napoleonic Wars) He led this army in a crushing and costly attack on the Austrians at the battle of Wagram in July and was made a marshal of France and duc de Tarente. His command in Catalonia (1810–11) only injured his health. He did nothing in Lithuania during the campaign of 1812 against Russia; but in 1813 Napoleon left him in command of three corps in Silesia, where a rash offensive by him was routed by Blücher in the battle of the Katzbach (Aug. 26). Having barely escaped alive at the battle of Leipzig (Oct. 1813) he was sent to hold Holland and brought a few troops to northern France. One of the last of the marshals to accept Napoleon's abdication in 1814, he was thereafter loyal to Louis XVIII. In 1815 he demobilized the remains of the Waterloo army. He died at Courcelles-le-Roi, Seine-et-Oise, on Sept. 25, 1840. (I. D. E.)

MacDONALD, JAMES RAMSAY (1866–1937), British statesman, first Labour prime minister and one of the founders of the British Labour party. He was born on Oct. 12, 1866, at Lossiemouth, on the east coast of Scotland, the illegitimate son of a maidservant. His father was reputed to be a farm labourer but MacDonald himself was never a manual worker. His formal education ended at the age of 12, but he remained at the board school for another six years working as a pupil teacher. He then went to Bristol and later to London. In Bristol he first established contact with socialist organizations. In London he was employed by the Cyclists' Touring club and then at 12*s.* 6*d.* a week as an invoice clerk in a City warehouse. For three years he worked hard in his spare time for a science degree, but he was forced to abandon this project when his health broke down. Upon his recovery, in 1888, he took a job as secretary to Thomas Lough, a radical politician, and also began part-time journalism. He supported James Keir Hardie's candidature at mid-Lanark in 1888, but did so as a Liberal with socialistic leanings, rather than as a believer in independent Labour politics. But by 1894 he was a member both of the Fabian society and the newly formed Independent Labour party (I.L.P.), and by the following year he had achieved a sufficient reputation as a lecturer and speaker to be asked to stand as I.L.P. candidate for Southampton, where he polled 886 votes.

In 1896 he married Margaret Gladstone, the daughter of John Hall Gladstone, fellow of the Royal society, and the great-niece of Lord Kelvin, another distinguished scientist. His marriage brought him no great affluence, but it enabled him to travel widely during the next few years. At home he served on the London county council and devoted most of his energies to persuading the large trades unions to sponsor a Labour party totally independent of the two other parliamentary parties. The establishment of the Labour Representation committee (L.R.C.) in 1900, following on a resolution of the Trades Union congress in 1899, was a great triumph for MacDonald's ideas and he became the first secretary of the new committee. At the general election of 1900 it won only two victories and MacDonald himself was heavily defeated at Leicester. In the following years his delicate task was the two-fold one of getting enough of the larger unions to support the new party actively, and also to prevent their making it too narrow to gain full national status. In the main he was successful and the reward came at the general election of 1906 when the L.R.C. won 29 seats and MacDonald was elected at Leicester, his vote having grown over three-fold since 1900. The new group was big enough to merit an independent parliamentary existence. MacDonald was from the beginning incomparably the most distinguished parliamentary performer and in 1911 he succeeded James Keir Hardie in the chairmanship of the party, by which time he led a group of 40 members.

When World War I began on Aug. 4, 1914, MacDonald broke the unity of the house of commons with a moderate antiwar speech. The speech had been approved by his colleagues beforehand, but a majority of them quickly swung into support for the war and MacDonald resigned the leadership. For the next four years he was an object of considerable obloquy, but he behaved with courage and dignity, neither retreating from his views nor accentuating differences so as to make a permanent split likely. He paid the penalty by being heavily defeated at Leicester in 1918 and he failed to return to the house of commons for four years, despite a by-election attempt at East Woolwich in 1921.

In 1922, when he was elected for the south Wales mining seat of Aberavon, he found that a great change had come over the house of commons. There was a strong Conservative majority, but the Labour party, with 142 seats, was larger than the combined Liberal factions and it therefore became, for the first time, the main alternative to the government. MacDonald was elected by a narrow margin over J. R. Clynes to lead the opposition. Even at that stage MacDonald was in no ways an extreme socialist, although some of his supporters were misled by his opposition to the war into believing that he was. But MacDonald had long made clear his opposition both to syndicalism and to any form of extraparliamentary action. His socialism was of a highly evolutionary nature, ethical, a little vague and frequently expressed in biological metaphor. In addition he had a high respect for traditional British institutions and a strong desire that the Labour party, under his leadership, should play a full part in their working. As a result he was the best possible leader at the time for a party that was eager to become an instrument of government. He

welcomed men of upper and middle class backgrounds into the party; he urged moderate policies; and he impressed the country as a leader of distinguished appearance, captivating voice and lofty purpose.

The rewards came sooner than had seemed possible. Stanley Baldwin, the prime minister, decided to appeal to the country on a program of tariff reform in 1923. The result was the destruction of the huge Conservative majority. The new parliament of 1923 was made up of 258 Conservatives, 191 Labour members and 158 Liberals. The Tories were still the biggest party but there was a clear majority against the policy on which they had fought the election. H. H. Asquith (afterward earl of Oxford and Asquith), the Liberal leader, decided to offer MacDonald the prospect of the premiership. MacDonald leaped at the opportunity. He secured the approval of the Labour party and of the Trades Union congress, and on Jan. 22, 1924, the man who had never previously held office and was not even a privy councilor, became the first Labour prime minister of Great Britain. Lord Haldane became lord chancellor; Arthur Henderson somewhat reluctantly accepted appointment to the home office; Philip Snowden became chancellor of the exchequer and Lord Chelmsford, a former Indian viceroy who was not a member of the Labour party, became first lord of the admiralty. MacDonald himself took on the foreign office as well as the premiership, and it was in this field that the most notable achievements of the government lay. The Soviet regime was afforded *de jure* recognition; the first negotiated agreement with Germany since the war was reached in the London settlement of the reparations problems; and MacDonald joined with Édouard Herriot, the French prime minister, to initiate the Geneva protocol for security and disarmament. At home the budget met with general approval and an important housing act was passed. After nine months the clumsy withdrawal of a crown prosecution against J. R. Campbell, the Communist editor of the *Workers' Weekly*, led to an adverse vote in the house of commons and MacDonald secured a dissolution of parliament. The ensuing campaign was dominated by the Zinoviev letter scare (*see* ENGLISH HISTORY), and MacDonald's handling of the incident was open to much criticism. The Labour party increased its popular vote but lost more than 40 seats and the Conservatives regained a clear parliamentary majority. MacDonald resigned on Nov. 4, 1924. There was some murmuring against his party leadership at this stage, but it was not serious and he led the opposition throughout the following parliament.

At the general election of 1929 MacDonald was again successful in dislodging the Conservatives from their position. With Labour the largest single party (287 seats), his claim to office was much stronger than in 1924. Baldwin resigned without waiting to meet parliament and MacDonald became prime minister for the second time on June 5, 1929. Snowden returned to the exchequer; Henderson became foreign secretary; Clynes was home secretary; John (afterward Lord) Sankey became lord chancellor; and J. H. Thomas was lord privy seal and deputy leader of the house of commons. Foreign affairs were again the government's strong field. A naval treaty for which MacDonald had prepared the ground by a visit to the United States was concluded in 1930, and Henderson was preparing the ground at Geneva for the World Disarmament conference. Home affairs were dominated by mounting unemployment and the growing effects of the world-wide economic slump. MacDonald, in common with most of his cabinet, showed no understanding of the forces at work or of the way in which they might be controlled. At first he appointed J. H. Thomas to co-ordinate antiunemployment measures, but later attempted, equally ineffectively, to do this himself. Budgetary difficulties arose and the May committee, an extraparliamentary body, was appointed to recommend economy measures. By the time of its report, in Aug. 1931, a foreign exchange crisis had added itself to the other problems. Snowden supported the prime minister in demanding full economy cuts, but the majority of the cabinet, led by Henderson, refused to accept the full cuts in unemployment benefit and MacDonald thereupon went to Buckingham palace to resign (Aug. 24). The following day his colleagues were amazed to discover that it was the government and not the prime minister which was out. MacDonald was retained as head of a coalition cabinet with Tory and Liberal support. Only three members of the former cabinet—Snowden, Thomas and Sankey—followed him. The remainder went into opposition and faced a political massacre at the general election of Oct. 1931.

MacDonald remained as prime minister for over three years but his powers of speech, thought and action soon began to decline and the real power in the government was exercised by Baldwin. MacDonald was not greatly respected by the Conservatives and he was reviled by his former colleagues who regarded his action in 1931 as a betrayal of everything for which he had previously stood. In June 1935, MacDonald exchanged offices with Baldwin and became lord president of the council. At the general election later that year he was heavily defeated in his constituency at Seaham Harbour (to which he had moved in 1929) and had to seek refuge as member for the Scottish universities. He died at sea, on a health visit to South America, on Nov. 9, 1937.

MacDonald's contribution to the rapid rise of the Labour party and its evolution into a party capable of forming a government was unique. He first built up its self-confidence and then, in 1931, gravely damaged it, leaving behind a legacy of suspicion for the party leadership that lasted for some years. As prime minister his greatest achievements lay in the field of international politics.

The most important of MacDonald's political books are: *Socialism and Society* (1905), *Socialism and Government* (1909), *The Awakening of India* (1910), *The Socialist Movement* (1911), *Syndicalism* (1912), *The Social Unrest* (1913), *National Defence* (1917), *Parliament and Revolution* (1919), *Parliament and Democracy* (1920), *The Government of India* (1919), *A Policy for the Labour Party* (1920) and *Socialism, Critical and Constructive* (1921). In addition there is his biography of his wife, *Margaret Ethel MacDonald* (1921), and a volume of essays and travel pictures, *Wanderings and Excursions* (1925).

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MACDONALD, SIR JOHN ALEXANDER (1815–1891), first premier (1867–73) of Canada, was born in Glasgow, Scot., on Jan. 11, 1815. His parents emigrated to Canada in 1820, settling at Kingston, Upper Canada (now Ontario), and there Macdonald received his education, studied law and was called to the bar in 1836. He was elected to the assembly of the province of Canada as Conservative member for Kingston in 1844, entered the government as receiver-general in 1847 and went into opposition when the Reformers triumphed in 1848. These were difficult years for his party. To counter Tory extremists in Montreal who signed a manifesto urging that Canada secede from the British empire, Macdonald helped organize the British-American league to promote closer ties with the mother country, the adoption of a national commercial policy and the confederation of the British North American provinces.

In 1854 Macdonald took the lead in shaping a coalition of Conservatives, Reformers interested in state-aided railway construction and French-Canadian members. From this union emerged the Liberal-Conservative party with which Macdonald was henceforth identified. In 1856 he became head of the administration for Upper Canada, and prime minister in 1857 with Georges Étienne Cartier as his colleague and leader for Lower Canada.

During the troubled years of shifting party alignments and domestic and international tensions Macdonald revealed an easy-going, tolerant, resourceful, somewhat unscrupulous personality; also remarkable talents for winning support from influential men and for balancing rival sections and cultural interests. Confronted with parliamentary stalemate, in June 1864 Macdonald and Cartier joined their chief opponent, George Brown, in a new coalition to work for the confederation of the British North American colonies.

Macdonald headed the delegations from Canada which discussed the outlines of the proposed union with public-spirited men from the maritime colonies at conferences at Charlottetown and Quebec, and which later assembled in London to help draft the British North America act. Macdonald had played the leading part in the negotiations and was accordingly appointed first premier of the new dominion; he was created a knight commander of the order of the Bath for his services to the empire.

In his cabinet Macdonald assembled political chieftains who represented Canada's various interests and regions and could act as his agents in maintaining the government's popularity within their sections. His tact and sense of the practical were vital in allaying anticonfederationist sentiment in Nova Scotia and in the speedy, relatively untroubled expansion of the dominion to continental dimensions by incorporating Rupert's Land and the Northwest Territory and establishing Manitoba as a province in 1870, British Columbia in 1871 and Prince Edward Island in 1873. Appointed one of five British plenipotentiaries negotiating the treaty of Washington (1871), his was the difficult, thankless role of upholding Canadian interests against both U.S. and British representatives and afterward of defending the treaty in Canada. Construction of the intercolonial railway link promised the maritime provinces in 1864 was begun. To persuade private capital to undertake the task of building the Pacific railway, an ambitious undertaking the government was pledged to complete by 1881, Macdonald offered lavish assistance in cash and land. The disclosure that Sir Hugh Allan, the recipient of the contract, had given large sums of money to assist the elections of Cartier and Macdonald in 1872 forced Macdonald and his cabinet to resign office on Nov. 5, 1873. His offers to quit the party leadership, however, were rejected by his followers and colleagues.

Macdonald soon found ample occasions for attacking the lacklustre performance of the Liberal government of Alexander Mackenzie in combating the severe depression which had fallen upon the country. During the summer of 1876 Macdonald began agitating for a thoroughgoing protective tariff system to relieve manufacturing and maintain employment. Since the Liberal government continued to proclaim its faith in the principle of free trade and tariff for revenue only, commercial policy constituted the principal issue of the general election of 1878.

Much to the Liberals' surprise, the voters preferred the "old corruptionist" with the dynamic "National Policy" program of nation building, and returned Macdonald to office. Tariffs were raised to protective levels to stimulate textile, iron and steel, and other manufacturing industries. In 1880 a new group of capitalists became interested in building the Pacific railway, postponed by the former government, and, assisted by considerable initial grants as well as by timely loans during construction, they succeeded in driving the steel rails across the continent by November 1885. Times improved slightly and a measure of settlement began to flow into western Canada.

The final years saw Macdonald's skill marshaled against growing political opposition and severe challenges to Canadian unity. In 1885 the prairies blazed with the second Riel, or Northwest, rebellion, caused partly by Macdonald's own negligence. The rebellion, in turn, provoked a series of French-English controversies that convulsed the dominion for years. In 1887 an interprovincial conference linked premiers of Canada's five largest provinces in protest against the supposed favouritism of Macdonald's policies and his alleged encroachment upon provincial constitutional prerogatives. Continued hard times awakened outcries against the protective tariff and renewed appeals for unrestricted reciprocity (free trade) with the United States.

Facing these challenges, Macdonald eased the weight of his protectionist and constitutional programs. But against unrestricted reciprocity, which he felt meant annexation to the United States and national suicide, he rallied his failing strength. "A British subject I was born; a British subject I will die. With my utmost effort, with my latest breath, will I oppose the 'veiled treason' which attempts by sordid means and mercenary proffers to lure our people from their allegiance"—so ran his political manifesto for the general election of March 1891. The people did not fail the leader who symbolized their national purpose in the face of all obstacles. But the campaign proved too much for the 76-year-old veteran. On May 29 he suffered a stroke of paralysis and, still prime minister of Canada, he died at Ottawa on June 6, 1891.

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MACDONALD, JOHN SANDFIELD (1812–1872), Canadian Liberal politician and statesman, first premier of Ontario, was born on Dec. 12, 1812, at St. Raphael, Glengarry county, Upper Canada (later Ontario). Educated at Cornwall, he was called to the bar in 1840. He represented Glengarry in the legislative assembly, 1841–57, and Cornwall, 1857–72. In 1867 he was elected to both dominion and provincial parliaments. He worked closely with Robert Baldwin, but fell out with Francis Hincks. Politically, he was a moderate, independent, "Eastern Ontario" reformer, and represented a position quite distinct from the Radical, or "Clear Grit," reformers. Yet George Brown included him as attorney general in the "Short" Reform administration of 1858; and from 1862 to 1864 Sandfield Macdonald led the government. He opposed the confederation movement in the period 1864–67, but in 1867 he was appointed premier of Ontario, and in close cooperation with the federal government initiated provincial government. His government was defeated in the Ontario election of 1871. He died at Cornwall June 1, 1872. He was a hardworking man of integrity and independent views but lacked the touch of his great contemporary Sir John A. Macdonald. (P. G. Co.)

MACDONNELL (MACDONELL), **ALESTAIR** (ALEXANDER) **RUADH** (*c.* 1725–1761), chief of Glengarry, a Scottish Jacobite who was later known as Pickle the spy, was born in Scotland probably in 1725, his family being a branch of the clan Macdonald. Alestair ran away when a boy and entered the Royal Scots, a regiment then in French service, and was sent to Scotland as a Jacobite agent in 1744. He was in France in 1745 when Prince Charles the Young Pretender landed in Scotland but was later captured at sea while bringing help to Charles and was imprisoned in the Tower of London for 22 months. He then went abroad, but in 1749 he was again in London and is believed to have acted as spy for the British government, under the name of Pickle, keeping a close watch on Jacobite activities. He died on Dec. 23, 1761.

See Andrew Lang, *Pickle the Spy* (1897) and *The Companions of Pickle* (1898). (W. Fe.)

MacDONNELL, SORLEY BOY (*c.* 1510–1590), Irish chieftain of Scottish descent who firmly established his power under Elizabeth I and reversed the Tudor policy of diminishing aristocratic privileges, was the son of Alaster (Alexander) MacDonnell, lord of Islay and Kintyre (Cantire). He was born at Ballycastle, County Antrim, and from a marriage in the 15th century between Ian Mor MacDonald and Marjorie Bisset had a claim to the Glens (Glynns), the territory east of the river Bush. Despite the English efforts to master the Scottish settlers in Ulster, Alaster MacDonnell managed to increase the family fortunes by marriage alliances to the O'Neill (*q.v.*) family and by his position as captain of the O'Neill mercenary forces. Sorley Boy (Somhairle Buidhe) became prominent when he was backed by the government in 1558 to oppose Shane O'Neill's claims to his father's inheritance. Sorley Boy was defeated near Coleraine in 1564 and at Ballycastle in 1565, and both he and his brother, James of Dunyveg, were taken prisoner. James died in captivity and Sorley Boy was kept in subjection for two years. O'Neill was defeated by the O'Donnells of Donegal in 1567 and later died in a quarrel with the MacDonnells, which was instigated by the Dublin government.

Sorley Boy, freed, and unopposed by powerful rivals, built up his family's power from 1568 to 1586 by alliances with the O'Neills and by recruiting family reinforcements from Scotland. Despite the government's efforts to dislodge him he held his own, and

when Francis Drake and Sir John Norris, under the earl of Essex' command (*see* ESSEX, WALTER DEVEREUX), massacred the refugees on Rathlin Island, MacDonnell retaliated by taking Carrickfergus. He later held Dunluce castle for James VI (later James I of Great Britain) of Scotland. Ultimately Elizabeth admitted the MacDonnells as subjects in 1585–86, accepted their allegiance and confirmed Sorley Boy's possession of most of the Route (the land between the rivers Bann and Bush) and his nephew Angus' possession of the Glens. Peace was fully restored by the time MacDonnell died in 1590. (R. D. Es.)

MACDONOUGH, THOMAS (1783–1825), U.S. naval officer, who commanded the U.S. squadron at the battle of Lake Champlain during the War of 1812, was born in Delaware on Dec. 31, 1783. He entered the U.S. navy in 1800. During long service as a lieutenant, he took part in the bombardment of Tripoli and on a subsequent occasion showed great firmness in resisting the seizure of a seaman as an alleged deserter from the British navy, his ship at the time lying under the guns of Gibraltar. When war with England broke out in 1812, he was ordered to cruise in the lakes between Canada and the United States, with his headquarters on Lake Champlain. He was instrumental in saving New York and Vermont from invasion by his brilliant victory of Lake Champlain, gained on Sept. 11, 1814, with a flotilla of 14 vessels carrying 86 guns, over Capt. George Downie's 16 vessels and 92 guns. *See* WAR OF 1812.

McDOUGALL, FRANCIS THOMAS (1817–1886), first Anglican bishop of Labuan and Sarawak, was born at Sydenham, south London, on June 30, 1817; he first qualified in medicine, but took holy orders in 1845, and in 1847 was accepted for service in Sarawak, which had recently become an independent principality under Sir James Brooke. McDougall used both his medical skill and his powers as a preacher to commend the gospel to the three peoples—Malay, Dayak and Chinese—who made up the population of his area. His health and that of his family suffered grievously in the early years of his mission. Numbers of both missionaries and converts gradually increased. Brooke desired that the church in his dominions should be regularly organized under a bishop, and in 1854 McDougall was designated for this office. Grave difficulties were felt as to the constitution of a diocese of the Church of England in what was not strictly British territory; these were at last overcome by giving the new bishop the title of Labuan, the small island which was a British colony. McDougall was consecrated in Calcutta, India, in 1855. During his 13 years' episcopate he laid solid foundations for what later became the flourishing dioceses of Singapore and Malaya, and Borneo. In 1867 he was obliged by ill-health to return to England and in 1868 resigned. Thereafter he held various positions of dignity in the Church of England, and at the time of his death (on Nov. 16, 1886, at Milford, Isle of Wight) he was canon of Winchester and archdeacon of the Isle of Wight.

See C. J. Bunyon, *Memoirs of F. T. McDougall and of His Wife* (1889); H. McDougall, *Sketches of Our Life in Sarawak* (1882). (S. C. N.)

McDOUGALL, WILLIAM (1871–1938), British psychologist, who did more than any other writer at the beginning of the 20th century to establish British psychology on an experimental and physiological basis. He was born in Lancashire on June 22, 1871, and was educated at school at Weimar, Ger., and at the universities of Manchester and Cambridge, at the latter of which he studied medicine. In 1899 he joined the Cambridge anthropological expedition to the Torres straits, where he applied psychological tests to the native peoples. He then went to Göttingen to acquire a fuller knowledge of experimental techniques from G. E. Müller. McDougall's first important publication described a series of ingenious experiments seeking to reinstate Thomas Young's three-colour theory of vision. He turned next to the study of attention (which he identified with apperception) and its neurological correlates and formulated the hypothesis that the basis of intellectual activities is a hierarchy of neural circuits arranged in four main levels. In his *Physiological Psychology* (1905) and his *Psychology, the Study of Behaviour* (1912) he demonstrated the value of a thoroughgoing biological standpoint in place of the traditional philosophical approach. In 1901 McDougall joined James Sully as assistant in the new experimental laboratory at University college, London; and in 1904 he accepted a readership at Oxford. There he encouraged research students to apply Sir Francis Galton's method of mental testing to determine the innate factors of individual differences.

In his best-known work (*An Introduction to Social Psychology*, 1908), McDougall developed a theory of human behaviour based on the assumption of inherited instincts with their accompanying emotions and an acquired superstructure of sentiments. In 1920 he accepted the chair of psychology at Harvard university, and in 1927 moved to Duke university, Durham, N.C., where, with J. B. Rhine, he continued his earlier studies on extrasensory perception and paranormal psychology. In *Modern Materialism and Emergent Evolution* (1929) and *The Riddle of Life* (1938) he elaborated his hypothesis of interaction between body and soul and drastically criticized the materialistic revival inaugurated by the American behaviourist school and the consequent neglect of purposive factors in human life. He died at Durham, N.C., on Nov. 28, 1938. (Cy. B.)

MacDOWELL, EDWARD ALEXANDER (1861–1908), U.S. composer known for his piano pieces, who helped establish an independent American school. Born on Dec. 18, 1861, in New York city, he first studied there with Teresa Carreño and then went to Paris, where he was a pupil of Antoine Marmontel (1876–78) at the conservatoire. In 1878 he went to Germany to study composition with Joachim Raff at the Frankfurt conservatory and later taught the piano at Darmstadt. In 1882 Raff introduced MacDowell to Liszt, who arranged for him to play his first *Modern Suite* at the Allgemeiner Musikverein at Zürich on July 11, 1882. In 1884 he went to the U.S., where he married his former pupil Marian Nevins (1857–1956). He returned with her to Wiesbaden and remained there until 1887. The following year he settled in the U.S. On March 5, 1889, he played in New York city the first performance of his second Piano Concerto in D minor, his most successful larger work.

In 1896 he was invited to establish a department of music at Columbia university, New York. He undertook the task with enthusiasm but was frustrated in carrying out his plans. As a result of disagreement with the university authorities he resigned in 1904, unfortunately becoming the subject of much unpleasant publicity. His mental balance was gravely undermined; this led to a collapse and eventually to a recession to infantilism from which he never recovered. A public appeal for funds was made on his behalf in 1906, but he died in tragic conditions in New York city on Jan. 23, 1908. After his death his widow organized the MacDowell colony at their residence in Peterborough, N.H., as a permanent institution in the form of a summer residence for American composers and writers.

MacDowell's music derives from the contemporary romantic movements in Europe. His lyrical style suggests Grieg, and his harmony, Schumann and sometimes Liszt. Almost all his works have literary or pictorial associations. His early symphonic poems include *Hamlet and Ophelia* (1885), *Lancelot and Elaine* (1888), *Lamia* (1889) and *The Saracens* (1891). More distinctive is his orchestral *Indian Suite* (1892), depicting American Indian life and rituals and based on authentic Indian tunes. His songs, though derivative, are genuinely lyrical, but he is at his best in his piano music, particularly in small pieces when he shows the gift of a sensitive miniaturist. The best of his piano works are the suites *Sea Pieces* (1898) and *Fireside Tales* (1902) and the imaginative evocations of the American scene in the albums *Woodland Sketches* (1896) and *New England Idylls* (1902). His four piano sonatas, *Tragica* (1893), *Eroica* (1895), *Norse* (1900) and *Keltic* (1901), are ambitious attempts at programmatic music in classical forms.

See L. Gilman, *Edward MacDowell* (1909); Marian MacDowell, *Random Notes on Edward MacDowell and His Music* (1950). (N. Sy.)

McDOWELL, EPHRAIM (1771–1830), U.S. surgeon who performed the first successful ovariotomy (removal of an ovarian tumour) and thus demonstrated the feasibility of elective a

lominal operations. He was born in Rockbridge County, Va., on Nov. 11, 1771, but spent most of his youth in Danville, Ky., where is family settled in 1784. He received his preliminary schooling at eminaries in Georgetown and Bardstown and then studied under physician as a preceptor in Staunton, Va. After studying in Edinburgh in 1793–94, he returned to the U.S. and in 1795 began to practise in Danville, which then had fewer than 1,000 inhabitants. There in Dec. 1809 he undertook the operation that previously ad been generally considered impossible. Without anesthesia or ntisepsis, he removed a 20-lb. ovarian tumour from Mrs. Jane Todd Crawford, who survived the operation for more than 30 ears. McDowell operated upon two additional patients before e made his first report in the *Eclectic Repertory and Analytical Review* in April 1817. His article was met with skepticism and lisbelief. He continued, however, to perform the operation and ompleted 13 prior to his death in Danville on June 25, 1830.

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MACDUFF, a small burgh and seaport of Banffshire, Scot., n the Deveron, 1 mi. E. of Banff and 46 mi. N.W. of Aberdeen by oad. Pop. (1961) 3,478. The site, occupied by the fishing illage of Doune (or Down), was purchased by the 1st earl of Fife, bout 1732, and the name was later altered to Macduff by the 2nd arl. In honour of its constitution as a burgh in 1783 he rebuilt he market cross in front of the parish church. Behind it is a World War I memorial in the shape of a tower 70 ft. high. The iarbour is safer and more accessible than that of Banff. The inabitants are chiefly employed in the whitefish industry and in oatbuilding. New Fishmarket buildings were opened in 1955. Grain and fish are exported and coal imported. A stone bridge cross the Deveron connects with Banff.

McDUFFIE, GEORGE (1790–1851), U.S. congressman, tate governor and strong advocate of states rights, was born on ug. 10, 1790, near Augusta, Ga. He graduated from South arolina college, Columbia, in 1813 and began to practise law the ext year. In 1818 he was elected to the state legislature and in 821 to the U.S. house of representatives. At first a nationalist avouring internal improvements, he soon became a strict conructionist and vigorous opponent of the protective tariff. He layed a leading role in drafting the "tariff of abominations" in 328, and then advocated nullification, the doctrine that a state ould nullify within its borders any federal law that it regarded as nconstitutional. Not content with Calhoun's "short of war" exosition of 1828, he spoke at Charleston on May 19, 1831, with ich force and logic as to drive Calhoun (then vice-president of ie United States) into open advocacy of nullification. A national isis ensued and the protective tariff of 1832 was replaced by the ompromise tariff of 1833.

McDuffie served as governor of South Carolina from 1834 to 36; he urged the South to carry on direct trade with Europe d visited England in 1839. In Dec. 1842, he returned to the nate to battle the protectionist Whigs, who were in power. In 46 McDuffie returned in ill health to Cherry Hill, Sumter disct, S.C., where he died, March 11, 1851. (T. P. Ma.)

MACE, originally a weapon of offense, made of iron or steel, apable of breaking through armour. The mace was carried in ittle by medieval bishops (Odo of Bayeux is represented on he Bayeux tapestry wielding one) instead of the sword, so as t conform to the canonical rule which forbade priests to shed lood. It continued in use as a weapon until the late 16th cenry, though many of the later examples with elaborately pierced inges and damascened shafts seem to have been carried as a sign f rank. The Turkish mace (*pushkan*), with an almost spherical ead of iron sheathed in silver gilt, was also used in the 17th cenry in eastern and northern Europe, mainly in those countries unr Turkish domination, as a symbol of authority. The earliest eremonial maces, as they afterward became, though at first inended to protect the king's person, were those borne by the sergeants at arms, a royal bodyguard established in France by Philip II and in England probably by Richard I. The history

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MACE (SCEPTRE) OF LORD MAYOR OF LONDON: HEAD DATES FROM 15TH CENTURY

of the civic mace in England (carried by the sergeants at mace) begins about the middle of the 13th century, though no examples of that period exist today. Ornamented civic maces were considered an infringement of one of the privileges of the king's sergeants, who, according to the commons' petition in 1344, were alone deemed worthy of having maces enriched with costly metals. This privilege was granted, however, to the sergeants of London and later to those of York (in 1396), Norwich (in 1403–04) and Chester (in 1506). Maces covered with silver are known to have been used at Exeter in 1387–88; two were bought at Sandwich in 1435 and others for Launceston in 1467–68. In the next century several other cities and towns had silver maces, and in the 16th century they were almost universally used.

The mace was carried as a symbol of royal authority, and for this reason the royal arms were set on the button at the end of the handle. During the 15th century this button was greatly expanded in size, in order to give due prominence to the royal arms. Thereafter it was surrounded by a coronet, which by the 17th century developed into an arched crown. At the same time the flanges of what had been the head dwindled into decorative brackets, and the mace was carried upside down with the crown uppermost, what had started as the head being held in the hand. As the custom of having sergeants' maces ceased, the large maces borne before the mayor or bailiffs came into general use.

In 1649 it was decided that the house of commons should have a mace of approved design. This was furnished by Thomas Maundy, who supplied many others of the same pattern for provincial towns. This pattern remained standard in England thereafter, with the exception that at the Restoration the royal devices were replaced on the head. There are two maces in the house of lords, the earlier dating from the reign of Charles II. Historic silver maces of the 18th century include the one of 1753 at Norfolk, Va., and that of 1756 of the state of South Carolina.

Among other maces, more correctly described as staves, in use at the present time, are those carried before ecclesiastical dignitaries and clergy in cathedrals and parish churches, and the maces of the universities. The silver mace with crystal globe of the lord high treasurer of Scotland, at Holyrood palace, Edinburgh, was made about 1690. The remarkable mace or sceptre of the lord mayor of London is of crystal and gold and set with pearls. The head dates from the 15th century, while the mounts of the shaft are early medieval.

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MACEDO, JOSÉ AGOSTINHO DE (1761–1831), Portuguese didactic poet and a critic and pamphleteer notable for his acerbity. Born at Beja, Sept. 11, 1761, he became professed as an Augustinian in 1778. Because of his turbulent character he spent much time in prison and was constantly transferred from one community to another. In 1792 he was unfrocked but obtained a papal brief which gave him the status of a secular priest. He was soon recognized as the leading pulpit orator of the day and in 1802 was appointed one of the royal preachers.

The best examples of his didactic poetry are *A Meditação* and *Newton* (1813). In 1814 he produced *O Oriente*, an insipid epic dealing with Vasco da Gama's discovery of the sea route to India. He also founded and wrote for a large number of journals, and the tone and temper of these and of his political pamphlets caused one of his biographers to call him the "chief libeler" of Portugal.

His malignity reached its height in a satirical poem in six cantos, *Os Burros* (1812–14), in which he pilloried, by name, men and women of all grades of society, living and dead, with the utmost licence of expression. From *c.* 1823 onward he was the virulent champion of the absolutist reaction. He died at Pedrouços, Oct. 2, 1831.

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(N. J. L.)

MACEDONIA, the central part of the Balkan peninsula, lying athwart the political frontiers of Yugoslavia, Greece and Bulgaria. In historical times, from the Roman conquest of the ancient kingdom of Macedonia (*q.v.*) to the 20th century, the area has been strategically important as a crossroads. The Via Egnatia, the shortest Roman route between the Adriatic coast and the Bosporus, passed through places now known as Bitola (Yugoslavia) and Salonika (Greece). The valley of the Vardar (Axios) river was and continues to be the easiest highway from Salonika to the north. Both the Roman (Byzantine) and the Ottoman empires based on Constantinople considered it essential to hold Macedonia, through which Serbia, Bosnia, Albania and continental Greece could be reached. This stretch of land had, therefore, a complex history and, as a result, a mixed population. When in the 19th century the national consciousness of the Balkan peoples began to waken, Macedonia became a problem of international magnitude. (*See* Macedonian Question.)

Physical Geography.—Macedonia is bounded on the east by the lower Mesta (Nestos) river and by the western slopes of the Rhodope (Rodopi) upland. North of the Pirin massif the boundary turns west, passing south of Kyustendil (Bulgaria), by the Siroka Planina, Crna Gora and Sar Planina. Thence it turns southward by the Korab and Jablanica range and lakes Ohrid (2,280 ft.) and Prespa (2,799 ft.) to the massif of Grammos (8,033 ft.); then eastward, embracing the whole basin of the Aliakmon (Bistritsa) river and reaching the Gulf of Salonika near Mt. Olympus. Including the Khalkidhiki (Chalcidice) peninsula, Macedonia covers an area of about 25,700 sq.mi. It is not, however, a geographic entity.

Yugoslav or Vardar Macedonia.—This is the People's Republic of Macedonia (9,928 sq.mi.), one of the six component parts of the Federal People's Republic of Yugoslavia (*q.v.*). It is divided from Greek Macedonia by the Kozuf and Nidze ranges with Mt. Kajmakcalan as the highest peak (8,271 ft.). With the exception of the Vardar valley, lower Bregalnica valley and lower Crna valley, this part of Macedonia is a plateau lying from 2,000 ft. to 3,000 ft. above sea level, with mountain massifs reaching 8,331 ft. (Jakupica). The climate approaches the continental type, with summer rains and often copious winter snowfalls. Chief crops are wheat, barley, maize, rice and tobacco, while extensive pastures support large flocks of sheep and cattle. There is also a considerable mineral wealth.

Greek or Aegean Macedonia.—The coastal belt along the Aegean sea, with the wide flat and almost treeless *kámpania* of Salonika and the plains of lower Strymon (Struma) river and of Kavalla, has a Mediterranean climate, and its agricultural products are varied. They include wheat, barley, rice and fruit, especially figs and grapes, as well as such industrial crops as tobacco and cotton; there are also mulberry trees for silk production.

Bulgarian or Pirin Macedonia.—This is the *okrug* or district of Blagoevgrad (formerly Gorna Djumaya), the smallest of the three parts of Macedonia (2,509 sq.mi.). It lies north of a belt of mountains through which the gorges of the Struma and Mesta rivers are the only highways to the south. While in the valleys climatic conditions are somewhat Mediterranean, the wild Pirin massif lying between them is snowbound in winter. The Belasitsa (Gr. Oros Kerkini) range, with a peak reaching 6,655 ft. (Radomir), is a natural frontier boundary between Aegean and Pirin Macedonia, and the Maleshevska and Osogovska ranges, with peaks reaching 6,310 ft. (Kadiytsa) and 7,386 ft. (Ruen), are the boundary between Pirin and Vardar Macedonia. The only highway leading westward from the former to the latter is the Strumeshnitsa (Yugos. Strumica) valley, parallel to the Belasitsa range.

Population.—Yugoslav Macedonia comprises the great majority of the Macedonian people, whose Slavonic language is more akin to Bulgarian than to Serbo-Croatian. The 1961 census revealed a population of 1,404,883, including 893,247 Macedonians (64.1%); of the rest, the major groups were Albanians (17%) and Turks (8%).

According to the census of 1961, there was a population of 1,890,654 in the Greek province of Macedonia, overwhelmingly Greek by nationality and language, with only about 80,000 "Slavophones" (65,000 Macedonians and 15,000 Pomaks or Bulgarian-speaking Muslims).

The population of Bulgarian Macedonia amounted in 1956 to 281,015; of this total 83% were described as Bulgars, no Macedonian nationality being recognized in Bulgaria.

See also references under "Macedonia" in the Index.

(K. Sm.)

MACEDONIA, KINGDOM OF. The boundaries of the ancient Macedonian kingdom varied; but it was always centred on the plain in the northeastern corner of the Greek peninsula, at the head of the Thermaic gulf.

Prehistory.—The cultural links of prehistoric Macedonia were mainly with Greece and Anatolia. The people who arrived in the Late Neolithic period (*c.* 2650–2500 B.C.) were perhaps of Danubian, but more probably of Anatolian, origin; and the newcomers who from 2500 onward gradually imposed the uniform culture of the Early Bronze Age from the peninsula of Chalcidice to Epirus and Thessaly were certainly from northwest Anatolia. Transition from Early to Middle Bronze Age in Macedonia was peaceful (1900). Similarly the matte-painted pottery found throughout Macedonia and Chalcidice in the Late Bronze Age (1500) developed without a break from what went before, though both areas show Mycenaean influence. An irruption of a northern people of the Lausitz (Bohemia) culture into the Axios (Vardar) valley about 1150 was short-lived. From about 1050 in the Early Iron Age Protogeometric ware points to Greece, but its persistence long after similar styles have been superseded there indicates the fall of a curtain which was only lifted with the founding of the first Greek colony in Chalcidice in the 8th century. Of these early peoples, the Neolithic reveal a highly developed aesthetic sense, but their successors are unenterprising in both artistic and material achievement; their remains permit almost no conclusions about their beliefs.

The continuity in the archaeological record suggests that the Early Bronze Age people were the ancestors of the historical Macedonians. The nationality and language of these are both disputed, but the weight of evidence points to their belonging to the family of Greek-speaking peoples, though they may have absorbed various subject tribes with Thracian or Illyrian affinities.

The Argeads to 336 B.C.—From about 700 onward the people who called themselves Macedonians pushed eastward from their home on the Haliacmon (Aliakmon) river under King Perdiccas I and his successors, seized Eordaea and dispossessed the Pierians, Bottiaeans and other tribes of the plain. Aegae (Edessa, *q.v.*) became the capital, and by the reign of Amyntas I (6th century) Macedonian power extended beyond the Axios to dominate the Thracian tribes in Mygdonia and Anthemous behind Chalcidice. Amyntas enjoyed relations with the Pisistratids at Athens; after Darius' expedition across the Danube (513) he had to become a Persian vassal.

His successor, Alexander I (before 492–*c.* 450), was obliged to accompany Xerxes against Greece (480), though he secretly aided the Greek allies. Xerxes perhaps helped him to tighten his control over the western princes of Lyncestis, Elimiotis and Orestis who later used every opportunity to reassert their independence. Alexander seized the Greek colony of Pydna, and advanced his frontiers eastward to the Strymon, taking in Crestonia and Bisaltia with the rich silver deposits of Mt. Dysorus (mod. Krousia Oros); he issued a fine coinage. It was probably Alexander who organized the mass of his people as a hoplite army called *pezhetairoi* "foot-companions," with rudimentary political rights, to act a

a counterweight to the nobility, the cavalry *hetairoi* or "companions." His byname, the Philhellene, indicates his efforts to win Greek sympathies. He spread the legend deriving his Argead house from the Temenids of Argos, thus obtained admission to the Olympic games; from Persian spoil he erected a golden statue at Delphi; and he entertained Pindar at his court. But Athenian ambitions around the Strymon embittered previously cordial relations with Athens.

Alexander's son, Perdiccas II (*c.* 450–*c.* 413), asserted his succession against various brothers, of whom Philip enjoyed Athenian help. Angered at the founding of Amphipolis (437/436) Perdiccas used the Athenian clash with Potidaea (432) to unite the Greek cities of Chalcidice in a federation centring on Olynthus; and he twice broke the peace which Athens forced him to make. When the Spartan Brasidas marched north, Perdiccas enlisted his help against Arrhabaeus of Lyncestis; then fearing the power of Sparta he reduced his assistance and returned to the Athenian fold. He died about 413, having perfected the technique of playing off the Greek powers one against the other.

Perdiccas' son Archelaus (413–399; *q.v.*) adopted a strongly philhellenic policy, introducing Greek artists to his new capital at Pella. He strengthened Macedonia by building roads and fortresses, improving army equipment and encouraging city life; but his assassination in 399, followed by seven years of murder and anarchy, indicates that his reforms had contributed nothing to political stability. There followed him in rapid succession his assassin Crateuas, his own infant son Orestes, the latter's guardian Aeropus (who removed him, and was reigning when Agesilaus marched through Macedonia in 394), and on his death Amyntas II, a bastard son of Archelaus. Derdas, a prince from Elimiotis, murdered Amyntas. His successor Pausanias, Aeropus' son, was dethroned by a great-grandson of Alexander I, Amyntas III (393/392–370/369).

Amyntas was expelled from Macedonia by the Illyrians, having received little help from a treaty with the Chalcidic league; on his return he allied himself with the Spartans who, after three years' campaigning (382–379), dissolved the league and so allowed him to regain lost territories from Olynthus. Later he made treaties with Athens and Jason of Pherae; in 370/369 he died. An aggressive policy in Thessaly caused the death of his son Alexander II within a year. His assassin Ptolemaeus reigned as guardian for Alexander's two brothers, Perdiccas III and Philip II; but Perdiccas killed him (365), ascended the throne and made an Athenian alliance against Thebes. After Athens took Pydna and Methone, however, he aligned himself with Amphipolis. Profiting from the general confusion in Greece that followed the battle of Mantinea (362) Perdiccas seized Lyncestis, but in 359 died fighting the Illyrians.

In this crisis his brother Philip assumed control in the name of the infant heir, Amyntas; but having restored order he put Amyntas aside and as king in his own right raised Macedonia to a predominant position throughout the whole of Greece (359–336; *see* PHILIP II). Our main knowledge about the Macedonian monarchy derives from this period. It was a popular, almost Homeric institution, limited in power by a strong nobility and a free, outspoken peasantry. The eldest inherited; but the people in arms had the right to acclaim the new king and also to act as a court of high treason. Foreign policy remained a royal prerogative.

Alexander and the Successors, 336–280 B.C.—Philip's son Alexander III (336–323) overthrew the Persian empire and carried Macedonian arms to the Nile and the Indus (*see* ALEXANDER III THE GREAT). On his death at Babylon his generals divided up the satrapies of his empire and used them as bases in a struggle to acquire the whole. From 321 to 301 warfare was almost continual between those struggling to maintain the unity of the empire and those who, like Ptolemy, saw that it must disintegrate and were resolved to profit from its dissolution. Alexander's half brother Philip III Arrhidaeus and his son Alexander IV furnished a nominal focus for loyalty down to 317/316, but the real power lay in other hands. Macedonia itself remained the heart of the empire and its possession (along with the control of Greece) was keenly contested. Antipater was confirmed in the control assigned to him during Alexander's absence in Asia, and he crushed the Greek rising which followed Alexander's death (322); his coalition with Ptolemy secured the defeat and death of Perdiccas (321), and having been declared regent at Triparadisus he held this office till he died (319). His son Cassander, allied with Antigonus I Monophthalmus in Asia, fought a war against Polyperchon and Eumenes, who claimed to represent the kings; Antigonus defeated and executed Eumenes (316), and in 317 Cassander seized Athens and expelled Polyperchon from Macedonia. He then set about recovering Greece, leaving Philip III and his wife Eurydice in Macedonia; but Olympias, the mother of Alexander the Great, on Polyperchon's instigation invaded Macedonia from Epirus and destroyed both Philip and Eurydice. Cassander quickly recovered Macedonia and had Olympias executed for treason (316). As effective master of Macedonia he now founded Cassandria and Thessalonica (Salonika), and in Greece he refounded Thebes. Between 315 and 312 he combined with Ptolemy and Lysimachus to thwart the ambitions of Antigonus who, since Philip III's death, embodied the hopes of reuniting the empire. By a peace in 311 Cassander lost much of Greece, but strengthened his hold on Macedonia; he then murdered Alexander IV, the surviving king.

In 307 Antigonus' son Demetrius I (*q.v.*) (Poliorcetes) liberated Athens from the tyranny of Demetrius Phalereus, thus giving his father a Greek base. After gaining most of central Greece and part of the Peloponnese he reinstituted Philip II's Hellenic league against Cassander (303/302). But Cassander followed Antigonus' lead by assuming the title of "king of the Macedonians" and revived the coalition against Antigonus, who in 301 perished at the battle of Ipsus. This confirmed Cassander's authority and led to the restoration of his power in Greece. Henceforth the reuniting of the empire was no longer a practical issue. Cassander's death threw Macedonia into confusion (298/297). His son Philip IV died soon after, and the division of the kingdom between his other sons Antipater and Alexander V led to civil war. In 294 Demetrius Poliorcetes, again master of Athens, was called in by Alexander, but promptly murdered him and took the kingdom for himself. Demetrius ruled Macedonia for six years; he annexed Thessaly and central Greece, and founded a new capital at Demetrias on the site of Pagasae. But in 288 the other dynasts united against him; while Ptolemy stirred up Greece, Lysimachus and Pyrrhus (*qq.v.*) invaded Macedonia. Demetrius' army deserted to Pyrrhus; he himself fled; and Macedonia was partitioned between Pyrrhus and Lysimachus. Soon, however, Lysimachus succeeded in expelling Pyrrhus, and having added western Macedonia and Thessaly to his share ruled alone until his defeat and death at Corupedium in 281. His conqueror Seleucus was, however, stabbed to death by Ptolemy Ceraunus, a son of Ptolemy I of Egypt and a grandson of Antipater, who now seized the Macedonian throne.

The Antigonids, 277–168 B.C.—In 280/279 Galatian marauders invaded Macedonia and defeated and decapitated Ceraunus. For two years the only government and defense was that provided by the separate towns; then in 277 Antigonus II Gonatas, the capable son of Demetrius (now dead), having come to terms with Antiochus I of Syria, seized a base in the Chersonese, and after defeating a Galatian band at Lysimachia in Thrace was hailed king by a Macedonian army (perhaps not until early 276). Under him the country acquired a stable monarchy. From 277 to 168 the Antigonid dynasty ruled Macedonia. Their relations with the people and army-assembly remained much like those of the Argeads. Ceremony was slight; the king was first among his peers and esteemed for his prowess in the hunt, in battle and at the drinking table. Under the Antigonids the outer districts, where separatism still existed, were controlled by *strategi*, "generals"; *epistatai*, "overseers," were placed in many cities. Like other Hellenistic kings the Antigonids consulted a royal council of "friends," but heeded their advice only when they wished. The population remained mainly agricultural (except in cities like Beroea and Pella and the Greek coastal towns); the economy was backward; and mines and forests were a royal monopoly.

Early in Gonatas' reign a Greek rising under Areus of Sparta reduced his control of Greece to a handful of towns, and in 274 Pyrrhus, back from Italy, annexed western Macedonia. But

Gonatas soon recovered control, and on Pyrrhus' death (272) his position was unassailable. The Chremonidean War (267/266–262), a Greek revolt led by Athens and Sparta and inadequately fostered by Ptolemy II, ended in a victory for Gonatas, who perhaps then acquired Atintania from Alexander II of Epirus. His decisive naval victory over Ptolemy II at Cos, which fell then or a little later, gave him control of the Aegean. But an attempt to win Cyrene failed with the murder of his half brother Demetrius the Fair by Berenice, the future consort of Ptolemy III. Shortly afterward his governor of Corinth, Alexander, son of his half brother Craterus, was incited by Ptolemy to revolt (250/249). This cut off the Peloponnese, where the Achaean league made great headway under Aratus, who with Egyptian subsidies directed a campaign against the tyrants fostered by Gonatas in southern Greece. Though in 245 Gonatas recovered Corinth from Alexander's widow by a trick, he lost it to Aratus in 243 and his countermeasures in conjunction with the Aetolians proved a failure. In 240/239 he died. His resilience and solid work had restored to Macedonia a sound and durable government.

His son Demetrius II (*q.v.*; 240/239–229) at once became involved in a war with the Achaean and Aetolian leagues which lasted until his death. Macedonia was weakened and his heir, Philip V, was a child. Antigonus Doson, the son of Demetrius the Fair, became Philip's guardian. He decisively defeated and expelled the Dardanians, recovered the Thessalian provinces annexed by the Aetolians (except Phthiotic Achaea), and at the threat of an army mutiny assumed the kingship as Antigonus III. An expedition to Caria established connections which outlasted his reign, but the navy then fell into decay. In 224 Aratus offered him Acrocorinth as the price for help against Cleomenes III of Sparta, who threatened to destroy the Achaean league; he marched into Greece, and after defeating Cleomenes at Sellasia (222) re-established the Hellenic alliance as a confederacy of leagues, with himself as president. An Illyrian invasion then called him north, and after a victory he died in 221 leaving Demetrius II's son Philip to succeed. Doson had restored internal stability and re-established Macedonia in a stronger position in Greece than it had enjoyed since Gonatas lost Corinth.

Under Philip V (221–179) Macedonia first clashed with Rome. Until 217 Philip was engaged in successful warfare against a coalition of Sparta, Elis and Aetolia, during which he overthrew the council of guardians left by Doson and asserted his personal authority over the army. In 217 he captured the Dardanian capital, Bylazora (Titov Veles). Incited by Demetrius of Pharos, an Illyrian prince in flight from the Romans, he set out to attack the Roman client-states in Illyria, and confirmed his purpose by an alliance with Hannibal (215). Despite an Aetolian alliance (211) the Romans fought the ensuing war ineffectively, and in 206 Philip forced Aetolia to make a separate peace; in 205 the peace of Phoenice ended the Roman war in Philip's favour. He made minor concessions but kept his Illyrian conquests and Atintania. The war consolidated Macedonia in relation to both the Greek alliance and the northern frontiers, and by such measures as the enrollment of new citizens at Larissa Philip had secured the southern gateway to Macedonia. He now turned eastward, perhaps influenced by Antiochus III's return from a triumphant expedition in central Asia. He intrigued against the Rhodians who policed the seas, and embarked upon a program of aggression against the Greek cities of the Aegean and the northeast. He also secretly conspired with Antiochus to plunder the dominions of the child Ptolemy V. Though Rhodes and Pergamum scored a slight advantage over him at Chios, he defeated the Rhodians at Lade (201); but Rhodian and Pergamene envoys contributed to the Roman decision to make war on him (200).

Philip had seriously miscalculated. The conclusion was foregone, and the defeat of Cynoscephalae (197) led to a peace which confined him to Macedonia, depriving him even of Thessaly. Already the Hellenic alliance had fallen apart; now a series of leagues were established in former Macedonian areas. Orestis was independent; once again Lake Lychnidus (Ohrid) formed the western frontier; and Macedonia lost its fleet. Above all, the equilibrium established in 301 had vanished: Rome was the decisive power in the eastern Mediterranean. Between 197 and 189 Philip collaborated loyally with Rome against Nabis and Antiochus; he recovered parts of Thessaly and his remaining tribute was remitted. Until his death in 179 he concentrated on consolidating Macedonia, and despite successful denunciations at Rome by his neighbours, he amassed wealth, crushed internal opposition and issued new currencies both national and local, the latter reflecting a new policy designed to capitalize regional feeling. Three campaigns advanced Macedonian power in the Balkans (184, 183, 181); but at home he let Perseus, his elder son, persuade him to execute the younger, Demetrius, as a traitor. Those years of adversity revealed Philip's more admirable qualities. His death left a full treasury and an impressive army for the final struggle with Rome. Perseus (*q.v.*), Philip's successor, reigned for 11 years (179–168). He courted favour in Greece, cultivating the revolutionary party in Aetolia, Thessaly and elsewhere. By 172 when Eumenes II of Pergamum successfully incited Rome to war many saw in him the champion of Greek freedom. But Perseus failed to deploy his full resources; the 6,000 talents which Lucius Aemilius Paulus found in his treasury after the battle of Pydna (168) might have bought Illyrian help and saved the Epirote alliance. Neither Philip nor Perseus had been a real threat to Rome, but both had failed to adapt themselves to Roman predominance.

Roman Macedonia.—From 168 to 146 Macedonia formed four independent republics with representative assemblies and annual magistrates, but no common bonds. Tribute was halved, and the mines, at first closed, were re-opened in 158. After the suppression of a revolt led by Andriscus, an alleged son of Perseus (152–148), Macedonia became a Roman province with the four sections as administrative units, and the supervision of such parts of Greece as from time to time forfeited their independence. Macedonia was still the bulwark of Greece, and the northern frontiers saw frequent campaigning against the Scordisci, Maedi and Dardanians. After Caesar's death Macedonia was a base for Brutus and Cassius; in 27 B.C. it became a senatorial province separate from Achaea (Greece). A Macedonian league with high priests and an imperial cult appeared under Claudius I; it had some political functions and embraced Thessaly. Toward A.D. 400 the province was divided into Macedonia and Macedonia *secunda* (or *salutaris*), in the diocese of Moesia.

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(F. W. WA.)

MACEDONIAN QUESTION, the name given to the historic problem of drawing international frontiers across or around Macedonia (*q.v.*), where strategic or economic considerations cannot easily be reconciled with ethnic considerations.

The Middle Ages, to the 14th Century.—The population of the ancient kingdom of Macedonia seems to have been largely Greek-speaking, with Thracian and Illyrian admixtures; but after the constitution of the Roman province of Macedonia in the 2nd century B.C. some Latin element may have been introduced. When the Roman empire was divided in the 4th century A.D. into eastern and western halves, Macedonia was assigned to the eastern half which, as the Byzantine empire, with its capital at Constantinople, was long to survive its western counterpart. By this time the population was largely Christian; and its ethnic composition was little affected by the invasions of Goths, Huns and Avars. The arrival of the Slavs in the Balkans, however, led to a far-reaching colonization of Macedonia, where few towns were left Greek. The Bulgars began to follow the Slavs in the 7th century, and in the 9th century almost all Macedonia, except Salonika, was included in the first Bulgarian empire; but the Bulgars themselves became very largely slavicized. On the decay of the first Bulgarian empire in the second half of the 10th century the four sons of a local count, Nicolas, set themselves up as the dynasty of the Comitopuli

in Macedonia; and one of them, Samuel, founded the empire sometimes described as the West Bulgarian, which comprised much of the Balkan peninsula. This was destroyed by the Byzantine emperor Basil II, who in 1018 brought all its territory back under Byzantine rule. (*See* BULGARIA: *History.*)

Migratory movements and invasions continued. Nomadic Vlachs found in Macedonia a region well suited to their mode of life. Turkic invaders, called Polovtsy by the Slavs and Kumans by the Greeks, were crossing the Danube and entering Byzantine domains; some of them settled in Macedonia and were later known as Vardariotes. While the brothers Ivan and Peter Asen were laying the foundations of the second Bulgarian empire, the Normans under William II of Sicily captured and sacked Salonika (1185). After the diversion of the fourth crusade to Constantinople in 1204, a Latin kingdom of Salonika was set up; but this was overthrown in the 1220s by Theodore Angelus, the Greek despot of Epirus, who thereafter ruled over most of southern Macedonia and styled himself emperor of Salonika in opposition to the Greek emperors of Nicaea. Theodore Angelus was in turn defeated in 1230 by the Bulgarian tsar Ivan Asen II, who then annexed southern Macedonia, except Salonika, to his own dominions; but the Bulgars were themselves defeated in 1246 by the Nicaean emperor John III Vatatzes, who then took for himself not only southern Macedonia but also much of what had been Bulgarian since the beginning of the century. In the 1280s the Serbs began to encroach on western Macedonia; and after their victory over the Bulgarian tsar Michael Shishman (1330) their ruler Stephen Dushan could pursue a series of campaigns against the Byzantines (Greek rule in Constantinople had been restored by the Nicaeans in 1261). By 1346, when Stephen Dushan was crowned "tsar of the Serbs and Greeks" at Skopje, all Macedonia except the vicinity of Salonika was in Serbian hands.

Turkish Rule.—The Ottoman Turks, meanwhile, had already begun to make incursions into the Balkans. They held most of Macedonia by 1371; and their victory at Kosovo in 1389 sealed the fate of the Serbian empire. Salonika fell into Turkish hands for the first time in 1387, for the second in 1391 and finally in 1430. The best lands in the plains were distributed among the Turkish chiefs and a system of feudal tenure was developed. The Christian peasants either were driven to the less fruitful regions or remained on the lands assigned to the Muslim lords, to whom they paid a tithe. (*See* SERBIA: *History.*)

The ethnic conditions of Macedonia were still further complicated. Large colonies of Turks were settled in the plains, while the Muslim Albanians (called Arnauts by the Turks and Shkipetars by the Serbs) spread eastward, occupying much land in western Macedonia. The Serbian element, which had been strengthened under Stephen Dushan, was weakened by the great northward emigration of 1691 and 1740. The national consciousness of Serbs and Bulgars alike suffered a heavy blow when the patriarchates of Pec or Ipek (Serbian) and of Ohrid (Bulgarian) were abolished in 1766 and 1777 respectively. From that time the spiritual control of the Christian peoples in the Balkans became vested solely in the Greek Phanar or ecumenical patriarchate of Constantinople. The Greeks continued to live in towns controlling trade, but from the 16th century onward they had to face serious competition among the Sephardic Jews, who, expelled from Spain, founded prosperous communities at Salonika and in other Macedonian towns. There were also, as centuries before, Vlachs (called Kutso-Vlachs by the Greeks and Tsintsars by the Slavs) and a few Armenians.

With the decadence of the central power in the Ottoman empire the condition of the Christian population of Macedonia worsened. The reforms of 1839 and 1856, both of which proclaimed the equality of races and religions, remained unfulfilled. In 1864 Macedonia was divided into three *vilayets* or provinces: that of Salonika; that of Monastir (Bitola), which included parts of Albania; and that of Kosovo, with the capital at Uskub (Skopje), which protruded into "Old Serbia."

The Resurgence of Bulgaria.—In the 19th century the Russian empire, in pursuance of its designs on Istanbul and the Turkish straits, presented itself in the Balkans in the guise of a liberator, addressing itself in particular to the Bulgars. Russia started by pressing the Porte to agree to the creation of an autocephalous Orthodox Church for the Bulgarian people. After some resistance, the Porte acquiesced, hoping to strengthen its grip on the Balkans by dividing its Christian subjects. In 1870 Sultan Abdul-Aziz issued the firman creating the Bulgarian exarchate with jurisdiction over 15 dioceses: "Christian" and "Greek" were no longer synonymous in European Turkey. The ecumenical patriarch succeeded in postponing for two years the appointment of the first Bulgarian exarch and then excommunicated him and his flock as schismatics.

In 1878, after a victorious campaign, Russia compelled Turkey to recognize the independence of Bulgaria. By the treaty of San Stefano (March 3), the new Bulgarian state was given the whole of Macedonia, except Salonika and the Khalkidhiki (Chalcidice) peninsula. But Great Britain had also its protégés in the Balkans and immediately and energetically vetoed this treaty as unfair to the Greeks of Macedonia. The treaty of Berlin (July 13), to which all the great powers were signatories, created in the northern part of the Danube *vilayet*, as Bulgaria was then styled, a Bulgarian principality with Sofia as capital under the suzerainty of the sultan; in the southern part was formed an autonomous province of Eastern Rumelia, with Plovdiv as capital, under a Christian governor appointed by the Porte, with the assent of the powers. Russian-sponsored Bulgaria was thus seriously reduced in size, but the Macedonian strongholds of Hellenism remained under Turkey.

The artificial division of Bulgaria into two units did not last long; on Sept. 18, 1885, Bulgarian nationalists deposed the governor and proclaimed the union of Eastern Rumelia with Bulgaria. To the general surprise the coup succeeded, because Turkey abstained from intervening; and a Serbian attack on Bulgaria was very soon repulsed (*see* SERBO-BULGARIAN WAR). The Russian emperor, however, was offended because his protégé Alexander of Battenberg, first prince of Bulgaria, with the advice of Stefan Stambulov, then the speaker of the Bulgarian *sobranye*, had dared to proclaim the unification without asking for Russian help. To recover their influence in Sofia, the Russians organized a *coup d'état* on Aug. 21, 1886, which enforced Alexander's abdication. On July 7, 1887, Ferdinand of Saxe-Coburg-Gotha was elected second prince of Bulgaria. But clumsy Russian diplomacy only increased the Bulgarian people's spirit of independence. Stambulov, now premier, saw clearly that it was in Bulgaria's interest to establish friendly relations with Turkey; he was thus able to secure exequatur for Bulgarian bishops at Ohrid and Skopje in 1891 and at Veles and Nevrokop in 1894. In 1894 Ferdinand felt strong enough to dismiss Stambulov and to make his peace with Russia, but he continued to cultivate the good grace of the sultan, his suzerain. In 1898 Bulgarian prelates were appointed bishops of Bitola, Debar and Strumitsa. In 1900 Bulgaria had 785 schools in Macedonia; Serbia had only 178 and Greece 927.

Komitaji, Andartai and Chetnitsi.—The Sofia nationalists argued that the Slavs of Macedonia spoke a dialect akin to Bulgarian and therefore should be regarded as Bulgars and that all Macedonia should be incorporated into Bulgaria. The Belgrade nationalists affirmed that, as the Macedonian Slavs retained the custom of *slava* (feast of ancestors), common to all Serbs but not occurring among the Bulgars, they could not be genuine Bulgars, but were at best superficially bulgarized Serbs, whose land, it was argued, should be incorporated into a greater Serbia. The Greek nationalists maintained that the few hundred thousands of "Slavophones" whom they acknowledged to be in Macedonia were attracted by the superior Greek culture and considered themselves of Greek nationality. The Rumanians had no territorial claims in Macedonia but considered it useful to support the Vlachs, whom they called Arumanians.

The liberation of Macedonia from the Turks was desired by all non-Muslim Macedonians. To prepare it, a group of Macedo-Slavonic leaders, Dame Gruev (1871–1906), Gotse Delchev (1871–1903), Yane Sandanski (1875–1915) and others, formed a secret Internal Macedonian Revolutionary organization (Vatreshna Makedonska Revolutsionna Organizatsia or V.M.R.O.) in Salonika in Nov. 1893, which put forward a slogan of "Macedonia for the Macedonians" and the idea of a Balkan federation. After the fall

of Stambulov (1894), the Bulgarian nationalists had reason to believe that the Russian government would attempt to restore the Bulgaria of the San Stefano treaty. In March 1895 a Supreme Committee for Macedonia and Adrianople (Vrkhoven Makedonski Odrinski Komitet) was formed at Sofia; its aim was to prepare the incorporation of the whole of Macedonia and the province of Adrianople into Bulgaria. Ferdinand was not opposed to the idea of maintaining a pro-Bulgarian agitation in Macedonia and Thrace but ordered his war ministry to keep the V.M.R.O. and the Supreme committee under control. This, he thought, should be simple, because both were to be supplied with money and arms from Sofia. The first president of the Supreme committee was Traiko Kytanchev, but, as the real power was in the hands of the war ministry, the position of president was not easy and changes were frequent. From 1899 the president of the committee was Boris Sarafov (1872?–1907). His main task was to send guerrilla bands (hence the name of *komitaji* or "committeemen") into Macedonia to coerce the population into declaring itself Bulgarian and to make certain that the V.M.R.O. would follow Sofia's line.

Sofia was not the only Balkan capital from which such irredentist activity was organized in Macedonia. Athens was disconcerted by the progress of Bulgarian propaganda. The Greek religious and educational organizations were well established but fighting a defensive battle. To counteract the Bulgarian activities and also to bring about a war with Turkey, a newly formed Ethniki Etaireia was sending guerrilla bands of *andartai* into Macedonia. These succeeded in provoking the Greco-Turkish War (*q.v.*) of 1897, which ended in the complete defeat of Greece and thus benefited the Bulgarian movement. By then the Turks were sufficiently informed about the underground activities of the V.M.R.O. and of the Supremists; to counterbalance their influence the Porte inclined to favour other nationalities. Serbia, cut off from expansion in Bosnia-Hercegovina by the Austrian occupation, could look only southward. The patriotic society Narodna Odbrana ("National Defense"), controlled by the ministry of war, started sending *chety* (companies) of underground fighters into Macedonia to encourage a pro-Serbian movement among the Macedonian Slavs, and a Serbian source mentions the names of Jovan Dovezenski, Djordje Skopljance, Gligor Sokolovic and Jovan Babunski (Stojkovic) as the most famous *chetnitsi*. At the same time Belgrade began to agitate for the restoration of the Serbian patriarchate of Pec; a prolonged conflict with the Phanar secured only the appointment of a Serb, Msgr. Firmilian Drazic, as archbishop of Skopje in 1902. In 1905 a Rumanian bishop was appointed at Bitola. At that time there were about 40 Rumanian schools in Macedonia, including a *gymnasium* at Bitola founded in 1866 by the priest Apostol Margaritis. The Bulgars did not like this Serbian and Rumanian trespassing into a land that they considered their own; but they concentrated their efforts on combating the Greeks and the Grekomans (as they called pro-Greek Macedonian Slavs). At this time it was Lambros Koromylas, the Greek consul general at Salonika, who directed the whole secret organization of agents and bands upholding Hellenism against the Bulgars.

The terrorist activities of Bulgarian, Greek, Serbian and Turkish elements created so serious a situation in Macedonia that on Feb. 21, 1903, the Russian and Austro-Hungarian ambassadors presented identical notes to the Porte demanding the appointment of an inspector general for the three Macedonian *vilayets* and the reorganization of the *gendarmerie* with the aid of foreign officers. Sultan Abdul-Hamid II accepted the scheme, and the Sofia government, under Russian pressure, pretended to have dissolved the Supreme committee.

The V.M.R.O., however, was unreachable, and on Aug. 2 a general rising started in Macedonia, no doubt inspired by Sofia. The Supremist agents assured Gruev and Delchev that, once the insurgents had tied down a sufficient number of Turkish forces, the Bulgarian army would intervene. By the end of September, however, the rising was suppressed and the Bulgarian army, although partly mobilized, did not cross the frontier. Having achieved a complete surprise, the insurgents had some initial successes but they were eventually defeated. According to Bulgarian sources, the insurgents numbered 15,000, of whom 948 were killed as compared with 3,087 Turks killed. Turkish repression was ruthless; 105 Macedo-Slavonic villages comprising 9,830 houses were destroyed, 1,778 noncombatant Macedonian Slavs were shot and 60,953 rendered homeless. Thousands fled to Bulgaria, and their leaders complained of having been betrayed by Sofia. But Ferdinand was gratified because, he thought, the federalist tendencies of the V.M.R.O. had suffered a decisive blow so that thenceforward it would be easy to control.

On Oct. 9, 1903, the Russian and Austro-Hungarian governments submitted to the Porte a second part of their reform plan, called, after the place where the emperors Nicholas II and Francis Joseph I met, the Mürzsteg program; this also was accepted by the sultan. Russian and Austrian civil advisers were attached to Hussein Hilmi Pasha, the Turkish inspector general of Macedonia, and an Italian general was entrusted with the reorganization of the *gendarmerie*.

In 1905 Hilmi carried out in the three *vilayets* the first census of population since the Turkish conquest, which disclosed the following results: Muslims 1,720,007; Greeks 648,962; Bulgars 557,734; Serbs 167,601; Jews and others 77,386; total 3,171,690. Under "Muslims" were included Turks and Albanians inhabiting the western part of the Bitola *vilayet* and the northwestern part of the Kosovo *vilayet;* under "Greeks," all the "Patriarchists," whether of Greek, Slavonic or Rumanian speech; under "Serbs," only those attending Serbian churches and schools, who were confined to the northern and northwestern districts of the Kosovo *vilayet*.

A Bulgarian source, dealing with Macedonia proper (*i.e.*, excluding the Albanian and "Old Serbian" *sanjaks* of the Bitola and Kosovo *vilayets*), gave the following figures for 1905: in a total population estimated at 2,258,224, there were 1,370,949 Christians, 819,235 Muslims and 68,040 Jews. From the point of view of nationalities, this source stated that there were 1,181,336 Bulgars, 499,204 Turks, 228,702 Greeks, 128,711 Albanians, 80,767 Vlachs, 68,040 Jews, 54,557 gypsies, 700 Serbs and 16,207 others (Armenians, Circassians, etc.).

In June 1908, when King Edward VII paid a visit to Nicholas II at Reval (Tallinn), an Anglo-Russian program of limited autonomy for Macedonia was prepared; but one month later the bloodless revolution of the Young Turks broke out. The internal conflicts between the various nationalities in Macedonia came temporarily to a standstill. Using this opportunity, Bulgaria proclaimed itself independent and Ferdinand took the title of tsar. The hopes of Macedonian populations that the new Turkish regime would grant them territorial autonomy were disappointed. The policy pursued by the Young Turks, who attempted to transform a multinational Ottoman empire into a national Turkish state, brought about a gradual *rapprochement* between the governments of Bulgaria, Serbia and Greece. This *rapprochement* was converted in the summer of 1912 into a military alliance, and in October the allies, declaring that promises of reform in Macedonia and elsewhere had not been fulfilled, attacked Turkey.

The Balkan Wars and World War I.—Bulgaria and Serbia concluded an agreement stipulating that Bulgaria should annex "the territory east of the Rhodope mountains and the river Struma," while Serbia was to annex the lands lying "north and west of the Sar Planina." But so great was their mutual distrust that no agreement could be reached as to the destiny of the main bulk of Macedonia. The Serbo-Bulgarian treaty of March 13, 1912, stipulated that, if autonomy for the rest of Macedonia were found to be impossible, the two states were to accept a partition along a line running roughly southwestward from Kriva Palanka through Veles to Ohrid; alternatively, the Russian emperor would be asked to arbitrate and fix the Serbo-Bulgarian frontier in Macedonia. Between Greece and Bulgaria the feud was even deeper; and no previous agreement had been reached as to the ultimate distribution of territory to be taken from Turkey. Such a situation was fraught with danger, and, after the Balkan league's victorious campaign against the Turks, the Bulgars, on June 29, 1913, suddenly turned on their allies. Defeated by both Serbs and Greeks, attacked from the rear by the Rumanians, the Bulgars had to sue for peace. (*See* BALKAN WARS.) By the treaty of Bucharest of Aug. 10, 1913 Macedonia was divided: Greece took the southern half of it with a new northern frontier running from Lake Prespa through

Kajmakcalan to Lake Doiran, then eastward along the Belasitsa range and the lower Mesta; Bulgaria received the Strumitsa district, with the Pirin massif; and Serbia had the remainder.

When World War I broke out in 1914, Ferdinand saw a chance of revenge and of realizing his territorial ambitions in Macedonia. Bulgaria entered the war in Oct. 1915, on the side of the Central Powers and rapidly occupied not only all Serbian Macedonia but also parts of Serbia proper. The Allies landed at Salonika to help Serbia, but only in 1918 were they able to carry through a successful offensive, which led to the Bulgarian armistice of Sept. 29, 1918. The treaty of Neuilly (Nov. 27, 1919) left the Greco-Yugoslav frontier unchanged but transferred the district of Strumitsa (Serb. Strumica) to Yugoslavia. Greek or Aegean Macedonia then had 13,361 sq.mi.; Yugoslav or Vardar Macedonia, 10,229 sq.mi.; Bulgarian or Pirin Macedonia, 2,621 sq.mi.

The 1920s and 1930s.—During the period between the outbreak of the first Balkan War and the end of World War I, certain movements of population had taken place in Macedonia; about 100,000 Turks had fled or been transported to Turkey in 1912–13; many pro-Bulgarian Macedonians had fled to Bulgaria in 1913 and many others in 1918; and in 1913 the Greeks from Melnik, Strumitsa and Bitola had withdrawn to Greek Macedonia. After the treaty of Neuilly, moreover, about 25,000 Greeks left Bulgaria and 46,878 Bulgars left the eastern half of Greek Macedonia (approximately 80,000 "Slavophones," however, preferred to remain in the western half). A much more radical exchange of population took place under the Lausanne convention (Jan. 30, 1923), after Greece's defeat in Anatolia: 375,976 Turks left Greek Macedonia and 638,253 of the 1,222,000 Greek refugees from Turkey were installed in their place.

No exchange of population took place in Yugoslav Macedonia. The Belgrade authorities considered the Macedonians as "Southern Serbs" and, to make the population thoroughly Serbian, took steps to repress pro-Bulgarian sentiments. This soon led to new tension. In 1920 the V.M.R.O. was revived and Todor Aleksandrov became its leader. It started a campaign of terrorism in Yugoslav Macedonia. When in March 1923 Aleksandr Stamboliski, the Bulgarian premier, attempted to make terms with Yugoslavia, Aleksandrov declared "irrevocable hostility" against his government. Macedonians took an active part in overthrowing Stamboliski and in his assassination (June 1923).

A movement for an autonomous province within a federal Yugoslavia was born with Pero Shandanov as its leader, but the Belgrade government gave it no support. In April 1924, in Vienna, Dimiter Vlahov, a Macedonian Communist (and a former Bulgarian civil servant), persuaded Aleksandrov to fight for an autonomous Macedonia within a Communist Balkan federation. A manifesto along these lines, signed on May 6 and published on July 15, frightened the Sofia government; and on Aug. 31, 1924, Aleksandrov was assassinated in his Pirin hiding place. Gen. Aleksandr Protogerov and Ivan Mikhailov then became the leaders of the V.M.R.O. Mikhailov organized the assassination of many federalist Macedonian leaders and eventually of Protogerov himself, in Sofia on July 7, 1928, because he opposed the policy of assassinating federalists indiscriminately.

Yugoslav security measures made V.M.R.O. activity in Macedonia more difficult; and in the 1930s, as Fascist Italy began to exploit the organization, opposition to its activity increased also among Bulgarian politicians and army officers. On May 19, 1934, when a government headed by Kimon Georgiev and Col. Damian Velchev took power in Sofia, the V.M.R.O. was dissolved, its leaders were arrested and its members disarmed. Mikhailov escaped to Turkey, whence he later went to Germany.

World War II and After.—When Yugoslavia was partitioned in 1941 by the Axis powers, Bulgaria again occupied almost all Macedonia; a few northwestern districts, however, were incorporated into Albania and some southwestern ones occupied by the Italians, while Salonika (where only 9,000 of the 50,000 Jews escaped the gas chambers) was occupied by the Germans.

On July 12, 1943, at Petrich, in Bulgarian Macedonia, Dushan Paskalov, on behalf of the Bulgarian Communist party, and Yanis Ionnidis, on behalf of the Communist party of Greece, signed an agreement stipulating that the whole of Macedonia after the war should be an independent republic within the Balkan Communist federation. By then, however, the importance of Tito (Josip Broz) was growing inside Yugoslavia. In Tito's opinion Balkan federation should be effected under the leadership of the Communist party of Yugoslavia; and already in Feb. 1943 he had sent Svetozar Vukmanovic (General Tempo) to Skopje to organize a Macedonian section of the Yugoslav liberation movement. In 1945 Vlahov became chairman of the presidium of the Macedonian national assembly and vice-president of the federal republic of Yugoslavia, while Lazar Kulishevski became premier of the republic of Macedonia (with Skopje as capital).

Immediately after the war Tito was looking south, toward Salonika. At Skopje on Oct. 11, 1945, he said: "We shall never renounce the right of the Macedonian people to unite. There are brothers in Aegean Macedonia to whose destiny we are not indifferent." The peace treaty with Bulgaria, signed in Paris on Feb. 10, 1947, nevertheless introduced no changes in the territorial settlement in Macedonia as fixed in 1919, although the Greek government attempted to put in a claim to the Pirin area. But at that time the second Communist rising in Greece was in progress and the future of the country was in the balance. At a meeting at Bled, in Aug. 1947, between Tito and Georgi Dimitrov, the Communist premier of Bulgaria, it was agreed that, on the successful conclusion of the Greek Communist rebellion, Greek Macedonia should be incorporated into Yugoslav Macedonia, that Greek Thrace should become part of Bulgaria and that a great South-Slav federation uniting Yugoslavia and Bulgaria should be formed. In Jan. 1948, however, Moscow, already exchanging somewhat cool notes with Tito, rebuked Dimitrov for supporting such a plan; and on June 28, 1948, the breach between Tito and Moscow was made public.

In Nov. 1948 an organization of Macedonians in Bulgaria was allowed to announce that the only correct and democratic solution of the problem was a Macedonian state equal to Yugoslavia and Bulgaria; and in March 1949 the Greek rebel government (which had its seat in the Vitsi massif in Greek Macedonia) sponsored a similar plan. Tito's reply, the closing of the Greco-Yugoslav frontier (announced on July 10, 1949), contributed much to the crushing of the rebellion in Greece (September).

Yugoslavia concluded a pact of friendship with Greece on Feb. 28, 1953, and a military alliance with Greece and Turkey on Aug. 9, 1954; but after the Soviet-Yugoslav *détente* (from 1955) Tito lost interest in the military alliance and proclaimed Yugoslavia a noncommitted country. In Dec. 1961, under the pressure of the Skopje Macedonian authorities, the Yugoslav government publicly urged the Greeks to acknowledge the Macedonian minority in Greece and to give due consideration to its status and interests. The Greek government, however, maintained that no Macedonian minority existed within its frontiers and, in March 1962, suspended the agreement that it had made with Yugoslavia in 1959 to allow the easy movement of border populations across the frontier.

See also GREECE: *History*; YUGOSLAVIA: *History*.

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(K. SM.)

MACEDONIUS (d. *c.* 362), bishop of Constantinople after whom are named the Macedonian heretics (*Pneumatomachoi*) who denied the uncreated nature of the Holy Spirit. Macedonius was

not himself a heresiarch; it seems that some of his followers became *Pneumatomachoi* after his death. Macedonius was a candidate for the see of Constantinople when Alexander died and Paul was elected. Paul was banished in favour of the Arianizing Eusebius of Nicomedia. On Eusebius' death, in spite of Paul's presence in the city, Macedonius was elected bishop in 342. Constantine I's attempts to banish Paul were resisted, but the rivals remained unmolested. Paul went to Rome to appeal, and appears to have been reinstated, being exiled again on the death of Constans; Macedonius returned to the see, and was again deposed *c.* 358. Macedonius was semi-Arian rather than Arian in belief, supporting the homoiousians as against the homoousians of Nicaea (*see* COUNCIL). On the whole the semi-Arian position was nearer to orthodoxy than has been formerly conceded. The attributing of heresy to Macedonius occurs first *c.* 380 in St. Jerome's translation of Eusebius' *Chronicon*. Macedonius was anathematized by Pope Damasus in 381, and in 385 Theodosius I grouped the Macedonians with other heretics in his repressive measures.

See G. Bardy in A. Vacant (ed.), *Dictionnaire de théologie catholique*, vol. ix, col. 1464–78 (1926). (A. O.)

MACEIÓ, a city and port in northeastern Brazil and capital of the state of Alagôas, about 125 mi. S.S.W. of Recife, in latitude 9° 39′ 35″ S., longitude 35° 44′ 36″ W. Population (1960) 153,305. The city stands at the foot of low bluffs, about a mile from the Atlantic ocean. The lighthouse, situated in the middle of the city, is a conspicuous landmark. Jaraguá, the port of Maceió, is practically a suburb of the city. South of the port is the shallow entrance to the Lagoa do Norte, or Lagoa Mundaú, a salt-water lake extending inland for several miles. Maceió is attractively situated in the midst of large plantations of coconut and *dendé* palms, though the broad sandy beach in front and the open sun-burned plain behind give a barren character to its surroundings. The tropical heat is moderated by the southeast trade winds, and the city is considered healthful. Maceió has rail and road connections with interior towns and with Recife and other cities to the north, but to the south both railroad and highway extend only to the São Francisco river. Domestic airlines provide regular service from the airport at Jaraguá to all major cities of Brazil. The port is protected by a reef parallel with and a half mile from the shore, behind which vessels of light draft find a fairly safe anchorage. Ocean-going ships anchor outside the reef. Exports consist principally of sugar, cotton and rum. Maceió dates from 1815 when a small settlement there was created a "villa." In 1839 it became the provincial capital and was raised to the status of a city by the provincial legislature. (R. E. P.)

MACEK, VLADIMIR (1879–1964), Croatian national leader who opposed both Serbian domination of his country and the Communist dictatorship, was born at Jastrebarsko, near Zagreb. In 1905 he became a solicitor and joined the Croatian Peasant party. In 1920 he was elected member of the Yugoslav constitutional assembly, but boycotted its work, as did other party members. In Aug. 1928, after Stjepan Radic's assassination (June 20), Macek succeeded him as leader of the Peasant party and in that capacity proposed that King Alexander should reorganize Yugoslavia on a truly federal basis by re-establishing the historical boundaries as they existed before Yugoslavia had been established. The king rejected this suggestion and introduced his dictatorship. Macek stubbornly opposed this regime and was twice imprisoned (1929–30 and 1933–34). The semidictatorial regency of Prince Paul after Alexander's assassination (1934) held parliamentary elections in 1935 and in 1938, and on both occasions Macek headed the list of candidates of all Yugoslav opposition parties. On Aug. 25, 1939, Macek negotiated with the Yugoslav government headed by Dragisa Cvetkovic an agreement which established a Croatian *banovina* (province) with its own parliament and government at Zagreb and autonomy extending to all political activities except foreign affairs, defense, transport, communications and finance. Two days later Macek joined the Yugoslav government as deputy prime minister.

On March 25, 1941, Macek reluctantly agreed to Yugoslavia's adherence to the German-Italian-Japanese pact in exchange for German guarantees. When on March 27 King Peter II took over full royal powers and Gen. Dusan Simovic overthrew the Cvetkovic government, Macek joined the new administration. After the Germán-Italian aggression of April 6, 1941, he remained in Croatia, refusing the German invitation to head the Croatian puppet government. In May 1945 he left for Paris to escape from the Communists. From 1948 he lived in Washington, where he died on May 15, 1964. He published *In the Struggle for Freedom* in 1958. *See* also YUGOSLAVIA: *History*. (A. S. PA.)

McENTEE, JERVIS (1828–1891), U.S. landscape painter of the Hudson River school, was born at Rondout, N.Y., July 14, 1828, and was a pupil of Frederick E. Church. He was made an associate of the National Academy of Design, New York city, in 1860, and a full academician in 1861.

In 1869 McEntee visited Europe, painting much in Italy. He excelled in pictures of autumn scenery, as in "Edge of a Wood, November" and "Yellow Autumn Woods."

McEntee died at Rondout, Jan. 27, 1891.

MACEO Y GRAJALES, ANTONIO (1845–1896), Cuban patriot and general, was born July 14, 1845, at Santiago, Cuba, of a Venezuelan father and a Dominican mother. He fought for Cuban independence throughout the Ten Years' War (1868–78), rising to the rank of commander. Much of the time between 1878 and 1895 he spent in exile in the United States, Central America and elsewhere. Soon after revolt again broke out in Cuba, Feb. 1895, Maceo returned there to assume command of all rebel forces in Oriente province. He was a daring leader and won many skilful victories over larger Spanish forces. After many narrow escapes, Maceo was killed in a skirmish at San Pedro, Dec. 7, 1896. (R. H. FL)

MACERATA, the chief town of Macerata province, the Marches, Italy, and an episcopal see, is situated on a hil' between the Chienti and Potenza rivers, 35 km. (22 mi.) S.S.W. of Ancona, on the Civitanova Alta-Marche-Fabriano railway line. Pop. (1961) 38,709. The town was built in the 10th and 11th centuries on the ruins of the ancient Helvia Ricina, which had been destroyed in A.D. 408 by Alaric. Noteworthy buildings include the 15th-century Loggia dei Mercanti; the neoclassic Sferisterio (sports arena); and the church of Sta. Maria delle Vergini, containing a painting by Tintoretto. The Pinacoteca Civica has a good collection of paintings. The library, with documents and incunabula, has an annexed art gallery and Museo del Risorgimento. Macerata is the seat of a university with a faculty of jurisprudence, founded in 1290, and of several learned institutes. It is the birthplace of the astronomer Francesco de Vico, the Jesuit missionary Matteo Ricci and the poet Giovanni Crescimbeni. The town has an important agricultural market for cereals and is noted for sheep and pig breeding, horticulture and floriculture. Industries include brewing, brickmaking and the manufacture of musical instruments.

The province of Macerata, with an area of 1,724 sq.km. (666 sq.mi.) and a population (1961) of 289,517, is largely agricultural, producing chiefly cereals. Cattle and sheep breeding are important in the Apennines. Camerino is the seat of a university. There are mineral waters at Sarnano, and Bolognola contains extensive ski runs. (M. T. A. N.)

MACEWEN, SIR WILLIAM (1848–1924), Scottish surgeon, was born on June 22, 1848, at Rothesay, and educated at Glasgow university. In 1892 he was made regius professor of surgery in the university. In 1922 he was president of the British Medical association. Macewen was a firm supporter of the methods of Joseph Lister, and experimented on the sterilization of instruments and dressings and the preparation of catgut for surgical use. He advanced the practice of bone grafting and became famous for his operative treatment of knock-knee. His paper on surgery of the brain and spinal cord marked him as a pioneer of modern cerebral surgery. He died on March 22, 1924.

Macewen's best-known works are *Osteotomy* (1880); *Atlas of Head Sections* (1893); *On Pyogenic Infective Disease of the Brain and Spinal Cord* (1893); *On the Growth of Bone* (1912); and "Brain Surgery." in *British Medical Journal* (1922).

MACFARREN, SIR GEORGE ALEXANDER (1813–1887), English composer and teacher, born in London, March 2 1813. He entered the Royal Academy of Music in 1829 and be-

came professor there in 1834. He wrote four operas, *Don Quixote, Charles II, Robin Hood* and *Helvellyn*, produced in London between 1846 and 1864, oratorios, sacred works, songs and theoretical works. In 1875 he was appointed professor of music at Cambridge university and, the following year, principal of the Royal Academy of Music. He was knighted in 1883 and died in London on Oct. 31, 1887. Natalia Macfarren (1827–1916), whom he married in 1844, was an opera singer and teacher of singing.

See H. C. Bannister, *G. A. Macfarren* (1891).

McGEE, THOMAS D'ARCY (1825–1868), Irish-Canadian politician and writer, who began his career as an Irish patriot and ended as a powerful advocate of Canadian federation, was born at Carlingford, County Louth, Ire., on April 13, 1825. A prolific poet, he was of a type comparatively rare in North America, the man of letters in public life. Between 1842 and 1848 as orator and writer McGee became a strong champion of Ireland's national interests. Although he did not take up arms he was implicated in the abortive Irish rebellion of 1848 and escaped to the United States. Between 1848 and 1853 he established two newspapers there, the *New York Nation* and the *American Celt*.

McGee gradually came to advocate peaceful development for Ireland instead of the revolution urged by the extremists and in 1857 he moved to Canada. As a loyal adherent of the British connection he began an active career in Canadian public life. Elected to the legislative assembly in 1858 as the member for Montreal west, he soon distinguished himself by his powerful debating skill. He was the president of the council in the Reform administration (1862–63) and minister of agriculture in the liberal-conservative administration of 1864 and in the coalition government (1864–67). He played an active and eloquent part in the movement leading to Canadian federation. On April 7, 1868, he was shot by an assassin in Ottawa. His utterances against the Fenian invasion were believed to have been the cause of the crime, for which P. J. Whelan, a Fenian, was convicted and executed.

Among McGee's many works were *A History of the Irish Settlers in North America* (1851), *Canadian Ballads and Occasional Verses* (1858); *A Popular History of Ireland*, 2 vol. (1864); *Speeches and Addresses, Chiefly on the Subject of British American Union* (1865); and *The Poems of Thomas D'Arcy McGee*, ed. by M. A. Sadleir (1869).

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MACGHILL-EATHAIN, SOMHAIRLE (SORLEY or SAMUEL MACLEAN), (1911–), Scottish Gaelic poet, an outstanding figure in the establishment of a new school of Scottish Gaelic poetry in the 20th century, was born in Raasay, Skye, on Oct. 26, 1911, and was educated at Portree and Edinburgh university.

The book on which his reputation rests is *Dàin do Eimhir agus Dàin Eile* (1943), the first section of which consists of 48 lyrics, mainly celebrating two unhappy love affairs, and largely written between 1937 and 1939, although earlier poems are incorporated in it. The series is remarkable for its emotional intensity, the richness of its imagery and its combination of the love theme with a wide range of literary, political and social references. The political background is radical, with strong leanings to a communism tempered by Scottish nationalism. In the second part of the book Maclean renounces his love for Eimhir, and a mood of disillusion, accompanied by intellectual frustration, appears.

Maclean's metrical technique is traditional, his main innovations being in subject matter. His poetry was a reaction against 19th-century Gaelic verse. He made a conscious attempt to widen horizons, by wide-ranging references to Russia, to the Spanish Civil War, to characters in French romance and early Irish literature. His reading and thought were brought to a fruitful connection with his experience and were used to illumine and add new dimensions to that experience.

BIBLIOGRAPHY.—*17 Poems for 6d* (1940), 5 poems in *Modern Scottish Poetry, 1920–1945*, ed. by J. M. Lindsay (1946); *Honour'd Shade*, ed. by Norman MacCaig (1959). *See* also Iain Smith, "Modern Scottish Gaelic Poetry," *Scottish Gaelic Studies*, vol. vii, pp. 199–202 (1955). (D. S. T.)

McGILLIVRAY, ALEXANDER (*c.* 1759–1793), an American trader of mixed blood, chief of the Creek tribe, who played an important role in the history of the southwestern colonial frontier during and after the American Revolution. His father, Lachlan McGillivray, was a Scottish trader and politician in the colony of Georgia; his mother is thought to have been Sehoy Marchand, a half-breed French-Creek woman. McGillivray spent his childhood on his father's plantation and trading post in what is now the state of Alabama. In early youth he was sent to Charleston, S.C., and Savannah, Ga., to learn business methods and to acquire some polish. During the American Revolution he was pro-British in politics and became a powerful personal factor for the British cause in the southwest, inciting the Indians to attack the settlers. As a trader he was thrown into frequent contact with the famous trading firm of Panton, Leslie and Company. From the end of the Revolutionary War in 1783 to his death in 1793 he played important roles in dealing on behalf of the Indians with the U.S. and Spanish governments. Both nations paid him tribute, and the United States made him a brigadier general. McGillivray's main concern was the welfare of his Indian wards and the rich trade that went on about him.

Some authorities claim that this famous leader was one of the most cultivated Indians in North America. His interests ran more to diplomacy than to military affairs. Though he was a brigadier general he could never be called a warrior. The territory where he lived was a haven for speculators and adventurers and required shrewd management and ruthless dealings to survive. That McGillivray's leadership was capable was demonstrated by his influence over so large a number of Indians. As a plantation owner he pioneered in Alabama with a pattern of life that was later to characterize the great black belt of that state.

See John W. Caughey, *McGillivray of the Creeks* (1938). (T. D. C.)

McGILL UNIVERSITY, a private, nonsectarian coeducational institution in Montreal, Can., was chartered in 1821 as McGill University college; instruction began in 1829. *See* MONTREAL.

McGUFFEY, WILLIAM HOLMES (1800–1873), U.S. educator, who is remembered chiefly for his elementary school readers, was born in western Pennsylvania on Sept. 23, 1800, of Scotch-Irish parents. In 1802 they moved into the forests of the Ohio Territory four miles north of the present city of Youngstown. With little home or school instruction, McGuffey mastered the school arts and began teaching in the subscription rural schools of Ohio when he was 13 years of age. During spare time and vacations, through his 11 years of teaching in Ohio and Kentucky, he continued his own education intermittently under private tutors, in Greersburg academy and in Washington college, receiving his A.B. degree with honours in 1826.

McGuffey went to Miami university, Oxford, O., as instructor in ancient languages in Nov. 1825, became professor of languages in 1826, and during 11 years there took great interest in public education. He assisted the teachers of the elementary schools of the community and established in his own home a model school of the neighbourhood children.

In 1835 he contracted with Truman and Smith, publishers, of Cincinnati to compile four school readers, the first and second of which were published in 1836 and the third and fourth in 1837. A fifth was published in 1844, a spelling book by McGuffey's brother, Alexander Hamilton McGuffey, came out in 1846, and a sixth reader was added in 1857. These textbooks became virtually the universal readers in the expanding common schools of the great empire of the Mississippi and the south. They went through many editions and sold 122,000,000 copies.

From 1836 to 1839 McGuffey was president of Cincinnati college and from 1839 to 1843 president of Ohio university, Athens. He was one of the three founders of the common school system of Ohio. In 1845 he was elected to the chair of mental and moral philosophy in the University of Virginia, Charlottesville, which position he eminently filled until his death on May 4, 1873.

MACH, ERNST (1838–1916), Austrian physicist and philosopher, whose work, both in physics and in philosophy, had a great influence on 20th-century thought, was born on Feb. 18, 1838, at

Turas in Moravia and educated in Vienna. He was professor of physics at Graz from 1864 to 1867 and at Prague from 1867 to 1895, and professor of inductive philosophy at Vienna from 1895 to 1901. He was made a member of the Austrian house of peers in 1901 and died at Haar, near Munich, on Feb. 19, 1916.

Mach was a thoroughgoing positivist and took the view, which most scientists now share, that no statement is admissible in natural science unless it is empirically verifiable. His criteria of verifiability were, however, exceptionally rigorous: they led him not only to reject such metaphysical conceptions as that of the ether and that of absolute space and time but also to oppose the introduction of atoms and molecules into physical theory. Nevertheless it was his criticism along these lines of Sir Isaac Newton's system that made the way clear for Albert Einstein's theory of relativity. As a positivist, he regarded scientific laws as purely descriptive; and he held that the choice between alternative hypotheses covering the same facts was to be made on the grounds of economy.

Mach's philosophical position was phenomenalistic. He maintained that all empirical statements, including those that occur in scientific theories, were in the end reducible to statements about sensations. He tried to lay the basis for the phenomenalist reduction in his book *Analysis of Sensations,* but neither he nor any other philosopher has yet succeeded in carrying it through. Though it would be incorrect to call him an idealist, Mach's views have a certain resemblance to those of Berkeley, and for this reason he was sharply attacked by Lenin in *Materialism and Empirio-Criticism.* His philosophy survived to become one of the sources of inspiration of the Vienna circle of the 1920s (*see* Logical Positivism), the members of which mostly came to reject Mach's phenomenalism but continued to support him in his hostility to metaphysics, in his positivist conception of scientific method and in his insistence upon the unity of science.

Mach's name is popularly associated with the Mach number (*q.v.*), which expresses the air speed of an aircraft in terms of its relation to the local speed of sound.

Mach's works include: *Die Mechanik in ihrer Entwicklung historisch-kritisch dargestellt* (1883; rev. ed., 1908; Eng. trans. by T. J. McCormack, *The Science of Mechanics,* 4th ed., 1919); *Beiträge zur Analyse der Empfindungen* (1886; 5th ed., *Die Analyse der Empfindungen und das Verhältnis des Physischen zum Psychischen,* 1906; Eng. trans. by C. M. Williams, *Contributions to the Analysis of Sensations,* 1897); *Leitfaden der Physik für Studierende* (1881), in collaboration with others; *Populärwissenschaftliche Vorlesungen* (1896; 3rd ed., 1903); *Die Prinzipien der Wärmelehre* (1896); *Erkenntnis und Irrtum* (1905; Fr. trans. by M. Dufour, *La Connaissance et l'erreur,* 1908). (Ad. J. A.; X.)

MÁCHA, KAREL HYNEK (1810–1836) Czech romantic poet of great power and individuality. Born at Prague on Nov. 16, 1810, of poor parents, Mácha was influenced as a student by the Czech national revival and by English and Polish romantic literature. Other sources of inspiration were his wanderings amid ruined castles in the Bohemian countryside and a journey to northern Italy (1834). In 1836 he took up a legal post in Litomerice but died there, of pneumonia, on Nov. 5, 1836.

After schoolboy attempts in German he began to write poems, sketches and novels in Czech. Practically all his prose works remained unfinished, but their style shows a mastery not previously attained by writers in the newly revived Czech literary language. His lyrics express a characteristic but highly individual romantic pessimism. His best work is the lyrical epic *Máj* ("May"; 1836). Strongly Byronic in subject, this poem is yet personal in treatment and style, and stands comparison with the work of such Slavonic contemporaries as Adam Mickiewicz and Lermontov. Coldly received at the time, it has exercised an almost magical fascination on poets and critics of the 20th century. The subtle melody and rhythms of Mácha's verse defied the efforts of his numerous translators. His letters and diaries, *Dílo Karla Hynka Máchy,* edited by K. Janský, (3 vol., 1948–50), in vivid colloquial prose, are an essential supplement and background to his poetry. (R. Av.)

MACHADO, BERNARDINO LUÍS (1851–1944), Portuguese statesman, president of Portugal from Aug. 1915 to Dec. 1917 and from Dec. 1925 to May 1926, was born in Rio de Janeiro on March 28, 1851, and educated in Portugal. He received the doctorate from Coimbra university in 1876 and became a full professor there in 1879. He was elected twice to the chamber of peers as representative of the university (1890, 1894). He served as grand master of Portuguese Masonry. His parliamentary career was marked by his concern for public education. As minister of public works (1893), he created the first labour court in Portugal. Later, upon his return to Coimbra, he became president of the Instituto de Coimbra. In 1902, after espousing republicanism, he was elected president of the governing board of the republican party. He resigned his professorship as an aftermath of the national student strike (1907). With the overthrow of the monarchy (1910), he served as minister of foreign affairs (1910–11); deputy to the constituent assembly and senator (1911); and minister (later ambassador) to Brazil (1912). For the second half of 1914 he was prime minister and minister of the interior, when, under his guidance, Portugal committed itself to participation in military operations on the side of Great Britain in World War I. He was elected president on Aug. 6, 1915, but was overthrown by the revolution of Dec. 8, 1917. He became president again on Dec. 11, 1925, but was once more deposed (May 28, 1926). The revolution which brought António de Oliveira Salazar to power ultimately sent Machado into exile. With the invasion of France (1940), he was allowed to return home. He died at Oporto on April 29, 1944.

See António Machado, *Bernardino Machado, memórias* (1945); Ramos de Almeida, *Bernardino Machado* (1951). (M. Ca.)

MACHADO Y MORALES, GERARDO (1871–1939), fifth president of Cuba and considered one of its major dictators, was born at Camajuani, Santa Clara province, Sept. 29, 1871. He fought valiantly in the war for independence (1895–98) and rose to the rank of brigadier general. After the war he engaged in farming and business but retained a strong interest in politics. By 1920 he had become leader of the Liberal party.

Machado was overwhelmingly elected president in 1924. He was popular at first, but declining sugar prices brought economic depression to Cuba in 1925 and Machado had to begin a vast program of public works to counteract it. Construction under this program of the very costly Central highway and the Capitol later led to charges of graft against his government.

By 1927 Machado had gained control of all three Cuban political parties. His regime then rapidly became more dictatorial. Rising opposition in 1933, climaxed by the defection of the army, forced him out of office and into exile on Aug. 12. He died at Miami Beach, Fla., on March 29, 1939. (R. H. Fi.)

MACHADO Y RUIZ, ANTONIO (1875–1939), Spanish poet, who gained a high posthumous reputation in the "committed" literature of the period after World War II, was born in Seville on July 26, 1875. Most of his childhood was spent in Madrid, where he was educated at the liberal Institución Libre de Enseñanza. In 1899 and 1902 he visited Paris and in 1907 he took the decisive step of his life when he became French master at the Instituto de Soria. There he married the 15-year-old Leonor Izquierdo Cuevas, who died only three years later in 1912. Subsequently Machado taught in Baeza, Segovia and Madrid. A staunch supporter of the republic during the Civil War, he crossed the French frontier when it collapsed at the beginning of 1939 and died at Collioure, Pyrénées-Orientales, on Feb. 22, 1939.

His early poems, *Soledades* (1903) and *Soledades, galerías y otros poemas* (1907), are concerned largely with evoking memories and dreams and with the subjective identification of the poet with natural phenomena, especially the sunset. Machado created, with characteristically slow persistence, an austere, "nonpoetic" style and a series of fixed images to describe the "galleries" of his mind. In his groping spiritual quest for significance in life he characterized himself as "a poor man wandering in a dream, always searching for God among the mists."

In Soria Machado turned away from pure introspection, but infused into the considerable topographical precision of his descriptive poems of the arid Castilian *meseta* (contained in *Campos de Castilla,* 1912) his deep personal involvement with the landscape and people. The loving, yet critical, attitude he displays toward

Castile shows his affiliations with the "Generation of '98." Under the influence of Henri Bergson, Machado now saw poetry as essentially a reflection of the passing of time; his verse makes careful use of tense, adverbs of time and assonance, and avoids cerebral imagery and defining adjectives. His wife's death produced a few moving poems, but henceforth his poetry became more fragmentary and more philosophical. He invented the writings of two "apocryphal philosophers," Juan de Mairena and Abel Martín, through whom he expressed his profound existentialist views in a deceptively disjointed form. Machado was admired for his simple modesty, his concern with authenticity and his unhurried, thoughtful dedication to poetry.

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MACHADO Y RUIZ, MANUEL (1874–1947), Spanish poet of a delicate technique and decadent refinement, strongly influenced by Paul Verlaine and the *modernismo* movement of Rubén Darío (*q.v.*), was born in Seville on Aug. 29, 1874. His main merit lies in the light sensuous verse contained in *Alma* (1902), *Caprichos* (1905) and *El mal poema* (1909) in which he evokes either *fin de siècle* Paris or Moorish Andalusia; he was not, however, devoid of deeper concerns which link him with the "Generation of '98" and his brother Antonio (*q.v.*). He was influenced by popular verse and song and also wrote polished sonnets inspired by famous paintings. In collaboration with his brother he wrote some good poetic plays, the most successful being *La Lola se va a los puertos* (1929). Machado died in Madrid on Jan. 19, 1947.

See M. Pérez Ferrero, *Vida de Antonio Machado y Manuel* (1947). (G. W. Rs.)

MACHAULT D'ARNOUVILLE, JEAN BAPTISTE DE (1701–1794), French statesman notable for his attempt at fiscal reform under Louis XV, was born in Paris on Dec. 13, 1701, of a distinguished family of lawyers. He served as intendant of Hainaut before being appointed controller general of finances in Dec. 1745, during the War of the Austrian Succession. Having had to resort to the usual expedient of borrowing in order to finance the war, he determined to institute a regular sinking fund for the redemption of the large public debt. For this, in May 1749, he introduced a 5% tax or *vingtième* on all revenue from land, offices or industry. Based on the principle of complete fiscal equality, this levy was intended to be permanent and was to be imposed on the privileged *pays d'états* (which voted their own taxes), as well as on the *pays d'élection.* The resistance of the *parlements* and the provincial estates was overcome, but the violent opposition of the assembly of the clergy, supported by the Ultramontane party at court, brought about the failure of Machault's proposals and the continued exemption of the privileged orders from the *vingtième.* Transferred to the ministry of marine in July 1754, Machault (who was also keeper of the seals from 1750) was dismissed in Feb. 1757, during the negotiation of the Franco-Austrian offensive alliance at the opening of the Seven Years' War; and no further effort was made before 1787 to subject the privileged orders to direct taxation. After the outbreak of the Revolution, Machault was arrested as a suspect during the Terror, and he died in prison in Paris on July 13, 1794. *See* FRANCE: *History.*

See M. Marion, *Machault d'Arnouville* (1891). (A. Gn.)

MACHAUT, GUILLAUME DE (*c.* 1300–1377), French poet and musician, greatly admired by contemporaries as a master of French versification, both in the lyric and in longer verse forms such as the *dit* and *roman.* Born at Machault (to use the old spelling) in the Ardennes, *c.* 1300, in 1323 he entered the service of John of Luxembourg, king of Bohemia, as chaplain and secretary. He accompanied him on his wars and was rewarded, in 1337, with a canonry at Reims. After the king's death at the battle of Crécy (1346), he found another protector in Bonne of Luxembourg, wife of the future king John II of France, and (1349) in Charles II, called the Bad, king of Navarre. From this time on, Machaut was honoured and patronized by kings and princes at his chosen residence in Reims, where he died in 1377.

In his longer poems, Guillaume did not go beyond the themes and genres already widely employed in his time. The *Dit dou Vergier* once again takes the reader to the Garden of Love already sung by Guillaume de Lorris in the *Roman de la Rose* (*q.v.*). Both the *Remède de fortune* and the *Confort d'Ami* are indebted to Jean de Meun (*q.v.*) and Boethius: the latter is an attempt to sustain the courage of Charles II when accused of conspiracy and imprisoned by King John. In the *Jugement du roi de Navarre* (1348), which debates a casuistic problem of love, it is the wheel of fortune which turns again. When Guillaume sings the life and deeds of Pierre de Lusignan, king of Cyprus, in the *Prise d'Alexandrie* (*c.* 1370), he becomes flat and tedious. Of all this part of his work, only the *Voir Dit* is considered of permanent interest. It relates how a young girl of high rank falls in love with him solely on the strength of his fame and creative accomplishment, but the difference in age is too great and the idyll ends in mutual disappointment; true or false, the story holds the attention by its sincerity. The two main protagonists exchange letters and poems; some of the verses are set to music, and indeed Machaut's beloved explicitly asks for them to be notated.

It is in fact more to his skill as a lyric poet and as a composer that Guillaume owes his reputation. He was the last great poet in France to think of the lyric and its musical setting as a single entity. As a master of the "second rhetoric," namely poetry, he composed a considerable number of *ballades, chants royaux, lais, rondeaux* and *virelais.* Certainly they are based on the old theme of *amour courtois* which Guillaume takes over and reworks, but their form and verbal music is often perfectly achieved. A *rondeau* or a *ballade* is written with a wit that makes a jewel out of nothing; and if there is little poetry in the romantic sense there is an abundance of charming, exquisite and lively poems, the product of an ingenious and quiet fancy.

There is equal skill, but more originality, in his musical compositions. The Mass Ordinary for four voices, which includes the *Ite missa est,* competes with the three-part Mass preserved at Tournai for the title of the earliest complete polyphonic Mass. Certainly the Machaut work is far superior in artistic quality to the Tournai Mass; it employs the characteristic 14th-century motet technique of isorhythm (*q.v.*) in *Kyrie, Sanctus, Agnus* and *Ite,* while the *Gloria* and *Credo* proceed in an ornamented note-against-note style. The *Hoquetus David* is also isorhythmic, and there seems to be some justification for the idea that this work forms a conclusion to the organum *Alleluia Nativitas* of Pérotin (*q.v.*), although written over 100 years later; at least the melisma *David* concludes the plainsong in question.

Of his 23 three- and four-part motets, 17 are in French and thus form a continuation to the 13th-century motet repertory, though the technique of isorhythm is new and cannot date from much before 1316: it is employed in all but three of Machaut's motets. The 19 *lais* are representatives of a complicated lyric genre usually set to music as an unaccompanied vocal solo. Machaut has left two three-part canonic *lais* and one in normal two-part harmony. Of 33 *virelais,* 25 are monodic, 7 have an additional accompanying part for an instrument and 1 has two such parts. The latter is typical of the accompanied solo song which became so popular in the 14th century, and which Machaut may have invented to replace the polytextual motet. At all events his 42 *ballades* and 21 *rondeaux* are best represented in the sources, which reveal that Machaut was esteemed, not only in France, but also in Italy, Spain and much of the rest of Europe.

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MACHEN, JOHN GRESHAM (1881–1937), U.S. Presbyterian theologian and churchman, one of the most eloquent spokesmen for the conservative position in the theological controversies of the 1920s and 1930s, was born at Baltimore, Md., on July 28, 1881. Educated at Johns Hopkins and Princeton universities, Princeton Theological seminary and the Universities of Marburg and Göttingen, he taught at Princeton seminary from 1906 until its reorganization in 1929. Thereupon he left to help found Westminster Theological seminary in Philadelphia, where he served as professor of New Testament until his death on Jan. 1, 1937.

Machen's leading contribution to the conservative cause in the Fundamentalist-Modernist controversy was perhaps his book *Christianity and Liberalism* (1923), which contended that theological liberalism was not really Christian in the biblical and historic sense.

Machen's most scholarly books were *The Origin of Paul's Religion* (1921) and *The Virgin Birth of Christ* (1930; 2nd ed., 1932). His publications also included numerous pamphlets and articles, in addition to several other books, many of a popular nature. Refusing to resign from the Independent Board for Presbyterian Foreign Missions on the ground that the mandate of the general assembly of the Presbyterian Church, U.S.A., ordering its members to do so was unconstitutional, Machen was suspended from the ministry. When his appeal was not sustained, he left in 1936 to join in forming the Presbyterian Church in America, later known as the Orthodox Presbyterian Church.

Machen also enjoyed a world-wide reputation as a Greek scholar and learned Christian apologist. His theological position, he was wont to emphasize, was not fundamentalist, but the Reformed Faith of the Westminster Confession of Faith. *See* also FUNDAMENTALISM; PRESBYTERIANISM.

See autobiographical sketch in V. Ferm (ed.), *Contemporary American Theology* (1932); Ned B. Stonehouse, *J. Gresham Machen: a Biographical Memoir* (1954). (N. B. S.)

MACHIAVELLI, NICCOLÒ (1469–1527), Italian statesman and writer, a patriot and a thinker of genius whose acute understanding of contemporary politics and profound insight into human nature produced masterpieces that have too often been misjudged as immoral or cynical, was born in Florence on May 3, 1469. His family (about whose descent from the ancient lords of Montespertoli in Valdipesa there is some doubt) had from the 13th century onward been counted among the principal houses of the city, holding on occasion the most important offices and rich in worldly goods. His father, Bernardo Machiavelli (1428–1509), a doctor of laws, was however among the poorest members of the family; he lived frugally, administering his little property of Sant'Andrea, near San Casciano, and supplementing his meagre income from it with small earnings from the restricted and almost clandestine exercise of his profession, since he was debarred from any public office as an insolvent debtor of the commune of Florence. Niccolò was to write later that he had "learnt to do without before he learnt to enjoy"; and this poverty may have been the reason why he did not have the education suited to his ability. In the years when young Florentines crowded to the lectures of Politian, Machiavelli never embarked on the study of Greek. His father's *Ricordi* (memoirs) show him working at Latin under obscure teachers: he learned more by himself in the books which were the only luxury of his home than he did at school. This kind of education saved him from the faults and excesses of humanist erudition and preserved the originality of his thought and the unequaled force of his style, which is elevated and popular at the same time.

Public Life.—In 1498, after the changes in the Florentine government following the death of Savonarola and the triumph of the opposing faction, Niccolò Machiavelli was made head of the second chancery (*cancelleria*) at the early age of 29. He was then completely unknown; the tradition of his having an apprenticeship in the lower grades of the chancery from 1494 onward is not confirmed by documentary evidence, and his own statements tend to disprove it. The office to which he was appointed, though not comparable in power with that of first chancellor, was an important one. Originally it dealt only with internal affairs of the republic, but it was later made one for practical purposes with the secretariat of the Ten (*i Dieci*). Machiavelli was, moreover, secretary to the magistracy which, in the name of the *Signoria* and under its authority, directed foreign affairs and defense. The chancellors were often entrusted with diplomatic missions to Italian and foreign courts when it was not desirable to send ambassadors because time was short or for some other reason. Machiavelli's first important mission was to the French court in 1500. Five months spent beyond the Alps enriched his experience, introducing to his eager mind another people and other customs, a nation strong with its own arms and united under the rule of a single prince.

On his return to Florence, Machiavelli found much to do, as the republic was on the verge of being ruined by the ambitions of Cesare Borgia (*q.v.*). As well as dictating letters in the chancery, Machiavelli undertook missions whenever the need arose: he was always ready to ride off and to face danger and hardship, being fonder of action than of words. His short work *Del modo di trattare i sudditi della Valdichiana ribellati* ("On the Way to Deal With the Rebel Subjects of the Val di Chiana") belongs to this period. In it the fundamental principle of a new doctrine is enunciated for the first time: "The world has always been inhabited by human beings who have always had the same passions." He was sent twice to Cesare Borgia; and during the second embassy (Oct. 1502–Jan. 1503) he was a witness of the bloody vengeance taken by Cesare on his mutinous captains at Senigallia, of which he wrote a famous account, *Del modo tenuto dal Duca Valentino nell'ammazzare Vitellozzo* . . . ("On the Manner adopted by the Duke Valentino to Kill Vitellozzo . . ."). That strong sinister prince caught the imagination of the Florentine statesman with his natural bent for abstraction and theory. Implacable, resolute, ferocious and cunning, Cesare Borgia had conquered a dominion for himself in a few months; and Machiavelli adapted Cesare's qualities and methods to his own ideal of a "new prince" who would provide a desperate remedy for the desperate ills of Italy. It is clear that this was a case of idealization and that his admiration for the prince did not go hand in hand with admiration for the man. In 1503, when Pope Alexander VI died and his successor, Pius III, too died shortly afterward, Machiavelli was sent to Rome for the duration of the conclave which elected Julius II. There, with ever-increasing scorn, he witnessed the inglorious decline of his hero and finally celebrated Cesare's imprisonment "which he deserved as a rebel against Christ."

In Florence meanwhile Piero Soderini had been elected gonfalonier for life, and Machiavelli was immediately able to win his favour and became his righthand man. This remarkable influence over the head of state encouraged him to realize his military ideas. For centuries the states of Italy had used mercenary troops in their wars, and Machiavelli had seen in practice their lack of discipline, their faithlessness and their unbearable arrogance. Inspired both by the military enterprises of ancient Rome and by his own observations in France (where he went on a second mission early in 1504) and in Romagna (where Cesare Borgia had replaced mercenaries with levies from his own territory), Machiavelli ardently pursued the idea of giving the Florentine state a militia of its own, recruited from the peoples under its control. Age-old prejudices had to be overcome, as well as the reluctance of suspicious townsmen to arm men from the country districts around. Having set to work immediately after his return from the Roman legation, he succeeded in persuading the gonfalonier to risk an experiment and then to have a law passed in order to establish a militia (1505). His first *Decennale* (a short poem in *terza rima* somewhat prosaic like the rest of his verses) ends with a call to arms. In 1506, as the importance of the new militia increased, the council of the Nine (*i Nove*) was created to control it, and Machiavelli was made secretary of this body also. To get the law on the militia passed, he had also written a *Discorso dell'ordinare lo stato di Firenze alle armi* ("Discourse on Arming the State of Florence") which is lucid, closely argued and vigorous. The territory of the republic was divided into districts, and Machiavelli himself went out to see to the levies and to carry out inspections, alternating these military tasks with those of th

chancery and with a further mission (1506) to Julius II, whose armies, moving up to free the States of the Church from their usurpers, entered Bologna in triumph.

In Dec. 1507 the Holy Roman emperor Maximilian I was preparing an invasion of Italy from Germany. The gonfalonier, who did not trust his own ambassador at the imperial court, accordingly sent Machiavelli on another journey beyond the Alps. On the outward journey Machiavelli passed through Switzerland, and three days spent in that country were enough for him to produce some brief but acute observations on it. He did the same, at greater length, for Germany, composing on the day after his return to Florence, June 17, 1508, a *Rapporto delle cose dell'Allemagna* ("Report on the State of Germany"). In this work, compiled in the course of his official duties, and likewise in the literary version made four years later under the title *Ritratto delle cose della Magna* ("Portrait . . ."), he was able to pick out with great acumen the reasons both for the strength of the German nation and for its political weaknesses. Yet all his official reports, though marvelously intuitive, are marred by a tendency to theorize; they are bold syntheses, not complete and accurate sources of information.

On his return from Germany, as the Florentines were showing new strength in an effort to recapture Pisa, Machiavelli was able to try out the militia that he had created. He went to command his troops at the front and put all his usual enthusiasm into the task: when the Ten begged him to remain at headquarters, he answered that they must let him be with his soldiers, since behind the lines he would die of melancholy. Such was the patriotism and passion of a man who has been represented as skeptical, cautious and cynical. Pisa capitulated on June 8, 1509, and Machiavelli with his militia had no small share in this success for Florence.

After a mission to Mantua in connection with yet another ill-fated invasion by Maximilian, Machiavelli had to go again to France in July 1510 to persuade Florence's ally Louis XII either to make peace with Julius II or at least not to drag Florence into a war that would bring the republic to certain, swift and useless ruin, whereas a neutral Florence could be very useful to the French. The French, however, "who knew nothing about statecraft," were not influenced by what Machiavelli had to tell them. From this mission, which resulted in the *Ritratto delle cose della Francia,* he returned in Oct. 1510, convinced that there would be a major war between the French king and the pope and that the Florentines would be involved. All his efforts now were to arm his country. As he carried out his military duties and those of the chancery, he was continually traveling about. At the end of the summer of 1511 he went to France for the fourth time, to persuade Louis XII to remove the schismatic council that he was sponsoring in Pisa, since this had brought on the Florentines the rage of Julius II. As soon as he was back from France, Machiavelli himself went to remove this council and did so without much ceremony. For the free republic, however, the last hour had already come: the army of the pope's Holy League was already on its way to punish Florence. The gonfalonier Soderini was deposed, and the Medici returned as masters of the city (1512). Machiavelli lost his position and was forbidden to enter the Palazzo della Signoria.

Machiavelli's misfortunes were not at an end. Pietropaolo Boscoli's ill-conceived conspiracy was uncovered at the beginning of 1513, and Machiavelli, already an object of suspicion to the new government, was accused of complicity. Thrown into prison, he maintained his innocence even under tortures which often persuaded the innocent to declare themselves guilty. His name, however, was on a list taken from the conspirators (perhaps merely a list of people attached to the old regime); and finally, though he was released from prison, restrictions were put on his freedom of residence. In the meantime Julius II had died, and Giovanni de' Medici had become pope under the name of Leo X. Machiavelli composed for the celebrations on that occasion a pious *Canto degli spiriti beati* ("Song of the Blessed Spirits"). He sought in vain to get into the good graces of the Medici through the intercession of Francesco Vettori, his old colleague in the German legation and now Florentine ambassador to a Florentine pope; but his brilliant letters to Vettori were powerless to stir that selfish and opportunist friend.

Hounded by poverty and unhappiness, Machiavelli sought refuge in the little property at Sant'Andrea inherited from his father. There he employed his leisure in writing, between spring and autumn 1513, his two most famous works, *Il Principe* ("The Prince") and a large part of the *Discorsi sopra la prima Deca di Livio* ("Discourses on the First Decade of Livy"). In a letter to Vettori, which is one of the most remarkable in any language, he describes his life in the country with its violent contrasts, its mixture of plebeian coarseness and dreams of greatness. Machiavelli's great hope was that the *Principe,* dedicated to Lorenzo between 1515 and 1516, would obtain from the Medici an office to support his family and satisfy his love of action; but in vain. Full of bitterness, he then dedicated the *Discorsi* (of which he had been giving public readings in the Oricellari gardens) not to a prince but to two private citizens. Of this period also are the mediocre poem *L'Asino* (1517) and the marvelous comedy first entitled *Commedia di Callimaco e Lucrezia,* later *Mandragola* (1518). It may be that other minor works such as the amusing tale *Il demonio che prese moglie* ("The Demon who Took a Wife"; now called the *Novella di Belfagor*) and the *Dialogo intorno alla lingua* ("Dialogue on Language") belong to these same years in which, disillusioned, he abandoned political writings for the consolations of literature.

Machiavelli's hopes were raised when, on the death of Duke Lorenzo, the cardinal Giulio de' Medici came to govern Florence. He was presented to the cardinal by Lorenzo Strozzi, to whom in gratitude he dedicated the dialogue *Dell'arte della guerra* ("On the Art of War"; 1520). In this, in the *Discorsi* and in the *Principe,* his study of classical authors was combined with his experience of modern affairs; *i.e.,* his recent military adventures. The first employment given him by the cardinal was to go to Lucca on a matter of small importance. On that occasion he wrote his *Vita di Castruccio Castracani,* a kind of romanticized biography of the Luccan *condottiere* in which he idealized, as he had done with Borgia, his myth of a "new prince." This short work is only a historical sketch for a much larger work (in a contemporary document it is called a "modello di storia"). The cardinal agreed to have Machiavelli elected official historiographer of the republic, a post to which he was appointed by the *Studio* or University of Florence in Nov. 1520 with a salary of 57 gold florins a year, later increased to 100. The university's terms allowed for Machiavelli's also being employed in other ways. In the meantime he was to compose for the Medici pope Leo X a *Discorso* on the organization of the government of Florence after the death of Duke Lorenzo, the last legitimate lay descendant of the Medici; in this he boldly advised the pope to restore the city's ancient liberties. Shortly after, in May 1521, he was sent to the Franciscan chapter at Carpi. The commission was an insignificant one and even slightly absurd; but it provided the occasion for Machiavelli's forming with Francesco Guicciardini (*q.v.*), governor of nearby Modena, a friendship that was to have a great importance for Italian literature.

After Pope Leo X's death (Dec. 1521) the cardinal Giulio de' Medici, who remained sole master of Florence, was more than ever inclined to reform its government. He sought the advice of Machiavelli, who simply furbished up the *Discorso* composed for Leo X. Pope Adrian VI then died (Sept. 1523) and Giulio de' Medici was himself elected pope, taking the name of Clement VII. Machiavelli now worked with more enthusiasm at the *Storia fiorentina,* his official history of Florence; in June 1525 he was able to present the pope with eight books and received in return 120 florins and encouragement to continue. Early in the same year he had written the *Clizia,* a free imitation of the *Casina* of Plautus, which he produced within a few days for a festival. In this comedy he probably intended to satirize himself and his affair with Barbara, a singer with whom he was infatuated.

In April 1526 Machiavelli was elected secretary of the *Cinque provveditori alle mura,* a five-man body lately constituted to superintend the fortifications. Next, the pope having formed the League of Cognac against the Holy Roman emperor Charles V, Machiavelli went with the army to join Guicciardini, the pope's lieutenant, with whom he remained almost continuously until the

sack of Rome by the emperor's forces brought the war to an end (May 1527). Florence having regained its freedom by casting the Medici off, Machiavelli on his return hoped to be restored to his old post in the chancery; but the little favours which the Medici had so meagrely doled out to him caused the supporters of the free republic to forget the love that he had always had for his native city and for freedom. It was the last of his disappointments and the greatest. Machiavelli fell ill and died, with the comforts of religion, on June 21, 1527, at the age of 58.

Machiavelli's life thus fell into very nearly proportionate phases: midway, at 29, he was given the chancery (1498); having devoted the third quarter of his life entirely and exclusively to public affairs, he was dismissed at the end of it (1513); then the first half of the last quarter was enough for him to write all the major works on which his fame rests (the *Principe,* the *Discorsi, Mandragola* and the *Arte della guerra*); and the last eighth of his life (1521–27) was spent in writing the *Storia fiorentina* and a few minor works.

Character.—Machiavelli was of medium height, thin, with a bony face, a high forehead, black hair, piercing eyes and thin lips compressed in an enigmatic smile. He was an upright man, a good citizen and a good father. He was not by any means a faithful husband, but lived in affectionate harmony with his wife Marietta Corsini (whom he had married in the latter part of 1501) and had five children by her. As he said in a letter, he loved his native city "more than his own soul"; and even in his devotion to the state he must often have written "state" while thinking "native land."

Out of devilment and a desire to shock his contemporaries Machiavelli liked to appear more wicked than he was. This, together with certain blunt maxims in his works, gave him a reputation for immorality. In fact those maxims were purely theoretical abstractions of an art itself not always based on moral scruples, least of all in Machiavelli's own time; but their bold, lapidary style made it easy to detach them from their context and to ignore the purpose that had inspired and the needs which had conditioned them. The maxims thus became a target for attacks by the Catholic Counter-Reformation; and the word "Machiavellianism" was coined as a term of opprobrium by the French, out of hatred for all things Italian, during the rule of Catherine de Médicis. On the other hand Machiavelli was an innovator and, as such, was inclined to give extreme form to his utterances. He himself in the *Discorsi* forecast the dangers which awaited him, like all those who have sought "new methods and new orders . . . undiscovered seas and lands." He "was a scapegoat because he was a great man and because he was unfortunate."

In judging Machiavelli one must likewise take account of his anguished despair of virtue and his tragic sense of evil. Again on the basis of sentences taken out of context and of outward appearances he was judged a cold and cynical man, a sneerer at religion and virtue; but in fact there is hardly a page of his writings and certainly no action of his life that does not show him to be passionate, generous, ardent and basically religious. To understand him nothing is better than the self-portrait which he drew in two lines of verse:

Io rido, e il rider mio non passa dentro:
Io ardo, e l'arsion mia non par di fore

("I laugh, and my laughter is not within me; I burn, and the burning is not seen outside.")

The Thinker and Writer.—Machiavelli had an eminently speculative mind. Unlike Guicciardini, who was empirical and pragmatic, he was irresistibly drawn to reduce human actions to scientific forms and rules, to go beyond particular facts and to seize on universal motives. The founder of the philosophy of history, he well knew (as he wrote in the preface to the *Discorsi*) that he was opening "a road as yet untrodden by man." As he had been the first to appreciate in histories "that flavour which they possess in themselves" beyond any merely literary or recreational ends, so he was the first to understand the doctrine of historical cycles and, starting from the principle that human nature does not change with the passing of time, the first to build a political science based on the study of man. The fallacy of always referring and holding to the example of the Romans without taking account of changed conditions was criticized, even in Machiavelli's day, by Guicciardini; but the latter was by nature inclined to concern himself rather with particular errors and inaccuracies than with his friend's universal theories. The *Discorsi* must have come into existence in the form of notes in the margins of a copy of Livy, which Machiavelli, as is known from his father's book, had been reading from the age of 17. They retained that form, but in substance they are a theoretical treatise on republics, as the *Principe* is a treatise on principalities (*De principatibus* was the book's original title).

Machiavelli's affections and theories were always for the republic; but the corruption of the times, the weakness of the states of Italy and the threat of foreign conquest made him long for that "new prince" who might give reality to his great dream of the redemption of Italy. This "redeemer" of his, to whom he sought in vain to give a face and a name, would have had to overcome superhuman difficulties; nor could there be much choice of means in attaining such ends. Machiavelli, in a book which is not a moral treatise, attempted to indicate to the prince those means which were compatible with the conditions of the time and with human nature. Even religion—for which he had a deep feeling though he was not outwardly pious—was subordinated by him, in matters of state, to the state's iron necessity and made into an *instrumentum regni,* or tool of power. Machiavelli indeed is regarded as the inventor of the "reason of state" (*ragione di stato*), though that expression appears for the first time 20 years after his death. The *Principe,* while its underlying ideas are the same as those of the *Discorsi,* won a greater reputation thanks to its concision, its vigorous imagery, the splendour of its close and energetic style and the bluntness of some of its aphorisms, which were taken too literally by contemporaries and by posterity. He remarked of certain cynical precepts that he would not have proffered them if mankind had not been wicked; and this bleak pessimism is certainly not refuted by the annals of his own time. Yet his longing was for a society of good and pure men; he sought it in ancient times and, for the present, admired less civilized nations as being less corrupt.

The *Arte della guerra,* properly considered, is merely complementary to Machiavelli's two political treatises, but it is more closely linked with the *Principe* and its great dream of Italian unity than with the *Discorsi.* Like the *Discorsi,* it has the defect of taking the ancient Romans at all costs and in everything as its model; and this fault appears greater in the *Arte* because too little attention is paid in it to technical advances, such as the use of artillery—which in those very years was beginning to make its weight felt decisively in battle. Even so Machiavelli can be said to have laid the foundations of modern tactics.

What has already been said about Machiavelli's hidden but strong and deep morality could be repeated in connection with the *Mandragola,* where the wickedness and corruption of men, particularly of the clergy, are the subject of laughter, but of a bitter and painful laughter which is never an end in itself. It reminds the reader of what was written about the author by one who had a better opportunity of knowing him than anyone else, his friend and critic Francesco Guicciardini: "He laughs at the failings of men because he cannot cure them." In the *Mandragola,* where the characters are no longer the stylized ones of classical comedy but true-to-life Florentines, the character most lovingly drawn in contrast with a stupid and pretentious doctor, is a ribald monk. There is no lack of comic force; but behind the scenes there is an occasional glimpse of tragedy. In this, rather than in its complete freedom from imitation of Plautus, lie the originality and the force of this extraordinary comedy, comic and shocking at the same time and highly poetic. The loose and static construction and the carelessness with which characters less interesting to the author are drawn make the miracle seem all the greater.

The *Storia fiorentina* also bears the impress of a powerful and original mind. In this work, written by fits and starts and unwillingly and wearily dragged on into his later years, Machiavelli enters on a new road, leaving behind him the traditions and methods of humanist historiography. He writes history more as

politician than as a historian set on discovering the truth. He cares nothing for the criticism of sources and sometimes seems to have no scruples about accommodating facts to his thesis. It is not narrative exactitude which is to be sought in him, but the power of synthesis, the brilliant co-ordination and organization of facts. Machiavelli does not lack certain of the historian's qualities, but he lacks his interests: when he is writing he sometimes accepts without hesitation the most ingenuous sources and follows them page by page until he lights on a fact which fires his sympathies and his imagination or which awakens the theorist, the thinker capable of tracing the hidden connections and historical consequences of political phenomena. The same thing happens with his style, sometimes dormant in the *Storia fiorentina*, but always recovering its power when his interest revives, equaling the brilliance of the finest pages of the *Principe* and the *Discorsi*.

Machiavelli was a great writer because he was a great thinker. He was also a poet, but his poetry is to be found not so much in his verse as in his prose, which has no equal in Italian literature. It is also noteworthy that his excellence showed itself in nearly all the genres that he attempted: in historical writings, in political treatises, in the short story and, particularly, in comedy. It is to be regretted that he did not attempt tragedy, having all the qualities needed to excel in the theatre and a highly dramatic temperament.

Texts.—The edition of Machiavelli's works by P. Fanfani and L. Passerini remains incomplete after six volumes (1873–77) but is still the best for his reports of his legations. There is a collected edition of the historical and literary works by G. Mazzoni and M. Casella (1929); *Lettere familiari*, edited by F. Gaeta (1961). The *Discorsi* are translated into English by L. J. Walker, two volumes (1950); English translations of the *Principe* include those of E. Dacres (1640; reprinted 1929), L. Ricci (1903; reprinted 1955), W. K. Marriott (1908), A. H. Gilbert, with a version of Machiavelli's personal letters (1941), and P. Rodd (1954); and there are versions of the *Storia fiorentina* by N. H. Thomson, two volumes (1906), and by W. K. Marriott (1909). For a portrait of Machiavelli *see* ITALIAN LITERATURE.

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MACHINE. A machine may be defined as a combination of resistant parts so connected as to have constrained motion and to be capable of transmitting or transforming energy. Although modern machines with their complex controls appear to be extremely complicated, every one is merely a combination of one or more of three basic elements: the wheel (*q.v.*) and axle, the lever (*q.v.*) and the inclined plane. Machines composed of combinations of these three basic machines may be classified according to two general functions: (1) generation and transformation of power; (2) transmission of power and performance of work, accomplished by means of such types of machinery as the pump, compressor, fan, crane, elevator and pulley (*qq.v.*) and the different types of vehicles. *See* also MACHINE TOOLS; MATERIAL HANDLING; and POWER TRANSMISSION. For specific machines not listed above, consult the Index.

MACHINE GUN, a military firearm of small calibre capable of rapid, sustained fire. The modern machine gun is an automatic, belt-fed weapon that, barring a malfunction, will continue to fire as long as the trigger is held back, or until the supply of ammunition is exhausted.

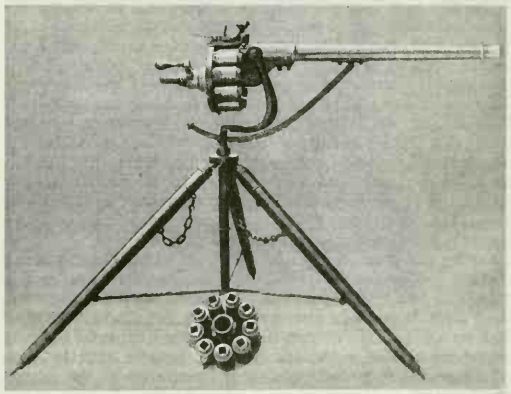
The first machine guns, such as the famous Gatling gun described below, were manually operated by turning a hand crank, though they could be powered by a motor. The U.S. patent office described such weapons as being "capable of sustained fire from energy derived from an outside source." Later, truly automatic machine guns, such as the Maxim gun of the 1880s, required no outside source of power; they used the energy released by the burning propellant to feed, load, lock and fire each round, and to extract and eject the empty cartridge case.

The term automatic gun came into use after World War I to describe automatic aircraft weapons larger than the calibre .30 or calibre .50 machine guns. Such weapons were merely large machine guns (from 20 mm. to 57 mm.) and, as a rule, operated from energy released by the burning propellant. Beginning about 1945, some automatic guns reverted to the original external drive principle of the Gatling gun and employed either an electric motor or a gas turbine as a source of power. (For submachine guns, *see* SMALL ARMS, MILITARY: *20th-Century Small Arms.*)

EVOLUTION OF THE MACHINE GUN

Soon after the advent of the first primitive firearms inventors began to contrive means for firing more than one shot before reloading. The first of these devices, known as ribaulds or ribaudequins, were simply bundles or rows of barrels, fired either all at once or in sequence. Many rather ingenious methods were used to control the firing, such as sliding locks that fired several superimposed charges in succession but required that the trigger be pulled for each shot. The idea of a multibore cylinder started in the matchlock period and has been used throughout the age of firearms, culminating in the most modern aircraft automatic guns. Before the invention of metallic cartridges, machine guns did not provide reliable, controlled ignition. They either suffered from stoppages or, even worse, permitted several charges to go off at once, with disastrous results.

The first soundly conceived manually operated machine gun was that patented in London, May 15, 1718, by James Puckle. The patent drawing of the Puckle gun has been widely published, but it is not generally known that the gun was actually produced, tested and found operable. Fig. 1 shows one of the production models in the Tower of London armouries. Puckle called his invention "a portable machine that discharges so often and so many bullets . . . as renders it next to impossible to carry any ship by boarding." The flintlock ignition was a limiting factor in its design, but other features were strikingly similar to those used in the Gatling and other systems of a century and a half later.



REPRODUCED BY PERMISSION OF THE CONTROLLER OF H. M. STATIONERY OFFICE. BRITISH CROWN

FIG. 1.—PUCKLE MACHINE GUN, 1718, WITH REVOLVING BLOCK FOR FIRING SQUARE BULLETS SHOWN IN THE FOREGROUND

The Percussion Cap.—The many problems arising from inability to ignite all charges at the same time, or with a high degree of reliability, regardless of how close the barrels were grouped, held further development almost at a standstill until 1807, when

Alexander John Forsyth (1769–1843), a Scottish Presbyterian minister, patented an "application of the detonating principle to exploding gunpowder firearms." Forsyth utilized mercury fulminate, rolled into "pills" or small pellets which were placed in a nipple at the breech end of the barrel and detonated by the impact of a falling hammer.

Joshua E. Shaw (1776–1860), a U.S. sea captain, perfected a method whereby Forsyth's principle could be given a practical application—use of the percussion cap. Shaw developed a cup, made first of pewter and later of copper (about 1816), in which the mercury fulminate was placed so that the detonating mixture would be protected from the weather, would grip the sides of the nipple and could be used as a unit to transmit fire to the propellent charge. This invention opened the field for numerous weapons that were officially defined by the U.S. patent office as machine guns.

One of the earliest of the devices so classified was invented by Charles Emerson Barnes on July 8, 1856. Although there is no record of even a working model being made from the patent issued to the inventor, the illustration showing his toggle-locking action is still considered basically sound. Among other practical mechanisms of this period were the Ripley machine gun, the Ager "coffee mill" gun (commonly called the Union gun), the Claxton machine gun, the Williams machine gun and the Gorgas machine gun. The battle of Fair Oaks (Seven Pines), Va. (May 31, 1862), where the Confederates fired volleys from a battery of Williams guns, marked the first record of the use of the machine gun in warfare. There were, during the American Civil War, 11 hand-operated mechanisms that could be classified as machine guns available for service use. However, it remained for one man to resolve all the serious problems facing designers of manually powered machine guns at the time. That man was Richard Jordan Gatling (*q.v.*).

The Gatling Gun.—Gatling's original gun (about 1862) was a single-barrel device with a rotary chamber that combined certain features of the Ager and the Ripley guns. He employed the best ammunition available at the time. It consisted of a paper cartridge placed in a heavy-walled steel cylinder countersunk at the base and equipped with a nipple on which was placed the percussion cap. The first model of a Gatling gun using this type of cartridge was finished in time to see limited use by the Union army in the American Civil War.

Parallel with Gatling's efforts to improve gun mechanisms appeared the deciding factor which would govern the future of all machine gun design. It was first introduced to the sporting world in the form of the lightweight brass cartridge containing in a single unit a means of ignition, the propellant and the bullet. (*See* SMALL ARMS, MILITARY.) Gatling recognized the significance of this great improvement and redesigned his weapon. It consisted of a number of barrels mounted parallel one to another and equidistantly spaced to rotate about a central shaft. The gun was actuated by a hand crank which could be turned slowly or rapidly at the will of the operator, thus providing control of the rate of fire. The positioning of the incoming cartridge in the chamber of each individual barrel was accomplished by gravity or by the camming action of the cartridge container located directly above the gun. This was done while the chamber being loaded was making a half-revolution about the central shaft. Firing then took place, followed by extraction and ejection during the second half-revolution. The combination of all factors, from the basically sound mechanism to the self-contained metallic cartridge, was vitally necessary in the evolution and perfection of the Gatling machine gun.

The introduction of the self-contained metallic cartridge made possible not only rapid fire but also bursts of long duration with great reliability since the round could be mechanically controlled throughout the entire gun mechanism and the base of the cartridge could be designed to facilitate chambering, firing, extracting and ejecting.

Other Types.—The Gatling gun was without peer in the manually operated era and, when powered externally, could fire 3,000 rounds per minute. But its multibarreled arrangement placed a serious limitation on its tactical use. This gave other inventors the opportunity to display their genius in devising variations of hand-powered machine guns to meet specific purposes. Among the foremost of these hand-cranked weapons was the Hotchkiss (1878) developed primarily for shipboard use, being chambered almost exclusively for the large artillery type of cartridge. More mobile than the Gatling, the Gardner was another successful mechanism employing conventional military rifle calibre cartridges only. It was adopted by the navies of many world powers because the one- and two-barrel versions could be easily carried ashore by one man. The prevailing military belief that volley fire was more effective than rapid continuous shots led to the development of another type of volley-firing, hand-powered machine gun, universally known as the Nordenfeldt (patented in 1879). Although never officially adopted, many other ingenious hand-manipulated mechanisms were developed between 1865 and 1880 in the United States. These guns were actually constructed and passed exhaustive government tests. Representative types were the Lowell, which mechanically indexed and fed the incoming round at high speed; the Wilder, which combined the revolver system with reciprocating action; and the Bailey, which was the first to employ belt feeding.

During the American Civil War, French observers attached to the Union and Confederate armies recognized the devastating effectiveness of grapeshot fired from light artillery against concentrated attacking personnel. From these observations there was developed in Europe a peculiar multifiring weapon resembling a piece of standard artillery. It was considered an improved method of delivering grapeshot and was called a mitrailleuse, meaning grape shooter or more literally, grapeshot shooter. This marked the beginning of French interest in machine guns and each subsequent hand-powered or automatic firing device manufactured by the French carried the marking mitrailleuse, although the meaning of the word had no connection with the weapon beyond the first effort.

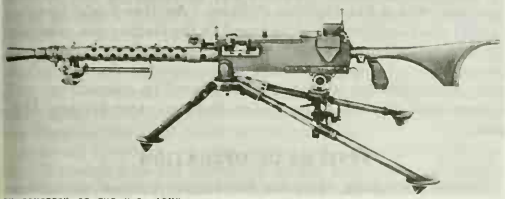
For the second time in machine gun history another completely new concept entered the field and quickly made all previous efforts obsolete. This revolutionary development came through the invention (about 1885) of a new form of propellant, a progressive burning powder. By gelatinizing nitrocellulose, the burning speed of the explosive mixture could be controlled to a high degree. Another important feature of this new powder was that during combustion there was almost no smoke. Quickly acclaimed by both military and civilian observers for its smokeless qualities it was named smokeless powder. To the machine gun inventor however, its real significance lay not in its lack of smoke but in its progressive burning qualities. It not only yielded a higher chamber and bore pressure to give increased velocity to the projectile, but also made it possible for a metered amount of gas pressure to be used for operating a weapon. By drilling a small hole or port in the barrel a fraction of the pressure could be brought to bear on a piston or lever that provided complete control during firing.

Still another method for powering the weapon was provided by the recoil force which was also governed solely by the progressive burning qualities of the new propellant. When the weight of the charge was constant it gave the same amount of thrust with each shot. This assured consistency of the distance and speed of the recoil stroke.

Hiram Stevens Maxim (1840–1916), a U.S. engineer and inventor residing in England, conceived the idea of the first fully automatic machine gun. Again, the conception and development of the automatic machine gun was retarded initially because the inventor was forced to employ as ammunition only what was available at the time, in this case the conventional black powder cartridge. In spite of this handicap, by June 1884, Maxim had progressed to the point where he had a workable product. The principle of short recoil was used by Maxim for the complete cycling of his single-barrel weapon. Although Maxim's early experiments were conducted with black powder cartridges, and he had reached a limited degree of success, it was the introduction of the new propellant, smokeless powder, that not only assured the

success of the Maxim gun but also brought about the golden era (from 1884 to World War I) of automatic machine gun inventions. His guns, as manufactured by Vickers and known by that name as well as Maxim or Vickers-Maxim, were used by every major power. The Vickers machine gun was adopted by the U.S. army as its model 1915.

Following closely behind Maxim came the prolific U.S. inventor, John M. Browning (*q.v.*), of Ogden, Utah. His work on automatic gun mechanisms is well known; no design of his ever failed. After his entry into the field the United States used his automatic weapons almost exclusively. Official adoptions by the U.S. include the calibre .30 Browning automatic rifle (B.A.R.), the calibre



BY COURTESY OF THE U.S. ARMY

FIG. 2.—AIR-COOLED, .30-CALIBRE BROWNING MACHINE GUN, MODEL M1919A6, USED BY THE U.S. ARMY IN WORLD WAR II

.30 light Browning machine gun, the calibre .30 heavy Browning machine gun, the calibre .45 auto-loading pistol, the calibre .50 aircraft and heavy-barrel ground-type Browning machine gun and the 37-mm. aircraft automatic gun.

From 1890 to World War I, the large standing armies prevalent in Europe furnished an impetus and ready market for tremendous activity in machine gun design, and there was an influx of U.S. automatic weapon designers to Europe. Among them were Hugo Borchardt, Benjamin Hotchkiss, Laurence V. Benét, Col. Isaac N. Lewis and later Browning. Consequently, both the Allies and the Central Powers during World War I armed their military forces with machine guns designed by persons of U.S. origin, such as the Maxim, Vickers, Lewis, Hotchkiss, Benét-Mercié and Browning.

The Skoda gun was used by Austria and tested by the United States. The Madsen light machine gun, made in Denmark, was used by Russia, Denmark, Norway, Argentina and several other countries. The Bergmann and Dreyse guns were used by Germany. The Schwarzlose was used by several countries. Before and during World War I, the Chauchat, Benét-Mercié, Berthier and Lewis light machine guns were extensively tested and used. During that war, the Lewis gun, in an adaptation for aircraft, became one of the favourite weapons of fighter pilots. Some of them were still in service at the beginning of World War II. A famous gun, the ZB, was developed in Brno, Czech. The British government acquired a licence to manufacture it before World War II and used it extensively. The weapon was manufactured at the Enfield plant and called the Bren gun, the name being derived from Brno and Enfield.

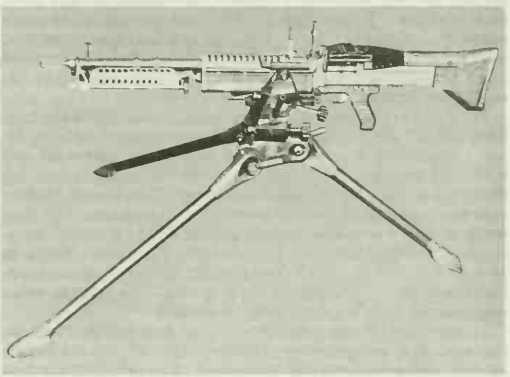
Designers of other nations active during this time included Germans such as Paul Mauser, Fritz and George Walther, Theodor Bergmann, Louis Schmeisser and Reinhold Becker; the Austrian, Rudolf Frommer; the Italians, Bethel Revelli and Alfredo Scotti; the Frenchman, André Berthier; the Swiss, Marc Birkigt; and the Mexicans, Manuel Mondragon and Rafael Mendoza. Their designs, then still in experimental stages, were not used extensively during World War I, but they laid the foundations for many subsequent developments.

World War I, often called the machine gun war, brought to the foreground the importance of the machine gun as a deadly military weapon. Lloyd George, in a speech before the British house of commons on Dec. 15, 1915, estimated that over 80% of the British casualties to that date had been inflicted by machine gun fire and it is reasonable to assume that the other participants suffered in the same ratio. This great conflict also introduced a hitherto unproved weapon, the airplane, which was destined to be combined with the machine gun as a weapon of war of vast potentiality.

Throughout automatic weapon history, new situations that stimulated design always appeared. By World War I, when the ground-type machine gun had reached a stage of near perfection, aviation provided an incentive that opened up fresh concepts in automatic weapons. Certain features, hitherto unforeseen, became immediately critical. Among these were weight, compactness, high rate of fire, amount of ammunition used in comparison with allowable weight to be carried by the airplane, synchronization to fire through the propellers, mounting of weapons and ejection of empty cartridges and links. At first, with the slow flying speed, these problems were easily overcome; in fact, planes originally carried regular ground-type machine guns with slight modifications for mounting purposes.

Machine gun designers managed to stay ahead of aircraft requirements throughout the 1920s, 1930s and the early part of World War II. However, the advent of jet-powered aircraft in the latter days of World War II introduced a new factor in machine gun design. The problem was to design an extremely light, large-calibre gun shooting an explosive projectile at a very high rate of fire to cope with the supersonic speeds, tremendous stresses and compact design of jet aircraft. However, advances in impact forming had by then developed the art of stamping to such close working tolerances that the forging and machining of receivers, feed mechanisms and internal parts became unnecessary. Metallurgists, successful in the development of new alloys of high tensile strength, found they could replace steel when weight became the important factor. As these things came into being, the weight of the automatic gun was considerably reduced, thus allowing more installations of guns per aircraft and more firepower per pound of weight carried.

To this end scientists and machine gun designers worked constantly to produce reliable, light, compact, rapid-firing automatic guns to keep pace with the ever-advancing aircraft industry. There has been a universal exploitation of systems to take advantage of certain features that are highly adaptable for a specific purpose and to design an automatic firing mechanism having the desired



BY COURTESY OF U.S. DEPARTMENT OF ARMY

FIG. 3.—U.S. MACHINE GUN, M60, ADOPTED IN 1957

qualities. This resulted in a great advance in aircraft automatic weapon design. In 1957 the U.S. army adopted the M60, a lightweight, general purpose machine gun to replace three older calibre .30 machine guns. The gun could be fired from the shoulder, from the hip, from a bipod or from an aluminum tripod mount. It was chambered for the standard 7.62-mm. NATO (North Atlantic Treaty organization) cartridge.

AUTOMATIC GUNS

When aircraft were first used in combat during World War I they were armed with the types of small arms then used in ground warfare, but machine guns specially designed or adapted for mount-

ing in aircraft were soon developed. Some were mounted in open cockpits while others were installed to fire through the propeller—synchronized so as to miss the blades. Before the end of the war, it was evident that a heavier weapon was needed for firing at ground targets such as trucks, locomotives or light tanks. Some of the first attempts at a solution simply placed in the airplane a conventional light fieldpiece with so-called quick-fire breech mechanism. As the recoil energy to be absorbed by the aircraft structure was excessive, it became apparent that specially designed weapons were required. The Puteaux factory in France modified some 37-mm. aircraft cannon designed by Birkigt (of Hispano-Suiza) to fire through the hub of a propeller. But these did not go into service until after World War I. The Germans had placed a 20-mm. Becker gun in a ring mount and found it an effective aircraft weapon. This was the forerunner of the 20-mm. Oerlikon gun of World War II service.

In 1938 the Royal Navy adopted the 20-mm. Oerlikon gun as its standard light antiaircraft weapon on all ships. A short time later the U.S. navy took similar action. During World War II, both Japan and Germany also used the Oerlikon extensively. It was the principal Nazi aircraft gun before and during the battle of Britain.

One of the first automatic aircraft cannon used in World War I was the Revelli (Fiat) which the Italians installed in their large Caproni and Savoia-Pomilio bombers. The calibre of this gun was 25.4 mm. It could fire eight rounds in two seconds from a ring mount. The British Vickers 37-mm. automatic aircraft cannon was installed in British naval aircraft as early as 1915. Its excessive recoil made it unpopular, but during the 1930s, Vickers improved the design and produced some 37-mm. guns which were satisfactory. The size was later increased to 40 mm., and near the end of World War II a few of 57 mm. were produced.

In the United States, a Browning 37-mm. aircraft cannon was used to some extent during World War II. The U.S. government furnished thousands of these weapons to Russia with Bell Airacobra fighter planes. Most U.S. aircraft carried 20-mm. guns of either Hispano-Suiza or Oerlikon type.

The principal gun used by the army air forces was the 20-mm. M1 and AN M2, which operated on a combination gas and blowback principle. It used either a belt-feed mechanism or a 60-round drum magazine. It was mounted as a fixed gun in the wing or fuselage of an airplane, or in a turret. It could also be mounted to fire through the propeller hub. Its rate of fire was 600 to 700 rounds per minute.

The French developed but did not use a 25-mm. Hotchkiss gun. They did not use it because the plant was captured early in the war. Japan, however, made the gun on a licence agreement and used it extensively. The Italian Scotti gun superficially resembled the Oerlikon, but was not used to any extent. The Danish Madsen guns in 20 mm. and 23 mm. were never very popular. The Nazi forces during World War II used several different aircraft guns, among them the Mauser 20-mm., and the Rheinmetall-Borsig in 20-mm. and 30-mm. sizes. The Swedish Bofors plant also produced aircraft guns in 20-mm. and 57-mm. sizes. Breda made some 20-mm. guns for the Italian government.

Most of the early automatic aircraft guns were mounted on flexible rings. However, some were arranged to fire through the propeller hub, and a few, notably types used in heavy U.S. bombers during World War II, were placed in remotely controlled turrets. But the weapon most commonly used in such turrets was the calibre .50 Browning machine gun. As first adopted by the U.S. services, this gun was known as the model 1921. It was made with either water-cooled or air-cooled barrels. The former were for antiaircraft use, the latter, either with flexible or fixed mounts, for aircraft installations. The principal type used during World War II was the M2, which is distinguished from earlier models by the fact that it could be fed either from the right or left side. Older guns fed from the left only. The variants of the M2 included aircraft models (fixed and flexible), heavy-barrel models for ground use and water-cooled models for antiaircraft fire. The aircraft guns could be fired mechanically or electrically either by an accessory or by a manual trigger. Their rate of fire was from 750 to 850 rounds per minute. The AA version had a rate of from 550 to 700 shots per minute, while the heavy-barrel ground gun fired at from 400 to 500 shots per minute. Late in the war an improved gun, the M3, was introduced. Its main distinction was an increased rate of fire—1,200 shots per minute.

In the Korean War the predominant weapon on planes of the United Nations was the calibre .50 aircraft gun. The Soviet MIG-15 planes were armed with a variety of larger calibre, slower firing weapons ranging in size from the calibre .50 to the 37 mm., including a 23-mm. gun with a cyclic rate of 700–800 rounds per minute. To meet the challenge of supersonic jet planes, aircraft guns firing at the rate of several thousand rounds per minute were under development. One adopted by the U.S. air force was a 20-mm. machine gun operating on the revolver principle, with a five-chamber cylinder. Another model unveiled in 1957 was the 20-mm. Vulcan based on the Gatling gun principle. Its six rotating barrels could fire at the rate of about 7,000 rounds per minute. In spite of these developments, aircraft rockets and guided missiles steadily gained ground in competition with conventional machine guns. (*See* ROCKETS AND GUIDED MISSILES.)

SYSTEMS OF OPERATION

Generally speaking, there are five known practical applications for accomplishing sustained fire as outlined in the definition of an automatic gun: (1) residual pressure remaining in the bore a few milliseconds after the projectile has cleared (blowback); (2) gas pressure in the bore bled off externally through an orifice (gas operation); (3) long recoil; (4) short recoil; and (5) blast energy generated by the expanding gases after being released from the confines of the barrel at the muzzle end (muzzle blast actuation). The last application has had only limited development in automatic weapon design and is not further discussed in this article.

Principles of Blowback.—In some guns, all the energy required for the performance of the automatic cycle is obtained through blowback action while in others only a portion of the required energy is from this source, the remainder being derived from some other system of operation. In any event, the blowback effect is present, at least in part, whenever the bolt of a gun is not locked while there is powder gas pressure in the chamber. When blowback action occurs, the energy derived from the pressure of the powder gases appears in the form of kinetic energy transferred to the bolt mechanism by the empty cartridge case as it is blown from the chamber of the barrel; *i.e.*, it appears in the form of a velocity imparted to the bolt mass. The basic problem involved in blowback operation is in the complete control of this velocity so that the gun will operate as desired. There are several well-defined methods by which the control of the rearward motion of the bolt may be accomplished in guns employing blowback and these various methods are referred to as blowback "systems."

Plain Blowback.—This system is used extensively in the design of lightweight shoulder arms chambered for short-range pistol cartridges. This type of weapon is officially designated as a submachine gun—the Thompson calibre .45 submachine gun, for example. The method is also universally employed in construction of small-bore, auto-loading hand arms; *e.g.*, the calibre .22 Colt Woodsman pistol. In the plain blowback system (*see* fig. 4), the

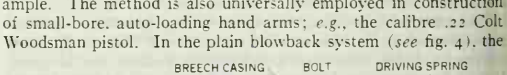


FIG. 4.—SCHEMATIC DRAWING OF PLAIN BLOWBACK SYSTEM

bolt returns to the firing position with relatively low velocity but with considerable kinetic energy and this energy is absorbed by impact before the next cycle starts. Since the bolt is stationary when the new round is fired, all of the explosive force of the round is effective in accelerating the bolt to the rear. As has been explained this condition requires the use of an extremely heavy bolt in order to keep the bolt velocity within safe limits.

Delayed Blowback.—This may be defined as a method of opera

tion in which the bolt remains locked until the peak powder gas pressures have passed and a safe operating limit is reached after the projectile clears the muzzle. The bolt is then unlocked by some means so that it can be blown back by the residual pressure with sufficient energy to perform the remainder of the cycle of operation. In this system, the time at which the bolt is unlocked can be controlled in the design so that any desired portion of the residual pressure can be utilized. Of course, the bolt must be unlocked while there is still sufficient impulse available from the residual pressure to produce the required operating energy.

Any gun in which the bolt is unlocked while residual pressure still exists is subject to some blowback and partakes of some of the characteristics of the delayed blowback system. Such guns include certain gas-operated and short-recoil-operated weapons in which the bolt is unlocked almost immediately after the projectile has left the muzzle. However, in guns of this type, the operating energy does not come solely from blowback but is derived also from the action of the gas piston or from a mechanical accelerator actuated by the motion of the recoiling parts. This system is highly adaptable to large calibre automatic guns, such as the Birkigt 404, Hispano-Suiza and Scotti aircraft weapons.

Retarded Blowback.—In this system a special retarding mechanism is operated by the movement of the bolt. The mechanism itself is composed of relatively light parts and the inertia forces which result when these parts are set in motion by the bolt are therefore relatively small. However, the mechanism is arranged so that the bolt must act through a tremendous mechanical disadvantage to overcome the inertia forces and is accordingly subjected to a very high resistance to motion. In other words, although the bolt and the associated mechanism may be quite light, the effective resistance to bolt acceleration can be made just as great as that which would be obtained by the use of an extremely heavy bolt. The mechanism of a retarded blowback gun is similar to that of a plain blowback gun except for the presence of the retarding mechanism. This can take many forms but the basic principle underlying all of these is that the bolt must overcome the inertia forces in the mechanism by acting through a high mechanical disadvantage. Being unadaptable to large bore weapons, this system is used exclusively in design of machine guns employing rifle or pistol cartridges; *e.g.*, the Schwarzlose and Skoda machine guns.

Advanced Primer Ignition.—A substantial saving in bolt weight and other advantages can be realized by making use of the kinetic energy of the returning bolt. Instead of permitting this energy to be dissipated by impact before the next round is fired, it is possible to time the ignition so the new round is fired just before the bolt reaches its fully forward position. In this method, known as advanced primer ignition, the impulse of the propellant explosion must first slow and stop the returning bolt before it can propel the bolt to the rear. With this action, only a portion of the explosive impulse is effective in blowing the bolt back and the interval of time during which the pressure of the powder gases acts to produce a rearward acceleration of the bolt is also reduced. Both of these effects permit the use of a much lighter bolt and produce a condition in which higher bolt velocities are allowable. Thus, not only can the gun be lighter, but it is also possible to achieve a higher rate of fire. This operation is used exclusively in the design of large bore automatic guns; outstanding examples are the Oerlikon and the German MK-108.

Principles of Gas Operation.—In all machine guns, the fundamental source of operating energy is the high-pressure gas created by the explosion of the propellant charge. This is true, in a general sense, of guns operated by any system of true automatic operation, as defined in this article. In spite of the fact that the ultimate source of operating energy in all machine guns is the pressure of the powder gases, the term gas operation is reserved for a particular type of operating system in which the pressure of the powder gases is employed in a specific way.

In a typical gun which uses the system of gas operation, an opening or port is provided in the side of the barrel. When the projectile has passed this opening, some of the high-pressure gases behind the projectile are tapped off through the hole and pass through an orifice to operate a piston or some similar device for converting the pressure of the powder gases to a thrust. This thrust is then utilized through a suitable mechanism to provide the energy necessary for performing the automatic functions required for sustained fire. These functions include unlocking the bolt, retracting the bolt and operating the other portions of the gun mechanism necessary to perform the complete cycle.

The gas operating mechanism can take many forms. Fig. 5 illustrates a commonly used device, consisting of a simple gas cylinder and a piston which is driven rearward to transfer its energy to the bolt by direct impact. In some cases, the piston may be driven forward instead of rearward, but this does not involve any significant change in the principle of operation. Even the nature of the member which is acted upon by the gas pressure is subject to great variation. Instead of being a conventional piston, this member can be in the form of a sleeve, slide or other device arranged to receive an impulse from the gas pressure.

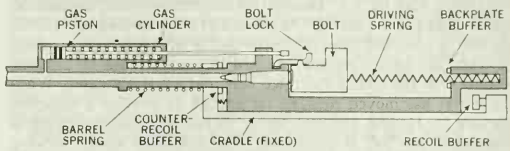


FIG. 5.—SCHEMATIC DRAWING OF GAS-OPERATED SYSTEM

The methods used for transferring energy from the piston to the gun operating mechanism are also extremely diverse in form and function. Instead of transferring energy directly to the bolt, the piston itself sometimes moves through a very short stroke and transfers its energy by impinging on an intermediate sliding member or lever. A great number of devices have been designed to minimize the shock involved in the energy transfer through the use of levers, links or cams. In certain instances, the shock of transfer is reduced by causing the piston to load intermediate springs which subsequently transfer their stored energy to the mechanism. Existing examples of gas-operated guns (*e.g.*, the Hotchkiss) incorporate many ingenious arrangements for tapping the energy in the powder gases and for handling related problems such as sealing, timing and adjustment.

Principles of Recoil.—These principles can be understood best by considering the forces which result from firing a cartridge in an elementary gun. Such a gun consists of a barrel having a chamber at its rear end for receiving the cartridge and a breech closure in the form of a bolt. The bolt is rigidly locked to the barrel after the cartridge is inserted and provides a firm support for the base of the cartridge case so that the case will not be blown out of the chamber by the explosion of the propellant charge. When the cartridge is fired, the explosion of the propellant results in the rapid generation of extremely high gas pressure in the chamber and the expansion of this high-pressure gas drives the projectile forward through the bore. As the powder gases expand behind the projectile, the centre of mass of the gases also moves forward. While the projectile is in the bore, the same pressure which causes the projectile and powder gases to move forward also acts simultaneously at the breech end of the gun to produce an equal and opposite reaction which tends to drive the entire gun to the rear. The force resulting from this reaction is called the recoil force, and the magnitude of this force at any instant depends on the chamber pressure.

The distinguishing characteristic of any recoil system is that energy used for operation is obtained from the recoil movement of

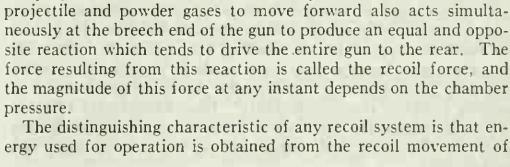


FIG. 6.—SCHEMATIC DRAWING OF LONG RECOIL SYSTEM

the barrel and bolt while these parts are locked together. Any gun in which the bolt is locked to the barrel while there is pressure in the chamber will be subject to some recoil action, but unless the recoil is put to use in actuating the gun mechanism, the weapon is not considered to be recoil operated.

Long Recoil.—This type is defined as an operation in which energy for operating the gun mechanism is obtained from a recoil movement which is greater than the over-all length of the complete cartridge. (*See* fig. 6.) During this entire movement, the bolt remains locked to the barrel. At the end of the rearward movement, the bolt is unlocked from the barrel and is latched in its rear-most position, the barrel moving forward in counterrecoil to pull the chamber off the empty cartridge case and eject the case. When the barrel has moved forward far enough to provide a sufficient opening for feeding, and just before its counterrecoil movement is completed, the bolt is unlatched. The bolt then moves forward for loading and the cycle is completed as the bolt relocks to the barrel (*e.g.*, the Browning 37-mm. aircraft cannon).

Short Recoil.—In this system, the barrel and bolt remain locked and recoil together for a short distance until the powder gas pressure has dropped to a safe limit. The recoil movement then unlocks the bolt and, after unlocking, the barrel is stopped while the bolt continues to move to the rear until the opening between the barrel and bolt is sufficient to permit feeding. It would be possible for the bolt to complete this movement merely by the momentum it possesses at the instant of unlocking, but in all short recoil weapons, in order to speed up operation, the bolt is given additional momentum by an accelerating device which transfers energy to the bolt from the barrel during the short time that the barrel is still moving to the rear after unlocking. Also, unlocking usually occurs before the residual pressure reaches zero and therefore the bolt receives an additional impulse from blowback action. The basic elements of a short-recoil mechanism are shown in fig. 7.

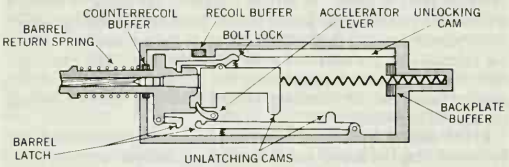


FIG. 7.—SCHEMATIC DRAWING OF SHORT RECOIL SYSTEM

The Browning calibre .30 and calibre .50 machine guns represent this type of action.

See also references under "Machine Gun" in the Index.

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(G. M. CH.; B. R. L.)

MACHINE TOOLS. Of the many power-driven tools that have been developed, machine tools are probably the most important, because it is by means of them that other tools such as those for earth working, materials handling, etc., are made. They are important also because they have made it possible to produce identical parts shaped to sufficiently precise dimensions as to provide complete interchangeability. Interchangeability of parts has made possible the assembly of products on a mass-production scale and the quick and inexpensive replacement of worn and broken parts.

Machine tools are often defined as power-driven machines, ordinarily not portable by hand, which cut, shear, or press metal into desired forms. Though they may be classified in various ways, perhaps the most meaningful arrangement is according to their respective modes of shaping materials, usually metals, which they are designed to work. (*See* table below.) Figs. 1–6 show the basic method of operation of various classes of machine tools.

Although evidence indicated that man first used hand tools during the Early Stone Age (35000 to 15000 B.C.), it is interesting to note that the machine tools listed below were themselves originated and developed in the very short span of about 400 years, beginning in the 16th century. Leonardo da Vinci's records show a lathe with a pole drive apparently in use in the 1500s. The basic tools in this list, however, did not assume their present general forms and characteristics until mechanical power became available during the Industrial Revolution beginning in the latter part of the 18th century. In 1794 Henry Maudslay developed his first all-metal lathe with a sliding tool rest. John Wilkinson improved the lathe for boring purposes in 1776 for James Watt. Maudslay's adaptation of the lead screw to his lathe in 1810 made possible the construction of lathes, planers, and milling machines in quantity and really laid the basis for the modern family of machine tools. By 1840 these tools were fairly well established as productive machines for industrial use. Their objective is two-fold: to provide much greater power than man himself can furnish to form and shape certain of his materials of construction; and to give him skill and precision in this work.

Classification of Machine Tools

Classification	Process	Machine tool
Cutting	Turning	Lathe
	Drilling and boring	Drill press, boring machine, lathe
	Milling	Milling machine
	Planing	Planer
	Shaping	Shaper
	Slotting	Slotter, keyway miller
	Sawing	Power hack saw, band saw, circular saw
	Broaching	Broaching machine
	Filing	Filing machine, band file
	Generating	Hobbing machine, gear generator
Shearing	Shearing	Power shear, rotary shear
	Punching	Punch press, nibbler
Abrading	Grinding	Grinder
	Honing	Honing machine
	Lapping	Lapping machine
	Polishing and buffing	Polishing machine, buffing machine, speed lathe
	Abrasive blasting	Sandblast, shot blast, liquid blast
	Tumbling	Tumbler, tumbling barrel, vibratory bowl
Forming (impact, bending, squeezing and pressing)	Forging and upsetting	Forging press, drop hammer, 2-movable-die impacter, forging machine, die-rolling mill, header, upsetter, explosion forging
	Swaging	Swaging machine, rotary swager
	Hammering	Power hammer, hammering machine
	Bending and forming	Roll bender, press brake, roll forming mill
	Stamping and deep drawing (punching, bending, forming, shallow drawing, swaging, coining, shaving and trimming)	Stamping press, punch press, drawing press
	Extruding	Extruding press, impact press
Other metal-removing processes	Flame cutting	(Special device and energy source for each process)
	Spark disintegration	
	Ultrasonic grinding	
	Electrochemical disintegration	
	Chemical milling	
	Electron or radiation beam disintegration	

The basic machine tools are the lathe (*q.v.*), milling machines, drilling machines, broaching machines, sawing machines, shapers and planers, gear-cutting and metal-forming machines.

Milling Machines.—This class of machines employs a cutting process in which rotary cutters with multiple teeth are used. Flat or formed surfaces usually are produced. Diesinking (*q.v.*) is a milling process involving formed end mills for producing contour surfaces. The cut of each tooth is not continuous but intermittent on the feeding side of the cutter. In general, the cutter, mounted on an arbor fitted into the end of the spindle (a face mill is attached to the end of the spindle), rotates to provide cutting speed, while the work, mounted on the table, is fed into or past the cutter. The commonest operation is plain milling, using a cylindrical or circular section cutter, of the

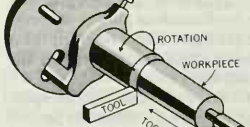

FIG. 1.—BASIC MACHINE-TOOL OPERATIONS: TURNING

profile or formed type, with teeth on its periphery; side or face milling employs a cutter with teeth projecting from its end, while end milling is a combination of plain and face milling. Milling cutters can be made in a variety of shapes for specific operations.

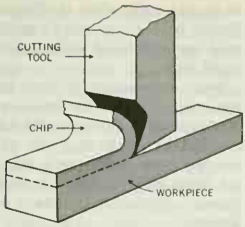

FIG. 2.—BASIC MACHINE-TOOL OPERATIONS: PLANING

Milling machines differ widely in construction and use. A classification may be based on general appearance (column-and-knee or fixed-bed type) or design (plain or universal; bench or floor mounting; horizontal or vertical spindle; hand, mechanical [lead screw], or hydraulic feed) or on the type of work handled (job shop or manufacturing; thread milling and planetary milling; diesinking).

Historically, milling is supposed to have originated in the 16th century; the cutter resembled a circular saw or rotary file with a large number of cutting edges spaced about its periphery. The first successful milling machine was built by Eli Whitney prior to 1818. Simeon North also used a plain miller in 1820 to manufacture firearms. The first universal knee-type miller is believed to have been built in Windsor, Vt., in 1852. In 1855, a fixed-bed or manufacturing type of miller was built by G. S. Lincoln in Hartford, Conn. This used the screw-and-nut table feed instead of the earlier rack and pinion. In 1862, the first fully universal milling machine, equipped with a universal dividing head, was built by J. R. Brown and used for cutting helical flutes in twist drills.

In 1906 the feed mechanism was driven from the single pulley drive shaft (making it possible to express the feed in inches per minute) rather than from the spindle (which gives inches per revolution of the spindle); in other words, it was possible to achieve constant feed per tooth of the cutter for all spindle speeds. The feed in inches per minute is the product of the feed per tooth, the number of teeth in the cutter and the rotational speed of the cutter.

The column-and-knee milling machine is used for general work in small quantity production. A rigid vise rests on the table for holding the work. In the plain type machine three motions of the table are possible (longitudinal, transverse and vertical), while the universal type, having a swivel table, permits a rotational motion. The spindles fixed in the head of the column, either vertically or horizontally, have only a rotating motion. The spindle of the vertical machine may be fixed in the head of the column or provided with a quill to permit the spindle to be fed vertically by hand or power. Hand millers are usually small for light work, of the column-and-knee type. The table is fed longitudinally by hand.

The fixed-bed types, or manufacturing millers, offer rigid construction and simple operation for production of relatively small parts. The spindlehead is adjustable vertically on the column, and the table has only longitudinal feed. Large machines of this general type are called planer millers. Rotary millers, which are usually of the vertical spindle type, have tables provided with fixtures; they are used for mass production in which the cutting is continuous, that is, there is no idle machine time, as the operator loads the fixture in front of the cutter and removes the finished parts prior to loading the next piece. Thread-milling machines are designed to cut threads and worms using form-milling cutters rather than single-point tools.

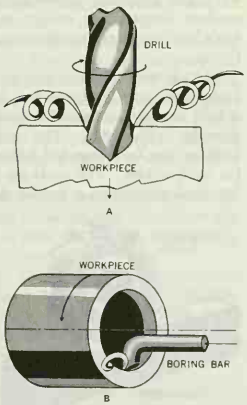

FIG. 3.—BASIC MACHINE-TOOL OPERATIONS: (A) DRILLING AND (B) BORING

The horizontal boring, drilling, and milling machine is provided with a horizontal spindle which is adjustable on the column and may be fed both longitudinally and vertically. The table on which the work is clamped may be fed longitudinally and transversely, or the machine may be provided with a rotary table. An almost unlimited variety of operations of boring, drilling, threading, and milling may be performed on such a machine. Recently developed omnidirectional mills use a traveling, tilting head with quill feed from any angle to complete operations on all sides of a workpiece. Tools are changed rapidly with mechanical assistance. The cutting edges are preset in position in the tool holders so as to cut right to size, with minimum delay for trial and adjustment. Also, greater accuracy is attained, since the workpiece requires no shifting or reclamping between cuts.

Drilling Machines.—A drilling machine, or drill press, is designed to hold a drill or other end-cutting tool in a spindle rotated and fed by power. The size of most drill presses is expressed by the diameter in inches of the largest circle whose centre can be reached by the drill.

Drilling machines are made in many different types and sizes, each designed to handle a class of work or specific job to the best advantage. The classification is based on design or construction, purpose, and application of power. Upright drilling machines, of the single-spindle type for floor mounting, are general purpose machines. They are provided with a wide range of spindle speeds and feeds, and a table, vertically adjustable on the column, on which the work is supported. Tools such as drills, reamers, taps, and counterbores, in interchangeable quick-change holders, may be used successively to finish holes in a part. In production, upright drilling machines are often mounted in gangs of two to eight, on a common base, so that successive operations may be performed on a part as it is passed from one spindle to the next. A multiple-spindle vertical drilling machine may have a fixed number of spindles, radially adjustable in a head so that all holes in one face of a part produced in small lots may be drilled simultaneously. Other multiple-spindle drill presses for mass production have the spindles built on fixed centres into the head for a given job. If the job is changed the head must be replaced.

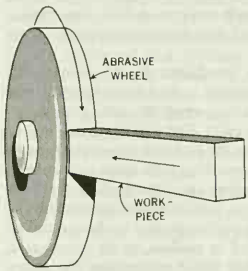

FIG. 4.—BASIC MACHINE-TOOL OPERATIONS: GRINDING

The radial drilling machine carries a spindle in a head mounted on a horizontal arm, the arm in turn being vertically adjustable on a column about which it swivels. The head may be moved radially on the arm, and the spindle moved vertically in the head, by hand or power feed. Radial drills are employed for general utility work, particularly on large castings and weldments. They are rigidly constructed and are provided with a wide range of speeds and power feeds; they may be used to drive drills from one-eighth to three or four inches in diameter, as well as large boring tools, taps, etc.

A deep-hole drilling machine, with one or two horizontal spindles, is used for such work as drilling gun barrels. The barrel is rotated at high speed while a single-lipped, sintered-carbide-tipped drill, provided with a high-pressure system for applying cutting oil at the drill point, is fed into the work. For short work, such as drilling oil holes in connecting rods from the crankpin to the wrist-pin hole, vertical multiple-spindle machines operating on the same principle are used.

Way drilling machines for mass production of parts are built for each job and may consist of several multiple-spindle heads carrying drills, reamers, boring tools, and even milling or threading tools operating simultaneously on one or several faces of the work. These are built in horizontal, vertical, and a combined form. The transfer machine, an outgrowth of the way drill, represents the

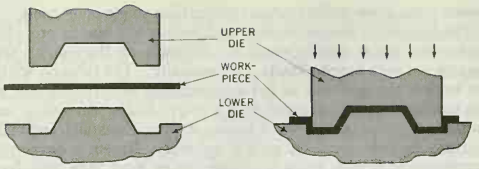

FIG. 5.—BASIC MACHINE-TOOL OPERATIONS: PRESSING; (A) WORKPIECE IN POSITION; (B) DIES CLOSED

ultimate production tool. A complicated part such as a cylinder block is carried on a transfer bar from one machine to the next while it is machined on all surfaces successively and then discharged at the end. All clamping and transfer is automatic.

Boring machines, capable of drilling or boring, are made in a variety of types and sizes for specific jobs. Precision boring for mass production of relatively small parts, such as piston-pin holes, employs one or more horizontal spindles which carry single-point tools with diamond or sintered-carbide tips. These tools operate at very high speeds to finish the previously drilled holes in such parts as bushings and aluminum pistons to great accuracy and smooth finish. The jig borer is used to drill, bore, or finish holes within very close limits in such work as drilling jigs, multiple drilling-head parts, and dies which are accurately spaced. They drill, bore, or ream as required.

Broaching Machines.—These machines finish surfaces by drawing or pushing one or more cutters, called broaches, entirely past the surface. The broaches have a series of cutting teeth, increasing in height from the leading end. The first teeth are low to permit the broach to enter the hole (in internal broaching), or to pass over the surface (in external broaching), to catch any unforeseen high spots. The first few roughing and intermediate teeth remove most of the metal; the last few, taking lighter cuts, finish the hole or surface to size. Broaching machines may be horizontal or vertical. The broach may be pulled or pushed, or, in some cases, work is held in fixtures on a chain belt which moves past stationary broaches. Most machines are operated hydraulically.

Many broaching operations are completed in the time ordinarily taken to clamp the piece. Broaching is superior to reaming because the broach will hold its size for a much longer time, thus insuring greater accuracy. Other advantages are the good finish, great speed of production, interchangeability of work, and adaptability of the broach to produce irregularly shaped holes or forms, such as splines. The broach will machine many more pieces before regrinding than any other type of cutter, because of the great number of teeth. Each tooth removes but a few thousandths of an inch of metal because the total depth of cut is proportioned over the total number of teeth.

Sawing Machines.—Saws for parting metals consist of thin disks of metal with cutting teeth on the periphery, or a band of metal with teeth formed on one edge. To eliminate binding between the cut surfaces and the side of the saw, either the teeth are "set" (bent alternately to each side) or the blade below the edge of the cutting teeth is hollow-ground. The width of the groove cut by the saw blade is called the kerf.

Three types of metal-sawing machines in common use are the hack saw, band saw, and circular saw. The power hack saw has a short, straight blade that is mounted under tension in a frame and reciprocated over the work in a straight line. The teeth are forced against the work on the cutting stroke by gravity, spring pressure, hydraulic pressure, or positive screw feed, but lifted on the return stroke to avoid dragging the cutting teeth over the work. The reciprocation on small machines is by crank and connecting rod. On some of the larger machines this is done by crank or hydraulically. The smallest machine of the reciprocating blade type is known as the jig saw. The blade, clamped at its lower end, moves vertically through an opening in a horizontal table. The power hack saw has a vise under the saw for clamping the work. The small machines will take work up to 4 in. square in section and the largest up to 14 in. The small machine uses blades from 12 to 18 in. in length, while the largest machine uses blades up to 24 in. Blades have from 4 to 18 teeth per inch, the coarse teeth being used for large, solid work and the finer teeth for tubes, sheets, and small bars.

Band saws employ a long, endless strip of steel with teeth on one edge, carried over two large-diameter rotating wheels. This blade passes down through a table on which the work is mounted and fed by hand or screw into the saw. A guide to prevent the saw from deflecting is adjustable just above the work. The machines vary in size with bands from $\frac{1}{4}$ in. to 18 in. in width. Power is applied to the lower wheel and the sawing action is continuous.

Circular saws have disk-shaped blades that may be classified in three groups: cold sawing, abrasive disk, and high-speed friction disk. Cold sawing is a milling operation using thin, metal-slitting saws of any desired diameter and the correct number of teeth and tooth shape for any metal. Standard milling machines are used with light cuts per tooth and conventional cutting speeds of 50–150 ft. per minute (fpm) with high-speed steel cutters on hard to soft steel, or 400–1,000 fpm for brass and aluminum. For large cold saws, 12–72 in. in diameter, special machines are constructed. These machines may be used to cut a bundle of bars or one large bar at a time, held rigidly in a vise. Abrasive disks made of silicon carbide for cast iron and nonferrous metals, or aluminum oxide for steel, are produced in wheels from $\frac{1}{16}$ to $\frac{1}{8}$ in. thick and up to 14 in. in diameter. These wheels are particularly effective on hard, abrasive material and may be run safely at 12,000–16,000 fpm. They are interchangeable with steel-friction saws.

Steel-friction disks are carefully balanced and hollow-ground, usually with teeth hobbed or notched in the edge. These saws range up to 60 in. in diameter and $\frac{3}{8}$ in. in thickness and are run at peripheral speeds of 18,000–20,000 fpm. This speed and the pressure against the work melts the metal and carries it away. Hot or cold bars may be parted, and rails, channels, etc., from rolling mills can be cut to length in a matter of seconds.

Shapers and Planers.—The shaper was developed to machine flat surfaces on small work. The tool is held in a holder, supported on a clapper, in the head at the forward end of a ram. The ram reciprocates in a straight line, while the table, carrying the vise and work, feeds transversely on each return stroke. The clapper which carries the tool post is hinged near its top. On the cutting stroke the tool forces the clapper against its rigid seat; on the return stroke it swings outward about its hinge, as the tool is dragged back over the work, thereby relieving the cutting edge of excessive wear and reducing danger of chipping.

Shapers may be classified as horizontal or vertical (slotters), according to whether the ram operates horizontally or vertically; or they may be classed as plain or utility shapers for general light work and standard, heavy-duty, and production shapers. Most modern shapers are driven by self-contained motors, and the table has both rapid traverse and power feed, horizontally and vertically.

The planer was developed to machine flat surfaces on small or large work, too large for the shaper. The work to be machined is held in a vise or fixture bolted to the table, or it may be clamped directly to the table. The table is reciprocated past the cutting tools as the tools are fed horizontally, vertically, or at an angle for each stroke. The tools are held in a clapper box on a swiveling head carried on a saddle mounted on a horizontal rail. The head is fed horizontally on the rail. Sometimes two heads are provided on the rail, and a third is mounted on the face of the housing. Large planers may take work 6–8 ft. in section and up to 30–40 ft. in length.

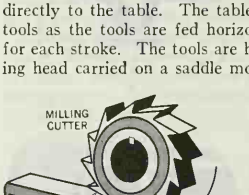

FIG. 6.—BASIC MACHINE-TOOL OPERATIONS: MILLING

Gear-Cutting Machines.—There are six types of gear-cutting machines. For a composite tooth form a standard knee-type miller with dividing head is used for jobbing work. For large quantities

of these gears a special production miller is used which automatically repositions the gear blank after each tooth is cut. The cutter has the approximate shape of the generated space between two teeth. This process is nongenerating and requires eight form cutters for each pitch for all gear teeth. The gear planer uses a cutter in the form of a short rack which cuts on its end as it is reciprocated across the face of the gear blank while the gear blank rolls with it, similar to a gear meshing with a rack. The gear shaper uses a disk-type cutter of the shape of a finished gear. It cuts on its end while reciprocated across the face of the blank as the two are rolled in unison. The gear-hobbing machine uses a cutter or hob consisting of a series of rack teeth arranged in a helix around the periphery of a cylinder. As the hob rotates continuously in unison with the blank to provide the generating action, it is fed across the face of the blank. The teeth of straight-tooth bevel gears are generated but, because of the tapered form, a special type of machine is needed to cause the single-tooth cutters of the rack shape to reciprocate along the cone of the pitch surface. Lastly, the spiral-bevel or hypoid-gear generator uses a cutter with single teeth of rack shape, arranged in a circle on the end of a disk, somewhat like those of a face mill. As the cutter is fed into the proper depth, it is rolled with the bevel-type gear blank to create the generating motion.

For precision gears, tooth profiles may be refinished, particularly after hardening, by special grinding or lapping machines, or by shaving. The gear-shaving machine runs the cutter and work-gear together under pressure with their axes slightly crossed, similar to the arrangement for lapping. The cutter of hardened steel is provided with multiple radial slots to form cutting edges on the tooth face. These have a side-sliding motion on the gear tooth to remove thin chips. (*See* also GEARS.)

Metal-Forming Machine Tools.—This large class includes machines used to shear, bend, draw, squeeze, coin, upset, swage, circle-cut, flange, forge, press, hammer, horn, and wire. In all these machines a movable ram works against an anvil. Power to the ram may be furnished by gravity; mechanically by a crank, cam, toggle, or knuckle joint; or through hydraulic or pneumatic systems. The machines may have one, two, or three rams on moving slides. The two-ram machine may blank and draw a part; the three-ram may blank with one ram, hold with the second, and form with the third. Dies, usually made in mating pairs, are an integral part of the equipment. One member of the pair is mounted on the fixed bed, or platen, of the press, and the other is attached to the lower end of the moving ram.

Flat sheets or plate stock are cut by squaring shears using a shearing action developed between a pair of straight cutting blades. The shearing action, called blanking, is employed also to cut a variety of shapes from a flat sheet. The press brake, similar to the shear, is equipped with either punching dies or bending dies to form edges.

Power presses are made in a large variety of types and sizes, some weighing nearly 1,000,000 lb. The dies used in stamping presses may also be very complicated. Cutting dies are made either plain, for one operation of punching or blanking; progressive, for performing successive operations; compound, to pierce and blank; multiple, and combination, to cut and shape. Shaping dies may be classified as bending, curling, drawing, or compression dies.

Presses are made automatic and safe in operation by feeding strip metal from rolls to the dies and removing the scrap from the dies. Some presses are combined to pass the parts automatically from one to another for a series of operations.

Forging machines are also made in several types, some vertical, some horizontal. They range from the small upsetting machine that makes balls, screw blanks, springs, etc., from wire, to the large steam forging hammer for making drop forgings in dies and the large hydraulic presses which forge parts weighing many tons.

Auxiliary Equipment.—Numerical control, using punched cards or tape or magnetic tape to direct the path or locations and rates of cutting, is being applied to many machines. It has great economic value in obtaining high accuracy and uniformity of complicated parts. As with any costly equipment, the time for checking and adjustment should be minimized. Cutting tools dimensionally preset or automatically adjusted in response to measuring devices built into the machine are essential to numerical control and desirable in any high-production machine. Similarly, the time and effort of handling, inspecting, and sorting workpieces is minimized by all sorts of hoists, mechanical positioners, storage and delivery conveyors, and easily read integrated inspection devices which might mark the piece or select its route through the handling system.

New processes for materials difficult to machine by conventional methods are rapidly developing. In some instances, processes using such sophisticated "tools" as laser beams provide the only solution. These unconventional (nonmachining) processes are described in the article METALWORKING PROCESSES.

See also references under "Machine Tools" in the Index.

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MACH NUMBER, named for the Austrian scientist Ernst Mach (*q.v.*), is the ratio of a flow velocity to a velocity of sound (*see* SOUND: *Analysis of Sound Propagation.*) The speed of sound varies with temperature, and thus with altitude, but at sea level is approximately 760 m.p.h. The most commonly used Mach number is the "free-stream Mach number" defined for the flow about a body immersed in a uniform free stream. This number is the ratio of the uniform velocity in the free stream to the sound speed there. It is the same as the "flight Mach number," the ratio of the velocity of a vehicle flying in an atmosphere to the sound speed in the atmosphere. The free-stream Mach number is the most important parameter characterizing the flow field and aerodynamic forces. A flow is termed "incompressible" if this number is negligible; "subsonic" if it is not small but significantly less than one, as 0.80; "transonic" if it is approximately one; "supersonic" if it is significantly greater than one, as 1.75; and "hypersonic" if it is much greater than one.

The "local Mach number" is the ratio of the local flow velocity in a steady flow of a gas to the local sound speed. If this number is less than one the partial differential equations governing the flow field are locally of elliptic type. If this number is greater than one the equations are locally of hyperbolic type. If the flow is sufficiently close to a uniform flow, the local Mach number may be approximated at each point by the constant free-stream Mach number, and the differential equations of motion by linear ones. (W. D. Hs.)

MACHRAY, ROBERT (1831–1904), first primate of the Church of England in Canada, was born at Aberdeen, Scot., on May 17, 1831, and educated at Aberdeen and Cambridge universities. He was ordained in 1855 and in 1865 was appointed to be the second bishop of Rupert's Land. For the next 40 years he was undoubtedly the outstanding churchman in Canada. When in 1877 the University of Manitoba was constituted, the government appointed Machray to be its chancellor, a post he held until his death. His first diocesan conference was attended by 10 priests and 18 lay delegates; at his death in 1904 the province over which he presided as metropolitan consisted of nine fully constituted dioceses. In 1889 proposals were made for the constitution of the Church of England in Canada as a fully independent church within the fellowship of the Anglican communion. This was a natural step in view of the unification of the country through improved communications and its progress in the political field toward the status of an independent nation. On Sept. 18, 1893, Machray was unanimously elected to be the first primate of the church. He died on March 9, 1904, at Winnipeg, Man.

BIBLIOGRAPHY.—R. Machray, *Life of Robert Machray* (1909); H. H. Walsh, *The Christian Church in Canada* (1956); P. Carrington, *The Anglican Church in Canada* (1963). (S. C. N.)

MACHYNLLETH, an urban district and market town in the Montgomeryshire parliamentary division of Wales, 10 mi. E.N.E. of Aberdovey and the coast and 40 mi. W.N.W. of Montgomery by road. Pop. (1961) 1,904. Lying in the Dyfi (Dovey) valley on

the threshold of mountainous country, it is a centre for anglers and for tourists. In 1291 a charter was obtained which established the Wednesday market and the two annual fairs. Owen Glendower held a parliament at Machynlleth in 1404, allegedly in a house (now the town institute) opposite Plâs Machynlleth, a manor with a spacious park given to the town by Lord Londonderry. The woolen and tanning industries flourished in the 19th century.

MACIÀ, FRANCESC (1859–1933), Catalan nationalist, a leading figure in the struggle for home rule for Catalonia in Spain, was born at Villanueva y Geltrú on Oct. 21, 1859. He became a military engineer and rose to the rank of colonel. On a wave of regional enthusiasm aroused by his action against anti-Catalanist military demonstrators in 1905, he was elected to the *Cortes*. Thereafter he was prominent in the Catalan separatist movement, founding the Estat Català in 1922. Exiled under Primo de Rivera, he organized the unsuccessful Prats de Molló attempt to overthrow the government in 1926. When he returned to Spain after the fall of the dictatorship he created the coalition of Catalan left republican parties (Esquerra Republicana) that won the municipal elections of April 12, 1931. Two days later, before the republic was established in Madrid, he was acclaimed president of the Catalan republic. He compromised with Madrid over the status of Catalonia, and on Sept. 9, 1932, the constituent *Cortes* passed the statute of autonomy. Macià, known as *l'Avi* ("Grandfather"), became first president of what was called the *Generalitat* of Catalonia (*see* SPAIN: *History*.) He died in Barcelona on Dec. 25, 1933. (H. F. Gr.)

MACÍAS (O NAMORADO) (fl. 1340–1370), the last of the Galician *trobadores*, is best known as the protagonist of a legend attributing his death to a lance wound at the hands of his lady's jealous husband. This story, fancifully derived from one of Macías' own poems and enriched by Arabic and other accretions, is a peninsular representative of the universal courtly tradition of the love martyr, and has been since the 15th century a favourite theme of Spanish writers, including, among many others, Lope de Vega and Mariano José de Larra (*qq.v.*). Macías' poems are preserved in the 15th century *Cancioneira de Baena*.

See H. A. Rennert, *Macías, o Namorado* (1900; Spanish trans. 1904; 2nd ed., 1941). (F. S. R.)

McINTIRE, SAMUEL (1757–1811), U.S. architect and craftsman, known as "the architect of Salem," was born in Jan. 1757 in Salem, Mass. One of a family of substantial housewrights, he was at 23 already working for his chief patron, the merchant Elias Hasket Derby. The solid foursquare house he created for Jerathmeel Peirce, with details derived from an English handbook, Batty Langley's *Treasury of Designs* (1740), was one of the finest houses of New England in the post-Revolutionary period. His academic style was exemplified in the Salem court house (1785; demolished 1839) and culminated in a competitive design of 1792 for the Capitol in Washington, based on plates in James Gibbs's *Book of Architecture* (1728). Charles Bulfinch meanwhile had introduced to New England the style of Robert Adam, with its attenuated proportions, its classic ornaments often cast in composition and its greater variety of forms of space, with rooms oval and circular. McIntire studied Bulfinch's first houses, and from 1793 he adopted their style and carved many of their chief ornaments. Bulfinch made the first designs, and McIntire the final ones, for the lavishly decorated Derby mansion begun in 1794 (destroyed in 1815). In numerous houses McIntire placed his stamp on the town in the prosperous early years of the 19th century.

His carvings included busts, reliefs and the decorations of ships and furniture. Sofas, chairs and other pieces he carved with his typical eagles, baskets of fruit, draperies and pendants of the greatest delicacy. Over 100 pieces survive, constituting the most impressive body of U.S. furniture of the Sheraton style. Works of this modest craftsman and sober citizen, who never traveled more than a few miles from his native town, adorn the leading U.S. art museums.

McIntire died in Salem on Feb. 6, 1811.

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MACINTOSH, CHARLES (1766–1843), Scottish industrial chemist after whom "macintosh" raincoats were named, was born in Glasgow on Dec. 29, 1766, and died near Glasgow on July 25, 1843. He improved the manufacture of dyes, mordants and iron, and he devised the process for making dry bleaching powder. He applied the solubility of india rubber in naphtha to cement together two thicknesses of rubber and so make waterproof fabrics.

See George Macintosh, *Biographical Memoir of . . . . Charles Macintosh, F.R.S.* (1847). (D. McK.)

MACIP (MASIP), **VICENTE JUAN** (also called JUAN DE JUANES or JOANES) (?1523 or earlier–1579), Spanish artist, one of the chief Valencian painters of the third quarter of the 16th century, was the son of another Valencian painter, Vicente Juan Macip the elder. Most of his work was done in Valencia, and he died in nearby Bocairente on Dec. 21, 1579. He may have studied in Italy, since his style is largely a provincial adaptation of the manner of Leonardo da Vinci's followers, with the addition of some Florentine motifs. But his paintings also display strong Flemish influence, and the Italian elements may have been derived from the works of italianizing Flemings, which abounded in Spain and which were probably also the source of Macip's somewhat grotesque realism.

Almost all Macip pictures are religious; the "Last Supper" and the scenes from the life of St. Stephen, in the Prado museum, Madrid, are among the best known, and he painted many versions of Christ as *Salvator Mundi*. (N. Mn.)

MACK, CONNIE (CORNELIUS MCGILLICUDDY) (1862–1956), U.S. baseball manager, the "grand old man" of major league baseball in the first half of the 20th century, managed the Philadelphia Athletics from 1901 to 1950, during which period they won the American league pennant nine times and the world series five times (1910, 1911, 1913, 1929 and 1930). Born in East Brookfield, Mass., on Dec. 23, 1862, and christened Cornelius McGillicuddy, he shortened his name so that it would fit on a scoreboard. A catcher, Mack entered organized baseball with his home town team in 1883, moving the next year to Meriden, Conn., then to Hartford, Conn. (1885). With Washington, D.C. (1886–89), Buffalo, N.Y. (1890) and Pittsburgh (1891–96), he played 695 games with a lifetime batting average of .252.

Mack caught in 664 major league games and occasionally played first base or in the outfield. He was catcher-manager of the Milwaukee, Wis., club of the Western association from 1897 to 1901, and in 1901 became manager and part owner of the Athletics and helped establish the American league (*see* BASEBALL: *Later History*). He spent 65 years in baseball, retiring in 1951. He died in Philadelphia, Pa., on Feb. 8, 1956. (J. D. McC.)

MACKAY, CHARLES (1814–1889), Scottish writer, was born at Perth on March 27, 1814. As editor of the *Glasgow Argus*, he made his reputation in 1846 with the publication of *Voices from the Crowd*. He wrote songs, including "Cheer, Boys! Cheer!" some of which were set to music by Henry Russell and Sir Henry Bishop (published 1855). Also, he wrote *Memoirs of Extraordinary Public Delusions* (1841) and edited *A Thousand and One Gems of English Poetry* (1867). Mackay died in London on Dec. 24, 1889. Marie Corelli (*q.v.*) was his daughter. His son, Eric Mackay (1851–99) wrote *Love Letters of a Violinist* (1886).

MACKAY, CLARENCE HUNGERFORD (1874–1938), U.S. capitalist and philanthropist, who as president of the Mackay system of telegraphs and cables directed the completion of the first trans-Pacific cable between the United States and the far east in 1904, was born at San Francisco, Calif., on April 17, 1874.

The foundations for his career were laid by his father, John William Mackay (1831–1902), California and Nevada miner, born in Dublin, Ire., Nov. 28, 1831, whose parents brought him to New York in 1840. When he was 21 he sailed for California to try his luck in the gold fields. Working with pick and shovel in the Sierra Nevada mountains, and later in western Nevada, John Mackay learned mining engineering and geology through experience. In 1873, he and his partners, James C. Flood, William O'Brien and James G. Fair, discovered the big bonanza of the

Comstock lode that yielded approximately $120,000,000 in the next five years. With James Gordon Bennett, Mackay organized the Commercial Cable company in 1883, succeeded in breaking the communications monopoly of the Western Union Telegraph company directed by Jay Gould and established the competing Postal Telegraph company.

In 1907, the company, of which Clarence Mackay had become president after his father's death, placed a cable in service between New York and Cuba and later established cable communication with southern Europe by way of the Azores and with northern Europe through Ireland. He was the first, in 1928, to combine radio, cables and telegraphs under one management.

As a patron of the arts and education, Mackay served as chairman of the board of the Philharmonic Symphony society of New York, trustee of the Metropolitan Museum of Art and director of the Metropolitan Opera company. In memory of his father, he and his mother presented the University of Nevada with the Mackay school of mines. This and a subsequent series of gifts to that university totaled more than $1,500,000.

Mackay was a member of the French Legion of Honour, and in 1931 Pope Pius XI made him a Knight of Malta, the highest Catholic lay honour. He died in New York city Nov. 12, 1938. (W. T. J.)

McKAY, DONALD (1810–1880), U.S. shipbuilder and naval architect, builder of the largest and fastest clipper ships, was born Sept. 4, 1810, in Nova Scotia. He moved to New York city in 1827 and was apprenticed ship carpenter to Isaac Webb. His indenture completed, he worked at this trade in New York and Newburyport, Mass. In 1845 McKay established his own shipyard at East Boston, Mass., and there designed and built the ships that gave him his reputation. His first, the "Stag Hound," launched 1850, was followed by many others. His "Lightning" sailed 436 nautical miles in 24 hours, at times reaching a speed of 21 knots. The "Great Republic" registered 4,555 tons when completed and was the largest clipper ship built.

By 1855 the demand for these specialized ships was over and McKay closed his yard. In 1863 he equipped the yard to build iron ships and built several vessels for the U.S. navy, one of which was the monitor "Nausett"; but he was not financially successful in this work. His last sailing ship, the "Glory of the Seas," built in 1869, lasted until 1923. McKay died at Hamilton, Mass., on Sept. 20, 1880. *See* also CLIPPER SHIPS. (M. R. D.)

MACKAY, HUGH (*c.* 1640–1692), Scottish general, was born in Scourie, Sutherlandshire. He entered Douglas' (Dumbarton's) regiment of the English Army (later the Royal Scots) in 1660, and accompanied it to France when it was lent by Charles II to Louis XIV. In 1669 he was in the Venetian service at Candia, and in 1672 he was back with his old regiment, taking part in the invasion of Holland. Convinced that he was fighting in an unjust cause, he resigned his commission to take a captaincy in a Scottish regiment in the Dutch service. In 1685 he returned with the Scots Brigade to England to assist in the suppression of the Monmouth rebellion. He went back to Holland, and in 1688 when William, prince of Orange, sailed for England, Mackay's division led the invading corps. As major general commanding in chief in Scotland, he had to deal with the insurrection headed by Viscount Dundee. Dundee was killed in the Battle of Killiecrankie (July 27, 1689) but Mackay was severely defeated. He was killed three years later at the Battle of Steenkerke (*q.v.*). Mackay is credited with introducing the ring bayonet that replaced the plug bayonet; its haft was not inserted in the muzzle but was held to it by rings (*see* BAYONET).

MACKAY, a seaport on the northeast coast of Queensland, Austr., 600 mi. N. of Brisbane by rail. Pop. (1961) 16,809. The city is situated on the Pioneer river, and the district is bounded by the Clarke and Leichhardt ranges, the highest peak being Mt. Dalrymple (4,190 ft.). The climate, which is moderate generally, is very good during the main tourist season, from April to October. The average annual rainfall is 70 in. The chief industry is the manufacture of sugar, and others are dairying, sawmilling and the production of power alcohol (ethyl alcohol suitable for use as a fuel in internal-combustion engines), industrial methylated spirits and other sugar by-products. Large deposits of coal exist in the hinterland area, and copper mining is undertaken in a small way. Tropical fruits (bananas, pawpaws and pineapples) are grown. A sugar research institute was established there in 1953.

Mackay has a deepwater artificial harbour, about three miles north of the city. It is served by daily air and rail links north and south.

MacKAYE, PERCY (1875–1956), U.S. poet and dramatist, an advocate of civic theatre and a significant figure in the development of the modern pageant in the U.S. (*see* PAGEANT). The son of Steele MacKaye (*q.v.*), he was born in New York city on March 16, 1875. After graduating from Harvard in 1897, he traveled and studied abroad (1898–1900).

After his return to the United States, MacKaye lectured in schools and colleges and wrote *The Civic Theatre* (1912), advocating amateur community theatricals. The pageants he wrote encouraged community participation. They included *The Canterbury Pilgrims*, produced at Gloucester, Mass., in 1909 with a cast of 1,500, and *The Pageant and Masque of St. Louis* (Thomas Wood Stevens, co-author), performed in St. Louis, Mo., in 1914 with 7,500 participants. In 1948 MacKaye received the Academy of American Poets fellowship award for his cycle of four plays, *The Mystery of Hamlet, King of Denmark* (1945). He died at Cornish, N.H., on Aug. 31, 1956.

MacKaye's many other works include poetry, plays, essays and a biography of his father (1927).

MacKAYE, (JAMES MORRISON) STEELE (1842–1894), U.S. playwright, actor, theatre manager and inventor, a brilliant man of many talents who was, perhaps, the closest approximation to the Renaissance man produced by the United States in the 19th century. He was born in Buffalo, N.Y., June 6, 1842. In his youth he studied painting with Hunt, Inness and Troyon. A pupil of Delsarte and Régnier, he was the first American to act Hamlet in London (1873). At Harvard, Cornell and elsewhere, he lectured on the philosophy of aesthetics. In New York city he founded the St. James, Madison Square and Lyceum theatres.

MacKaye wrote 30 plays, including *Hazel Kirke* (performed many thousands of times), *Paul Kauvar*, *Money Mad*, etc., acting in them in 17 different roles. He organized the first school of expression (which later became the American Academy of Dramatic Art) and originated "harmonic gymnastics"; initiated overhead lighting (1874); invented the first moving "double stage" (1879); and invented folding theatre seats. In all, he patented over 100 theatrical inventions.

At the Chicago World's fair of 1893, MacKaye projected the world's largest theatre, his Spectatorium (seating 12,000, with 25 moving stages), revolutionizing stage production and anticipating motion pictures. Financial difficulties prevented completion of the theatre—the first production was to be *The World Finder*, a saga of Columbus, for which Dvorak composed his *New World Symphony*—but a scale model was later successfully demonstrated.

Though he is best remembered for *Hazel Kirke*, MacKaye's chief importance actually lies in the area of stage production and in his influence toward higher professional standards and ethics in the theatre. He died at Timpas, Colo., Feb. 25, 1894.

See Percy MacKaye, *Epoch: the Life of Steele MacKaye*, 2 vol. (1927). (S. W. H.)

MACKE, AUGUST (1887–1914), German painter, one of the leaders of the Blue Rider school, was born on Jan. 3, 1887, at Meschede, Westphalia. His youth was spent in Cologne and Bonn, and he studied art from 1904, at the Düsseldorf academy and later in Berlin with Lovis Corinth. He was influenced, particularly in his earlier work, by the older Impressionists, Cézanne, Matisse, Picasso and the Cubists. He also visited Paris, Holland and Italy. The period of his independent creation embraces the years 1909–14.

With Kandinsky, Jawlensky and Marc, Macke was one of the most important representatives of the Blue Rider group of painters from which Expressionism in Germany originated (*see* PAINTING: *Expressionism and the German School: Der Blaue Reiter*). His art combines the tradition of French painting, its sense of the

grace of movement and atmosphere in landscape painting, with the cosmic sentiment of German art, without losing itself in the subtle and problematical. A journey to Tunis in the spring of 1914 inspired some of his most beautiful pictures.

Macke was killed in World War I at Perthes-les-Hurlus, Champagne, on Sept. 26, 1914.

McKEESPORT, a city in Allegheny county, southwestern Pennsylvania, U.S. Approximately 10 mi. S.E. of Pittsburgh's "golden triangle," the city was founded at the junction of the Monongahela and Youghiogheny rivers. The former has long been an important avenue for the movement of coal and steel, essential elements in the industrial complex of the Pittsburgh (*q.v.*) standard metropolitan statistical area, of which McKeesport is a part. In the early 1960s about half of the community's working force was engaged in steel production.

The first settlement was made about 1755 by David McKee, who operated a ferry there, and the town was platted in 1795 by his son John. It did not develop appreciably until the basic ingredients of the U.S. steel industry (coal, iron and railroads) had progressed in the late 19th century. Coal mining in the area began about 1830. The G. C. Murphy chain of variety stores originated there in 1896. McKeesport was incorporated as a borough in 1842 and chartered as a city in 1890. It was a centre of dissident activity during the Whisky insurrection (*q.v.*) in 1794.

For comparative population figures *see* table in PENNSYLVANIA: *Population.* (P. R. J.)

McKEES ROCKS, a borough of Allegheny county, Pa., U.S., on the Ohio river, 3 mi. from downtown Pittsburgh (*q.v.*). Producing a variety of small iron and steel products, it is an integral part of Pittsburgh's industrial complex. As industry expanded, the population declined slowly from a peak of 18,116 in 1930. Through an extensive rebuilding program launched in 1954, McKees Rocks was among the first suburbs to share in Pittsburgh's renaissance.

The first permanent homes in the area were built near a 100-ft. cliff overlooking the Ohio river, shortly after Pontiac's conspiracy of 1763. The cliff, later cut away for a railroad bed, was the site of an Indian burial mound. The borough, which was incorporated in 1892, was named for the imposing rock formations along the river and for Alexander McKee, a pioneer settler. For comparative population figures *see* table in PENNSYLVANIA: *Population.* (J. A. KE.)

McKENNA, REGINALD (1863–1943), English statesman noted for his naval construction program before World War I, was born in London on July 6, 1863, the fifth son of W. C. McKenna, a civil servant. He was educated abroad, at King's College school, London, and at Trinity hall, Cambridge, where he studied mathematics. In 1895 he entered parliament as Liberal member for North Monmouthshire. He made a name for himself by a well-informed attack on one of Austen Chamberlain's budgets and when his party took office in 1905, McKenna became financial secretary to the treasury, entering the cabinet as president of the board of education in 1907. H. H. Asquith made him first lord of the admiralty in 1908, where he supported a full program of naval construction against the pacifist wing of the cabinet. The continuance of Britain's lead in battleships down to the outbreak of World War I was thus in part his achievement. In 1911 acute differences with Lord Haldane, the war minister, over the roles of the navy and army in war led to his changing offices with the home secretary, Winston Churchill. McKenna became chancellor of the exchequer in May 1915 and was responsible for two wartime budgets, a task well suited to his cool, statistical mind. At the end of 1916, Lloyd George, whom McKenna disliked, succeeded Asquith as prime minister. McKenna at once resigned. He lost his seat in 1918 and became chairman of the Midland bank in 1919. Bonar Law offered him the chancellorship of the exchequer in 1922 but McKenna, though in sympathy with the Conservatives, declined. A similar offer was made by Stanley Baldwin in 1923, and this he would have accepted, had it been possible to find him a safe seat. He never returned to politics and remained chairman of the bank till his death on Sept. 6, 1943.

(R. N. W. B.)

MACKENNAL, ALEXANDER (1835–1904), English Congregational minister prominent in the Free Church federation, was born at Truro in Cornwall, on Jan. 14, 1835, the son of Patrick Mackennal, a Scot, who had settled in Cornwall. In 1848 the family moved to London, and at 16 Mackennal went to Glasgow university. He entered the Congregational ministry in 1858, and from 1877 to his death was pastor of the Congregational church at Bowdon, Cheshire. In 1887 he was chairman of the Congregational union. In 1892 Mackennal became associated with a movement for free church federation which developed out of a series of meetings held to discuss the question of home reunion. Out of this grew the Free Church federation, of which Mackennal was secretary for six years. Mackennal was a lifelong advocate of international peace and made a remarkable declaration as to the Christian standard of national action when the Free Church federation met at Leeds during the South African War in 1900. He died at Highgate, London, on June 23, 1904.

See D. Macfadyen, *Life and Letters of Alexander Mackennal* (1905).

MACKENSEN, AUGUST VON (1849–1945), German field marshal, one of the most successful commanders in World War I, was born at Haus Leipnitz in the Wittenberg district of Saxony on Dec. 6, 1849, the son of a land agent. He joined the 2nd Death's Head hussars in 1869 and served in the Franco-German War of 1870–71 as a regimental officer. Appointed to the general staff in 1882, he accompanied the German emperor William II on his journey to Palestine in 1898. In 1908 he was given command of the XVII corps on the Vistula. Early in World War I he commanded the 9th army on the eastern front and was successful against the Russians at Kutno, Lodz and Lowicz. He took command of the combined German-Austrian 11th army in western Galicia in April 1915 and, ably assisted by his chief of staff, Hans von Seeckt, achieved the great German breakthrough in the Gorlice-Tarnów area. He was rewarded by promotion to field marshal on June 20, 1915. This was the beginning of a run of victories for Mackensen: the defeat of the Russians at Brest-Litovsk and at Pinsk (Aug.–Sept. 1915), the overrunning of Serbia (Oct.–Nov. 1915) and the occupation of Rumania (1916–17).

After the armistice of Nov. 1918 Mackensen was interned by the French until Dec. 1919. He retired from the army in 1920 and was made a state councilor in 1933. He died near Celle on Nov. 8, 1945. His *Briefe und Aufzeichnungen aus Krieg und Frieden* was published in 1938. (C. N. B.)

MACKENZIE, SIR ALEXANDER (1764–1820), North American explorer, was born in 1764 at Stornoway, Island of Lewis, Scot. Emigrating to North America, he entered a Montreal trading firm in 1779 which in 1787 amalgamated with the Northwest Fur company, the recently established rival to the Hudson's Bay company. In 1788 Mackenzie and his cousin Roderick set up on Lake Athabasca the trading post Fort Chippewyan. This was the starting point of Mackenzie's expedition in 1789 to discover the water passage believed to link the Great Slave lake with the Northern ocean. He followed the river now named after him to its delta in 69° N. on the Arctic ocean, completing, on his return to Fort Chippewyan, a journey of 2,990 mi. in 120 days. After a visit to England he made his second expedition from Fort Chippewyan, crossing the Rocky mountains in 1793 to reach the Pacific coast at Dean channel in 52° 21′ N., 128° W., and returning by the same route, to accomplish the first crossing of the American continent to the north of Mexico. In 1808 he settled in Scotland, where he died at Moulinearn near Pitlochry on March 11, 1820.

See his *Voyages from Montreal . . . to the Frozen and Pacific Oceans* (1801); M. S. Wade, *Mackenzie of Canada* (1927). (H. M. Ws.)

MACKENZIE, ALEXANDER (1822–1892), prime minister of Canada, 1873–78, was born in Perthshire, Scot., on Jan. 28, 1822. He emigrated to Upper Canada (Ontario) in 1842 and eventually became a building contractor at Sarnia. Through his interest in political reform, he met George Brown, editor of the *Toronto Globe* and leader of the Reform party. Their friendship grew while Mackenzie was editor (1852–54) of the Reform *Lambton Shield,* and after Mackenzie's election to the legislative assembly of Canada in 1861 they worked in close association. Both supported the confederation movement in 1864.

Mackenzie remained in politics after Brown's retirement. He was elected for Lambton to the first dominion house of commons in 1867 and soon became leader of the opposition. He also sat in the legislative assembly of Ontario in 1871, holding the position of provincial treasurer until dual representation was abolished in 1872. When the Pacific railway scandal caused the defeat of Sir John A. Macdonald's government in 1873, he became prime minister and leader of the first Liberal administration. As a tactician, he lacked Macdonald's skill and found it difficult to construct a strong party.

The great depression of the 1870s multiplied his difficulties. Although influential members of the Liberal party were opposed to the commitment, his government had inherited a pledge that a railway would be built to the Pacific by 1881. As his own minister of public works, Mackenzie decided to build only short lines of track, making whatever use he could of stretches of water and U.S. lines. British Columbia became restive at the delay and threatened to secede from the confederation. Other ventures were unsuccessful: he failed to revive reciprocity with the United States in 1874. The most constructive work of his administration was accomplished by his minister of justice, Edward Blake, who succeeded in having the supreme court of Canada established in 1875 and the powers of the governor general clarified in 1876.

In the election of 1878, Macdonald caught the popular imagination by advocating a protective tariff. Mackenzie was defeated. He remained leader of the opposition until 1880, when he retired in favour of Blake. He sat in the house of commons until his death at Toronto on April 17, 1892.

See Dale C. Thomson, *Alexander Mackenzie, Clear Grit* (1960). (M. A. O.)

MACKENZIE, SIR ALEXANDER CAMPBELL (1847–1935), Scottish composer, was born in Edinburgh on Aug. 22, 1847. At the age of ten he was sent to study music in Germany at Sondershausen, where he also played the violin in the ducal orchestra. Returning to Britain, he continued his studies at the Royal Academy of Music, London. Then followed some years in Edinburgh as composer, conductor and violinist, until, encouraged by Hans von Bülow, he settled in Florence to devote himself to composition. The cantatas *The Bride* (1881) and *Jason* (1882) belong to this time, as do his first two operas, *Colomba* (1883) and *The Troubadour* (1886). From 1888 to 1924 he was principal of the Royal Academy of Music, of which he improved the economy and the teaching methods. In London he was also active as a conductor and lecturer. Together with Sir Hubert Parry and Sir Charles Stanford, he was associated with the renaissance of British music at the end of the 19th century. He was knighted in 1895. Among other notable works by him were an oratorio, *The Rose of Sharon;* a *Scottish Concerto* for piano; three Scottish rhapsodies; and the overture *Britannia.* He died in London on April 28, 1935.

See A. C. Mackenzie, *A Musician's Narrative* (1927). (H. Ru.)

MACKENZIE, CHARLES FREDERICK (1825–1862), first Anglican bishop in central Africa, was born at Portmore, Peeblesshire, on April 10, 1825, and educated at Cambridge. In 1854 he accompanied Bishop J. W. Colenso to Natal as his archdeacon; he shared with his diocesan the view that African Christians should take part, on a basis of full equality, with white Christians, in all the affairs of the church. Ill health caused his return to England in 1859. In 1860 he was invited by the Universities mission to central Africa to become head of their projected mission in the Zambezi region. He was consecrated bishop on Jan. 1, 1861, in Cape Town cathedral—the first occasion in Anglican history on which a bishop was consecrated as a pioneer for an area in which as yet no church existed. The difficulties involved in establishing a mission in central Africa had been gravely underestimated. All the missionaries suffered from illness. They were badly served by those who should have helped them by maintaining communications and supplies. They compromised their position by becoming involved in the endless warfare of the local tribes. Then, while on a journey to meet Livingstone, Mackenzie fell ill and died on Jan. 31, 1862. He was a man of transparent and humble Christian devotion, but with hardly the strength and prudence required in the leader of so hazardous a venture.

See H. Goodwin, *Memoir of Bishop Mackenzie,* 2nd ed. (1865); O. Chadwick, *Mackenzie's Grave* (1959). (S. C. N.)

MACKENZIE, SIR EDWARD MONTAGUE COMPTON (1883–), a prolific and versatile English novelist, came from a well-known theatrical family and was born at West Hartlepool, on Jan. 17, 1883. Educated at St. Paul's school, London, and Magdalen college, Oxford, he turned from the stage to literature in his late twenties. His first success, *Sinister Street,* two volumes (1913–14), describes growing up, and its second volume remains the most successful novel of undergraduate life at Oxford. World War I took Mackenzie to intelligence work in the eastern Mediterranean, about which he wrote racy volumes of memoirs: one, *Greek Memories* (1932), had to be revised after a prosecution under the Official Secrets act. Two of his best satirical novels, *Vestal Fire* (1927) and *Extraordinary Women* (1928), set in Capri, show the influence of his friend Norman Douglas. After 1928 he lived in Scotland; he was a keen Scottish nationalist, and his broadly comic *Whisky Galore* (1947) is one of his later lighthearted tales with a west highland setting. Compton Mackenzie, as he is generally known, was knighted in 1952. The range of his output, some of it topical or ephemeral, has made it difficult to evaluate his work and it may be said that he has never fulfilled the promise that Henry James saw in him. But his writing has a rich, full life behind it, and shows verve, wit and unquenchable feeling for romance. (G. S. F.)

MACKENZIE, SIR GEORGE (1636–1691), of Rosehaugh, Scottish lawyer noted as a prosecutor of covenanters and founder of the Advocates' library, was born at Dundee in 1636. He was educated at the grammar school there and also at the universities of Aberdeen, St. Andrews and Bourges, and was called to the Scottish bar in 1659. As king's advocate after Aug. 1677, he conducted a vigorous prosecution of covenanters for their violation of statutes, earning for himself an unenviable distinction as "the bloody Mackenzie." He boasted (1680) that he had never lost a case for the crown. His methods, however, were questionable, notably in the prosecutions of the earl of Argyll and James Mitchell. As dean of the faculty of advocates, he was the main promoter of the Advocates' library, now the National Library of Scotland, founded in 1682. His refusal to concur in the measures for dispensing with the laws against Catholics led to his removal from office in May 1686, but he was reinstated in Feb. 1688. At the Revolution of 1688, he was one of the five members of the convention who opposed the decision that James II had forfeited the crown. William III refused to declare him incapacitated for holding any public office, but when the death of John Graham, Viscount Dundee, in July 1689 had destroyed the hopes of his party in Scotland, Mackenzie withdrew to England, and died at Westminster on May 8, 1691.

Mackenzie wrote widely on religious issues and moral philosophy; he also wrote an early piece of fiction, *Aretina* (1661), but the bulk of his writing was concerned with the law. In *Jus Regium* (1684), and in other writings, Mackenzie appears as an advocate of the highest doctrines of prerogative, a supporter of hereditary monarchy, a critic of intolerance and inhumanity, but a firm believer in enforcing obedience to the law in what he regarded as nonessentials. His *Vindication of the Government of Scotland During the reign of Charles II* (1691) is valuable as contemporary history. His collected *Works* were published at Edinburgh (2 vol., 1716–22) and *Memoirs of the Affairs of Scotland From the Restoration of King Charles II,* from previously unpublished sources, in 1821.

See A. Lang, *Sir George Mackenzie of Rosehaugh* (1909). (Gn. D.)

MACKENZIE, HENRY (1745–1831), Scottish novelist and miscellaneous writer, and the leading literary figure in Scotland during the last 30 years of the 18th century, was born in Edinburgh on Aug. 26, 1745, the son of a doctor. On both sides he was descended from Highland gentlefolk and consequently throughout his adult life he was a convinced Tory. Educated at the high school and the University of Edinburgh, he wrote much verse during his adolescence, most notably two poems in the style

of the traditional Scottish ballads which are equal to anything in the same manner written by Sir Walter Scott about 30 years later. But after becoming an attorney in 1765, Mackenzie went to study exchequer law in London, where he lost touch with Scottish traditions and turned to southern styles, imitating the "novel of sensibility" as written by Laurence Sterne. His *The Man of Feeling* (begun 1767, published 1771) was a best-seller, but the cool clarity of Mackenzie's style scarcely redeems the lachrymose mawkishness of plot and characterization. His other novels in the same mode were *The Man of the World* (1773) and *Julia de Roubigné* (1777). After settling in Scotland as an exchequer attorney in 1768, Mackenzie wrote for the Edinburgh stage a successful tragedy, *The Prince of Tunis* (1773), and although his other plays were failures he retained his interest in the theatre, encouraging the work of Joanna Baillie.

Established as the luminary of Scottish literary circles, Mackenzie edited two periodicals, *The Mirror* (1779–80) and *The Lounger* (1785–87), his own contributions to which earned him doubtful praise as "the Scottish Addison." When he writes on Scottish scenes and characters, however, his essays are more than merely successful pastiche, and he pioneered the appreciation of Burns with an early review of the Kilmarnock edition (1786); later, his papers on German literature encouraged Scott to attempt his first translations of German verse. In 1783 Mackenzie helped to found the Royal Society of Edinburgh, and in 1784 the Highland society, for which he edited a report on the authenticity of "Ossian's" poems (1805). During the troubles at the outbreak of the French Revolution and the Revolutionary War, Mackenzie wrote much anonymous political journalism for the Tory party, some of which he later regretted; his reward was his appointment, in 1799, as comptroller of taxes in Scotland. The authorized edition of his *Works* (8 vol.) was published in 1808, and his position as patriarch of Scottish letters was recognized when Scott made him the dedicatee of *Waverley* (1814). Having long outgrown sentimentalism, Mackenzie provided witty and incisive sketches of 18th-century Scotland in his *Life of John Home* (1822) and in his *Anecdotes and Egotisms* (written *c.* 1824–26, but unpublished until 1927). He died on Jan. 14, 1831.

See *The Anecdotes and Egotisms of Henry Mackenzie* ed. by H. W. Thompson (1927); H. W. Thompson, *A Scottish Man of Feeling* (1931). (A. M. S.)

MACKENZIE, SIR MORELL (1837–1892), British physician, centre of a 19th-century *cause célèbre* over the death of the German emperor Frederick III (*q.v.*), was born at Leytonstone, Essex, on July 7, 1837. He studied at the London hospital, at Paris, Vienna and Budapest, where he learned the use of the newly invented laryngoscope under J. N. Czermak. In 1862 he took his degree and became a specialist in diseases of the throat. In 1863 he helped to found the Throat hospital in King street, Golden square, and became a leading authority.

In May 1887 Mackenzie was summoned to attend the German crown prince Frederick William, whose illness was difficult to diagnose. The German physicians who had attended the prince since the beginning of March had diagnosed his disease on May 18 as cancer of the throat; but Morell Mackenzie insisted (basing his opinion on a microscopic examination by R. Virchow of a portion of the tissue) that the disease was not demonstrably cancerous, that an operation for the extirpation of the larynx (planned for May 21) was unjustifiable, and that the growth might well be benign and therefore curable by other treatment. Mackenzie's opinion was followed; he was knighted in Sept. 1887 for his services, and decorated with the Grand Cross of the Hohenzollern Order. In November, however, it was ultimately admitted that the disease really was cancer; though Mackenzie, with very questionable judgment, more than hinted that it had become malignant since his first examination, in consequence of the irritating effect of the treatment by the German doctors. The crown prince became emperor, as Frederick III, on March 9, 1888, and died on June 15. A violent quarrel raged between Mackenzie and the German medical world. The German doctors published an account of the illness, *Die Krankheit Kaiser Friedrichs III* (1888), to which Mackenzie replied by a work entitled *The Fatal Illness of Frederick the Noble* (1888), the publication of which caused him to be censured by the Royal College of Surgeons. Mackenzie died in London on Feb. 3, 1892, leaving several books on laryngoscopy and diseases of the throat.

See R. S. Stevenson, *Morell Mackenzie: the Story of a Victorian Tragedy* (1946, 1947).

MACKENZIE, WILLIAM LYON (1795–1861), Canadian rebel, journalist and politician, led an armed band of farmers and mechanics against Toronto in 1837 in an unsuccessful attempt to end British colonial rule in Upper Canada. Several days after the rebels' defeat at the hands of the loyalist militia and Mackenzie's escape to the United States, he returned to set up a short-lived Canadian republic on Navy Island, in the Niagara river. Throughout 1838 Mackenzie's presence in the United States inspired a series of raids across the border that brought the United States and Britain to the brink of war. Along with Louis Joseph Papineau's rebellion in Lower Canada, Mackenzie's action eventually led to the British grant of responsible government in Canada in 1848, and to the beginnings of the modern commonwealth.

Mackenzie was born near Dundee in Scotland, and brought up on family pride, poverty and a good stiff dose of the Presbyterian catechism by his widowed mother. As a young man he read prodigiously, and was strongly influenced by the writings of the contemporary Scottish Whigs and Radicals. He was a wild-looking, wiry little man with a large head and high brow and restless piercing blue eyes. He had lost his hair from a fever and covered his baldness with a loose, flame-red wig.

Four years after his emigration to Upper Canada in 1820, Mackenzie founded a newspaper called the *Colonial Advocate,* and began attacking the political and economic priviliges enjoyed by a ruling colonial oligarchy of merchants, land speculators, lawyers and churchmen known as the Family Compact. His newspaper's invective was so violent that a Tory majority in the colonial assembly, to which he had been elected in 1828, expelled him from the house six times, only to have him returned on all six occasions by the electors of York county. A Reform majority in the next assembly enabled Mackenzie to take his seat in 1834, the year in which he was also elected first mayor of the new city of Toronto (formerly York). The report of Mackenzie's committee on grievances in 1835 was a thorough exposure of the inadequacy of colonial rule and was taken very seriously by the British government. But in the colonial elections of 1836 lieutenant governor Sir Francis Bond Head and the Compact managed to convince the electorate, many of them newly arrived British immigrants, that Mackenzie was disloyal, and as a result he and several other Reformers lost their seats.

Mackenzie had occasionally talked rebellion before, but he now began to consider it seriously. He founded a more radical newspaper, the *Constitution,* on July 4, 1836, to express the ideas of Jacksonian democracy which he had espoused during the 1830s. A severe economic depression helped bring big crowds to the series of rural meetings he held in the summer of 1837. He drafted a constitution along U.S. lines in the autumn and made plans for an armed uprising. After the outbreak of Papineau's Lower Canadian rebellion, the hard core of Mackenzie's supporters assembled just north of Toronto. Insufficiently trained and organized, they scattered before the first loyalist attack.

The rebellion ultimately foundered on the rock of popular loyalty to the crown and British institutions. Mackenzie himself, after 12 years of exile, became thoroughly disillusioned with U.S. politics. He was finally pardoned and allowed to return to Canada in 1849, and in 1851 was elected to parliament. Just as in the 1830s, Mackenzie was an intelligent and hardworking committee chairman. And again his extreme independence and unswerving incorruptibility made him an embarrassment to many of his allies. Unlike the expansionist wing of the Reform (and later Liberal) party, he opposed the incorporation of banking, canal and railway companies that would develop the country at the price of profit and power for their owners. He clung to the Jeffersonian ideal of agrarian democracy and an industrialism of the small independent craftsman. In 1858 he resigned his seat in the house. He died in Toronto on Aug. 28, 1861.

Most of the causes Mackenzie fought for, from universal suffrage and free schools to a professional civil service, from sound banking to Canadian self-government, eventually triumphed. But at heart Mackenzie was a prophet and visionary whom no reform short of Utopia would have satisfied, and he pursued his vision with a single-minded, sometimes ludicrous, sometimes tragic heroism. After his death he became a patron saint of Canadian radicalism. Legends about him have been absorbed into the folklore of southwestern Ontario. His life had a deep and mysterious influence on his namesake and grandson, the Liberal prime minister W. L. M. King.

Bibliography.—The *Life and Times* by his son-in-law, Charles Lindsey, 2 vol. (1862), while often biased and misleading, is an invaluable memoir. William Kilbourn's *The Firebrand* (1956), a brief biography built around the story of the 1837 rebellion, contains an extensive bibliography. *See* also Lillian Gates, "The Decided Policy of William Lyon Mackenzie," *Can. Hist. Rev.*, vol. xl, 185–208 (1959).

(W. M. Ki.)

MACKENZIE, created in 1895 as the western district of the three divisions of the Northwest Territories of Canada, was named after the Mackenzie river. It was bounded on the east by the District of Keewatin (longitude 102° W.), on the west by Yukon Territory, on the south by Saskatchewan, Alberta and the northeast corner of British Columbia (latitude 60° N.) and on the north by the Arctic ocean. Area 527,490 sq.mi. Pop. (1961) 14,895: the most populous district of the Northwest Territories. This fact, together with the growing economic potential and the opening of all-weather transportation routes in the second half of the 20th century, prompted the movement to replace the District of Mackenzie with the Territory of Mackenzie, comprising the mainland of the Northwest Territories west of the 105th meridian and Banks, Victoria and several smaller islands.

Physiographically the district is characterized by the Mackenzie, Franklin and Richardson mountains, the northern extension of the Rockies, on the west; the Mackenzie lowlands containing the Mackenzie river and Great Bear and Great Slave lakes in the central area; and the western edge of the Canadian shield on the east. *See* Northwest Territories.

MACKENZIE RIVER, a river of the Northwest Territories (*q.v.*), Canada, which discharges the waters of Great Slave lake into the Arctic ocean. Discovered and explored by Sir Alexander Mackenzie in 1789, it rises as the Finlay in north central British Columbia, flowing eastward to form the Peace (*q.v.*), which joins the discharge from Lake Athabasca as the Slave river and flows into Great Slave lake. From the Great Slave, the Mackenzie proper flows northwest for 1,100 mi. to empty into the Beaufort sea of the Arctic ocean near the Yukon border. The Mackenzie drains an area of 682,000 sq.mi., and is the longest river system in Canada. Ice-free from about the first week of June to the middle of October, the Mackenzie is navigable from its mouth to Great Slave lake. Connection with the railhead at Waterways, Alta., is made by way of the Slave and Athabasca (*q.v.*) rivers, with one 16-mi. portage from Fort Smith, N.W. Terr., to Fitzgerald, Alta. Boats also operate on the Liard river from Fort Nelson, B.C., to its junction with the Mackenzie at Fort Simpson and on the Peace from Peace River, Alta., to Fitzgerald except for the rapids near Fort Vermilion.

Settlements on the Mackenzie include Fort Providence, Wrigley, Fort Simpson, Fort Norman, Norman Wells, Fort Good Hope, Arctic Red River, Aklavik and Inuvik. Norman Wells is a petroleum centre, oil having been struck there in 1920.

The mouth of the Mackenzie, a lake-strewn delta measuring 110 mi. in length and 40 mi. in width, is noted for its muskrat catch.

(J. R. M.)

MACKEREL, a common name for many species of the family Scombridae, swift, carnivorous pelagic fishes found in tropical and temperate seas, characterized by a fusiform shape, a series of detached rays or finlets following the soft dorsal and anal fins, a slender caudal peduncle and a widely forked tail.

The common mackerel of the North Atlantic (*Scomber scombrus*) is distinguished from other scombrids by having the two dorsal fins separated by more than the length of the first (spinous) dorsal fin; two small keels on each side of the caudal peduncle, but no median lateral keel; and no air bladder. It occurs on both sides of the North Atlantic from North Carolina to the Strait of Belle Isle and from the Black sea and the Mediterranean to Norway. Mackerel congregate in schools, according to size, swimming actively in the upper 25–30 fathoms from spring until mid-autumn, then descending to as deep as 100 fathoms for the winter. They feed on plankton, including crustaceans, mollusks and fish eggs, and small fish, but eat little during the winter. Spawning occurs in spring and early summer, along the coast. The eggs, averaging about one millimetre in diameter, are buoyant and drift in the upper five fathoms of water; they hatch in about six days at 54° F. (12° C.). Mackerel attain about 15 in. in length by the third year.

The genus *Pneumatophorus* comprises species strikingly similar in appearance to *Scomber* (formerly included in the latter genus) but differing in having a well-developed air bladder. These are coastal fishes of the Pacific, Indian and North and South Atlantic oceans. The North American Pacific mackerel (*P. diego*), perhaps a subspecies or even a race of *P. japonicus* of the western Pacific and Indian oceans, is abundant from the Gulf of California to central California and yields around 50,000,000 lb. a year to commercial fishermen. The chub mackerel (*P. colias*), widely distributed on both sides of the North and South Atlantic, occurs along the coast of North America, sometimes in large numbers.

The Indian mackerels (*Rastrelliger*), called striped mackerel in the Philippines and rake-gilled mackerel in Australia, are deeper and stouter than either *Scomber* or *Pneumatophorus;* but like them, they have two keels on each side of the body near the base of the tail. They grow to be about 15 in. long. At least two species are recognized, *R. brachysoma* and *R. kanagurta.* The latter occurs all around the Indian ocean and is widely distributed in the Pacific as far north as the Ryukyu Islands and Hawaii. About 18% of the total catch of sea fish in India consists of *Rastrelliger.*

The Spanish mackerels (*Scomberomorus*) are elongate, slender fishes with strong knifelike teeth. They are fishes of warm seas, but move into temperate regions as seasonal migrants or occasional visitors. The common Spanish mackerel (*S. maculatus*), the king mackerel (*S. regalis*) and the cavalla (*S. cavalla*) are taken in the western Atlantic as far north as Cape Cod and as far south as Brazil. The largest specimens of cavalla exceed 5 ft. in length, and 70 lb. in weight. The sierra mackerel (*S. sierra*) of the Pacific, which may be identical to *S. maculatus,* ranges from Peru to southern California. The largest species, *S. commersoni* of the Indo-Pacific region, is said to attain a weight of over 100 lb. Spanish mackerel are favourite game fish wherever they occur, and their flesh is of excellent quality. U.S. commercial fishermen take about 8,000,000 lb. annually, mostly along the coasts of the South Atlantic and the Gulf of Mexico.

The frigate mackerel (*Auxis thazard*), distinguished from the common mackerel in having a median keel on the caudal peduncle as well as a smaller one below and above it, has been reported from warm and temperate waters of all seas. It travels in schools, is carnivorous and grows to be about two feet long. It has little commercial value.

Horse mackerels (*Trachurus*), of the jack family (Carangidae), are shaped like common mackerels but lack finlets and have bony plates along the entire length of the lateral line. They occur in nearly all warm and temperate seas. (Large bluefin tuna [*q.v.*] and Atlantic bonito [*q.v.*], both scombrids, are sometimes called horse mackerel.) Snake mackerel is a name applied generally to a family (Gempylidae) of fishes allied to the true mackerels and especially to *Gempylus serpens,* widely distributed in deep seas.

See also references under "Mackerel" in the Index.

(L. A. Wd.)

McKIM, CHARLES FOLLEN (1847–1909), U.S. architect, who was of primary importance in the American neoclassical revival, was born in Chester county, Pa., on Aug. 24, 1847. The son of a relentless abolitionist, he was educated at Harvard and at the École des Beaux Arts and trained as a draftsman by H. H. Richardson while the latter was completing Trinity church, Boston. In 1879 he joined William Rutherford Mead and Stanford

White to found McKim, Mead & White, perhaps the most successful and influential architectural firm in U.S. history. Until 1887 the firm excelled at informal summerhouses built of shingles, and McKim designed one of the most significant of these, the residence at Bristol, R.I., of W. G. Low (1887). In later years the firm was famous for championing the formal tradition of the Italian Renaissance and its classical antecedents. Among the celebrated examples of the formal planning of McKim are the Boston Public library (1887) and in New York the University club (1899), the Morgan library (1906) and the Pennsylvania station (1906–10). With D. H. Burnham and Richard Morris Hunt he charted the architectural program of the World's Columbian exposition at Chicago in 1893, which was classically inspired. He also aided Burnham in reviving Pierre L'Enfant's plan for Washington, D.C., and was the originator of the American Academy in Rome. He died at St. James, Long Island, N.Y., on Sept. 14, 1909.

See Charles Moore, *Life and Times of Charles Follen McKim* (1920); Wayne Andrews, *Architecture, Ambition & Americans* (1955).
(W. As.)

MACKINAC, STRAITS OF, the connection between Lakes Michigan and Huron. In their narrowest portion the straits are about 4 mi. wide but the straits area generally is considered as embracing a 30 mi.-long stretch of water which includes the passages between several islands in northwestern Lake Huron, Mackinac Island, within the straits, and an indefinitely defined portion of northeastern Lake Michigan. The straits, which provide a broad passage between the lakes, separate the lower and upper peninsulas of the state of Michigan. This natural barrier to land travel, which was traversed by state-operated ferryboats for many years, has been spanned by a bridge and two 20-in. submarine pipelines, carrying petroleum products from oil fields in the province of Alberta, across the straits from Pointe la Barbe on the north shore to McGulpin Point on the south shore.

Mackinac Bridge.—Extending from Mackinaw City, on the south side of the straits, to a point near St. Ignace, on the north side, the bridge with its approaches has an uninterrupted over-water length of 5 mi. and 44 ft. The main span is a suspension bridge with a total length of 8,344 ft. between cable anchorages. The centre span of the bridge, between towers, is 3,800 ft. long. A single deck carries four lanes of highway traffic and has a capacity of 6,000 cars per hour. The main towers are founded on bedrock more than 200 ft. below water level and extend 552 ft. above the water. The clearance under the centre span is 148 ft. above low-water datum (578.5 ft.). Built by the state of Michigan, with David B. Steinman as designer and supervisor of construction, the bridge cost $100,000,000. Construction began in July 1954, and the bridge was opened to traffic on Nov. 1, 1957.

See MACKINAC ISLAND; MICHIGAN, LAKE; HURON, LAKE.
(J. L. Hh.)

MACKINAC ISLAND, a summer resort in Mackinac county, Mich., U.S., is located in the Straits of Mackinac, where the upper and lower peninsulas of Michigan nearly join. The island is 9 mi. in circumference and is covered with a thick growth of pine, cedar, birch and beech. After 1895 more than 80% of the area was operated as a state park by the Mackinac Island state park commission. It has a horse-and-buggy setting and automobiles are banned. The winter population ([1960] 942) is concentrated in the city on the south side.

The island was used by ancient Indians as a burial ground, and its name is a shortened form of the Indian Michilimackinac. Father Claude Dablon, a French Jesuit, wintered there in 1670 among the Huron Indians. During the American Revolution the British moved their fort from Mackinaw City to the island. Fort Mackinac was ceded to the Americans by the treaty of Paris in 1783, and during the War of 1812 a British landing party under Capt. Charles Roberts caught the U.S. garrison by surprise and forced its surrender. After the war the island was the centre of John Jacob Astor's fur-trading empire.

The fur trade declined in the 1830s and Mackinac, rich in historic lore and scenic attractions such as Arch rock, Skull cave, Devil's Kitchen and Sugar Loaf, was subsequently promoted as a resort centre.

Points of interest along Market street include the Astor house, the Edward Biddle house, and the Dr. William Beaumont memorial, which honours the U.S. army physician who began there in 1822 his famous experiments in digestion. Other buildings include the Grand hotel, built in 1887, and the Moral Rearmament association's world headquarters buildings. Two steamship ferry services operate from Mackinaw City and St. Ignace. (E. T. P.)

MACKINDER, SIR HALFORD JOHN (1861–1947), ranked for many years as Great Britain's outstanding geographer, but it was not until the events of World War II showed the wisdom of the forecasts he made from 1904 to 1919 that his name became widely known among students of political geography. He was born on Feb. 15, 1861, at Gainsborough, Lincolnshire. In Germany, Gen. Karl Haushofer twisted Mackinder's teachings for his own purposes in promoting his doctrine of *Geopolitik*. Mackinder's famous paper, "The Geographical Pivot of History," which he read before the Royal Geographical society in London in 1904, evaluated the age-old cleavages between the heartland and coastland, the regions accessible to horsemen and shipmen respectively, and the conflicts between their peoples, with Russia, the heartland power, at the centre of his deliberations. These thoughts were further developed after World War I in his book *Democratic Ideals and Reality* (1919). During World War II, in another classical exposé of political geography, *The Round World and the Winning of the Peace* (1942), he reiterated his concept of the heartland under the conditions of (pre-atomic and pre-guided missile) modern warfare. (*See* also GEOPOLITICS.)

It would be mistaken to consider Mackinder's contributions solely in the light of his heartland vision. His great achievement was to raise geography from the slough into which it had fallen in England. At Oxford university and later at the London School of Economics, he promoted the teaching of regional and world geography. From 1910 to 1922 he served as a member of parliament and was chairman of the Imperial Shipping committee from 1920 to 1945. He died at his home in Parkstone, Dorset, on March 6, 1947. (H. W. Wt.)

McKINLEY, WILLIAM (1843–1901), 25th president of the United States, was born at Niles, O., Jan. 29, 1843, the seventh of nine children of William and Nancy Allison McKinley. His father was of Scotch-Irish and English Puritan descent and both of his grandfathers had served in the American Revolution. McKinley's father was at times owner or renter of two or three small pig-iron furnaces that provided a meagre living for his large family. Young William obtained his secondary school education at an academy in Poland, O., where he excelled in public speaking and debate. He entered Allegheny college at Meadville, Pa., but illness brought him home at the end of his first term and family reverses prevented his return. He taught school for a time and then, soon after the outbreak of the Civil War, enlisted as a private in the 23rd Ohio volunteer regiment where he won the confidence of its colonel, Rutherford B. Hayes, and became his aide-de-camp. He repeatedly distinguished himself in action and was mustered out in 1865 with the brevet commission of major.

Early Career.—After studying law in an office and at the Albany (N.Y.) law school, he was admitted to the bar and began the practice of law at Canton, O., the seat of Stark county, in 1867. Two years later he was elected prosecuting attorney of the county. In 1871 he married Ida Saxton. She bore him two daughters whose early deaths induced her chronic invalidism, requiring McKinley's constant care of her. In 1874, in the face of prevailing hysteria against 33 rioting miners imprisoned in the Canton jail, McKinley volunteered to defend the men and obtained the acquittal of all but one of them. By this service he earned the lasting gratitude of labour. In 1876 he was elected to congress as a Republican from the 17th Ohio district and soon became an outstanding champion of protective tariffs, thereby reflecting the interests of his district.

At the beginning of his final term in congress in 1889 he competed for the speakership but lost to Thomas B. Reed, who then appointed McKinley chairman of the ways and means committee. In this position he sponsored the McKinley tariff of 1890 but its high duties led to a reaction: the election of an overwhelmingly

Democratic congress, and the end of McKinley's career as a congressman. McKinley had now attained a reputation as a national Republican leader, presiding over the Republican national convention or serving as chairman of the committee on resolutions that framed the party platforms. In 1890 he was retired from congress but was elected governor of Ohio in 1891, and was soon required to call out the militia to deal with strikes provoked by the severe depression of the early 1890s. Nevertheless he retained the loyal support of workingmen and persuaded the legislature to enact legislation in the interest of labour.

By the mid-1890s, Marcus A. Hanna, a wealthy Cleveland businessman and friend of McKinley, decided to promote McKinley's candidacy for the presidency in 1896. Though the two saw eye-to-eye on party policies Hanna was perplexed by McKinley's resolute refusal to make any deals or pledges to capture delegates. In 1893 McKinley suddenly discovered that, due to the failure of a friend whose notes he had endorsed, he was obligated to pay debts far greater than the value of his and his wife's property, which was turned over as payment. His solvency was saved by friends who came to his rescue and thereby preserved him for further public service. McKinley's re-election as governor of Ohio in 1893 increased his prestige as a national leader and in 1896 the Republican national convention nominated him for president on a platform that stressed protective tariffs and the maintenance of the prevailing monetary standard based on gold and opposed the free coinage of silver except by agreement with the leading commercial nations. Garret A. Hobart of New Jersey was chosen as the vice-presidential candidate.

The nomination of William Jennings Bryan as the Democratic candidate on a platform advocating the free and unlimited coinage of silver at a ratio of 16 to 1 to gold activated the depression-harassed agrarian debtors and upset Hanna's campaign plans. He then utilized thousands of campaign speakers and distributed millions of pamphlets promoting McKinley's election. McKinley was hailed as "the advance agent of prosperity" and the slogan, "Bill McKinley and the McKinley Bill," became a campaign cry. While Bryan ranged the country in a vigorous campaign, McKinley remained at home in Canton and from his front porch addressed thousands of visitors who arrived daily by railway trains. McKinley won by an electoral vote of 271 to 176 for Bryan and a popular majority of more than 600,000. (*See* UNITED STATES OF AMERICA: *History.*)

Presidency.—President McKinley selected his cabinet with care, but his politically motivated choice of Senator John Sherman for secretary of state proved unfortunate. Within the year Sherman was forced to resign due to ill-health but was succeeded by John Hay, an experienced diplomat. Following his inauguration, President McKinley called a special session of congress to revise customs duties; the result was the Dingley tariff, which provided for the highest average duties yet laid.

From the beginning of his administration President McKinley was deeply concerned over the Cuban insurrection. The American people were embittered by the Spanish policy of combating the insurgents by concentrating the population in camps where they suffered from disease and near starvation. Early in 1898 a letter written by Dupuy de Lôme, the Spanish minister to the United States, which severely criticized President McKinley, was intercepted by a Cuban insurgent in Havana and published in the *New York Journal*. On Feb. 15 the U.S. battleship "Maine," on an official visit to Havana, was mysteriously sunk by a submarine mine with the loss of 266 officers and men. The sensational press played up these incidents and incited a war spirit; "Remember the 'Maine'!" became the slogan of those who felt the Spanish had sunk the ship. President McKinley attempted to prevent war hysteria and endeavoured to persuade the Spanish government to adopt a conciliatory policy with respect to the Cuban insurrectionists. The Spanish government eventually did yield but the change came too late to restrain the mounting popular demand in the U.S. for intervention. When congress was at the point of a declaration of war without the president's recommendation, McKinley sent it a message asking for "forcible intervention" to establish peace in Cuba. On April 20 congress adopted a joint resolution declaring for the freedom of Cuba, demanding that Spain withdraw from the island and authorizing the president to compel its withdrawal.

Commodore George Dewey, commanding the Pacific fleet of the U.S. navy stationed at Hong Kong, was ordered to attack the Spanish fleet at Manila. He did so and brought about its complete destruction on May 1. The Spanish home fleet meanwhile crossed the Atlantic to Santiago, Cuba, where it was confined by the U.S. Atlantic fleet under Adm. William T. Sampson until it tried to escape and was destroyed on July 3. American land forces under Gen. William Shafter invested but had failed to capture Santiago; the city finally surrendered on July 17 after severe naval bombardment and on Aug. 12 a peace protocol ended hostilities. (*See* SPANISH-AMERICAN WAR.)

President McKinley was perplexed as to whether the United States should annex the Philippines, but the Filipinos had risen in revolt against Spanish authority and it was doubted whether Spain could any longer govern the islands. Since the United States had annexed Hawaii in 1898, it had acquired an interest in the Pacific area and McKinley decided that the Philippines must not fall into the hands of another power. The peace treaty signed at Paris on Dec. 10, 1898, provided that Spain should relinquish title to Cuba, whose independence had been pledged by the United States, and should cede Puerto Rico, Guam and the Philippines to the United States. The ratification of the treaty remained doubtful until, under administration influence, the required two-thirds of the senate was mobilized (Feb. 6, 1899). Retention of the Philippines continued to be an issue for some time, but McKinley stood firm in his decision to retain the islands even in the face of some opposition within the Republican party.

With the acquisition of the Philippines the insurgents under Emilio Aguinaldo carried on guerrilla war against the United States until their leader was captured. There was bitter protest against this "imperialism" within the Republican party as well as by leaders of the Democratic party. President McKinley found an able administrator in William Howard Taft, an Ohio judge whom he appointed governor general of the islands. In the absence of a staff, the conduct of the Spanish-American War had fallen upon President McKinley himself, who became his own chief of staff. Secretary of War Russell A. Alger had proved inadequate and upon his resignation the president appointed Elihu Root, who reorganized the army and proved competent in dealing with Philippine problems.

President McKinley was the first president since the Civil War to assume leadership, though unobtrusively, in legislation. Following the acquisition of insular possessions he was faced with the question as to whether the entire constitution applied to them as it did to the United States itself. He accepted the view of congress that the possessions did not automatically lie within the free trade area of the United States, a constitutional issue later resolved by the supreme court with the decision in the Insular cases (1901) that these possessions were not "incorporated" territory until congress made them so and that consequently some provisions of the constitution might be inapplicable to them.

The Republican national convention of 1900 renominated McKinley with no opposition. The big question of the convention was the vice-presidency, for Hobart had died in Nov. 1899. Hanna, who was again in charge of McKinley's campaign, was opposed to the nomination of Gov. Theodore Roosevelt of New York for vice-president. The Republican organization of New York was determined to get rid of Roosevelt, whom it found troublesome, by retiring him to the vice-presidency of the United States. President McKinley virtually ordered Hanna not to interfere with the freedom of the convention in this matter, however, and Governor Roosevelt was nominated the Republican candidate for vice-president. The platform approved the Gold Standard act recently enacted by congress and the acquisition of insular territory, along with the assurance of its self-government. The Democratic convention of 1900 nominated William Jennings Bryan again on a platform condemning the gold standard and calling again for the free coinage of silver. This convention also declared that imperialism was the paramount issue of the campaign.

Because of President McKinley's well-known sincerity, Bryan's personal attacks on him backfired. The events of his administration had enhanced McKinley's prestige enormously, and the prosperity prevailing in 1900 further handicapped the Democratic candidate. McKinley was re-elected with an electoral vote of 292 to Bryan's 155 and his popular majority was nearly 850,000. This result so impressed McKinley that he said, "I can no longer be called the President of a party. I am President of the whole people."

In his second term McKinley was gratified by the decisions of the supreme court confirming the administration's limited application of the constitution to the insular possessions. The constitutional convention of Cuba posed a problem by refusing to recognize the protective interest of the United States in the island, but this was resolved by the president's firmness on that matter. McKinley planned that as one of the first acts of his second term he would make a tour of the country as far as the Pacific coast, and would speak on two subjects that had been overshadowed during the war: the control of trusts and the extension of commercial reciprocity. The one-time exponent of high protective tariffs and denouncer of free trade had been experiencing a change of heart under the tutelage of an eminent political economist, Jeremiah W. Jenks of Cornell university. He had come to recognize the importance of foreign trade. Since commercial reciprocity involved the treaty power, McKinley was preparing, through an appeal to the people on the issue, to pit the power of the executive against the power of the senate. The speaking tour was to culminate in a vigorous plea for reciprocity at the Buffalo exposition.

Deep concern had developed during the 1900 campaign concerning the possible assassination of President McKinley. Hanna had a haunting fear that McKinley might not live out a second term. The Intelligence bureau had learned of a group of anarchists at Paterson, N.J. It was reported that anarchists in Europe were plotting to assassinate the rulers of the world in the following order: Austria, Italy, Russia, England and the United States. King Humbert of Italy had just been assassinated by a former silk weaver of Paterson. As a consequence, when McKinley was shaking hands with the vast multitude of people who had come to the Temple of Music of the Pan-American exposition in Buffalo, N.Y., on Sept. 6, 1901, the most extraordinary precautions were taken for his safety. Somehow no one suspected that the scarf-wrapped hand of Leon Czolgosz, an anarchist, concealed a revolver with which he was to shoot the president. At first the doctors did not consider the president's condition serious, but he died on Sept. 14. The national mourning that followed was the most impressive since the death of Lincoln.

See M. K. Leech, *In the Days of McKinley* (1959); C. S. Olcott, *The Life of William McKinley,* 2 vol. (1916). (W. E. By.)

McKINLEY, MOUNT, a peak of the Alaska range in south-central Alaska in lat. 63° 04′ N. and long. 151° 01′ W., is the highest mountain in North America (20,320 ft. above sea level). On the north and west it rises abruptly 17,000 ft., while the southern and much more gradual slope begins from an even lower level. The upper two-thirds is covered with permanent snow fields that feed many glaciers. The greatest glaciers are on the relatively inaccessible southern slope. Muldrow (30 mi. long) and Peters are the largest on the northern slope.

The Indian name of the peak was Denali ("The High One"). The modern name was applied in 1896 by W. A. Dickey in honour of William McKinley, who was elected president later that year. The first attempt to climb the mountain, made in 1903 by James Wickersham, was unsuccessful. Frederick A. Cook's much publicized (but fraudulent) claim that he had reached the summit inspired the conquest of the north peak in 1910 by two prospectors, William Taylor and Pete Anderson. The south peak (true summit) was finally attained June 7, 1913, after an expedition of three months duration led by Hudson Stuck and H. P. Karstens. In 1932 two climbers from a cosmic ray research expedition, Theodore Koven and Allen Carpe, lost their lives on the mountain. All successful ascents have been made from the north base, which became more accessible because of the Denali (park) highway.

The Mount McKinley National park (*q.v.*) was created on Feb. 26, 1917. *See* also ALASKA. (V. H. C.)

MACKINTOSH, CHARLES RENNIE (1868–1928), Scottish architect, designer and water-colourist, was one of the most significant personalities contributing to the rise of modern architecture. Born in Glasgow, Scot., on June 7, 1868, he was apprenticed to a local architect John Hutchison, and attended evening classes at the Glasgow School of Art. In 1889 he joined the firm of Honeyman and Keppie, becoming a partner in 1904.

In collaboration with three other students, one of whom, Margaret Macdonald, in 1900 became his wife, Mackintosh achieved an international reputation in the 1890s as a designer of unorthodox posters, craftwork and furniture. The outcome of this work could be seen in four remarkable tearooms he designed for Miss Cranston in Glasgow (1896–1904) and in his domestic interiors of the early 1900s. In contrast to contemporary fashion this work was notable for its lightness, elegance and originality.

Mackintosh's chief architectural projects were: Glasgow School of Art (1896–1909); two unrealized projects—the 1901 International exhibition, Glasgow (1898) and "Haus eines Kunstfreundes" (1901); Windyhill, Kilmacolm (1900) and Hill house, Helensburgh (1902); the Willow Tearooms, Glasgow (1904–05); and Scotland Street school (1904–06). Although all have some traditional characteristics, they reveal a mind of exceptional inventiveness and aesthetic perception.

By 1914, however, Mackintosh had virtually ceased to practise and thereafter he devoted himself to water-colour painting. He died on Dec. 10, 1928, in London.

See T. Howarth, *Charles Rennie Mackintosh and the Modern Movement* (1952); N. B. L. Pevsner, *Charles R. Mackintosh* (1950). (T. Hh.)

MACKINTOSH, SIR JAMES (1765–1832), Scottish writer, philosopher and Whig politician, was born at Aldourie on Oct. 24, 1765. He was educated at Aberdeen university and at Edinburgh, where he took his degree in medicine in 1787. He migrated to London in 1788, earning a living by writing for the *Oracle* newspaper and on becoming interested in politics he published *Vindiciae Gallicae* (1791), as a reply to Edmund Burke's *Reflections on the French Revolution.*' Except for Tom Paine's *Rights of Man* it was the only effective answer that appeared. He prophesied that the conspiracy of the sovereigns of Europe to crush the liberties of the French people would recoil on their own heads.

The success of this pamphlet caused him to adopt the legal profession and he was called to the bar in 1795. A year after the death (1797) of Catherine Stuart, his first wife, he married Catherine Allen, sister-in-law of the Wedgwood brothers, through whom he introduced Samuel Taylor Coleridge to the *Morning Post.*

Mackintosh's greatest legal performances were his lectures in 1799 at Lincoln's Inn on the law of nature and of nations, and his defense in 1803 of Jean Gabriel Peltier, a French refugee charged with libel. On his appointment as recorder of Bombay in 1803, he was knighted, but ill-health compelled him to return to England in 1812. He entered parliament as Whig member for Nairn in 1813, and he sat for that county, and later for Knaresborough, till his death. He supported and continued Sir Samuel Romilly's penal reforms. From 1818 to 1824 he was professor of law and general politics in the East India Company's college at Haileybury. He would probably have been given office in George Canning's ministry (1827) could he have promised constant parliamentary attendance. Already a privy councilor (1827) he was appointed a commissioner for the affairs of India when the Whigs returned to office in 1830. He wrote for the *Cabinet Cyclopaedia* a "History of England from the Earliest Times to the Final Establishment of the Reformation." His more elaborate *History of the Revolution in England,* a work of original research, was published after his death, which took place on May 30, 1832.

See R. J. Mackintosh, *Memoirs of the Life of Sir James Mackintosh,* 2 vol., 2nd ed. (1836). (A. Al.)

MACKLIN, CHARLES (d. 1797), Irish actor and playwright, whose real name was McLaughlin; his distinguished though turbulent career spanned most of the 18th century and

made him a pillar of the English theatre. He first appeared as an actor at Bristol and in 1725 went to Lincoln's Inn Fields, London. A man of violent nature, he was a pioneer against the stilted declamation of his day. He went to Drury Lane theatre in 1733 and later was concerned in its management. In 1735 he killed a brother actor in the green room over a dispute about a wig, but although prosecuted he received no sentence. He set the seal on his stage career at Drury Lane on Feb. 14, 1741, when he played Shylock, rescuing the part from all the comic "portrayals" with which it had long been surrounded.

Macklin played many parts with distinction but was constantly involved in disputes and lawsuits. He attempted to be a restaurateur but failed and returned to the stage. Two of his plays were outstanding, *Love à-la-mode* (1760) and *The Man of the World* (1781). He died on July 11, 1797, claiming to be 107 years old; he may indeed have been a centenarian, though this is subject to dispute.

See Edward A. Parry, *Charles Macklin* (1891). (W. J. M.-P.)

MACKMURDO, ARTHUR HEYGATE (1851–1942), English architect, designer and a pioneer of the arts and crafts movement (*q.v.*), was born in London on Dec. 12, 1851. After studying at the Ruskin School of Art, Oxford, and traveling with John Ruskin to Italy, he set up practice in London. Known best for his plans for the Savoy hotel, he also built about 12 private houses—including 25, Cadogan square—and his wide interest in social problems was reflected in other types of building and several projects for communal living. Although some of his architecture shows Italian influence, its originality makes Mackmurdo a forerunner of the modern movement. He founded the Century Guild of artists (1882) to produce better furniture, etc., than was then available commercially, and designed textiles, wallpaper, furniture and metalwork. His style of the early 1880s includes swirling plant forms foreshadowing those of the later *art nouveau*. He also published *The Hobby Horse* from 1884, the first finely printed magazine on art. A friend of William Morris, he was founder member of the Society for the Protection of Ancient Buildings and was active in several art organizations. He died at Wickham Bishops, Essex, on March 15, 1942. (B. B. E. M. G.)

McLANE, LOUIS (1786–1857), U.S. congressman, diplomat, cabinet officer and business executive, was born in Smyrna, Del., May 28, 1786. At the age of 12 he entered the U.S. navy where he served under Commodore Stephen Decatur. He left the navy in 1801 to study law under James A. Bayard, a noted lawyer and congressman.

McLane's political career began in 1817 when he was elected to the U.S. house of representatives from Delaware. He served in the house until 1827 when he was elected to the senate. In 1829 he resigned from the senate to become U.S. minister to England. His principal achievement in this post was the negotiation of an agreement that reopened trade between the British West Indies and the United States. In 1831 Pres. Andrew Jackson recalled McLane from London and made him secretary of the treasury. His service in this position was made difficult by his fundamental disagreement with Jackson over the question of rechartering the Bank of the United States. McLane was transferred to the position of secretary of state in 1833 to give Jackson a chance to carry out his plans for destroying the bank. He served as secretary of state a little more than a year, resigning when he was overruled on a matter of policy.

When McLane left government service in 1834, he became president of the Morris Canal and Banking company in New York. Three years later he began a successful ten-year period as president of the Baltimore and Ohio Railroad company. While still holding this position, he was sent to England by Pres. James K. Polk in 1845 to negotiate a settlement of the dispute between the United States and Great Britain over the boundary of the Oregon territory. He died in Baltimore on Oct. 7, 1857.

His son, ROBERT MILLIGAN McLANE (1815–1898), was a lawyer in Baltimore, member of congress, governor of Maryland (1883–85) and U.S. minister to France (1885–89).

See S. F. Bemis (ed.), *The American Secretaries of State and Their Diplomacy*, vol. iv (1927–29). (G. C. O.)

MACLAREN, CHARLES (1782–1866), Scottish editor, who was cofounder of the *Scotsman* newspaper in Edinburgh, was born at Ormiston, Haddingtonshire, on Oct. 7, 1782. He was almost entirely self-educated, and became a clerk in Edinburgh. In 1817 when the *Scotsman* was established he at first acted as its editor. Offered a post as clerk in the customhouse, he resigned his editorial position, resuming it again from 1820 to 1845. He was editor of the 6th edition of the *Encyclopædia Britannica* in 1820. From 1864 he was president of the Geological society at Edinburgh, where he died on Sept. 10, 1866.

MACLAURIN, COLIN (1698–1746), Scottish mathematician, who alone of Newton's British successors, ranked equal with continental mathematicians of his day. Born at Kilmodan, Argyllshire, and educated at the University of Glasgow, at 19 he was elected professor of mathematics in Marischal college, Aberdeen. Two years later he was admitted a fellow of the Royal society and made the acquaintance of Sir Isaac Newton. In 1719 he published *Geometria organica, sive descriptio linearum curvarum universalis*, in which he developed several theorems due to Newton, introduced the method of generating conics that bears his name and showed that many curves of the third and fourth degrees can be described by the intersection of two movable angles. In 1721 he wrote a supplement to *Geometria organica*, which he amplified in the *Philosophical Transactions* for 1735. This paper is principally based on the following general theorem, which is a remarkable extension of Pascal's hexagram: "If a polygon move so that each of its sides passes through a fixed point, and if all its summits except one describe curves of the degrees m, n, p, etc., respectively, then the free summit moves on a curve of the degree $2mnp$ . . . which reduces to mnp . . . when the fixed points all lie on a right line."

In 1722 Maclaurin traveled as tutor and companion to the eldest son of Lord Polwarth and after a short stay in Paris resided for a time in Lorraine, where he wrote an essay on the percussion of bodies, which was awarded the prize of the French Academy of Sciences for 1724. In 1725 he was made professor of mathematics in the University of Edinburgh on the recommendation of Newton.

In 1740 Maclaurin divided with Leonhard Euler and Daniel Bernoulli the prize offered by the French Academy of Sciences for an essay on tides. His *Treatise of Fluxions* (1742), written in reply to George Berkeley, contains his well-known essay on tides. In this he showed that figures of equilibrium for a homogeneous rotating fluid mass are the ellipsoids of revolution, later known as Maclaurin's ellipsoids. He also gave in his *Fluxions*, for the first time, the correct theory for distinguishing between maxima and minima in general and pointed out the importance of the distinction in the theory of the multiple points of curves.

In 1745, when Jacobites were marching on Edinburgh, Maclaurin took a prominent part in preparing trenches and barricades for its defense. As soon as the rebel army got possession of Edinburgh, Maclaurin fled to England until it was safe to return. He died on June 14, 1746, at Edinburgh.

After Maclaurin's death his *Account of Newton's Philosophical Discoveries* was published by Patrick Murdoch, and also his *Algebra* in 1748. As an appendix to the latter appeared his *De linearum geometricarum proprietatibus generalibus tractatus*, an elegant treatise.

See J. R. Newman, *The World of Mathematics* (1962).

McLEAN, JOHN (1785–1861), U.S. cabinet member and supreme court justice, was born in Morris county, N.J., on March 11, 1785. His father, a farmer, moved to Virginia in 1789, later to Kentucky and finally to Ohio. The boy's schooling was irregular, but he went to Cincinnati to study law in the office of Arthur St. Claire, Jr., and in 1807 was admitted to the bar. In 1812 he was elected U.S. representative from the district that included Cincinnati, and in 1814 was re-elected. In 1816 he was appointed a judge in the supreme court of Ohio, a position he resigned in 1822 to become commissioner of the general land office under Pres. James Monroe. Monroe in 1823 appointed him postmaster general and he remained in that office throughout the administration of John Quincy Adams. His conduct of this office was notable for its efficiency and economy, and for the nonpartisan

treatment of postmasters and other employees. Pres. Andrew Jackson continued McLean in office, but McLean refused to accept the president's views on patronage and resigned. Jackson thereupon appointed him an associate justice of the supreme court, a position he held from 1829 until his death in 1861. His most famous opinion was his dissent in the Dred Scott case (1857). In 1848 he was considered as a presidential candidate at the Free Soil convention in Buffalo, and in 1856 he was the chief opponent of J. C. Frémont at the first Republican convention, receiving 196 votes. In 1860 his name was presented for the presidential nomination at conventions of both the Constitutional Union and Republican parties. He died at Cincinnati on April 4, 1861.

See Francis P. Weisenburger, *The Life of John McLean: a Politician on the United States Supreme Court* (1937).

MacLEISH, ARCHIBALD (1892–), U.S. poet, public servant and university professor, was born in Glencoe, Ill., May 7, 1892. Educated at Yale and Harvard law school, he first came to notice as a poet with *Tower of Ivory* (1917). The verse he published in the 1920s, *The Happy Marriage* (1924), *The Pot of Earth* (1925), *Streets in the Moon* (1926) and *The Hamlet of A. MacLeish* (1928), shows the fashionable influence of Ezra Pound and T. S. Eliot. In *New Found Land* (1930) a simple lyric eloquence, the persistent MacLeish note, is heard.

In the 1930s MacLeish was concerned about the threats to American society, particularly the Fascist menace. *Conquistador* (1932) is the first of his "public" poems. Others were collected in *Frescoes for Mr. Rockefeller's City* (1933), *Public Speech* (1936), and *America Was Promises* (1939). He wrote two radio verse plays on social themes, *The Fall of the City* (1937) and *Air Raid* (1938).

MacLeish served as librarian of congress (1939–44) and assistant secretary of state (1944–45), and in various governmental positions until 1949. He aided in the establishment of United Nations Educational, Scientific and Cultural organization (UNESCO). During these years he wrote and spoke constantly in defense of American democracy. In 1949 he became Boylston professor at Harvard. Two later works are outstanding, *Actfive and Other Poems* (1948) and a verse drama, *J. B.* (1957).

MacLeish's collected works are *Collected Poems, 1917–1952* (1952); *A Time to Speak: Selected Prose* (1941); *A Time to Act: Selected Addresses* (1943). (W. T.)

McLENNAN, JOHN FERGUSON (1827–1881), Scottish ethnologist who challenged the theory that modern society and the state evolved from a primordial, patriarchal family, was born at Inverness on Oct. 14, 1827, and educated at King's college, Aberdeen, and at Cambridge university. He was admitted to the bar in 1857, and in 1871 became parliamentary draftsman for Scotland. His work (1857) on the article "Law" for the 8th edition of *Encyclopædia Britannica* led him to an interest in ancient forms of marriage. In *Primitive Marriage* (1865, reissued as *Studies in Ancient History*, 2nd series, 1896) he outlined his theory of social evolution, postulating small, promiscuous groups initially, with kinship recognized in the female line. Promiscuity was seen as leading to polyandry, the reckoning of descent in the male line and eventually to marriage within the group. The terms exogamy and endogamy were introduced by McLennan, who also was first to recognize the significance of totemism in social origins. *The Patriarchal Theory* was published posthumously in 1885. McLennan's significance lay in the stimulation of research through his challenging theories, most of which, however, were generally rejected. He died on June 16, 1881, in Kent, Eng.

See E. B. Tylor in *The Academy*, vol. 20, pp. 9–10 (1885); R. H. Lowie, *The History of Ethnological Theory* (1937).
(Le. A. W.; X.)

MACLEOD, JOHN JAMES RICKARD (1876–1935), British physiologist, one of the discoverers of insulin (*q.v.*) and co-winner of the 1923 Nobel prize for medicine, was born on Sept. 6, 1876, near Dunkeld, Scotland, and was educated at Aberdeen grammar school, Marischal college, Aberdeen, and Leipzig university. From 1899 to 1902 he was demonstrator in physiology and then lecturer in biochemistry at the London hospital, holding also from 1901 to 1903 the Mackinnon research scholarship of the Royal society. From 1903 to 1918 he was professor of physiology at Western Reserve university, Cleveland, Ohio, subsequently becoming professor of physiology, director of the physiological laboratory and associate dean of the faculty of medicine in the University of Toronto, Ont. He died March 16, 1935.

Macleod's most important work was on the nature of the control of the metabolism of carbohydrates in the animal body, and, together with Sir Frederick Grant Banting, with whom he shared the Nobel prize, and C. H. Best, he achieved fame as one of the discoverers of insulin. Macleod's publications include *Practical Physiology* (1903); *Recent Advances in Physiology*, edited by Leonard Hill (1905); *Diabetes, Its Physiological Pathology* (1913); *Fundamentals of Physiology* (1916); *Physiology in Modern Medicine* (9th ed., 1941); and numerous papers on insulin, etc.

MACLEOD, NORMAN (1812–1872), one of the most liberal and enlightened Presbyterian ministers of the 19th century, was born at Campbeltown, Scot., on June 3, 1812. He took his arts course in Glasgow, but divinity in Edinburgh, drawn thither by Thomas Chalmers. In 1838, after traveling on the continent, he became minister of Loudoun parish, Ayrshire, at a time when the conflict that was to issue in the Disruption was most intense (*see* Scotland, Church of). Macleod threw in his lot with the small "middle party," which accepted Lord Aberdeen's proposed legislation as a satisfactory way out. At the Disruption of 1843 he moved to the parish of Dalkeith. In 1851 he was called to the Barony church, Glasgow, where he remained until his death (June 16, 1872). He was chaplain to Queen Victoria from 1857 and was elected moderator of the general assembly in 1869.

At Dalkeith, Macleod had been responsible from 1849 for a small religious periodical, the *Edinburgh Christian Magazine*. This led to his appointment in 1860 as editor of the new popular monthly magazine *Good Words*, which, during his lifetime, became a great success. His lively pen found constant use in entertainment, enlightenment and controversy, most notably in 1865 when he attacked the church's Sabbatarian policy. He worked to mitigate the strictness of Scottish religion and to encourage interest in churches abroad. From 1864 to 1872 he was convener of the Foreign Missions committee. What impressed his generation most was his versatility. He was equally at home in the pulpit of the Barony, in the editor's chair, in the workingmen's club he had founded, at Balmoral, at civic literary banquets and in the higher councils of the church.

See Donald Macleod, *Memoir of Norman Macleod* (1876); J. R. Fleming, *The Church in Scotland, 1843–74* (1927). (H. Wa.)

MACLISE, DANIEL (1806–1870), Irish history painter, was born at Cork on Jan. 25, 1806. At the age of 16 he left the employ of a local bank to enter the Cork school of art, maintaining himself by portrait sketching. In 1825 he made sketches of Sir Walter Scott, one of which was lithographed. He went to London in 1827 and entered the Royal Academy schools, where he carried off the highest honours. He exhibited subject pictures and portraits regularly at the Royal Academy and in 1835 was elected associate and in 1840, academician. Maclise's fame rests on the 72 lithographed portraits of literary and other contemporary celebrities which first appeared in *Fraser's Magazine* (1830–36) under the pseudonym Alfred Croquis (later published as the *Maclise Portrait Gallery*, 1871) and the two vast (12 by 45 ft.) frescoes for the Royal gallery in the house of lords. "The Meeting of Wellington and Blucher" was unsuccessfully begun in fresco in 1859 and completed in a new German "water glass" technique in 1861. Its companion "The Death of Nelson" was executed between 1861 and 1864. Maclise's harsh colour is largely offset by his unusually retentive visual memory and gift for large-scale composition. He died April 25, 1870, in London.
(D. L. Fr.)

MACLURE, WILLIAM (1763–1840), U.S. geologist, was born at Ayr, Scotland, Oct. 27, 1763. He became known as the father of American geology because of his publication of a geological map of the United States in 1809 which antedated William Smith's geological map of England by six years. The map, together with a memoir entitled *Observations on the Geology of the United States Explanatory of a Geological Map*, was the result

of his voluntary and unaided labours.

Maclure was a liberal patron of science for many years and from 1817 until his death was president of the Philadelphia Academy of Natural Sciences, to which he gave his valuable private library and about $20,000. He died at San Ángel, Mexico, March 23, 1840.

MacMAHON, MARIE EDMÉ PATRICE MAURICE DE, Duc de Magenta (1808–1893), marshal of France and second president of the third republic, was born at Sully (Saône-et-Loire) on July 13, 1808, a descendant of an Irish Jacobite family. He was educated at St. Cyr and on entering the army (1827) began a long period of military service in Algeria. He distinguished himself in the storming of Constantine (1837) as a soldier of daring and skill. In the Crimean War he led the division that stormed Malakhov (1855) and brought about the fall of Sevastopol. His military career reached its height in the Italian campaign of 1859, when his victory at Magenta led to his being created a marshal of France and given the title duc de Magenta. He became governor general of Algeria in 1864 and gained wider administrative experience.

In the Franco-German War (*q.v.*) of 1870–71 MacMahon took command of the 1st army corps in Alsace, which was defeated at the battle of Wörth (Aug. 6); and he was wounded and taken prisoner at Sedan (Sept. 2). Freed by the peace, he was appointed by Adolphe Thiers to command the Versailles army which conducted the second siege of Paris, crushing the Commune in May 1871. By 1873 he was widely esteemed as a veteran soldier of proven courage and distinction, and, next to the veteran statesman Thiers, the only public figure in France capable of commanding general confidence and esteem. When Thiers resigned his position as head of state on May 24, 1873, it was to MacMahon that men looked as his successor, though his known conservative, clericalist and even royalist inclinations made him particularly the candidate of the anti-republican right. Elected president of the republic on the same day, MacMahon at the age of 65 began a short-lived but highly controversial political career for which he was ill-fitted and in which he rendered poor service to the causes that he favoured.

On Nov. 20, 1873, MacMahon was entrusted with executive power as president of the republic for a period of seven years—a decision which marked a step away from the provisional regime of Thiers toward the more definitive constitution of the third republic. His presidency was a crucial period for France, because during it the new constitution took shape and was brought into force. Important precedents were established affecting the relationship between executive and legislature. Tenure of the presidency of the republic by a professional soldier with little skill or taste for politics tended to make that office a figurehead, honorific rather than decisive. MacMahon brought to the role a personality of modest simplicity and quiet dignity with a strong sense of duty, qualities which might have made him a good president in quiet times. In formative and complex circumstances he understood too little and lent himself to party intrigue.

The constitutional laws were passed during Jan.–Feb. 1875. The elections to the new chamber in 1876 returned a large majority of republicans. This majority was confronted with a conservative president and senate, and in Dec. 1876 it compelled MacMahon to invite the moderate republican, Jules Simon, to form a government. Simon's ministry met with fierce attacks from the right and on May 16 (*le Seize Mai*), 1877, MacMahon sent him a letter that was tantamount to dismissal. Though undefeated in the chamber, Simon chose to resign, thus precipitating the constitutional crisis of *le Seize Mai*. When the president commissioned the conservative Albert de Broglie to form a ministry and won the senate's assent to a dissolution of the chamber, the issues of presidential or parliamentary control over the government were squarely posed.

Dissolving the chamber of deputies on June 25, 1877, MacMahon behaved strictly within his presidential rights, though he showed great political ineptitude, for he posed the basic issue of ministerial responsibility when he was unlikely to get the solution that he wanted. The electoral campaign was strenuous, the government using all its resources of official pressure and manipulation, the opposition denouncing MacMahon's behaviour as a *coup d'état*. The outcome of a republican victory would be, as Léon Gambetta pointed out, that the president must either "give in or give up" (*se soumettre ou se démettre*). The results of the general election of Oct. 14 gave fewer seats, but still a decisive majority, to the republicans. By Dec. 13, 1877, MacMahon gave in to the extent of accepting a ministry led by Jules Dufaure and composed mostly of republicans. When, on Jan. 5, 1879, republicans also gained a majority in the senate, the president gave up as well, and on Jan. 28 he resigned, to be succeeded two days later by the republican leader Jules Grévy. Throughout the remaining 60 years of the third republic, no president again resorted to the power of dissolution.

The marshal died in Paris on Oct. 17, 1893. Out of his element in politics and lacking a grasp of the political realities in his day, the distinguished old soldier left a deeper mark on French government by his failures than by his achievements.

See D. Halévy, *La République des ducs* (1937). (D. Tn.)

McMASTER, JOHN BACH (1852–1932), U.S. educator and historian, who was a pioneer in the use of social rather than purely political materials, was born in Brooklyn, N.Y., on June 29, 1852. After he graduated from the College of the City of New York in 1872, McMaster worked as a civil engineer and was an instructor in civil engineering at Princeton university, 1877–83. From 1883 until 1920 he was professor of American history in the University of Pennsylvania.

His earliest writings were on engineering subjects, but he is best known for his *History of the People of the United States, from the Revolution to the Civil War* (1883–1913). It was supplemented by *A History of the People of the United States During Lincoln's Administration* (1927). Among McMaster's other books are *With the Fathers* (1896); *A Brief History of the United States* (1907, rev. enl. ed., 1918 and 1924); and *The Life and Times of Stephen Girard, Mariner and Merchant* (1918). His textbooks were used in many U.S. elementary and secondary schools. He died in Darien, Conn., on May 24, 1932.

See E. F. Goldman, *John Bach McMaster* (1943).

MACMILLAN, the name of a family of English publishers. The founders of the firm were two Scotsmen, Daniel Macmillan (1813–57) and his younger brother Alexander (1818–96). Daniel was born on the Isle of Arran on Sept. 13, 1813, and Alexander was born in Irvine on Oct. 3, 1818. Daniel was for some time assistant to the bookseller Johnson at Cambridge, but entered the employ of Messrs. Seeley in London in 1837. In 1843 the brothers began business in Aldersgate street and in the same year they purchased the business of Newby in Cambridge. They began to publish educational works in 1844. In 1845 they took over the more important business of Stevenson in Cambridge. Daniel Macmillan died at Cambridge on June 27, 1857. The firm had begun to prosper and in 1858 a branch office was opened in London. Alexander Macmillan died in Jan. 1896. In little over half a century he had built up one of the most important publishing houses in the world which, in time, had its branches in the United States, Canada, Australia and India. Macmillan published the works of Tennyson, Charles Kingsley, T. H. Huxley, Lewis Carroll, Rudyard Kipling and many other great Victorian authors.

Frederick Orridge Macmillan (1851–1936), the son of Daniel, became a partner in 1876 and first chairman in 1893, when the firm became a limited liability company. In 1898 the company purchased the business of R. Bentley and Son. Frederick's partners were his younger brother Maurice and his cousin George, both of whom died in 1936; they were succeeded by Maurice's sons Daniel (1886–), the chairman, and Maurice Harold (1894– ; *q.v.*), whose son Maurice Victor (1921–) is a director.

Bibliography.—T. Hughes, *Memoir of Daniel Macmillan* (1882); *A Bibliographical Catalogue of Macmillan & Co's Publications From 1843 to 1889* (1891); C. L. Graves, *Life and Letters of Alexander Macmillan* (1910); C. L. Morgan, *The House of Macmillan (1843–1943)* (1943).

McMILLAN, EDWIN MATTISON (1907–), U.S. physicist, recipient of the 1951 Nobel prize in chemistry, with Glenn T. Seaborg, for work on the chemistry of the transuranium

elements, and co-discoverer of neptunium and plutonium, was born at Redondo Beach, Calif., on Sept. 18, 1907. He was educated at the California Institute of Technology (B.S., 1928; M.S., 1929) and Princeton university (Ph.D., 1932). He went to the University of California at Berkeley in 1932, and after a period as research fellow (1932–34) and associate (1934–35) he joined the faculty, advancing to a full professorship in 1946. From 1934 he was a member of the staff of the radiation laboratory, of which he became associate director in 1954 and director in 1958. During World War II he was engaged in research on radar and sonar (asdic) and helped establish the Los Alamos, N.M., atomic energy laboratory, where he assisted in developing the first atomic bomb. In the spring of 1940 he discovered, with Philip H. Abelson, the first transuranium element, neptunium (atomic no. 93), thus opening the whole transuranium field. Later in 1940 he initiated the search for, and was a co-discoverer of, the next transuranium element, plutonium (atomic no. 94), with Seaborg and others. He developed the theory of the synchrotron independently of and nearly simultaneously with the U.S.S.R. physicist Vladimir I. Veksler; this theory (*Physical Review*, Sept. 1945) made possible the construction of huge machines for the acceleration of electrons and atomic projectiles to very high energies, opening the field of high energy physics and convenient study of the various fundamental particles. (G. T. Sc.; X.)

MACMILLAN, (MAURICE) HAROLD (1894–), British statesman, prime minister from 1957 to 1963, was born in London on Feb. 10, 1894, the son of Maurice Crawford Macmillan and Helen Artie Belles. His mother came from Spencer, Ind.; his paternal grandfather, of Highland crofter origin, founded the famous London publishing house, of which Harold Macmillan became an active director in 1924. Educated at Eton and at Balliol college, Oxford, he served with the Grenadier guards during World War I, was wounded three times and won the Military cross. After the war he became aide-de-camp to the governor general of Canada, the 9th duke of Devonshire, whose daughter, Lady Dorothy Evelyn Cavendish, he married in 1920.

Macmillan stood unsuccessfully for parliament at Stockton-on-Tees in 1923, but was elected for the seat in 1924 and held it thereafter, except in 1929–31, until 1945. His prewar political career was one of party unorthodoxy: to limit unemployment, he advocated a greater degree of state control over the economy than most Conservatives thought desirable; and in foreign affairs he was a bitter critic of Neville Chamberlain's appeasement policy. He expressed his political ideas in *Reconstruction: a Plea for a National Policy* (1933) and *The Middle Way* (1938). When Winston Churchill formed his coalition government in 1940, Macmillan was given office for the first time—as parliamentary secretary to the ministry of supply. In 1942 he spent some time as colonial undersecretary and was then sent out to northwest Africa as minister resident at Allied headquarters there. He was secretary of state for air in the 1945 "caretaker" government, then lost his seat at the general election but was re-elected in Nov. 1945 in a by-election at Bromley, Kent. A pioneer of the United Europe movement, he attended the 1948 congress out of which grew the Council of Europe.

When the Conservatives returned to power in 1951 Macmillan became minister of housing and local government. He held the post until 1954 and was responsible for achieving the government's promised target of more than 300,000 new houses a year. He was then successively minister of defense (1954–55), foreign secretary (April–Dec. 1955) and chancellor of the exchequer (1955–57). As chancellor he introduced the premium bond savings scheme. He was appointed prime minister on Jan. 10, 1957, following the resignation of Sir Anthony Eden, and was elected leader of the Conservative party 12 days later.

Macmillan long devoted himself to foreign and overseas affairs. It was his support of Eden's Suez policy in 1956 that led the Conservatives to choose him as their leader when Eden resigned. Macmillan set himself particularly to strengthen relations between the U.S. and Britain. He had several meetings with presidents Dwight D. Eisenhower and John F. Kennedy concerned especially with nuclear strategy. He visited Nikita Khrushchev in Moscow in 1959, and he kept regular and personal contact with Konrad Adenauer and Charles de Gaulle. Macmillan was a firm supporter of European unity, and in 1961 his government began strenuous negotiations for terms on which Britain might join the European Economic Community. These negotiations broke down in Jan. 1963 in the face of objections to Great Britain's entry by President de Gaulle.

Macmillan visited most of the countries of the commonwealth and was the first British prime minister to set foot in India since its independence. Early in 1960 he was in Africa, and in a speech to the South African parliament spoke of the "wind of change" that was blowing through Africa and asserted the British government's opposition to the policy of apartheid. In domestic politics he exercised his power boldly. A year after he became prime minister he accepted the resignations of all three treasury ministers, and in July 1962 party discontent led him to replace 16 members of his government, including the chancellor of the exchequer and the minister of defense.

At the end of 1962 Macmillan had to contend with difficult problems of defense strategy arising from the refusal of the U.S. government to continue the development of the Skybolt air-to-ground missile. These problems were resolved at a meeting between Macmillan and President Kennedy in the Bahamas in Dec. 1962 when the Nassau agreement was concluded.

The year 1963 brought Macmillan other difficulties. The possible security risk which led ultimately to the resignation (June) of John Profumo, secretary of state for war, caused a charge of negligence to be made against Macmillan and this was utilized by those of his own party who sought a change of leader before a general election due at the latest in Oct. 1964. Nevertheless, he seemed to have ridden out the storm successfully when illness brought about his resignation on Oct. 18. (J. F. B.)

MacMONNIES, FREDERICK WILLIAM (1863–1937), U.S. sculptor and painter, whose long residence in France accounts for the strong French influence seen in all his work, was born in Brooklyn, N.Y., Sept. 20, 1863. In 1880 he was employed as a studio assistant by Augustus Saint-Gaudens. In 1884 he went to Paris to study sculpture with Jean Alexandre Falguière and Marius Jean Mercié. He returned to New York in 1887 and went again to Paris in 1889, where he remained until World War I. In 1891 he was awarded a medal of the second class at the salon—an honour never before conferred on an American sculptor. His fame was established in the U.S. by his Columbian fountain, at the 1893 World's Columbian exposition in Chicago. Among the best known of his works are "Nathan Hale," in City Hall park, New York city, his "Bacchante," in the Metropolitan Museum of Art, New York city, the battle monument, at Princeton, N.J., and his decoration for the soldiers' and sailors' memorial arch at Grand Army plaza, Brooklyn, N.Y. He was also well known as a portrait painter. He died on March 27, 1937.

See L. Taft, *History of American Sculpture* (1924). (A. T. G.)

MACNAGHTEN, EDWARD MACNAGHTEN, 1ST BARON (1830–1913), was the first law lord appointed to the British house of lords directly from the bar without previous judicial experience. Born in Bloomsbury on Feb. 3, 1830, he was educated at Dublin and Cambridge universities. He was called to the bar at Lincoln's Inn in 1857. Appointed a lord of appeal in ordinary in 1887 on the retirement of Lord Blackburn after only seven years practice as a queen's counsel, Baron Macnaghten was a distinguished practitioner in chancery; but his chief distinction as a judge was his literary gift of short summaries of the factual case before him and of simple restatement and classification of the legal rules applied. McNaghten's rule, or the right and wrong test for insanity as a defense in a criminal trial (*see* INSANITY), is not to be associated with his name but with that of a 19th-century criminal in whose case the rule was formulated. The best-known legal rule to which Baron Macnaghten's name is attached is his classification of charitable gifts into four divisions: "trusts for the relief of poverty; trusts for the advancement of education; trusts for the advancement of religion; and trusts for other purposes beneficial to the community." He died in London on Feb. 17, 1913. (A. DM.)

McNAIR, LESLEY JAMES (1883–1944), U.S. army officer who directed the training of ground combat troops during the mobilization for World War II, was born in Verndale, Minn., on May 25, 1883, and graduated from the U.S. Military academy in 1904. McNair served with Gen. Frederick Funston's expedition to Veracruz in 1914 and with Gen. John J. Pershing's punitive expedition into Mexico in 1916. During World War I he was with the 1st division in France and with the army of occupation in Germany.

Appointed chief of staff, general headquarters, U.S. army, in 1940 (title changed to commanding general, army ground forces, when the war department was reorganized in 1942), McNair prepared the army for combat by a rigorous training program that included the use of films, obstacle courses, live ammunition and large-scale maneuvers. He sought to perfect the military skills of the individual soldier, promote the proficiency of field force units and develop teamwork among the combined arms. By stressing standardization of military doctrine and organization throughout the army, he provided for the interchangeability of individuals and units, thereby making possible their rapid and effective utilization in the diverse theatres of operation.

Assigned to the European theatre in the summer of 1944, McNair visited the Normandy front to observe the battle and was killed near St. Lô on July 25, when bombs dropped by Allied planes fell short and landed on U.S. positions. (Mn. Bn.)

McNARNEY, JOSEPH TAGGART (1893–), U.S. army officer, one of the foremost military administrators of World War II, was born at Emporium, Pa., on Aug. 28, 1893. After graduation from the U.S. Military academy at West Point in 1915, he followed a career in the air corps, which included service in France in World War I and school and staff experience in the 1920s and 1930s. McNarney was the chief architect of the important war department reorganization of March 1942, which established a simplified and effective structure. He was chosen immediately thereafter to be deputy chief of staff of the U.S. army, and his services in this position proved so valuable that he was not released for overseas duty until Oct. 1944, when he became commander of all U.S. forces in the Mediterranean. In Dec. 1945 he succeeded Gen. Dwight D. Eisenhower as commander of U.S. occupation forces in Germany, serving until early 1947 in that important and difficult position. McNarney retired in 1952 to enter private business. (A. Gg.)

McNAUGHTON, ANDREW GEORGE LATTA (1887–), Canadian army officer, commander of the Canadian army in Great Britain during World War II, was born on Feb. 25, 1887, at Moosomin, Sask. While at McGill university, Montreal, Que., he studied engineering and military subjects. Commissioned in the Canadian artillery in 1910, he went overseas as a major in 1914, served both in France and Belgium and was twice wounded. He ended World War I as a brigadier general. In 1920 he was appointed director of military training. Three years later he became deputy chief of the Canadian general staff and in 1929 was made chief, as a major general. He held this high post until he became president of the National Research council of Canada in 1935. Keenly interested in scientific developments, particularly in aviation, he was himself joint inventor of the cathode ray direction finder.

When World War II broke out in 1939, McNaughton was recalled to the army and commanded the 1st Canadian division, which went overseas at the end of the year, and then in 1940, with the rank of lieutenant general, the VII Canadian corps, and from April 1942 the 1st Canadian army overseas. He returned to Canada in 1944 and on Sept. 27, the date of his retirement from the army, was promoted full general. From Nov. 1944 to Aug. 1945 he was minister of national defense, at a time when conscription was a burning issue. During 1945 he twice sought election to parliament but was not successful. From Jan. 1948 to Dec. 1949 he acted as Canadian representative on the United Nations Security council, and from 1950 to 1962 he was chairman of the Canadian section of the International Joint commission, which dealt with water and boundary problems between Canada and the United States. (E. B. Bn.)

McNEILE, HUGH (1795–1879), Irish Anglican clergyman and a leader of the evangelical party in the 19th century, was born at Ballycastle, County Antrim, on July 15, 1795, and educated at Trinity college, Dublin. He came under the influence of Edward Irving but was soon alienated by the latter's increasingly extravagant preaching. In 1834 he became incumbent of St. Jude's, Liverpool, where for 30 years he had great political as well as ecclesiastical influence. In 1835 McNeile entered on a long contest with the Liverpool corporation, which proposed to secularize its elementary schools by the introduction of the Irish national system. He led a fierce agitation against the threatened withdrawal of the Bible as the basis of denominational religious teaching; before the new system could be introduced every child was provided for in new Church of England schools established by public subscriptions. In 1840 McNeile published *Lectures on the Church of England* and in 1846 (the year after John Henry Newman's secession to Rome) *The Church and the Churches*, maintaining the evangelical doctrine of the "invisible church" in opposition to the teaching of Newman and Edward Pusey. In 1860 he was appointed a canon of Chester and in 1868 dean of Ripon. He died in Bournemouth on Jan. 28, 1879.

MacNEILL, JOHN GORDON SWIFT (1849–1926), Irish historian and an authority on parliamentary procedure, was born in Dublin on March 11, 1849, and educated at Trinity college, Dublin, and Christ Church, Oxford. He joined Isaac Butt's Home Rule association in 1870. Having been called to the Irish bar he was sponsored, under Charles Parnell's (*q.v.*) leadership, for south Donegal in 1887 and retained the seat until Sinn Fein routed the constitutional party in 1918. He was a professor of law at the King's inns, Dublin, and his close study of parliamentary procedure helped Parnell's party greatly in their systematic obstruction of debates at Westminster. In 1909 he became professor of constitutional law in the new National University of Ireland. In 1925, in retirement, he published his amusing reminiscences *What I Have Seen and Heard* (1925). His other books include *The Irish Parliament: What It Was, and What It Did* (1885) and *Studies in the Constitution of the Irish Free State* (1925). MacNeill died in Dublin on Aug. 24, 1926. (D. G.)

MACON, NATHANIEL (1758–1837), U.S. political leader, was born at Macon Manor in what is now Warren county, N.C., Dec. 17, 1758. He studied at the College of New Jersey (now Princeton university) from 1774 to 1776, when the institution was closed because of the outbreak of the American Revolution. From 1777 to 1780 he studied law at Bute (now Warren) county courthouse, N.C., and from 1781 to 1785 served in the North Carolina senate. In 1791 he was elected to the U.S. house of representatives where he remained until elected to the senate in 1815.

Macon's point of view was always local rather than national; throughout his career he was an aggressive advocate of state sovereignty and an adherent of the doctrines of the "Old Republicans." As speaker of the house, 1801–07, he functioned as one of the most important leaders of the Republican forces. At first on close terms with Thomas Jefferson, he associated himself briefly between 1806 and 1809 with John Randolph and a dozen other congressmen who were called "Quids." They strongly criticized Jefferson for failing to adhere to pure republican principles and bitterly opposed the choice of James Madison as his successor. By 1809 Macon was again in accord with the majority of his party and as chairman of the house foreign relations committee he fully supported Madison's foreign policy. As chairman of this committee he reported a set of resolutions designed to exclude foreign war vessels from U.S. ports and to suppress the illegal trade carried on by foreign merchants under the American flag. In a drastically revised form these provisions were incorporated in a bill passed on May 1, 1810, which restored commerce with all nations but promised to revive nonintercourse against either Great Britain or France if the other power would reverse its commercial restrictions. This bill was labeled "Macon's Bill No. 2" because Macon was chairman of the committee that reported on it, but he was not its author and opposed its adoption. He voted for the declaration of war against England in 1812, but, motivated by an exaggerated fear of government expenditure and an ill-founded faith in the value of

the militia, he opposed conscription and all taxes needed to wage war. After the war his states' rights and sectional views became even more marked; he opposed internal improvements (building roads and canals), the rechartering of the Bank of the United States and the postwar protective tariff. In his later years he was one of the outspoken defenders of slavery.

Rural and local minded, Macon was obsessed with the idea of the necessity of public economy to the point of parsimony. His industry, kindliness, unquestioned integrity, and the absence of any selfish motives in his conduct made him universally liked. In 1824 Macon received the electoral vote of Virginia for the vice-presidency, and in 1826–28 he was president pro tempore of the senate. He died at Buck Spring, his home in North Carolina, on June 29, 1837.

See William E. Dodd, *The Life of Nathaniel Macon* (1903); E. M. Wilson, *The Congressional Career of Nathaniel Macon* (1900).
(H. Am.)

MÂCON, a town of east central France, capital of the *département* of Saône-et-Loire, 68 km. (42 mi.) N. of Lyons by road. Pop. (1962) 25,012. Mâcon is situated on the right bank of the Saône at the foot of the Monts du Mâconnais. An 18th-century 12-arch bridge connects it with St. Laurent and the plain of Bresse. Mâcon has fine old wooden houses. Of the old cathedral of St. Vincent (12th century), destroyed during the Revolution, nothing remains but the Romanesque narthex (the part west of the nave), now used as a chapel, the façade and its two flanking towers. The prefecture, formerly the episcopal palace, dates from the 17th century; the *hôtel de ville* contains a library, a theatre and a picture gallery. Mâcon was the birthplace of the poet and politician Alphonse de Lamartine.

The town is the junction of the Paris-Marseilles and Paris-Turin railways and an important meeting place of roads. The district produces an excellent wine and large quantities are exported. Copper founding and printing are important industries; manufactures include mats, esparto articles, matches and ropes.

Mâcon (ancient Matisco) was an important town of the Aedui, but under the Romans it was supplanted by Autun and Lyons. It was sacked by the Germans, Burgundians, Vandals, Huns, Hungarians and even by the Carolingian kings. In the feudal period it was an important countship and was sold in 1239 to Louis IX (St. Louis) of France, but in 1435 Charles VIII gave it to the duke of Burgundy and it did not revert to the French crown till Charles of Burgundy died in 1477. In the 16th century Mâcon became a stronghold of the Huguenots, but yielded to Henry IV in 1594. The bishopric, created by King Childebert, was suppressed in 1790. (Gd. L.)

MACON, a city of central Georgia, U.S., and the seat of Bibb county, is located about 75 mi. S.E. of Atlanta, on the Ocmulgee river, on the fall line. North Carolinians were the first settlers to build their homes on the east side of the river at Ft. Hawkins, a frontier trading post. The original settlement was called Newtown (1821), but after the Creek Indians ceded land west of the river, a site along its bank was platted in 1823 and named for Nathaniel Macon (*q.v.*). Newtown was annexed in 1829, and the city was chartered in 1832.

In the 1840s Macon became a market centre for cotton which was shipped downstream to Darien, and by the 1860s, with the coming of the railroads, its position as a trade and transportation centre had become established. During the American Civil War, Macon was a Confederate gold depository, and its factories produced munitions and supplies until Gen. Howell Cobb surrendered to the Union cavalry commander, Gen. James H. Wilson, on April 20, 1865.

Macon slowly rebuilt its economy during the Reconstruction period, and railroad shops, foundries, brickworks and textile mills were developed. The turn of the century saw civic improvements, which included the construction of a levee as a protection against river floods, and an extension of city limits. Economic stimulus was given during World War I with increased industrial employment and the influx of thousands of soldiers to Camps Harris and Wheeler. The United States naval ordnance plant and Warner Robins air matériel area (later Robins air force base) became permanent installations after World War II.

In the 1960s the inhabitants in the metropolitan area were principally engaged in processing and distributing agricultural products from the surrounding fertile farm lands, which include cotton, grain, pulpwood, peaches, peanuts and pecans.

There are also industries based on nearby mineral resources, such as kaolin, granite, clays, limestone and lime. Scores of newer industries, established in the area in the late 1940s and 1950s, include the manufacture of car accessories, candy, aircraft parts, drugs, clothing and chemicals.

The original settlers laid out exceptionally wide streets, which contain floral parkways. Macon's public parks are noted for their azaleas, camellias and glossy-leaved magnolias. The cultural atmosphere is enhanced by: Wesleyan college, a pioneer in higher education for women, established by the Methodists in 1836; Mercer university, founded by the Baptists at Penfield in 1833 and moved to Macon in 1871; and Georgia Academy for the Blind (1851). Amid the splendour of ante-bellum Greek Revival houses with their majestic white columns adding old south charm to the city, there is a modest cottage on High street, the birthplace of Sidney Lanier (*q.v.*), Georgia's most renowned poet. These homes plus Indian mounds and relics, notably the Lamar mounds and village site, at Ocmulgee National monument are major tourist attractions.

Pop. (1960) city, 69,764; standard metropolitan statistical area (Bibb and Houston counties), 180,403. In 1961 Macon annexed territory with a population (1960) of 53,112, giving the city a 1961 population, based on 1960 federal census figures, of 122,876.
(S. B. K.)

McPHERSON, AIMEE SEMPLE (1890–1944), U.S. evangelist and founder of the International Church of the Foursquare Gospel, was born near Ingersoll, Ont., Oct. 9, 1890. Her public career began as a missionary in China with her first husband, Robert Semple, a Pentecostal evangelist. She returned to the United States with her daughter after her husband's death, and a second marriage to Harold McPherson was ended by her turning to full-time itinerant evangelism and healing. In this she became an outstanding success, settling finally in Los Angeles, Calif., where for almost 20 years she preached to large congregations. Besides organizing (1926) and administering the International Church of the Foursquare Gospel (known in England as Elim Foursquare Gospel), Mrs. McPherson built a radio station, founded and headed a Bible school, edited a magazine, wrote books and pamphlets and carried on extensive social service work. An attractive woman, she used her charms to the full. Her dynamic personality, prodigious energy and bizarre methods won for her countless friends and a number of enemies. Theologically she was fundamentalist and in her emphasis Pentecostal. The loyalty of her followers—in the face of her third marriage, which ended in a divorce, and various grave charges (unproved) against her—was constant.

Mrs. McPherson died on Sept. 27, 1944, from an overdose of sleeping powders. Her son Rolf McPherson succeeded her, and the movement continued to grow, reporting in the late 1950s a membership of nearly 80,000.

Mrs. McPherson's published works include *This Is That* (1923); *In the Service of the King* (1927); and *Give Me My Own God* (1936). *The Story of My Life* was edited and published in her memory in 1951.

See Nancy B. Mavity, *Sister Aimee* (1931). (C. S. B.)

MACPHERSON, SIR DAVID LEWIS (1818–1896), Canadian railway builder and politician, was born at Castle Leathers, near Inverness, Scot., on Sept. 12, 1818, and emigrated to Canada in 1835. After a successful business career in Montreal he moved to Toronto and in 1853 obtained the contract to build a railway line from Toronto to Sarnia, Upper Canada (later Ontario), afterward part of the Grand Trunk railway. In 1872 he headed the Interoceanic Railway company which sought dominion government assistance to build to the Pacific. He refused to join Sir Hugh Allan's Montreal-centred company which gained the contract but subsequently proved unable to undertake the enterprise. He published several pamphlets on economic subjects.

Macpherson was elected to the Canadian parliament as member of the legislative council for Saugeen, Upper Canada, in 1864, and was named to the dominion senate in 1867. He became speaker of the senate and minister without portfolio in the Conservative cabinet in 1880. After Oct. 1883 he was minister of the interior but retired in Aug. 1885, following the second Riel, or Northwest, Rebellion. He was knighted in 1884 and died at sea on Aug. 16, 1896. (M. Za.)

MACPHERSON, JAMES (1736–1796), Scottish poet who published between 1760 and 1763 two epics and a number of shorter poems which he claimed were translations from 3rd-century A.D. Gaelic poems composed by Ossian. This was the starting point of the Ossianic controversy, which raged for 50 years, had repercussions in French, German and Italian literature, and still attracts interest.

Macpherson was born at Ruthven, Inverness-shire on Oct. 27, 1736. He enrolled as a student at King's college, Aberdeen, in 1752, and moved to Marischal college, Aberdeen, in 1754. In 1755 he went to Edinburgh, to study for the ministry, but shortly afterward he returned as schoolmaster to Ruthven. His first verse publication, *The Highlander* (1758), was undistinguished. Jerome Stone of Dunkeld, a linguist and poet, had published a loose translation of a Gaelic ballad in the *Scots Magazine* in 1756, and this may have turned Macpherson's thoughts to the Gaelic ballads. He was encouraged also by John Home, author of *Douglas* (1757). Hugh Blair of Edinburgh collected money to finance an expedition to the Highlands, and Macpherson visited Skye, Uist and Benbecula, and later the southern Highlands and Mull, collecting Gaelic manuscripts and having Gaelic poems written down from recitation. On the first of these expeditions he probably acquired the 16th-century manuscript now known as the *Book of the Dean of Lismore*. He also acquired manuscripts written by the MacMhuirichs, hereditary bards to the MacDonalds of Clanranald. In making this collection of manuscripts and of oral literature, and in stimulating the interest of other collectors, Macpherson made an important contribution to Gaelic studies.

His first publication of supposed translations was the *Fragments of Ancient Poetry Collected in the Highlands of Scotland and Translated From the Gaelic or Erse Language* (1760). Few of these fragments have more than a tenuous connection with Gaelic originals. His next publication, *Fingal, an Ancient Epic Poem* (1762), was much more indebted to genuine Gaelic sources. *Temora* (1763) is based in part on a Gaelic ballad, but the handling of his material is much freer. He published no new translations from Gaelic after 1763.

The Ossianic controversy began shortly after the publication of the *Fragments* in 1760. The authenticity of Macpherson's work was strongly upheld by Hugh Blair; David Hume tended to be skeptical; Thomas Gray's admiration for the "translations" was tinged with doubt; Dr. Johnson's assessment of the controversy combined common sense and prejudice. None of these critics had any knowledge of Gaelic.

Macpherson's claim to have translated from 3rd-century poems can be regarded as preposterous. The earliest fragments of Irish writing are dated, in their original form, to the 6th century A.D. In Irish sources, genuine Ossianic ballads can be dated to the 11th and succeeding centuries, although the basic legends are much older. What Macpherson did was to use a number of the ballads he had collected, and to add much material of his own. In *Fingal* he used at least nine ballads; in *Temora*, apparently only one. Sometimes his translations were close to the originals, but often he misunderstood these, and frequently he changed their entire mood in his wordy attempt to create a doom-laden, "romantic" atmosphere. The descriptions of gloomy, misty landscapes come from his own experience and imagination, and the language is strongly influenced by the Authorized version of the Bible.

Macpherson steadily evaded the task of publishing his originals during his lifetime, but he left £1,000 to pay for the publication of the Gaelic, which appeared in 1807. Although many people were deceived by it then and later, it is clear that this Gaelic version is a translation of Macpherson's English. The true Gaelic ballads have been published in various collections, notably in J. F. Campbell's *Leabhar na Féinne* (1872).

After 1763 Macpherson devoted himself to other interests, especially to business, political propaganda and the writing of history. His most important historical work is the *Original Papers, Containing the Secret History of Great Britain From the Restoration to the Accession of the House of Hanover*, two volumes (1775). He held the post of London agent to the nabob of Arcot, and entered parliament in 1780. He died at his home in Inverness-shire on Feb. 17, 1796.

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McPHERSON, JAMES BIRDSEYE (1828–1864), Union general of the American Civil War, was born near the modern town of Clyde in Sandusky county, O., Nov. 14, 1828. He entered West Point in 1849 and graduated four years later at the head of his class. After being commissioned in the corps of engineers he held minor army assignments, including a one-year appointment at West Point, until the outbreak of the Civil War in 1861. At the end of the year McPherson was appointed a lieutenant colonel and aide-de-camp to Gen. H. W. Halleck in Missouri, and several months later he was assigned to Gen. U. S. Grant's staff as chief engineer in the Tennessee campaign. McPherson distinguished himself both at Shiloh and Corinth, and after the latter battle was promoted to be major general of volunteers. He participated in the second advance upon Vicksburg in 1863 in command of the XVII army corps, and after the city fell he was promoted to the rank of brigadier general in the regular army upon the strong recommendation of Grant. On March 26, 1864, after serving for a period as military commander of Vicksburg, McPherson took command of the army of the Tennessee, which was to move against Atlanta under Gen. W. T. Sherman's supreme command. Shortly after reporting to Sherman's headquarters and receiving his orders, McPherson was killed by a Confederate skirmisher, July 22, 1864. Grant is reported to have said of this universally respected young general, "The country has lost one of its best soldiers, and I have lost my best friend."

See E. J. Whaley, *Forgotten Hero: General James B. McPherson* (1955). (J. R. Co.)

MACQUARIE ISLAND, in the Pacific ocean, lies about 850 mi. S.E. of Tasmania, Austr., to which it belongs, in latitude 158° 54′ E. and longitude 54° 37′ S. The island, about 21 by 2 mi., forms a plateau at about 800 ft. and is treeless but well vegetated. Discovered in 1810, and a sealing base until 1919, it is now a nature reserve. A remarkable avifauna includes four species of albatross and four kinds of penguin; the royal penguin is not known to breed anywhere else. In 1948 the Australian government established a permanent meteorological and research base there. (O. H. K. S.)

MACREADY, WILLIAM CHARLES (1793–1873), English actor, manager and diarist, the greatest figure of the 19th-century stage in the development of techniques of acting and production, was born in London on March 3, 1793, the son of a minor Irish actor, who shortly afterward undertook a career as manager of provincial acting companies. Macready was entered at Rugby to prepare for the bar, but his father's financial difficulties and his own highly developed sense of personal responsibility caused him to abandon his formal education and take up temporarily, he thought, the theatre, a profession to which he was to make an outstanding contribution but for which he always felt an intense dislike. On June 7, 1810, he made his debut as Romeo at Birmingham and rapidly acquired fame in other Shakespearean and romantic roles in the provincial theatres. On Sept. 16, 1816, he appeared at Covent Garden, London, as Orestes in *The Distressed Mother*, a dull and outmoded tragedy by Ambrose Philips. Theatrical rivalry forced upon him a series of romantic and melodramatic villains, which he performed with such earnestness and truth that he became firmly established, though they did nothing

to increase his affection for the stage. On Oct. 25, 1819, he was permitted to appear as Richard III in a text that he partially purged of the "improvements" of Colley Cibber, the first of his many important efforts to restore the original work of Shakespeare to the theatre. In 1820 he created the leading role in *Virginius*, the first produced play by James Sheridan Knowles, and from that time was recognized as belonging in the front rank of English actors, contested for the first place only by Edmund Kean.

Throughout his acting career at Covent Garden and at Drury Lane, Macready devoted himself wholeheartedly to his art. His method of long study and detailed rehearsal, at a time when the general practice was casual, conventional and inspirational, anticipated much of the naturalistic method of acting developed by Konstantin Stanislavski. In 1837 he undertook the management of Covent Garden, where he was able to extend his theory of acting to all the elements involved in production. He was thus the first to impose upon the theatre of realistic illusion the principle of unity: that the actors, from star to spear carrier, the designer, the costumer and all others connected with a performance be guided and controlled by the central ideas and concepts of the playwright. Macready gave impressive demonstrations of his theory in notable revivals of *As You Like It, Macbeth, King Lear, Henry V* and *The Tempest*, as well as Handel's *Acis and Galatea*. The historical research that went into these productions was to have a strong influence on English stagecraft; the principle of theatrical unity was adopted and developed by the German predecessors of the duke of Saxe-Meiningen and anticipated the *régisseur* of the 20th century.

In addition to reviving standard plays, Macready also made industrious efforts to improve the repertory of modern drama. He worked closely with such professional playwrights as Sheridan Knowles and Bulwer-Lytton and worked tirelessly to persuade the leading literary figures of the day to turn to playwriting. For him, Robert Browning created *Strafford* and Sir Thomas Talfourd, *Ion;* Charles Dickens, his intimate friend for many years, assisted him in the search for plays, supported him in his managerial efforts and endeavoured without success to write a stageworthy comedy. After 1825 Macready moved freely in the highest literary and artistic circles of London, and the pages of his voluminous diary (twice edited, 1875, 1912) are a happy hunting ground for literary and historical scholars.

Macready made several professional tours outside England. In 1828 he joined a group of English players in Paris, where his distinctive style, a combination of domestic sensibility and emotional power, was eagerly welcomed by the new romantic school, particularly by Victor Hugo and Alfred de Musset. He visited America three times, in 1826, 1843 and 1848. He was much impressed by the political and social achievements of democracy, particularly in the field of public education, and seriously entertained thoughts of settling in New England. However, during his last visit, he was made the scapegoat of the Nativist political movement; their attacks on him as a foreigner and an aristocrat culminated in a public riot outside the Astor Place "opera house" in New York city, during which more than 20 persons were killed by the militia and from which he narrowly escaped with his life (*see* FORREST, EDWIN). He abandoned all thoughts of emigrating, returned to England for his farewell performances and retired from the stage in his favourite role of Macbeth on Feb. 26, 1851.

Freed of his distasteful profession, he settled in Sherborne, Dorset, where he intended to devote himself to the education of his own large family and of the farm workers and labourers of the community. In 1823 he had married Catherine Atkins, an actress, who retired to motherhood and produced nine children. The family was cursed with ill health, the mother dying in 1852 and only one son and one daughter surviving Macready. In 1860 he married Cecile Louise Spencer, by whom he had a son. His last years were spent in increasing gloom and unhappiness in Sherborne and later in Cheltenham, where he died on April 27, 1873.

Macready was an intellectual rather than an inspirational actor, at his best in such philosophical roles as Richelieu and Hamlet. He was capable of great emotional intensity, however, and in such parts as Lear or Byron's Werner, involving paternal or domestic feelings, he was unequaled. A lesser actor than Garrick and perhaps Kean when the latter was at his best, Macready was more important than either in his influence on the acting style and production techniques that made possible the art of the modern theatre.

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MACRINUS, MARCUS OPELLIUS (*c.* 164–218), Roman emperor A.D. 217–218, was born about 164 at Caesarea in Mauretania (Cherchel in Algeria). A lawyer, first promoted by the emperor Lucius Septimius Severus' relative and praetorian prefect Plautianus, he rose rapidly through the usual career of an equestrian (knight) to become praetorian prefect under Caracalla, sharing the office, as was then normal, with a soldier. He is alleged to have instigated the army officer who murdered Caracalla in April 217 in the course of a Parthian war, and was himself proclaimed emperor by the army three days later. After an indecisive engagement, he signed an inglorious peace with the Parthians. When the legion of Phoenicia transferred its allegiance to Elagabalus (*q.v.*), a son of a cousin of Caracalla, Macrinus found little support. Most of his troops deserted to his rival, and he fled toward Italy, but was overtaken and killed in Bithynia in June 218. (JN. R. M.)

MACROBIUS, AMBROSIUS THEODOSIUS (fl. *c.* A.D. 400), Latin grammarian and philosopher, whose most important work is the *Saturnalia*, the last-known example of the long series of symposiums headed by the *Symposium* of Plato. He may be the Macrobius who was praetorian prefect in Spain (399), proconsul in Africa (410) and grand chamberlain (422). He was not Italian by birth. The *Saturnalia*, which is dedicated to Macrobius' son Eustachius, purports to give an account of discussions in private houses on the day before the *Saturnalia* and on three days of that festival. There is little attempt to give dramatic character to the dialogue. It is in seven books, parts of which are not extant, and contains countless quotations from earlier writers. It is also interesting for the light it throws on the educated society of the day. Its sources include Seneca, Gellius and Plutarch. The first book discusses, among other topics, the *Saturnalia*, the Roman calendar, the sun and other divinities. The second book, of which part is lost, is chiefly devoted to witticisms. The third book is partly concerned with the luxury of the ancients. The miscellaneous seventh book is partly concerned with scientific matters. The subject of part of the third book and of the fourth, fifth and sixth books is Virgil, who is treated with great reverence. His rhetoric and learning, or rather omniscience, is everywhere insisted upon.

Macrobius also wrote a commentary on Cicero's "Somnium Scipionis" ("The Dream of Scipio") from the *De Republica*. This is a neoplatonic work in two books. Plato's *Timaeus* is often mentioned. Macrobius may have used Porphyry's commentary on it, and he may also have used a neoplatonic commentary on Virgil. Of a third work by Macrobius entitled *De differentiis et societatibus Graeci Latinique verbi* ("On the differences and similarities of the Greek and Latin verb") only fragments remain.

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MACROZAMIA, a genus of cycads, palmlike gymnosperms, native to Australia and planted elsewhere as ornamental and conservatory specimens. *See* GYMNOSPERMS: *Cycadales*.

MACTAN, a low-lying coral island in the Philippines protecting the port of Cebu city (*q.v.*) and separated from Cebu island by a mile wide channel. Area 24 sq.mi. Pop. (1960) 57,969. On April 7, 1521, Ferdinand Magellan invaded Mactan with a force of 49 Spaniards while 1,000 Cebuan allies and 11 Spanish guards watched from boats.

In the ensuing battle Magellan was killed by the Mactans under the leadership of Lapu-Lapu, the first Filipino to defeat a west-

ern conqueror. The island is a part of the province of Cebu (*q.v.*). Coconut growing and fishing are important in the economy. (R. E. He.)

MacVEAGH, (ISAAC) WAYNE (1833–1917), U.S. lawyer, diplomat and political reformer, was born near Phoenixville, Pa., on April 19, 1833. He graduated from Yale in 1853. Admitted to the bar in 1856, he was district attorney of Chester county, Pa., 1859–64. He held commands in militia forces raised to meet threatened Confederate invasions of Pennsylvania (1862–63). He became a leader in the Republican party, and from 1871 was a prominent opponent of his father-in-law, Simon Cameron, the Republican political boss in Pennsylvania.

MacVeagh was minister to Turkey, 1870–71, a member of the state constitutional convention of 1872–73, and chairman of the "MacVeagh commission," sent in 1877 by Pres. Rutherford B. Hayes to Louisiana; it secured the settlement of the contest between the two existing state governments and thus made possible the withdrawal of federal troops from the state. He was also attorney general of the United States in 1881 under Pres. James Garfield, but resigned after Garfield's death.

An advocate of civil service reform and tariff reduction, he supported (1892) Grover Cleveland, the Democratic nominee for the presidency, and was later ambassador to Italy. He returned to the Republican party in 1896. In 1903 he was chief counsel of the United States before The Hague tribunal in the case of Germany, Great Britain and Italy against Venezuela. MacVeagh died at Washington, D.C., Jan. 11, 1917.

MA'DABA, a town of Jordan, in the *liwa'* (district) of 'Amman, 21 mi. S. of 'Amman in the southwest corner of a large, fertile plain devoted largely to the growing of wheat and barley. Pop. (1961) 11,255. The town is built over a large mound under which lie the remains of earlier towns, and so rises well above the level of the surrounding plain. The population is largely Christian. In the Greek Orthodox church are the remains of the famous mosaic map of Palestine and Jordan, dating from the 6th or 7th century A.D. (*see* Map: *History: Medieval Europe and Orient*). Parts of other mosaic floors can be seen in various houses, and in 1960 a fine pre-Christian mosaic came to light. (G. W. L. H.)

MADÁCH, IMRE (1823–1864), Hungarian poet, author of a poetic drama which won fame in Hungary and, in translation, in other European countries for its lofty philosophical thought and its effectiveness on the stage. He was born on Jan. 21, 1823, at Alsósztregova, and died there on Oct. 4, 1864. A nobleman by birth, he spent his life in farming and public service.

Intelligent, with keen and catholic interests, Madách indulged in poetry and wrote several dramas, all rather weak. He secured himself a place of honour in Hungarian literature by his *Az ember tragédiája* (1861; Eng. trans. *The Tragedy of Man*, 1933), a breath-taking drama in 15 acts covering the past and future of mankind, from the creation to an ice age caused by the cooling of the sun. The central figures are Adam (who in some of the scenes assumes the personality of a well-known figure, *e.g.* Miltiades, Tancred, Kepler, Danton), Eve and Lucifer (dramatically a most rewarding role) who, in a spirit of negation and out of spite, wishes to demonstrate the failure of God's work and the futility of man's endeavour to improve. Though his demonstration —in Madách's presentation—seems to carry conviction, he is vanquished through his inability to take into account God's infinite mercy to which Adam should pin his hopes. (Ds. Sr.)

MADAGASCAR: *see* Malagasy Republic.

MADAN, MARTIN (1726–1790), English preacher and writer of the Methodist revival. Educated at Westminster school and Christ Church, Oxford, he was called to the bar in 1748 but abandoned his career and the pleasures of society after hearing John Wesley preach. He was ordained in 1750 and appointed chaplain to the Lock hospital, London. A powerful itinerant preacher, he became known as "Counsellor Madan." His acutely argued *Thelyphthora . . . A Treatise on Female Ruin* (1780), advocating polygamy to check the evils of adultery, seduction and prostitution, was bitterly attacked, but he maintained that his views were strictly in accordance with Holy Scripture. He died at Epsom on May 2, 1790.

MADDALENA, an island of Italy, in the Sassari province of Sardinia, is located 4 km. (2½ mi.) from the northeast Sardinian coast. Area 13 sq.km. (5 sq.mi.). Pop. (1961) 12,622. Napoleon I bombarded it in 1793 without success, and Nelson made it his headquarters for some time. An important naval station of the Italian fleet, it was bombed by the Allies in World War II. A bridge and an embankment connect it with the island of Caprera. (G. Kh.)

MADDER (Dyer's Madder), the root of *Rubia tinctorum* and perhaps also of *R. peregrina*, both native European plants, and of *R. cordifolia*, a native of the hilly districts of India and of northeastern Asia and Java; the last supplies Indian madder, or *manjit*. *Rubia*, a genus of about 40 species of the madder family (Rubiaceae), is characterized by lance-shaped leaves in whorls and small yellowish flowers in clusters. Madder differs from the closely related yellow bedstraw (*q.v.*) in having flower parts in fives and the fruit somewhat fleshy.

The red colouring principle of madder, alizarin, is now made synthetically, and the once extensive use of madder as a dye has nearly disappeared. The dye properties appear to have been known from the earliest times; cloth dyed with madder has been found on the Egyptian mummies, and it was used for dyeing the cloaks of the Libyan women in the days of Herodotus. Madder also was employed medicinally, especially in the treatment of amenorrhea, by the ancients and in the middle ages. A remarkable physiological effect of alizarin is that of colouring red the bones of animals and the claws and beaks of birds that feed upon madder. This property was utilized by physiologists in ascertaining the manner in which bones develop and the functions of the various types of cells found in growing bones.

The only native British species is *R. peregrina*, found in Wales, southern and western England and eastern and southern Ireland. *R. tinctorum*, a native of western Europe, was once extensively cultivated in southern Europe, France and the Netherlands. *See* also Alizarin.

MADEIRA (Funchal), a group of islands in the North Atlantic ocean, belonging to Portugal, consists of two inhabited islands named Madeira and Pôrto Santo and two groups of uninhabited rocks named the Desertas and Selvagens. Area 494 sq.km. (191 sq.mi.). Pop. (1960) 282,678. Funchal, the capital of the archipelago, is on the south coast of Madeira Island, in 32° 37′ 45″ N. and 16° 55′ W. It is about 360 sea miles from the African

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coast, 535 from Lisbon, 1,331 from Southampton, 240 from Tenerife and 480 from Santa Maria, the nearest of the Azores.

Madeira (pop. [1960] 279,120), the largest island of the group, has a length of 34 mi., an extreme breadth of 14 mi. and a coast line of about 90 mi. Pico Ruivo de Santana, the highest summit, stands in the centre of the island and has a height of 6,106 ft., while some of the adjacent summits are only a little lower. The depth of the ravines, the rugged peaks, often snow covered, the bold precipices of the coast and the proximity of the sea afford many scenes of picturesque beauty or striking grandeur. The greater part of the interior, above 3,000 ft., is uninhabited and uncultivated, and the towns, villages and scattered huts are usually built either at the mouths of ravines or upon the lower slopes that extend from the mountains to the coast. The ridges between the ravines usually terminate in lofty headlands, one of which, Cabo Girão, rises sheerly to 1,804 ft., and much of the seaboard is bound by precipices of dark basalt. The north coast, being more exposed to wave erosion, is more precipitous than the south, and presents everywhere a wilder aspect. On the south is left a very little of the indigenous forest which once clothed the whole island. A long, narrow and comparatively low rocky promontory forms the eastern extremity of the island, where there is a tract of calcareous sands, known as the fossil bed, containing land shells and numerous bodies resembling the roots of trees, probably produced by calciferous infiltration.

Pôrto Santo is about 26 mi. N.E. of Madeira. Pop. (1960) 3,558. Its greatest length is 7 mi. and its width 4 mi. The capital is Pôrto Santo, called locally the *vila* or town. At each end of the island are hills, of which Pico do Facho, the highest, reaches 1,663 ft. The vine, wheat and barley are grown, but little else. There is a fine sandy beach and an airport.

The Desertas lie about 11 mi. S.E. of Madeira and consist of three islands, Ilhéu Chão, Bugio and Deserta Grande, together with Sail rock off the north end of Ilhéu Chão. They present lofty precipices to the sea on all sides. Rabbits and wild goats live on the poor pasture and attract occasional hunters to Deserta Grande, the largest islet, which is 7 mi. long by 1 mi. at its maximum width and attains the height of 1,601 ft. It was formerly inhabited.

The Selvagens or Salvages are a group of three islands, 156 mi. from Madeira and between it and the Canary Islands. The largest island is about 3 mi. in circumference.

Geology.—All the islands of the group are of volcanic origin. They are the summits of lofty mountains which have their bases on an abyssal ocean floor. The greater part of what is now visible in Madeira is of subaerial formation, consisting of basaltic and trachytic lavas, beds of tuff and other *ejectamenta*, the result of a long and complicated series of eruptions from innumerable vents. It is difficult to determine when volcanic action began in this locality, but considering the great depth of the surrounding sea it is clear that a long period must have elapsed to allow a mountain to reach the surface and then rise several thousand feet, as well as the excavation of the deep, wide ravines that everywhere dissect the island. There are now no live craters or smoking crevices.

Madeira has a few crateriform cavities. Among them are the Lagoa, a small, perfect crater 500 ft. across and 150 ft. deep on a tract 2,000 ft. high east of Funchal, and another, of a double shape, in Fanal district at nearly 5,000 ft. in northwest Madeira. In the cliff face at Ponta da Atalaia is displayed a remarkable cross section of a volcanic cone complete with lava plug. The basalt, of which much of the outer part of the island is composed, is of a dark colour and tough texture, with small disseminated crystals of olivine and augite, and often forms a rude columnar structure. The basalt yields good building stone, some of which is quarried.

Climate.—Near the coast at Funchal the mean annual temperature is about 18° C. (65° F.), February, the coolest month, having a mean of 15° (59°) and August, the warmest month, 22° (72°). As the diurnal range is small, the mildness of the climate may be judged from the mean daily minimum temperatures of 11° (52°) for February and 18° (65°) for August. At Funchal temperatures rarely fall below 7° (45°) and snow and frost are unknown. The highlands above 2,000 ft. are less clement, and mean monthly temperatures of about 14° (58°) in August and 5° (41°) in February are more representative for summit areas. From June to September the northeasterly trades blow strongly and bring fine, dry weather. The air flow on the sheltered south coast, as at Funchal, is exceptional; there afternoon sea breezes cause southerly winds to prevail. Very rarely, a hot, dry southeasterly wind (*leste*) from the direction of Africa raises temperatures above 32° (90°). From October to late May the climate is associated with the passage eastward of cyclonic depressions which, as in the Mediterranean, give variable weather with frequent sunny spells. Yet the mean relative humidity remains low (under 65%) and cloud cover is seldom excessive. The mean annual rainfall ranges from less than 25 in. (on 55 rain days) near the south coast to 80 in. on the rainiest slopes of the exposed northern flanks and about 60 in., including occasional winter snows, on the mountaintops. Everywhere summer is dry but the runoff is ample to supply an elaborate irrigation system and power for a hydroelectric station. Madeira deservedly has a high reputation as a health and winter resort.

Vegetation.—The vegetation has a distinctly south European character. Many of the plants in the lower region undoubtedly were introduced and naturalized after the Portuguese colonization. Others are found in the Canaries and the Azores, or in one of these groups, but nowhere else. There are also about 100 plants which are peculiarly Madeiran, either as distinct species or as strongly marked varieties. Among the large number of ferns three are endemic species and six others belong to the flora of the north Atlantic islands. A connection between the flora of Madeira and that of the West Indies and tropical America has been inferred from the presence of six ferns found nowhere in Europe or North Africa but existing on the islands off the east coast of America or on the Isthmus of Panama. A further relationship to that continent can be traced by the presence in Madeira of the beautiful ericaceous tree *Clethra arborea*, belonging to a genus which is otherwise wholly American, and of a *Persea*, a tree laurel, also an American genus. The dragon tree (*Dracaena draco*) is almost extinct. Among the trees most worthy of note are some of the laurel order belonging to separate genera, an *Ardisia, Pittosporum, Sideroxylon, Notelaea, Rhamnus* and *Myrica*—a strange mixture of genera to be found on a small Atlantic island. Two heaths of arborescent growth and a whortleberry cover large tracts on the mountains. In some parts there is a belt of the Spanish chestnut at about 1,500 ft. There is no indigenous pine tree as in the Canaries, but large tracts on the hills have been planted with *Pinus pinaster*, from which the fuel of the inhabitants is mainly derived. Several of the native trees and shrubs now grow only in situations which are nearly inaccessible but some plants of foreign origin have spread in a remarkable manner. Among these is the common cactus or prickly pear (*Opuntia tuna*), which in many spots near the coast is sufficiently abundant to give a character to the landscape. The coast being rocky and the sea unquiet, the species of algae are few and poor.

Animal Life.—No species of land mammal is indigenous to the Madeiras. The rabbit, rat, mouse and various domestic animals have been introduced. The first comers encountered seals, and this amphibious mammal (*Monachus albiventer*) still lingers at the Desertas. Among the 40 species of birds which breed in the islands only one, a wren (*Regulus madeirensis*), is endemic, but five other species are known elsewhere only in the Canaries. These are the green canary (*Fringilla butyracea*, the parent of the domesticated yellow variety), a chaffinch (*Fringilla tintillon*), a swift (*Cypselus unicolor*), a wood pigeon (*Columba trocaz*) and a petrel (*Thalassidroma bulwerii*). There is also a local variety of the blackcap, distinguished by the extension in the male of the cap to the shoulder.

The only land reptile is a small lizard (*Lacerta dugesii*), which is destructive to the grape crop. The loggerhead turtle (*Caretta caretta*) is frequently captured and cooked.

Many kinds of fish, such as the mackerel, horse mackerel, grouper, mullet and braise are caught in abundance and afford a cheap article of diet. Several species of tunny are taken plentifully in spring and summer, one of them sometimes attaining the

weight of 300 lb. There is a small whaling industry with a factory at Caniçal. The only fresh-water fish is the common eel.

A large majority of the land shells are considered to be distinctive. Many of the species are variable in form or colour, and some have an extraordinary number of varieties. About 43 species are found both living and fossilized in superficial deposits of calcareous sand in Madeira and Pôrto Santo. These deposits have been tentatively assigned to the Pliocene period. Some species have not been discovered alive elsewhere.

By the persevering researches of T. V. Wollaston the astonishing number of 695 species of beetles at the Madeiras was brought to light as early as 1870. The proportion of endemic kinds is large, and it is remarkable that 200 are either wingless or have wings so poorly developed that they cannot fly, while of 23 of the endemic genera all the species are in this condition. More than 100 moths have been collected, the majority being of a European stamp, but probably a fourth are peculiar to the Madeiran group. Among Neuroptera a certain number are distinctive.

History.—It has been conjectured, but on insufficient evidence, that the Phoenicians discovered Madeira. It is more probable that the whole archipelago was explored before the mid-14th century by Genoese adventurers, for an Italian map dated 1351 (the Laurentian portolano) depicts the Madeiras quite clearly. There is a romantic story to the effect that two lovers, Robert Machim or à Machin and Anna d'Arfet, fleeing from England to Brittany, were driven off course by a gale and landed on Madeira at the place subsequently named Machico in memory of Machin. João Gonçalves Zarco sighted Pôrto Santo probably in 1418, having been driven there by storm when exploring the coast of west Africa. When Zarco visited Madeira in 1420 the islands were uninhabited, but Prince Henry the Navigator at once began their colonization. The dense forests were subjected to felling and burning (the fires are said to have raged for seven years) and much land was brought into cultivation. The Madeiran sugar trade soon became important. Both the sugar and wine industry suffered temporary setbacks when slavery was abolished by order of the marqués de Pombal in 1775. From about 1660 to 1835 British influence was particularly strong; for a few months in 1801 and from 1807 to 1814 the island was occupied by British troops. It shared in the civil disturbances at the accession of Dom Miguel, but after 1833, apart from a brief abortive rebellion in 1931, it was peaceful.

Population and Administration.—Madeira has 57,611 families and a population density of 921 per square mile. The inhabitants are of Portuguese descent, with probably some intermixture of Moorish and Negro. The traditional national dress is restricted largely to flower and curio sellers in Funchal, but throughout the countryside men still favour a thick woolen cap with ear flaps and gay half boots; the people as a whole like black clothes. They are fond of fireworks at *festas;* indeed, the Madeirans are probably unexcelled in peaceful pyrotechnics and their chief display on New Year's Eve is widely attended.

Funchal (*q.v.;* pop. [1960] 43,301) is the headquarters of Madeira's commerce and industry. Over one-third of the island's total population lives within a few miles of its centre. The other chief towns, each the capital of a *concelho* (commune), are Câmara de Lobos (14,184; *concelho* 29,759) and Machico (11,608; *concelho* 21,606). Madeira's chief regular shipping connections are with Britain, Portugal, the Republic of South Africa, the United States and Brazil. There are local coastal steamship services, a much-improved road system inland and a small airport.

The archipelago is officially styled the district of Funchal. It returns two deputies to the Portuguese national assembly and is regarded as an integral part of the republic. The district is subdivided into 11 communes and 52 parishes. Funchal is a Roman Catholic bishopric in the archiepiscopal province of Lisbon.

Agriculture.—A large portion of the land was formerly entailed in the families of the landlords (*morgados*), but entails were abolished by the legislature, and the land is now absolutely free. An incredible amount of labour has been expended upon the soil, partly in the erection of walls intended to prevent its being washed away by the rains, and to build up tillable terraces. Watercourses (*levadas*) have been constructed at regular intervals for irrigation, without which the island would not produce a hundredth part of its present yield. These watercourses originate high up in the ravines, are built of masonry or driven through the rock, and wind about for miles until they reach the cultivated land. Some of them are brought by tunnels from the rainier north side of the island through the central ridge. Each cultivator takes his allotted turn at the running stream for so many hours, day or night.

The system of cultivation is rather primitive. Few occupiers own the land they cultivate, but they almost invariably own the walls, cottages and trees, the land and irrigation water alone belonging to the landlord. The tenant practically enjoys fixity of tenure, for the landlord is seldom in a position to pay the price at which the tenant's share is valued. The *métayage* system almost universally regulates the relations between landlord and tenant, the tenant paying with a certain portion of the produce, usually one-third to one-half. There are few meadows and pastures, the cattle being stall-fed when not feeding on the mountains. Draft labour is performed by oxen.

The three staple products are wine, sugar and bananas. The vine was introduced from Cyprus or Crete soon after the discovery of the island by the Portuguese, but it was not actively cultivated until the early 16th century. The wine usually termed Madeira is made from a mixture of black and white grapes, which are also made separately into wines called tinta and verdelho, after the names of the grapes. Other wines, known as bual, sercial and malmsey, are made from varieties of grapes bearing similar names. Sugar cane is said to have been brought from Sicily about 1452. It occupies about 16,000 ac. on the south side of the island below 1,000 ft.

The common potato, sweet potato and gourds of various kinds are extensively grown, as well as the *Colocasia esculenta*, the kalo or taro of the Pacific islanders, the root of which yields an insipid food. Most of the culinary vegetables of Europe are plentiful. Beside the common temperate fruits, oranges, lemons, guavas, mangoes, loquats, custard apples, figs, pineapples and bananas are produced. The last is an important export.

Industry.—Although agriculture predominates in the Madeiran economy, handicrafts, tourism and fishing are notable subsidiaries. Wickerwork is less important than embroidery which was introduced in 1850 by a Mrs. Phelps, an Englishwoman, and now employs part- or full-time over 40,000 women. In a normal year the exports of embroidery equal or exceed in value those of wine. Handicrafts and the economy generally are also stimulated by the purchases of visitors, who number nearly 25,000 annually, not including a further 156,000 persons who stop at Funchal for a day or two en route to distant destinations.

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MADEIRA RIVER in Brazil, is the main affluent of the Amazon (*q.v.*), formed in the northeast corner of Bolivia by the junction of the Mamoré and the Beni (*qq.v.*). The Madeira, which flows north, is the focal point of a riverine complex made up of the Beni, the Mamoré and the Guaporé. These rivers and their tributaries connect eastern Bolivia, part of eastern Peru and western Mato Grosso with the Amazon and the Atlantic. The Beni is navigable from Reyes to the Esperanza rapids near its confluence with the Mamoré. From Riberalta, after passing the rapids, the Beni joins the Mamoré near the town of Villa Bella. From there they flow northward as the Madeira, constituting the Bolivia-Brazil frontier until uniting with the Abuná. The Mamoré and its tributaries flow across the eastern plains of Bolivia. The Guaporé, or Iténez, the largest affluent of the Mamoré, rises in Mato Grosso and flows northwest until its confluence with the Mamoré near Puerto Sucre.

The Madeira is 2,013 mi. long from the upper sources of the Mamoré, and the general width is from ½ mi. to 1,000 yd. When the river is at half flood the current flows at about four miles per

hour. It is navigable by seagoing vessels most of the year from its mouth near Manaus to the San Antonio falls 807 mi. upstream. This is the first of 19 falls or rapids (*cachoeiras*) blocking further passage. The Madeira-Mamoré railway, extending for 227 mi. between Pôrto Velho and Guajará Mirim, provides a link with the upper sources of the Madeira. The rainy season generally begins at the end of October and ends in March. In the dry season the river's diminution is great and navigation is adversely affected, particularly on the upper reaches of the Madeira's affluents.

The exploration of the Madeira valley began in the 16th century and parts of the region are still unexplored. Notable Portuguese expeditions which ascended the Madeira into Bolivia were those of Francisco de Melo Palheta (1723), and José Gonçalves da Fonseca (1749), who reached Mato Grosso in western Brazil. In the 19th century the Madeira region was explored by José Augustín Palacios (1884), Lardner Gibbon (1853), a U.S. naval officer, Gen. Quintín Quevedo (1861) and José and Francisco Keller (1867–68). Río da Dúvida (River of Doubt), a tributary of the Madeira, was named Río Roosevelt following its exploration by the Roosevelt-Rondon expedition in 1914.

The heavily forested, rainy tropical region through which the Madeira flows is almost uninhabited except for occasional settlements of Indians and mestizos who dwell along the banks and gather forest products such as Brazil nuts and rubber.

(J. L. Tr.)

MADERNO (Maderna), **CARLO** (1556–1629), leading Roman architect of the early 17th century, was born at Capolago, near Lugano. From 1603 until his death in 1629 he was chief architect of St. Peter's in Rome.

Maderno built the nave and façade of the church (1607–17). Consonant with the spirit of the Counter-Reformation, Maderno reverted to the scheme of early Christian and medieval cathedrals; by adding the nave he transformed Michelangelo's Greek-cross plan into a longitudinal one. His façade has been both criticized for impairing the effect of Michelangelo's dome and admired for its forceful grouping of huge engaged columns. Besides the façade of Sta. Susanna (1596 ff.) Maderno designed the Palazzo Barberini for the family of Pope Urban VIII (1625). His buildings determined the style of early baroque architecture. The Palazzo Barberini was completed by Francesco Borromini and Giovanni Lorenzo Bernini, whose works were influenced by Maderno.

See Nina Caflisch, *Carlo Maderno* (1934). (W. Lz.)

MADERO, FRANCISCO INDALECIO (1873–1913), Mexican revolutionary leader and president from 1911 to 1913, was born in Parras, Coahuila, on Oct. 30, 1873, the scion of a wealthy landowning family. His education, received in Paris and California, was intended to train him for a career in business and agricultural management. He became a believer in the efficacy of democracy and a devotee of spiritism with its emphasis on human progress.

After five years in Europe, he returned to Mexico in 1893 and for a time devoted himself to agricultural activities; he merits recognition as a leading pioneer in the development of the Laguna cotton region. As a landowner, Madero was known for his disinterested promotion of the well-being of his tenants. Influenced by his democratic ideology, Madero chose politics as his means of serving his countrymen. Prior to the 1905 gubernatorial election in Coahuila he helped organize the Benito Juárez Democratic club and served his apprenticeship as a political writer on its weekly, *El Demócrata*. Undiscouraged by this unsuccessful effort, Madero learned that efforts against the dictatorship of Porfirio Díaz (*q.v.*) in individual states would inevitably fail; while awaiting an opportunity for a national democratic movement, he supported and encouraged independent journalists and carried on an extensive correspondence regarding political organization.

It was Díaz himself who inadvertently brought on a renewal of political activity when he stated to the U.S. journalist James Creelman that Mexico was ready for democracy. This declaration prompted a flood of political literature and a flurry of political activity. Madero contributed to the political reawakening by the publication, early in 1909, of his book *La sucesión presidencial en 1910*, in which he emphasized the problem of militarism and viewed the immediate political situation. Madero helped to organize the Antire-electionist party and became its presidential candidate. His correspondence, organization of political clubs and tireless and courageous campaign travels earned for him the designation of "apostle of democracy." On the eve of the farcical election, Madero was arrested on charges of fomenting a rebellion and insulting the authorities. Released on bond, he escaped across the border. From San Antonio, Tex., he issued the "Plan of San Luis Potosí," a political document which had as its principal planks effective suffrage and no re-election and which called for the revolution to begin on Nov. 20, 1910. While the initial response was sporadic, Pascual Orozco kept the rebellion alive in Chihuahua. The Díaz government, unsuccessful in the suppression of the movement by military means, undertook, successively, political reforms and negotiations with the rebels. However, the conflagration continued to spread and after the surrender of Ciudad Juárez a compromise peace was arranged.

For five months the conservative Francisco de la Barra directed an interim government whose mission was to restore order and conduct new elections. Friction occurred between revolutionaries and old regime elements and divisions appeared among the revolutionaries themselves. The presidential election resulted in a sweeping triumph for Madero, who assumed office Nov. 6, 1911. His administration was brief and difficult. He suffered from lack of political experience and was handicapped by his own overly optimistic idealism. Preoccupied with giving the people democratic conditions under which the needed reforms could be effected, Madero was attacked by the entrenched advocates of the old regime who opposed any change and by revolutionary elements who were insistent on far-reaching social and economic changes. He also had to contend with a hostile press, the harassment of U.S. Ambassador Henry Lane Wilson and a series of armed rebellions. Conservative-inspired movements were led by Bernardo Reyes and Pascual Orozco in the north and by Félix Díaz in Veracruz while Emiliano Zapata (*q.v.*) led land-hungry peasants in Morelos.

In the light of these overwhelming difficulties, the accomplishments of Madero's administration were not inconsiderable. The press and labour enjoyed freedom; agrarian reform was studied and humble beginnings of change were initiated; education was promoted; and democratic principles were applied. Many believe that Madero was moving or would have moved in the direction that the revolution demanded when, in Feb. 1913, a military revolt broke out in Mexico City. His betrayal by Gen. Victoriano Huerta caused Madero's overthrow. On Feb. 22, 1913, while being transferred to prison, Madero was assassinated by the escort.

In death Madero provided a symbol for revolutionary unity in the continuing struggle against the Huerta regime. His career and martyrdom served as an inspiration and exemplar for the establishment of a democratic polity in Mexico.

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MADHAVA ACHARYA (fl. *c.* 1380), Hindu statesman and philosopher, lived at the court of Vijayanagar, the vigorous south Indian kingdom that so long withstood Muslim influence. He had his education under three masters: Vidyatirtha was the most important of them, looked upon as an incarnation of Mahesvara and worshiped by the pupil at Sringeri under the name Vidyasankara; the other teachers were Bharatitirtha and Srikanthanatha. His younger brother Sayana (d. 1387), also a statesman and the minister of four successive Vijayanagar kings, is best known as the commentator of the Vedas; Sayana's commentaries were influenced by Madhava, who patronized the scholars collaborating in his brother's great work. Madhava turned ascetic about 1377 and was thereafter known as Vidyaranya. According to tradition he died in Sringeri in 1386, at the age of 90. He was part author of *Jivanmuktiviveka* and *Panchadasi*, works of Vedanta philosophy; *Dhatuvritti*, a treatise of Sanskrit grammar; and *Nyayamalavistara*, on the Mimamsa system; as well as the *Parasarasmritivyakhya*, an elaborate comment on the *Parasarasmriti*, adding a chapter on law to those on custom and penance

in the original. Madhava Acharya should not be confused with his contemporary Madhavamantrin, statesman, warrior and author, or with a later Madhava, the author of *Sarvadarsana Samgraha* ("Compendium of Speculations"). (K. A. N. S.)

MADHVA (ANANDATIRTHA; PURNAPRAJNA) (*c.* 1199–*c.* 1278), a prominent Hindu philosopher, was born at Rajatapitha near Udipi in south Kanara. Little is known of his life, but 37 Sanskrit works are attributed to him, dealing chiefly with the interpretation of Hindu sacred writings and the explanation of his own theological system.

According to Madhva, Vishnu (Krishna) is the one eternal God who rules the world and grants salvation to his devotees. Both souls (*jiva*) and matter (*prakriti*) coexist eternally with Vishnu. The individual souls are spiritual beings of atomic size, blissful by nature. As they are from eternity connected with matter and subject to the law of retribution for their deeds (*karma*), they wander about in bodies of angels (*deva*), men, animals and infernal beings, subject to pain and suffering. The inanimate world originates from primordial matter, out of which all elements and the organs and bodies of the souls are produced by evolution. The aim of man must therefore be to become free from impurities, ignorance, passion, *karma* and matter. The means of salvation is the grace of Vishnu, who predestines the souls to deliverance, permanent transmigration or eternal damnation in hell.

Madhva's teaching differs in two points from that of other Vedantins who like him base their doctrines on the Upanishads, the Bhagavad Gita and the Brahma Sutras: believing in the metaphysical reality of souls and matter, he repudiates all theories which attempt to reduce them to an illusion (*maya*), and he rejects all pantheistic ideas, as God is only the efficient, not the material, cause of the universe.

Madhva's philosophy is called Dvaita ("dualism"), because it acknowledges a difference in kind between God and souls. Salvation therefore consists not in the absorption of the soul into the absolute but in the independent existence of the released in Vishnu's supernatural world.

See also INDIAN PHILOSOPHY: *Six Systems: Vedanta.*

See H. von Glasenapp, *Madhva's Philosophie* (1923); S. Dasgupta, *History of Indian Philosophy*, vol. iv (1949). (H. v. G.)

MADHYA PRADESH, the largest state in the Republic of India (area 171,217 sq.mi.), lies as its name implies (Madhya, "central"; Pradesh, "region") in the heart of the subcontinent and has no seaboard. With the independence of India in 1947 the British Indian Central provinces and Berar were together restyled Madhya Pradesh, but boundary changes soon followed. The old Central India agency (divided after independence into Madhya Bharat and Vindhya Pradesh) was added to Madhya Pradesh; at the same time the eight Marathi-speaking districts of Akola, Amravati, Bhandara, Buldana, Chanda, Nagpur, Wardha and Yeotmal were ceded to Bombay (later Maharashtra) state. As redefined under the States Reorganization act of Nov. 1, 1956, the present boundaries of Madhya Pradesh bear little relation to those of the old Central provinces.

The present state comprises the former Madhya Bharat (except for the Sunel enclave of Mandsaur district), Vindhya Pradesh and Bhopal, together with the 14 Hindi-speaking districts of the former state of Madhya Pradesh, and the Sironj subdivision of Kotah district of Rajasthan. (Madhya Bharat comprised the united states of Gwalior, Indore and Malwa. Vindhya Pradesh included 25 states of Baghelkhand and Bundelkhand.)

Madhya Pradesh is bordered by seven states: Rajasthan, Uttar Pradesh, Bihar, Orissa, Andhra Pradesh, Maharashtra and Gujarat. Roughly 80% of the people are Hindi-speaking. The state capital is Bhopal.

Physical Features.—The whole state lies on the great plateau of India, the northern boundary coinciding roughly with the edge of the plateau overlooking the great plains of northern India. There is very little land below 1,000 ft. above sea level and on the eastern margins considerable tracts lie above 3,000 ft. The rolling plateau country is crossed by several west-east ranges, notably the Vindhya mountains and the Satpura range between which is the trough occupied by the westward-flowing Narmada (Narbada) river. The Narmada trough is continued northeastward by the valley of the Son, draining into the Ganges (Ganga), and the Narmada-Son line is often taken as the natural limit between northern and peninsular India. South of the Satpura range lie the open plains of Maharashtra's black cotton soil; the eastern part of Madhya Pradesh has broad valley plains in which most of the settlement and cultivation are concentrated; the plains are separated by forested hills rising on the whole eastward but drained mainly by tributaries of the Mahanadi.

Climate.—The state has a wide range of climate with an annual rainfall increasing from under 25 in. in some western plains to 60 in. and more on the forested hills of the east. The northern tracts have the considerable range of temperature found in the Delhi-Kanpur plain with a long pleasant cold season and a hot season there tempered by the elevation. Similarly the Vindhya and Satpura districts are comparatively temperate but the Narmada valley is enclosed and hot. The more humid regions in the east of the state tend to be steamy during the rains. Harvests are variable on the plateau valley-plains since the early rains are often deficient or late in arriving and the late rains may cease prematurely and cause heavy losses. Despite the adequate average rainfall suggested by the records, irrigation is much needed as an insurance against seasonal fluctuations.

Vegetation and Animal Life.—An outstanding feature of the physiographical aspect of Madhya Pradesh is the vast extent of forest and scrub. Of the great trees of the forests the sal (*Shorea robusta*) is among the most important. Mammals in the jungle include wild buffalo, gaur (bison), tiger, nilgai, red dog, panther, hyena, sambar, black buck and many other larger kinds of deer, wild pig, wildcat and innumerable monkeys. There are peacocks, jungle fowl, sand grouse, partridges and green pigeon, and many varieties of duck and other waterfowl on the big tanks. Snipe abound in the paddy fields. Crocodiles are to be found in the rivers, and there are cobra and the deadly Russell's viper and krait and many other types of snakes in the forests and plains. There is an immense variety of insects.

In 1955 the Kanha wildlife sanctuary, 180 mi. N.E. of Nagpur, was declared a national park. It covers 99 sq.mi. and is known chiefly for the Indian swamp deer (barasingha), but it also has tiger, leopard, gaur, chital, black buck, sambar and barking deer. (L. D. S.)

History.—Probably the earliest inhabitants of large tracts of Madhya Pradesh were the ancestors of the modern Bhils, Gonds and other primitive tribes still to be found in this area. In the lifetime of the Buddha, Avanti, with its capital at Ujjain, formed one of the 16 states referred to in the Buddhist canonical book, *Anguttara-Nikaya.* To the east of Avanti, also in central India, lay the territories of the Chedis and the Vatsas. Madhya Pradesh, geographically the heart of India, formed part of the great Mauryan empire. It was Asoka who built the famous group of stupas around Bhilsa, of which that at Sanchi is the best known. After the decline of Mauryan power the Sungas apparently ruled in eastern Malwa in the 2nd century B.C. They were supplanted by the Andhras who had extended their sway over eastern Malwa. About A.D. 150 Sanchi and Vidisa (modern Beshnagar) were annexed to the territories of the Saka (Western) Satraps by their most famous ruler Rudradaman. Later the whole of Madhya Pradesh to the north of the Narmada formed part of the Gupta empire. The eastern part of Malwa was later overrun by the White Huns. In the 6th century the powerful Kalachuri (Chedi) ruler seized the Narmada valley and took possession of most of Bundelkhand and Baghelkhand. The Narmada probably formed the boundary between the dominions of Harsha (*q.v.*), which included large tracts of Madhya Pradesh, and the territories of his great rival Pulakesin II, the Chalukyan ruler of the Deccan. In the 9th century the Gurjara-Pratiharas of Kannauj ruled over central India, though in eastern Malwa the Narmada formed a fluctuating frontier between the Rashtrakutas of the Deccan and the Paramaras to the north.

It was not until the 13th century that the Muslim invaders penetrated this area. In 1234, Iltutmish, the ruler of Delhi, captured Bhilsa and Ujjain. In the early years of the 14th century Malwa

was again overrun, by the forces of the Khalji sultans of Delhi. Madhya Pradesh was included in Mohammed Tughluq's extensive empire. When Babur invaded India in 1526, the western districts of what is now Madhya Pradesh had been absorbed into the kingdom of Malwa and the eastern portion had been annexed by the Gond rulers of Gondwana. It was not until the reign of Akbar that Malwa was annexed to the Mogul empire. About the same time Akbar's troops forced their way into the wild regions of Gondwana and, after a gallant resistance, Durgavati, the queen mother, was killed in a battle fought near Jabalpur, but it is doubtful whether Akbar annexed the whole of Gondwana. The weakness of the Mogul empire in the first half of the 18th century gave the Marathas an opportunity to make a bid for paramountcy in India. Maratha raids into Malwa had begun toward the end of Aurangzeb's reign and from that time onward central India was never secure from their depredations. By the year 1734 they were firmly established in Malwa. This was a great strategic advantage as Malwa lay athwart the main routes connecting the Deccan with northern India. Two years later they had carried their depredations into Bundelkhand. By 1760 they had consolidated their power over the whole of Madhya Pradesh between the Chambal and the Narmada. The defeat of the Maratha peshwa's forces at Panipat in 1761 while it weakened the confederacy increased the power of the Maratha generals and enabled Sindhia to establish himself in Gwalior, and Holkar to become independent in Indore. The early 19th century was marked by the growth of anarchy when Pindari robber bands, supported by Holkar and Sindhia, ravaged central India from Malwa to Bundelkhand. By the year 1818 the suppression of the Pindaris and the final defeat of the Marathas made the British the paramount power in India. In that year the "Saugor-Nerbadda" territories were ceded to them and were administered as part of the province of Agra. Sindhia of Gwalior, Holkar of Indore and all the states of central India came under British protection. The settlement and pacification of this area were the work of Sir John Malcolm. Between 1830 and 1835 the Thugs who infested central India were suppressed by Sir William Sleeman. The remaining districts of the present Madhya Pradesh came under British rule when the Nagpur state was declared an escheat in 1853. In 1861 these districts and the "Saugor-Nerbadda" territories were incorporated into the Central provinces.

On June 14, 1857, troops of the Gwalior contingent at Morar were the first to mutiny in central India. In the same month the Indore state troops guarding the residency followed suit. Further outbreaks occurred at Nimach, Nowgong, Mhow and Nagod. The suppression of the mutiny in this quarter was the work of Sir Hugh Rose (*see* STRATHNAIRN, HUGH HENRY ROSE, 1st Baron). The leaders of the rebellion were the rani of Jhansi and the Maratha Brahman Tantia Topi. The rani was killed fighting in the attack on Gwalior and Tantia Topi was captured and finally executed in April 1859. After the suppression of the mutiny the history of Madhya Pradesh was a record of steady improvement and unbroken peace under British rule.

The term Central India was officially applied at first to Malwa alone; but in 1854 Bundelkhand and Baghelkhand were added to Malwa to form the Central India agency. In 1901, for administrative purposes, it was divided into the following eight units: the Gwalior residency; the Indore residency; the Baghelkhand agency; the Bhopal agency; the Bhopawar agency; the Bundelkhand agency; the Indore agency; and the Malwa agency. The chief administrative changes after 1901 were: the abolition of the Indore agency in 1907 and its amalgamation with the Malwa agency; the removal of Gwalior from the agency in 1921; and the amalgamation in 1931 of the Baghelkhand and Bundelkhand agencies. After 1947 the Central India agency was divided into Madhya Bharat and Vindhya Pradesh, which, together with Bhopal and the predominantly Hindi-speaking districts of the former Central provinces, were united in 1956 to form the state of Madhya Pradesh. (C. C. D.)

Population and Administration.—The population of Madhya Pradesh, mostly Hindus, at the 1961 census was 32,372,408; an increase of 24.2% since 1951, when it was 26,071,637. The chief cities and towns, with their populations according to the 1961 census, are: Indore (394,941); Jabalpur (295,375); Gwalior (300,587); Bhopal (185,374); Ujjain (144,161); Sagar (104,676); Ratlam (87,472); Khandwa (63,505); and Bilaspur (86,706). The people are of diverse ethnic origin, the chief tribal groups being the Bhil, Munda, Baiga, Gond, Maria, Mandia and Bhattra. One out of every seven persons belongs to one of the tribes.

While Hindi is the chief language spoken and understood throughout the state, as many as 377 languages and dialects were returned as mother tongues at the 1951 census. A considerable number of these dialects are spoken by the tribal population.

Executive power is vested in the governor (appointed by the Union president) who acts on the advice of a council of 11 ministers. The legislative assembly comprises 289 members. Madhya Pradesh is divided administratively into 43 districts, grouped in seven divisions, each under a commissioner: Sehore, Raisen, Vidisha (Bhilsa), Hoshangabad, Betul, Rajgarh, Shajapur (Bhopal division); Bilaspur, Raigarh, Surguja (Bilaspur division); Gwalior, Bhind, Morena, Shivpuri, Guna, Datia (Gwalior division); Indore, Ratlam, Ujjain, Mandsaur, Dewas, Dhar, Nimar (East and West), Jhabua (Indore division); Jabalpur, Balaghat, Chhindwara, Seoni, Sagar, Mandla, Damoh, Narsimhapur (Jabalpur division); Raipur, Bastar, Durg (Raipur division); Rewa, Sidhi, Satna, Panna, Chattarpur, Tikamgarh, Shahdol (Rewa division).

Comparatively backward in education—in 1961 17% of the population was literate—the state had nevertheless made significant progress by the mid-1960s. There are more than 29,000 primary schools and 4,000 schools for general, vocational and technical education; *i.e.*, 1 school for every 800 persons. Primary education is free and compulsory in over 100 towns and nearly 3,000 villages. About 150 colleges and 4 universities—at Sagar, Jabalpur, Ujjain (Vikram university) and a university of music at Khairagarh—provide general, professional, technical and special education. There are more than 1,000 medical institutions including hospitals, dispensaries, health centres and family planning clinics. The Employees' State Insurance plan covers sickness, maternity and employment injury risks and provides medical care through about 30 exclusive dispensaries in 8 centres to more than 70,000 factory workers and their families.

For the tribal and backward classes, constituting a third of the state's population, special education, training and welfare schemes are run by the government. The Social Welfare board conducts welfare activities for destitute women, children, beggars and orphans, and also provides primary and adult education, and crafts-training for women. (S. CH.; S. B. L. N.)

The Economy.—The large majority of the population is dependent on agriculture, and almost every crop grown in India is to be found in Madhya Pradesh. A line drawn from Satna in the north to Balaghat in the south roughly divides the agriculture of the country. East of that line, where the rainfall is heavy, the principal crop is rice; west of it wheat, gram, maize (corn), oilseeds, sugar cane, fruit, tobacco, cotton and jowar (sorghum) are chiefly grown. The Narmada valley and the Vindhyan districts are the great wheat-producing areas; the two Nimar districts (south of the Narmada) are the great cotton and jowar tracts. But while cotton and jowar are insignificant in the rice country, and rice is insignificant west of the Satna-Balaghat line, practically every district in the state contains some heavy black soil areas that produce wheat and cold-weather crops. This variety of soil and cropping affords a certain degree of insurance against capricious rainfall. Rice is the most important cereal; the others are wheat, jowar, maize, barley, and pulses and peas of many kinds. There are considerable sugar cane and banana plantations, and oranges and citrus fruits are grown in large quantities. The state as a whole is a surplus area, and production has been increased by long-term planning. Under the second five year plan (1956–61) the state was scheduled for a large surplus of agricultural production, aided by an extension of tank irrigation and major works on the Tawa river, but achievement fell far short of the targets. The Chambal multi-purpose project (completed 1962) was irrigating about 700,000 ac. of land and generating 210,000 kw. of hydroelectric power. The main cash crops are cotton and sunn; there

are also large areas under oilseeds, peanuts, linseed and sesame. Animal husbandry is receiving increasing attention.

Vast tracts (about 30% of the total area of the state) are under forest, and the state is the largest producer of timber (including the best quality teak and sal), firewood and minor forest produce in India.

Mining and Heavy Industry.—Madhya Pradesh is rich in minerals, and the eastern region is believed to be the most highly mineralized area in the whole country. The manganese deposits, chiefly in Balaghat district and extending across the Maharashtra border into the districts of Nagpur and Bhandara, are among the best in the world. Iron ore is to be found in Durg, Jagdalpur and Sagar districts and in the former Madhya Bharat region (that in Jagdalpur is believed to be of high-grade quality), and mining was being developed in the 1960s. The chief coal mines are in Chhindwara and Ambikapur districts; development of those at Korba is taking place, and the state's annual output exceeds 5,000,000 tons. Limestone is found in large quantities in the Vindhya mountains and India's largest cement works are at Kymore, near Katni, while others are at Satna and Barmore; the total output of the three approaches 1,000,000 tons a year. There are in addition bauxite deposits, asbestos and alluvial gold in the state, which also produces 95% of India's diamonds.

The extent and variety of mineral deposits makes Madhya Pradesh an obvious centre of heavy industry, and a steel plant at Bhilai in Durg district, one of the three under India's second five-year plan, has a scheduled capacity of 1,300,000 tons a year. Limestone and manganese are to be found in the neighbourhood, and there are large iron deposits at Dalli-Rajara, 50 mi. to the south, and blending coal is available 140 mi. away at Korba. The U.S.S.R. agreed in 1955 to furnish all the equipment (to be paid for over a period of 12 years) and technical assistance needed for the construction and operation of the steel works. The heavy electrical plant at Bhopal began production in 1960. Another major industry is newsprint manufacture. The Nepa mills at Nepanagar in Nimar East (Khandawa) district, the first of their kind in India, began production in 1955. Using salai wood, which is grown in large quantity in the state, they have an output of 30,000 tons a year. A paper mill, with foreign financial and technical aid, was constructed at Amlai near Shahdol.

Other industries include textiles, oil and sugar refining, cement and match manufacturing, and engineering. There are old-established potteries at Gwalior. The state is also known for its traditional village and home crafts. These include Chanderi saris and turbans (Maheshwar and Chanderi), woodwork and lacquer ware (Shivpuri and Sabalgarh), wooden toys (Bhopal) and softstone work (Jabalpur).

Madhya Pradesh is served by three railroad systems; the South Eastern leading into Orissa and West Bengal, the Central into Maharashtra, Andhra Pradesh, Uttar Pradesh and Delhi, and the Western into Rajasthan and Gujarat. (L. D. S.)

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(C. C. D.)

MADI (MA'DI), a Sudanic-speaking people who inhabit both banks of the Nile river in the west Nile district of northern Uganda (*q.v.*). They numbered about 67,000 in the 1960s, including a few thousand living in the southern Sudan. They are closely related to their Lugbara (*q.v.*) neighbours to the west. Although today only a small trihe, the Madi are thought by some authorities once to have been distributed over a far wider area, including much of southern Uganda.

The Madi are primarily hoe cultivators, with millet as the staple crop. They also fish, hunt and keep cattle in areas where bovine sleeping sickness does not prevent it; smithing is an important craft.

The Madi are composed of groups of diverse ethnic origins, including Lugbara, Bari (*q.v.*), Kakwa, Acholi and other stocks. They are divided into three main divisions: western Madi on the Otzi massif, eastern Madi on the Nile flats, and southern (or "goat") Madi along the west bank of the Nile. The country is divided into areas under the ritual care of "owners of the land," and also into about 25 chiefdoms with boundaries that differ from those of the ritual land areas. The chief is the head of the dominant patrilineal clan which was first settled in the chiefdom, later immigrants being grouped into accessory lineages. The chiefship is divided among four functionaries, who are ideally half brothers, the most powerful being the "chief of the people," who had government recognition in the 1960s. The "chief of the rain," the "chief of the cattle," and a fourth chief whose duty is to protect the graves and relics of departed chiefs, are mainly ritual figures; only the rainmaker has any great importance. Religious rites are centred upon the worship of lineage ancestors, chiefs' ancestors and an over-all supernatural force, *Rubanga*. *See* also AFRICA: *Ethnography* (*Anthropology*): *East Africa;* SUDANIC LANGUAGES.

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(J. F. M. M.)

MADISON, JAMES (1751–1836), 4th president of the United States, often called "the father of the constitution," was born at Port Conway, in King George county, Va., on March 16, 1751. His great-great-grandfather, John Maddison (so spelled), a ship carpenter, came from England to take up 600 ac. in 1653. His father, also named James Madison, was the owner of large estates in Orange county, Va.

In 1769, Madison entered the College of New Jersey (now Princeton university). Graduating in 1771, he remained for another half year pursuing studies under the direction of the college president, John Witherspoon (1723–94). In 1772 he returned to Virginia, where he continued his reading and studies in religion and law. In Dec. 1774, as friction between the colonies and England increased, he was chosen a member of the Orange county committee of public safety of which his father was elected chairman. In the spring of 1776 he was chosen a delegate to the Virginia constitutional convention, where he was on the committee which drafted the declaration of rights and the Virginia constitution; he played a major role in the formulation of the article on religious freedom in the declaration of rights. As the constitution provided that the members of the convention should constitute the house of delegates, Madison became a member of the first Virginia state legislature. But in 1777, largely, it seems, because he refused to treat the electors with rum and punch after the custom of the time, he was not re-elected. In November of the same year he was chosen a member of the privy council or council of state, in which capacity he took a prominent part from Jan. 14, 1778, until the end of 1779, when he was elected a delegate to the continental congress.

As a member of the continental congress during the final stages of the Revolutionary War, he drafted instructions in 1780 to John Jay, then representing the United States at Madrid, that in negotiations with Spain he should insist upon the free navigation of the Mississippi and upon the principle that the United States succeeded to British rights affirmed by the treaty of Paris of 1763. When the government under the articles of confederation faced collapse because of the failure of the states to respond to requisitions of congress for supplies for the federal treasury, Madison was among the first to advocate the granting of additional powers to congress, and urged that congress should forbid the states to issue more paper money. In 1781 he favoured an amendment to the articles of confederation giving congress power to enforce its requisitions; and in 1783, in spite of the open opposition of the Virginia legislature, he advocated that the states should grant to congress for 25 years authority to levy an import duty. In the same year he was a member of the committee which reported a skilful compromise on the Virginia proposal as to the terms of cession to the confederation of the unoccupied western territory, held by several states.

When his term in congress expired, in Nov. 1783, Madison re-

turned to Virginia to study law. In the following year he was elected to the house of delegates. As a member of its committee on religion, he opposed giving special privileges to the Episcopal (or any other) Church, and spoke against a general assessment for the support of the churches of the state. His petition of remonstrance against the proposed assessment, drawn up at the suggestion of George Nicholas (*c.* 1755–99), was widely circulated and procured its defeat. On Dec. 26, 1785, Thomas Jefferson's bill for establishing religious freedom in Virginia, which had been introduced by Madison, was passed. In the Virginia house of delegates, as in the continental congress, he opposed the further issuance of paper money; and he tried to induce the legislature to repeal the law confiscating British debts.

Role in Forming Federal Constitution.—Meanwhile he did not lose sight of the interests of the confederation. His proposal for a conference between Maryland and Virginia relating to the navigation and commerce of the Potomac river led to a meeting of commissioners from the two states in March 1785. When the Maryland legislature proposed to invite Pennsylvania and Delaware to join in an arrangement, Madison, seeing an opportunity for more general agreement, proposed that all the states should be invited to send commissioners to consider commercial questions. A resolution to that effect was adopted (Jan. 21, 1786) by the Virginia legislature. This led to the Annapolis convention of 1786, and that in turn led to the Philadelphia convention of 1787. (*See* ANNAPOLIS CONVENTION; CONSTITUTIONAL CONVENTION [U.S.].)

In April 1787, Madison wrote a paper based on his study of confederacies, ancient and modern, in which he declared that no confederacy could long endure if it acted upon states only and not directly upon individuals. As the time for the convention of 1787 approached, he drew up an outline of a new system of government, the basis of the "Virginia plan," sometimes called the "Randolph plan" because it was presented in the convention by Edmund Randolph.

Madison's scheme, as expressed in a letter to George Washington, April 16, 1787, was that individual sovereignty of states was irreconcilable with aggregate sovereignty, but that the "consolidation of the whole into one simple republic would be as inexpedient as it is unattainable." He considered as a practical middle ground changing the basis of representation in congress from states to population, thus giving the large states a greater voice. He favoured giving the national government "positive and complete authority in all cases which require uniformity" and a negative authority on all state laws, a power he felt might best be vested in the senate, a comparatively permanent body. He also favoured electing the lower house for a short term; providing for a national executive and national judiciary chosen by the legislature; creating a council to revise all laws, and including an express statement of the right of coercion; and finally, obtaining the ratification of a new constitutional instrument from the people, and not merely from the legislatures.

The "Virginia plan" was the basis of the convention's deliberations which resulted in the constitution favourably voted on by the convention on Sept. 17, 1787. Madison, always an opponent of slavery, disapproved of the compromise (in Art. I, sec. 9 and Art. V) postponing to 1808 (or later) the prohibition of the importation of slaves. He took a leading part in the debates of the convention, of which he kept careful notes, afterwards published by order of congress (3 vol., 1843). He spoke before the convention more frequently than any delegate except James Wilson and Gouverneur Morris.

In spite of the opposition of the Virginia leaders, George Mason and Edmund Randolph, Madison induced the state's delegation to stand by the constitution in the convention. To meet the objections brought against it throughout the country, he joined Alexander Hamilton and John Jay in writing *The Federalist*, a series of 85 papers, of which 29 (numbers 10, 14, 18, 19, 20, 37 through 58, 62, 63) were written by him. In the Virginia convention for ratifying the constitution (June 1788), when eight states had ratified and it seemed that Virginia's vote would be needed to make the necessary nine, Madison appeared at his best against such opponents of ratification as Patrick Henry, George Mason, James Monroe, Benjamin Harrison, William Grayson and John Tyler. Against an originally adverse public opinion and against the eloquence of the opponents of the constitution, Madison and his associates, Edmund Pendleton, John Marshall, George Nicholas, James Innes and Henry Lee, won a significant victory. At the same time, Madison's labours in behalf of the constitution alienated from him valuable political support in Virginia. He was defeated by Richard Henry Lee and William Grayson for the U.S. senate, but in his own district he was chosen a representative to congress, defeating James Monroe.

In Congress and Cabinet.—Madison took his seat in the house of representatives in April 1789, and assumed a leading part in the legislation necessary to the organization of the new government. He drafted a tariff bill giving certain notable advantages to nations with which the United States had commercial treaties, hoping to force Great Britain into a similar treaty; but his policy of discrimination against England was rejected by congress. It was his belief that such a system of retaliation would remove the possibility of war arising from commercial quarrels. He introduced resolutions calling for the establishment of three executive departments—foreign affairs, treasury and war—the head of each to be removable by the president.

Most important of all, Madison proposed nine amendments to the constitution, which were the basis of the Bill of Rights embodied in the first ten amendments. A staunch friend of the constitution, Madison believed that the instrument should not be interpreted loosely. He opposed Hamilton's measures for the funding of the debt, the assumption of state debts and the establishment of a national bank and on other questions. He sided more and more with the opposition, gradually assuming its leadership in the house of representatives and playing a leading role in the formation of the Jeffersonian Republican party. Madison objected to carrying out the recommendations in Hamilton's report on manufactures (Dec. 5, 1791), which favoured a protective tariff.

In 1793–96 he strongly criticized the administration for maintaining a neutral position between Great Britain and France. He wrote for the public press five papers (signed "Helvidius"), attacking the "monarchical prerogative of the executive" as exercised in the proclamation of neutrality in 1793 and denying the president's right to recognize foreign states. He found in Washington's attitude an "Anglified complexion," in direct opposition to the popular sympathy with France and French republicanism. In 1794 he again tried his commercial weapons, introducing in the house of representatives resolutions based on Jefferson's report on commerce, advising retaliation against Great Britain and discrimination in commercial and navigation laws in favour of France; and he declared that the friends of Jay's treaty were "a British party systematically aiming at an exclusive connection with the British Government."

In 1797 Madison retired from congress, but not to a life of inactivity. In 1798 he joined Jefferson in opposing the Alien and Sedition laws, and Madison himself wrote the resolutions of the Virginia legislature declaring that the powers of the federal government were limited by the compact to which the states were parties, and affirming that, in case of a "deliberate, palpable and dangerous" exercise of powers, not granted by the constitution, the states had the right and the duty to interpose their power. The Virginia resolutions and the Kentucky resolutions (the latter having been drafted by Jefferson) were met by dissenting resolutions from the New England states, from New York and from Delaware. In answer to these, Madison, who had become a member of the Virginia legislature in the autumn of 1799, wrote for the committee to which they were referred a report elaborating and sustaining in every point the Virginia resolutions.

Madison became secretary of state upon Jefferson's accession to the presidency in 1801. Because of their close relationship it is difficult to separate their roles in the diplomacy of 1801–09. The great achievement was the purchase of Louisiana, and following it, the success with the Barbary pirates. Their failures were their inability to acquire Florida and the hopelessness of the relationship with England and France.

During eight years as secretary of state, Madison had continually to defend the neutral rights of the United States against the encroachments of European belligerents; in 1806 he published *An Examination of the British Doctrine which subjects to Capture a Neutral Trade not open in Time of Peace*, a careful argument against the doctrine set forth by Great Britain in 1756 and extended in 1793 and 1803.

President.—In 1808 Madison was elected president by 122 electoral votes over his Federalist opponent, Charles C. Pinckney, who received 47 votes. Taking office at a moment of crisis in relations between the United States and Great Britain, the first years of his administration were dominated by problems of foreign affairs. For two years the president did the work of his incapable secretary of state, Robert Smith, who was replaced in 1811 by James Monroe.

While many historians have viewed President Madison as a weak and indecisive executive, pushed hesitantly into war by congress, Madison's most exhaustive and critical biographer, Irving Brant, rejects this verdict. Brant depicts a president who led congress and the nation. When his peace policy of economic coercion failed, he aroused public opinion both to change the complexion of congress in the elections of 1810 and to support the War of 1812. The country, however, was not adequately prepared for war, nor was it united in support of what many called "Mr. Madison's War." Re-elected in 1812 in spite of formidable opposition, Madison grew increasingly unpopular as disaster followed the armies (*see* WAR OF 1812); the New England Federalists called for his resignation and even talked secession. In general, congress was more to blame than either the president or his official family, or the army officers. With the declaration of peace the president again gained a momentary popularity. In the postwar period, Madison assented to a new nationalistic program which included the creation of the Second Bank of the United States and levying a protective tariff.

Retiring from the presidency in 1817, Madison returned to his home, Montpelier, Orange county, Va., which he was to leave in no official capacity except in 1829, when he was a delegate to the state constitutional convention and served on several of its committees. Madison took an interest in education, in emancipation of slaves, and in agricultural questions, to the last. He died at Montpelier on June 28, 1836.

Madison was married in 1794 to Dolley (or Dolly) Payne Todd (1768–1849), a widow of great social charm. Her plump beauty was often remarked, notably by Washington Irving, in contrast to Madison's delicate figure and wizened face. He was, as Henry Adams wrote, "a small man, quiet, somewhat precise in manner, pleasant, fond of conversation, with a certain mixture of ease and dignity in his address." Henry Clay, contrasting him with Jefferson, said that Jefferson had more genius, Madison more judgment and common sense; that Jefferson was a visionary and a theorist, Madison, cool, dispassionate, practical and safe. The broadest and most accurate scholar among the "founding fathers," he was particularly an expert in constitutional history and theory.

See also UNITED STATES (OF AMERICA): *History;* and *see* references under "Madison, James" in the Index.

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MADISON, the capital of Wisconsin, U.S., the seat of Dane county and the University of Wisconsin, lies in the south central part of the state in a rich agricultural region of gently rolling wooded hills. Four lakes linked together by the Yahara river furnish a picturesque site for the city, located on an isthmus between the two largest, Lake Mendota (15.2 sq.mi. in area), and Lake Monona (5.5 sq.mi.). Pop. (1960) city 126,706; standard metropolitan statistical area (Dane county) 222,095. (For comparative population figures *see* table in WISCONSIN: *Population.*) Surrounded by a number of populous communities Madison began a program of annexation about 1940 which by 1958 had trebled its area and accounts in part for the population increase. Two independent residential villages, Maple Bluff and Shorewood Hills, lie within Madison's boundaries. Middleton borders it on the northwest.

History.—Madison was founded in 1836, a year of frenzied speculation in public lands and townsites in the newly created Territory of Wisconsin. The pleasant wooded knoll between the lakes caught the eye of one of Wisconsin's most far-sighted and inveterate speculators, James Duane Doty, who laid out a townsite for a company of investors which included Gov. Stevens T. Mason of Michigan. It was named for Pres. James Madison, who had recently died. That fall Doty lobbied a bill through the legislature, which was then meeting at the temporary capital of old Belmont, making Madison the permanent capital. The place was uninhabited but construction was quickly begun on a capitol and late in 1838 the legislature held its first session in the unfinished building. Controversies over the legal title to the townsite and financial stagnation following the panic of 1837 retarded settlement.

In 1846, when a village government was established, the lonely inland community still numbered only 626 inhabitants. Due in large measure to the efforts of Leonard J. Farwell, the "second father of Madison," small industries soon began to move in. The state university opened its doors in 1849, a railroad reached Madison in 1854, and in 1856 the city was incorporated. Its growth thereafter was unspectacular but steady, following the pattern laid down in early years.

The Economy.—Government operations, federal, state, county and city, account for much of the city's prosperity. Federal agencies include the U.S. forest products laboratory, the first of its kind in the world. The white granite capitol (the third on the site, constructed 1906–17) stands in the centre of the city in a 14-ac. wooded park. Nearby is the county and city building (completed in 1957), and a mile away is the University of Wisconsin, occupying 320 ac. within the city limits and an additional 1,654 ac. in Dane county. (For further discussion of the university *see* WISCONSIN: *Education.*)

Institutional agencies occupy more than a quarter of the land area of the city. This is divided almost equally among three groups: the city, for schools, parks, government buildings; the state and the university; and semi-public organizations such as churches, hospitals and lodges. The number employed by government agencies in Madison exclusive of educational staffs was estimated at 14,000 in the 1960s.

Industries developed substantially after World War I. In the early 1960s the city had more than 150 industrial plants employing more than 12,000 persons. Because of its central location and good transportation facilities, Madison became a jobbing and distributing centre for the wholesale trade. Truax field, used jointly by the city and the U.S. air force, serves as the commercial airport.

Other Facilities.—Madison is noted for its numerous public and parochial schools, its libraries and its hospitals. There are numerous parks and playgrounds, golf courses, bathing beaches, picnic grounds and other forms of recreational areas in the city. The city has a high proportion of professional, managerial and technical personnel. Its people are a middle-income population.

(AL. E. SM.)

MADIUN (Dutch MADIOEN), the name of a *kabupaten* (regency) of the province of Djawa-Timur (East Java), Indonesia, and of its capital town. Madiun town lies on the banks of the Madiun river, a tributary of the Solo. Pop. (1961) 123,373 (municipality), mostly Indonesians and Chinese. Its chief buildings face the Djalan Raya—the town hall, the Roman Catholic church, the city theatre, the radio station, the post office, hotels, etc. The well-kept Taman Pahlawan, where hundreds of soldiers killed in

the Indonesian revolution are buried, is the pride of the town. Madiun is served by the railway line connecting Jakarta and Surabaja and is connected by road with other towns. The airport is at Maospati, 6 mi. W. of Madiun. The inhabitants of the town are mostly labourers, working in the large railway shop, textile mill, sawmill, cigarette industries, transport, etc. There are also several sugar factories around the town.

MADIUN KABUPATEN has an area of 443 sq.mi. Pop. (1961) 509,428. In the north and centre are fertile plains. To the east and west are high volcanic groups, including Gunung Liman (8,335 ft.) and Gunung Lawu (10,712 ft.). There are limestone ranges to the south, forming a difficult coast without a harbour. Rice and sugar cane are the principal crops, supplemented by maize, cassava, coffee, cacao, cinchona, coconuts and peanuts. Teak is obtained from the forests. Under Dutch occupation, Madiun was a residency, with an area of 2,512 sq.mi. After creation of the republic the residency was broken up and the *kabupaten* of Madiun created. (D. So.)

MADRAS, a state of the Republic of India, lies in the south of the Indian peninsula and includes Cape Comorin, the southernmost point of the whole country. It is bounded on the northeast by Andhra Pradesh, on the northwest by Mysore and on the southwest by Kerala. Under British rule Madras presidency was one of the major provinces and stretched northward along the coast to the borders of Orissa. With the coming of independence in 1947 the northern Telugu-speaking districts were constituted into the state of Andhra Pradesh, leaving Madras state to include only the Tamil-speaking districts or Tamilnad. Under the States Reorganization act, 1956, the districts of Malabar (excluding the Laccadive and Minicoy Islands), the South Kanara district (excluding Kasargod *taluka* and Amindivi Islands), and the Kollegal *taluka* of Coimbatore district were transferred to Mysore state, the Laccadive, Minicoy and Amindivi Islands being constituted into a centrally administered territory. In return Madras gained four *talukas* of Trivandrum district (later constituted as Kanya Kumari district; *q.v.*) and the Shencottah *taluka* of Quilon district (now part of Tirunelveli district) from the old Travancore-Cochin state. The Andhra-Madras (alteration of boundaries) act, 1959, drafted on the Pataskar Award, came into force on April 1, 1960. Under this act, 319 villages in Tiruttani, Chittoor and Puttur *talukas* of Andhra Pradesh (area 405 sq.mi.) were exchanged for 151 villages in Tiruvallur, Ponneri and Hosur *talukas* of Madras (326 sq.mi.).

Madras, thus reorganized as a compact and homogeneous state, has an area of 50,331 sq.mi. The state capital is Madras.

Physical Features.—On the northwest the boundary with Mysore coincides roughly with the edge of the great Indian plateau, an edge known as the Eastern Ghats and rising in parts to more than 3,000 ft. In the extreme west the state includes the mountain mass of the Nilgiris separated from the southern end of the plateau by a deep trough and rising in Mt. Doda betta to 8,640 ft. overlooking the hill station of Ootacamund (Ooty). Southward of the Nilgiris and their spur, the Vellangiri hills, is the Palghat gap which affords a main routeway to the west coast. South of the gap and forming the boundary between Madras and Kerala are the Cardamom hills. Broadly speaking Madras comprises the land between this succession of heights on the west and the shallow shelving shores of the Bay of Bengal and Gulf of Mannar on the east. The western half is rolling or hilly country with settlement and cultivation in the valleys, giving place to the eastern half occupied mainly by alluvial plains. Nearly all the drainage is to the east, by a number of small streams in the south, by the important Cauvery (Kaveri) system in the centre (with a large alluvial delta), by the Penner or Ponnaiyar and the Cheyyar-Palar systems in the north.

The hill country consists of outliers of the old crystalline rocks of the plateau, with important mineral deposits in places; there are three detached areas of marine Cretaceous deposits near the coast.

The climate of Madras differs markedly from that of other parts of India since the main rainy season is in October–December—the season of the "retreating monsoon." The whole of the coastlands receive more than 10 in. in the two months November–December, and practically the whole state more than 5 in. In that part of the coast north and south of Madras city the total annual fall exceeds 40 in. but inland it drops, in places to only a little over 20 in. and that somewhat irregular. Consequently irrigation is needed not only for water-demanding crops such as rice but also to secure a certain harvest for such dry-zone crops as cotton and millet. Many of the small river valleys are dammed to provide "tanks" and there are important irrigation works on most of the rivers, many of great antiquity. In Kerala on the western side of the Cardamom hills, the rainfall is heavy: there the upper valley of the Periyar river was dammed and the water brought through by a tunnel to the dry Madras side. As might be expected from the southern situation the annual range of temperature is small—in Madras city from a May average of about 32° C. (a little under 90° F.) to a January average of 24.4° C. (76° F.). (L. D. S.)

History.—Madras state, as established in 1956, is confined to the Tamil-speaking areas of the old Madras presidency, the Telugu-speaking areas having been transferred to Andhra Pradesh (1953 and 1956), the Kanarese-speaking area to Mysore and the Malayalam-speaking districts to Kerala. It does not, however, correspond with any historical political subdivision of India.

For the ancient dynasties which disputed rule over southern India reference should be made to the articles CHOLA, PANDYA, KERALA and CEYLON. The Tamil civilization (out of which Malayalam civilization developed) is probably older than the Aryan, but it is difficult to isolate pure Dravidian elements even in the literature patronized by the earliest historical Tamil kings. The Chola-Pandya country, not less than Malabar, long enjoyed Greco-Roman trade, but Hellenistic culture made practically no impact since Abyssinians or Arabs monopolized the traffic. Tamil and Telugu influence upon southeast Asian cultures is more noticeable. The successive hegemonies of the Cholas and the Pandyas (subject to Hoysala incursions) gave way to a fragmentation, in which Andhra and even Oriya rulers shared northern Madras with Pandyas, Yadavarayas and Sambuvarayas, preparing the way for Muslim raids, the foundation of the sultanate of Madurai (*c.* 1340–78) and the conquest of all competitors by Vijayanagar (*q.v.*). Even after 1565, when Vijayanagar was virtually confined to the Karnataka portion of the Deccan, that empire was supreme in the Tamil country, giving it the misleading name "Carnatic," the other corruption, Coromandel (*Cholamandalam*), being more satisfactory.

The *nayakas* (nayaks) or district governors became virtually independent by the mid-17th century, and when the French and British superseded the Dutch they were able to meddle in the nayaks' rivalries. The British who had established a trading post at Peddapali (now Nizampatam) in 1611 settled at Madras (Ft. St. George) in 1639, and the French acquired Pondicherry in 1674. Interested in trade and in expanding the scope of Christianity (Nestorian churches existed on the eastern coast from antiquity), they were already implicated in Tamil politics when the Moguls created the nawabship of the Carnatic, the nawab at Arcot being the deputy of the nizam of the Deccan. Incursions of the Marathas into the Tamil country embarrassed the nawab. By the mid-18th century the local rulers needed European help, and wars in Europe gave point to British and French competition for the openings which developed. The Marathas set up a kingdom at Tanjore (Thanjavur). The British took a lease from the nawab in 1763 of the modern Chingleput district, in which Madras is situated. While the East India company was concerned to control the Carnatic without actually ruling it, the delicate relations with Arcot and Tanjore were complicated by money lending on the part of servants of the company with the rulers themselves. A somewhat discreditable chapter in Anglo-Indian history is mitigated by the fact that the Mysore wars rendered improbable the resurgence of local rulers in Madras.

Hostilities with the French, in which British success is largely to be attributed to sea power, spurred the latter on to force local rulers to become dependent upon them. In 1746 Madras surrendered to Mahé de la Bourdonnais, but it was recovered by

the British at the peace of Aix-la-Chapelle (1748) and Robert Clive's defense of Arcot in 1751 turned the tide in their favour. The defeat of Joseph Dupleix, governor general of the French establishment, was paralleled in 1760 by Col. (later Sir Eyre) Coote's victory of Wandiwash over the Comte de Lally. Pondicherry was taken in 1761. The Northern Circars region was granted to the Madras government in 1766. A revival of French power through the nizam and Mysore was feared during the revolutionary and Napoleonic wars. The Mysore wars of 1790–92 and 1799 brought territory on the west coast, and on the north and south of Mysore, to the presidency. Tanjore, which had been ruled by rajas who combined enlightened orthodoxy with tolerance of western culture, but had become inextricably involved in debt, passed to British administration in 1799. In 1801 a puppet nawab of the Carnatic resigned his dominions into British hands.

British administration was at first disturbed by the remoteness of the southern and western regions, the independent temperament of the *poligars* (hill chiefs), the power of predatory tribes and the results of centuries of fear of armed invasion from the north. The Madras presidency, with the rest of British India, was under the direct rule of the British crown from 1858 to 1947. The British period saw the arrival of western science, philosophy, law and letters, to all of which Madrassis contributed, while in music and the indigenous arts Madras remained pre-eminent in India. In the religious and moral field western influence enriched and confirmed (by example and by contrast) Indian traditions. Settlement of land revenue was largely direct with the cultivators. The government undertook irrigation and public works on a large scale. The public were not violently opposed to foreign rule. Prejudice in favour of Brahmanical culture discouraged more ancient ways, such as those in force in Malabar. The educational prowess of Brahmans led to a long prevailing anti-Brahman feeling. Hindi made rapid progress.

Trade-unionism and co-education made their first strides in Madras state. Conservative elements, after 1947, included the international traders, the Chettyars. Tamil "nationalism" was exemplified in the party called the Dravida Munnetra Kazhagam. (*See* also INDIA-PAKISTAN, SUBCONTINENT OF.)

(J. D. M. D.)

Population, Administration and Social Conditions.—Madras had a population (1961) of 33,686,953, the vast majority of which are Dravidians. The chief cities and towns, with their populations according to the 1961 census, are: Madras (1,729,141), Madurai (424,810), Coimbatore (286,305), Tiruchirapalli (249,862), Salem (249,145), Tuticorin (124,230), Vellore (113,742), Thanjavur (111,099), Nagercoil (106,207), Dindigul (92,947), Kancheepuram (92,714), Kumbakonam (92,581), Tirunelveli (87,988), Tiruppur (79,773), Cuddalore (79,168), Erode (73,762), Rajapalayam (71,203), Nagapattinam (59,063).

Executive power is vested in the governor (appointed by the Union president) who acts on the advice of a council of eight ministers. The bicameral legislature comprises a council of 63 members and an assembly of 206 members. Tamil is the principal and state language. The state is divided administratively into 13 districts: Madras; Chingleput; Arcot (North and South); Salem; Tiruchirapalli (formerly Trichinopoly); Thanjavur (Tanjore); Ramanathapuram (formerly Ramnad); Tirunelveli (formerly Tinnevelly); Madurai (Madura); Coimbatore; Nilgiris; and Kanya Kumari.

According to the 1961 census 45% of the male and 18% of the female population were literate. There are two universities, Madras and Annamalai, over 200 colleges, more than 23,300 primary schools and about 7,400 schools for general, vocational and technical education. Free primary education is in force in about 1,300 towns and villages. Every village with 500 people has a school and more than 8,000 schools provide free midday meals to children.

There are about 780 hospitals and dispensaries, and many primary health centres in rural areas provide free medical relief, maternity and child health facilities, health education, sanitation and antimalaria measures. Contributory social insurance covers risks of sickness, maternity, employment injury and general medical care for more than 160,000 factory workers. The State Social Welfare board provides free crèches, elementary schools, training in literacy for adults and crafts-training facilities for women in more than 600 villages. (S. CH.; S. B. L. N.)

The Economy.—Nearly two-thirds of the people of the state are engaged in agriculture. The principal food staples are rice and cholum, cambu, ragi and varagu (four kinds of millet). The most common oilseed is peanut. Sugar is derived from cane and the sap of palms. The principal fruit trees are coconut, areca nut, jack, tamarind and mango, and other crops include coffee, rubber, tobacco and tea. Excellent cotton is grown mostly in the western district. Coffee growing has suffered from fluctuating fortunes due to disease but is again an important crop in the Nilgiris together with tea. The greater part of the soil is held by the cultivators direct from the government under the tenure known as ryotwari.

The most important irrigation plan is the Perambikulam-Aliyar project (started in 1958), which would, when complete, irrigate about 250,000 ac. of land.

Forests cover more than 6,500 sq.mi. mainly in the hilly western areas where teak is an important tree. Other forest products are ebony, rosewood, sandalwood and redwood as well as quantities of bamboo. There are plantations of wattle, eucalyptus and cashew.

The mineral wealth of the state is largely undeveloped, though excellent iron has been smelted by local smiths from early times. The principal minerals are mica, barite, gypsum, bauxite, limestone, china clay, magnesite, etc., and lignite is mined at Neyveli in South Arcot district. Ilmenite and monazite deposits occur in Kanya Kumari district. Steel tubes are manufactured at Avadi, and a pig iron plant is in production at Coimbatore.

The chief industries in Madras are cotton ginning, spinning and manufacturing, coffee curing, rice milling, oil pressing, ropemaking, sugar refining, tanning, tile- and brickmaking, and the manufacture of bicycles, cement, glass, matches, salt and soap. The bicycle factory at Ambathur near Madras city is one of the largest of its kind in India. There has been considerable development and diversification of industry since independence. Much depends on hydroelectric power and by the early 1960s about half the villages of Madras were linked to the state power grid.

Communications.—The coast of Madras suffers from a shallow-shelving shore with no good natural harbour and dangerous surf through much of the year. The digging of the Buckingham salt-water canal running for 250 mi. close to the coast north and south of Madras city was an early attempt to help coastwise shipping, and it serves to link a number of small ports. With the completion of the deepwater harbour of Madras in 1909 the bulk of the overseas trade became concentrated there. The chief staples of the export trade are cotton and cotton piece goods, peanuts, hides and skins, tea and coffee, coir manufactures, rice and oil.

The state is well supplied with railways, which naturally have their centre in Madras city, the chief seaport. The broad-gauge line of the Southern railway connects with Bombay and Bangalore and also crosses the peninsula to Kozhikode (Calicut) and Mangalore on the west coast. The railways to the south of Madras city are metre gauge. Good motor roads now connect the main cities which include Madurai, Tiruchirapalli, Salem, Coimbatore and Tuticorin. (L. D. S.)

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MADRAS (Tamil CHENAI), the capital and chief port of the state of the same name, lies on the eastern coast of India, 850 mi. S.W. of Calcutta. Pop. (1961) 1,729,141. The city was

founded in 1639 when Francis Day, head of the English East India company's trading station at Armagon (Armagaum), which was concerned chiefly with the cloth trade, obtained a strip of land known as Madraspatam, or Madraspatnam, to the north of San Thomé and Mylapore. He got permission to build a fort there and this was completed in 1639 on St. George's day which probably accounts for its being called Ft. St. George. The town of Madras grew up round the fort and by 1641 it had become the company's headquarters and the chief English trading station on the Coromandel coast. In 1746 it was captured by the French who retained it until 1748, when it was returned to the English under the treaty of Aix-la-Chapelle. The corporation of Madras, the oldest in the east, was granted a charter under the East India company's seal in 1687. In 1871, with an area of 27 sq.mi., it was no more than a loose agglomeration of several distinct urban areas, a characteristic which in some parts it still retains. By 1931 the area had increased to 29.5 sq.mi.

The Cooum river cuts the city into two almost equal halves. The Adyar river runs 3 mi. S. of the Cooum and the Buckingham canal connects the Cooum with the Adyar. The centre of the city, George Town, to the north of Ft. St. George, is hopelessly congested, as also are some of the older parts in Triplicane and Mylapore, as compared with the newer extensions like Gandhinagar and Kasturbanagar, which have a pleasant rural appearance. Viewed from the air Madras looks quite green, since, even in the most overcrowded parts, there are fine trees, gardens and parks.

The main buildings include the high court (1892; Hindu-Saracenic style), the lighthouse (1889, 160 ft. high, with a revolving light), the Madras museum (1854) and the public library (1896). Madras is a centre of higher learning and research. At Adyar, a suburb, is the international headquarters of the Theosophical society. Madras university, founded with those at Bombay and Calcutta in 1857, is among the oldest in India, but there were English educational institutions even earlier: the Engineering college, the Medical college, the Madras Christian college (moved in 1937 to Tambaram) and the Presidency college. There are also a dozen institutions for arts and science. The university is federal in character, both affiliating and teaching, with more than 120 affiliated colleges throughout the state. In addition to the 30 research departments of the university and two colleges of technology, there are centres for leather research, textiles and preventive medicine.

For Indian Christians Madras is a very sacred spot; names like San Thomé and St. Thomas mount, both within the city limits, bring home its close association with the apostle St. Thomas, who is believed to have met with martyrdom in A.D. 53 at the hands of the king of Mylapore. The city has a large number of churches, ancient and modern; these include the chapel at the top of St. Thomas mount, built in 1514 under orders of King Emanuel of Portugal, the Luz church (1516), San Thomé cathedral (1557; the traditional burial place of St. Thomas), St. Mary's Church in Ft. St. George (1680), the Roman Catholic cathedral (1775), St. Andrew's Scottish kirk (1821), and St. George's cathedral (1816; Church of South India). Madras is the seat of a Roman Catholic archbishop and of an Anglican (South India) bishop.

The Port.—The port has an artificial harbour formed by masonry groynes extending eastward into the sea. The coastal current from north to south erodes the tract of Royapuram, to the north of the harbour abutment, and the sediment so brought down is effectively redeposited to the south, in Triplicane and Mylapore, to produce a fine beach, stretching uninterruptedly for about 6 mi., with an average width of 200 yd. The construction of the harbour started as a screw-pile pier in 1862; in 1876 the harbour proper was completed, to be destroyed by a cyclone in 1881. Its immediate reconstruction was finished by 1896 and it was further remodeled in 1901. It accommodates 18 vessels, 9 at moorings and 9 at quays, the depth at the moorings ranging from 28 to 31½ ft. and at the quays from 26 to 30 ft. In the mid-1960s attempts were being made to enlarge the harbour to cope with the increasing traffic, which includes the export of hides and skins, peanuts and manganese ore and the import of various commodities.

Industries and Communications.—The city's multifarious industries include cotton-weaving (the Buckingham and Carnatic mills were opened in 1874), the Railway Integral Coach factory (1953), motion picture production (1930), the manufacture of bicycles (1950) and assembly plants for automobiles and motorcycles (1950). It is the largest commercial centre and the main newspaper publishing centre of south India.

Madras can be reached by sea, rail, road and air. Ships of all countries call at the port, and the city is the headquarters of the Southern railway, with lines to all parts of the country. All the southern trunk roads converge on Madras. The international airport is at Meenambakkam, 10 mi. from the city, with connections to Singapore, Sydney, Australia and Colombo, Ceylon and internal services to the principal cities of India. (G. Kn.)

MADRAZO, a family of Spanish artists.

José de Madrazo y Agudo (1781–1859), portrait and history painter and etcher, was born at Santander, April 22, 1781, and died in Madrid, May 8, 1859. A supporter of Charles IV, he followed the king to France after his abdication in 1808 and became a pupil of J. L. David, whose influence shows clearly in his portraits. He went to Rome, and in 1819 returned to Madrid, where he was appointed keeper of the Prado and director of the Academia de San Fernando.

Federico de Madrazo y Kuntz (1815–1894), portrait and history painter, José's eldest son, was born in Rome, Feb. 9, 1815, and died in Madrid, June 10, 1894. He was a pupil of his father, of the Academia de San Fernando and of F. Winterhalter in Paris (where J. A. D. Ingres was among his portrait subjects). His "Godefroy proclamé roi de Jérusalem" was commissioned for Versailles in 1837. After a long stay in Rome he returned to Madrid as a fashionable portraitist, becoming painter-in-ordinary to the court and in 1859 succeeding his father in the direction of the Prado and the Academia. He was the founder of *El Artista, El Renacimiento, El Semanario pintoresco* and other journals.

José's second son, Luis de Madrazo y Kuntz (1825–1897), was a successful history painter, and his youngest son, Juan de Madrazo y Kuntz (1827–1880), was architect of the English church and other buildings in Madrid. Raimundo de Madrazo y Garreta (1841–1920), Federico's eldest son and pupil, was a portrait, subject and genre painter who eventually settled in France. Federico's youngest son and pupil, Ricardo de Madrazo y Garreta (1852–1917), also a pupil of Mariano Fortuny, was a genre painter and sculptor.

MADRE DE DIOS, a montaña department of southeastern Peru, bounded north by Brazil and Loreto, east by Bolivia, west by Cuzco and south by Puno. Area 30,271 sq.mi.; pop. (1961) 14,828. The department, created in 1902, is an isolated region of dense forests subject to periodic inundation. The climate is generally hot and humid with heavy rainfall; however, there is a fairly well-marked dry season from April through September. Economic resources of the department comprise rubber of the high-quality Beni-Acre type, Brazil nuts, medicinal plants and hardwoods. Crops cultivated include rice, cassava, bananas, sugar cane and other tropical commodities.

Puerto Maldonado, pop. (1961) 3,536, capital of the department, is situated at the confluence of the Madre de Dios and Tambopata rivers. It may be reached by air but otherwise transport is by river craft. The population is largely Indian and mestizo with a small colony of Japanese. (J. L. Tr.)

MADRE DE DIOS RIVER rises in the Cordillera de Carabaya near Paucartambo in southern Peru and flows 61 mi. north and northeast past Manú in Peru and Puerto Heath on the Peru-Bolivia border to meet the Beni river at Riberalta, Bol. The Beni and Mamoré unite northeast of Riberalta to form the Madeira river, one of the major tributaries of the Amazon. In Peru the Madre de Dios flows through the sparsely settled department of Madre de Dios. The Madre de Dios river is generally navigable for small craft on the upper course but its efficiency, like that of most rivers in eastern Bolivia, is much reduced by rapids and tree trunks. Traffic on the river is interrupted just below Puerto Heath.

During the days of the rubber boom in the Amazon basin there

were numerous rubber stations on the Madre de Dios, but after 1912 production ceased to be commercially important. The climate is hot and humid and the entire region is largely covered with virgin forest. There is still some gathering of rubber, balata, chicle and other products along the river's course. In a few small areas there is some unimpressive production of cacao, coffee, cotton, fruits, sugar cane and cassava. Development of this isolated area through which the Madre de Dios flows does not appear likely, but the river is the main communication line with the outside world. (L. WE.)

MADRID, a province of central Spain formed from districts included before 1833 in New Castile. Area 3,087 sq.mi.; pop. (1900) 2,206,254 (including the city of Madrid, pop. 1,250,351 [man.]). The province roughly coincides with the drainage of the southern slopes of the Sierra de Guadarrama (7,972 ft.) and the Jarama, Henares and Manzanares rivers. From the precipitous southern flanks of the Guadarrama, the relief descends to the gravel pediments that floor a series of lower platforms, merging into the gentle, rolling relief of Tertiary sediments. Miocene clays and sands cover most of the southern half of the province cut into by well-developed series of river terraces. Pine forests, preserved on the mountain slopes, now attract a new style of summer suburbia for the people of Madrid, but otherwise it is a bare, typically Castilian landscape of yellow soils and open cereal fields. Only along the Henares and Jarama do irrigated lands give a ribbon of green, intensive horticulture and on the outskirts of greater Madrid are poultry and pig farms interspersed with the ribbon development of villas or new factories. Chamartín, Carabanchel, Pueblo-Ventas and even Getafe already form part of greater Madrid. The province is well endowed with building materials: granite quarries in the Guadarrama, brick and tile works exploiting the clays to the south. The city's water supplies come from the headstreams of the Jarama and its affluents; the aqueduct, Canal del Lozoya (56 mi.), was first made in 1855 but has been much expanded.

An important factor in the growth of communications is the relative ease of passes over the central Cordillera. The easiest is the Somosierra (4,650 ft.) to the northeast, utilized by road and the new Burgos railway. The Puerto de Navacerrada links the Madrid-Segovia road. All the great national railways converge in this province which contains 171 mi. of line. (J. M. Ho.)

MADRID, the capital of Spain and Madrid province in New Castile, lies almost in the centre of the Iberian peninsula. Pop. (1897) 397,816; (1950) 1,571,939; (1960) 2,259,931.

The highest capital city of Europe, it is situated on the Meseta, an undulating plateau of sand and clay. On the northwest, beyond the Manzanares river (a 50-mi.-long tributary of the Jarama, which flows into the Tagus), the city is bounded by heath and parkland, the former comprising the royal hunting preserves (Casa de Campo); farther north is the Sierra de Guadarrama (7,972 ft.), the inner valleys of which, still fairly well wooded, are much frequented by the *Madrileños*. On the other sides Madrid is surrounded by agricultural land, mostly treeless and bare in appearance, but well cultivated. The highest point in Madrid is 2,373 ft. above sea level. This altitude and the open situation of the town makes it liable to sudden variations of temperature. On the other hand, to these same circumstances Madrid owes its clear, pure atmosphere which makes its climate healthful and reasonably pleasant except in July and August, when the heat becomes oppressive.

The Moorish name of the town (Majrit) first historical evidence of its existence, appears to have been mentioned in 932 when Ramiro II razed its walls but left it in Moorish hands. Traces have been found of a Roman settlement and even some indications of human habitation in prehistoric times. Nevertheless, Madrid must be considered a modern town by Spanish standards, and only gained some claim to fame when Alfonso VII granted it certain privileges. The parliament (*Cortes*) was twice summoned in Madrid (1309 and 1478). Henry III, John IV of Portugal and Henry IV of Castile all spent considerable periods of time in the town, where the latter king died. Philip II, taking into account its central position and healthful surroundings, established its capital there in 1561, a decision generally thought to be transitory. In fact, it was only in 1607, under Philip III, that Madrid finally attained its present status. During the War of the Spanish Succession, Madrid took the Bourbon side against the Hapsburgs. In 1808 it gave the signal for a mass uprising against the troops of Napoleon, remaining afterward obdurately hostile to his brother Joseph, whom he had placed on the Spanish throne. Ferdinand VII, on his return from imprisonment by Napoleon in 1814, bestowed upon the town the title of "heroic." As a consequence of the political vicissitudes of the 19th and 20th centuries the life of the capital was disturbed more than once. The disturbances remained sporadic until the Spanish civil war of 1936–39 when, as seat of the government, Madrid became the scene of the two-and-a-half years' siege, which ended on March 28, 1939, with the entry of the nationalist troops. All traces of the damage suffered were completely obliterated.

Madrid is the see of a bishopric, the headquarters of an army corps and residence of the captain general of the 1st military region, the focus of the main roads and railways, a banking centre, the seat of a university, of the supreme court and of all branches of the central administration. The head of the state lives in the former royal palace of El Pardo, 7 mi. from the city proper. Economically the importance of Madrid considerably increased. In the 1920s it was the second Spanish industrial town after Barcelona.

Development and General Description.—Madrid has known four well-defined periods of development, the first, under the house of Austria, shortly after having been chosen capital; the second, under Charles III (1759–88), one of the so-called enlightened despots; the third stretching from the end of the reign of Isabella II (1868) to the regency of María Cristina of Hapsburg (1885–1902); and the last, which includes World Wars I and II, interrupted by the Spanish civil war of 1936–39.

From the first period dates the Plaza Mayor, built in 1617, rectangular in shape and 430 ft. long, ornamented by an equestrian statue of Philip III and two small fountains. It has witnessed many a solemnity, from tournaments to bullfights and *autos-da-fé*. To the same period also belong the building housing the foreign office, the remnants of the royal palace of El Buen Retiro (an artillery museum) and the town hall. To Charles III are due the Puerta de Alcalá, one of the two city gates worthy of mention (the other being the Puerta de Toledo), the finance ministry and the observatory. He also completed the royal palace, constructed in 1735–64 by Filippo Iuvara and G. B. Sacchetti. The middle of the 19th century saw the opening of a new opera house (Teatro Real, 1850), the installation of water mains (1855) and the construction of the square known as Puerta del Sol.

José de Salamanca, a prominent banker, gave a new impetus to the extension of Madrid, by planning and financing the fashionable district bearing his name. From 1900 progress continued at a steady but leisurely pace. In 1910 the opening through a maze of old streets, of the commercial thoroughfare popularly called Gran Vía took place. Roughly one mile long, it became a smart shopping and amusement centre and altogether changed both the face and the tempo of life of central Madrid. Flanked by tall modern buildings including the 24-story telephone exchange, the Gran Vía ends at the Plaza de España, where stand the Cervantes monument and the España skyscraper, reputed to be the tallest in Europe.

In 1919 the first subway was opened. From that time the town's growth has been swift and constant. Between 1947 and 1951 nearly all the outlying suburbs were annexed to the capital and the municipal territory increased tenfold. A planning organization, the Comisaría Superior de Ordenación Urbana, was created. Developments after 1939 included reconstruction of the university city, destroyed during the civil war; new canalization of the Manzanares, thereby reclaiming further land along its banks, where a vast scheme of working-class dwellings, green spaces and artificial beaches has been carried out; the erection of the group of buildings housing the Higher Council for Scientific Research; and the construction of the Barajas international airport, linked with the capital by a magnificent highway. The Castellana avenue

was prolonged for nearly a mile, the main roads leading into the town widened and embellished, a new ring road constructed and several important housing schemes, comprising blocks of flats (Barrios de la Concepción, de la Quintana, del Niño Jesús, etc.) and suburban garden cities (Puerta de Hierro, la Florida), completed. Other municipal developments included an extension of the subway, replacement of streetcars by buses and trolley buses, improvements in sanitation and lighting, and new athletic fields, including the gigantic Chamartin stadium.

In the course of its somewhat haphazard growth Madrid has become the common modern type of sprawling city and has therefore no definite form, the only feature retained of its previous shape being that it still measures rather more from north to south than from east to west.

The Puerta del Sol (reputedly named after a gate, which stood there until 1510 and had on its front a representation of the sun) used to be the centre of Madrid and the busiest spot. Devoid of all architectural interest, it has become peripheral, and several other centres have sprung up in different parts of the town. On the north side of the Puerta stands a square red brick building erected in 1768 as a post office, later the police headquarters. The three-mile-long Calle de Alcalá starts in the Puerta del Sol. It contains the finance and education ministries, a theatre, two churches, nine of Spain's main banks and the Real Academia de Bellas Artes, founded in 1752 as an academy of art and music. Its collection of Spanish masters includes some of the best works of Murillo and Goya.

The Bank of Spain stands where the Calle de Alcalá intersects the Prado, an avenue laid out with gardens and adorned on the right side by the fountain of Apollo and on the left by an obelisk commemorating the rising against Napoleon. The Prado connects two oval plazas in each of which is a fountain, one representing Neptune and the other Cybele. At one end of the avenue stand the Prado museum and the Church of St. Jerome (founded by the "Catholic Sovereigns" Ferdinand and Isabella and the scene of royal weddings and ceremonies); at the other the general post office (1916) and the ministry of marine; in the middle the exchange (1894). The Paseo del Prado has great architectural distinction, bounded on one side by a residential quarter including the Retiro gardens, a park with ponds, fountains, monuments and a zoo. A royal palace, built for Philip IV and destroyed during the French occupation, once stood there.

Northward the Prado is continued by the Calvo Sotelo (formerly the Paseo de Recoletos) and the Castellana, in which are the national library, the mint, the Columbus monument, foreign embassies and residences of the aristocracy and the well-to-do.

Near the Puerta del Sol lies the Plaza de Oriente. A statue of Philip IV on horseback, designed by Velázquez, presides over its gardens, the whole dominated by the royal palace, built on an eminence overlooking the Manzanares. It replaces the old Alcázar, which burned down on Dec. 28, 1734, and contains richly decorated rooms, a priceless library, collections of tapestries and a famous armoury. Southeast of the plaza and down to the Manzanares stretch the *barrios bajos*, Madrid's most typical and poorest section.

BY COURTESY OF THE SPANISH NATIONAL TOURIST OFFICE

THE ROYAL PALACE BUILT DURING THE 18TH CENTURY ON THE WEST SIDE OF THE PLAZA DE ORIENTE, MADRID

Among the churches the following deserve mention: San Francisco el Grande (18th century, designed by Francesco Sabattini); San Andrés (17th century), one of the finest, which was set on fire by the mob and gutted in 1936; Capilla del Obispo (Gothic and Renaissance, 1520); San Pedro (Hispano-Moorish), built on the site of a mosque; Montserrat (baroque); Comendadoras and San Placido (both 18th century); and, lastly, San Isidro, used as a cathedral since 1885 (built from 1623 to 1665).

Of secular buildings, the following are notable: the Casa de Cisneros (plateresque); the Casa de los Lujanes, where Francis I of France, captured at Pavia, was kept prisoner; and above all the Prado museum, originally planned as a museum of natural science and formally opened in 1819. The building was designed by Juan de Villanueva, as were the entrance to the adjoining botanic gardens and the nearby observatory. In the Prado are exhibited the paintings collected by the Spanish monarchs from the 15th century, representing almost the entire range of western painting, mainly Spanish, Flemish and Italian, up to the 19th century. A new wing was added in 1956. There are 20 other museums in Madrid, some of them first class: archaeological, artillery, naval and decorative arts museums among them. Of the private collections three are outstanding, namely the Lázaro Galdiano, Cerralbo and Valencia de Don Juan. The Toledo and Segovia bridges (1735 and 1584) spanning the Manzanares are worthy of note.

Education and Culture.—Until 1836, when the university founded in Alcalá de Henares by Francisco Cardinal Jiménez de Cisneros was transferred to the capital, Madrid had no university of its own. Older existing institutions, such as the Medical College of San Carlos (1786) and the Royal Institute of San Isidro, were merged with it, and the University of Madrid became the foremost university in Spain. Among the buildings in the reconstructed university city are several newly created *colegios mayores* or students' residences. Madrid also contains teachers' training colleges, schools of arts and crafts, a conservatory of music, colleges of agriculture, architecture and engineering, etc. The principal learned societies are the royal academies for the cultivation of the Spanish language, of history, moral science, jurisprudence, medicine and pharmacy, mostly created in the 18th century and later incorporated into a body called the Institute of Spain.

From the time it was made a capital Madrid has had a vigorous and lively cultural life. The atmosphere of the town, its light and colour, the temperament of its people, generous, quick-witted, easygoing, even if perhaps superficial, form the background of the literary trend known as *Madrileñismo*, which extols the capital's charms and explores its past and present; the writers Ramón de Mesonero Romanos, in the 19th century, and later Ramón Gómez de la Serna being its main exponents. The so-called *zarzuela* ("musical comedy") and *sainete* ("light prose comedy") based on Madrid lore are the outcome of the same feeling.

Industries.—In 1900 Madrid was almost exclusively an administrative and commercial centre. Industries making luxury and fancy goods, pharmaceutical products, leather articles, furniture, etc., began to develop. After 1940, however, Madrid took its place among Spain's chief industrial cities and there are important factories manufacturing aircraft, radio and electrical equipment of all kinds (including domestic appliances), rubber, plastics, optical equipment, trucks and motor engines.

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MADRIGAL, the name given to a form of concerted vocal music, Italian in origin. The earliest school of madrigal writing

flourished in northern Italy in the 14th century and is quite distinct from the later one that began about 1530. The early madrigal, like the ballade or the ballata, is a poetical form as well as a musical one. Two or three strophes of three lines each are followed by a final ritornello of two lines; in each strophe two lines rhyme with one another. For this type of madrigal the suggested derivation from *mandria* ("sheepfold") may well be correct, since early writers associate it with the *pastourelle* of the troubadours and its subject matter is generally idyllic and contemplative, if not exactly pastoral. The principal composers in this form were Jacopo da Bologna and Giovanni da Cascia (or da Firenze); their settings are for two or three voices, of which the topmost is usually very ornate.

The madrigal was already becoming obsolete by the time of Francesco Landini (d. 1397) and it fell into complete oblivion during the 15th century. When it was revived by the humanistic circle that gathered about Cardinal Pietro Bembo in the early years of the 16th century it is probable that, whatever its original derivation had been, *madrigale* was thought of simply as equivalent to *matricale*, meaning "in the mother tongue"; *i.e.*, Italian and not Latin, for it is applied to poems without any fixed form. The madrigals of this period were intended as a literary return to the more elevated style of antiquity, in contrast to such current forms as the *frottola* and the *strambotto*. The music to which they were set was likewise intentionally dignified, and it drew upon the style of the contemporary sacred motet and upon Josquin Després's sonorous chansons; nevertheless the break was not a sudden one, and the first of these madrigals (published in 1533) are still similar to *frottole*.

The earliest group of 16th-century madrigal composers includes Philippe Verdelot, Jakob Arcadelt, Adriaan Willaert and Costanzo Festa. It will be noted that northern (French and Flemish) composers preponderate, and it was not until the middle of the century that native Italian composers began to play a large part in the composition of madrigals. Whereas the earlier madrigalists had aimed at a placid, almost abstract, musical accompaniment to the words, Cyprien de Rore, Andrea Gabrieli, Philippe de Monte and Orlando di Lasso cultivated a new and detailed expressiveness, with words such as *acerbo* ("bitter"), *ira* ("anger"), *pianti* ("weepings") underlined by dissonances, and *gioia* ("joy") or *riso* ("laugh") set to swiftly running figures. Although the application of these expressive symbols at times appears naïve, the result was the rapid development of a new musical language, one that had repercussions on the setting of words to music throughout Europe.

The final stage of the Italian madrigal, although it produced much superb music, can be seen as a decline from this intimate fusion of music and poetry. In the hands of such composers as Luca Marenzio, Carlo Gesualdo and Claudio Monteverdi the musical language of the madrigal became ever richer and more varied, but with this went a tendency to set stilted and epigrammatic poems of negligible literary value. The increasing independence of the separate voice parts eventually resulted in the complete breakup of the old polyphonic texture; in the later madrigals of Monteverdi, for example, passages for one or more solo voices are punctuated with sonorous passages for the full group, and unity is achieved not by continuity of texture but by the use of an accompanying *basso continuo*. From this type of accompanied madrigal it was a comparatively short step to the cantata, which in the 17th century was to take its place as the most elevated form of secular vocal music.

In France, Germany and Spain, the Italian madrigal made its influence felt on the native forms of secular part song, but nowhere was it so enthusiastically imitated or so completely naturalized as in England. Madrigals had been known at court since the later years of Henry VIII, but it was not until the 1580s that they achieved real popularity. In 1588 Nicholas Yonge was able to publish a large collection of Italian madrigals in English translation under the title *Musica Transalpina*, and similar collections followed it. William Byrd (1543–1623) was already a mature artist and was little influenced in his secular music by the Italian style, but his pupil Thomas Morley embraced it wholeheartedly, and even had two of his sets published in an Italian version as well as in the original English. Morley excelled in the lighter and more cheerful types of madrigal, such as canzonets ("little short songs" as he calls them) and ballets: the latter he modeled on the *balletti* of Giovanni Giacomo Gastoldi, but achieved a more elaborate musical development and a stronger sense of harmonic direction. John Wilbye (1574–1638) and Thomas Weelkes (1577?–1623) brought to the English madrigal a new depth of feeling and on occasion a profound melancholy that is not characteristic of the Italian school; Wilbye is the purer stylist, but Weelkes the bolder and more individual.

Of the later English madrigal publications those of Orlando Gibbons and Thomas Tomkins, published in 1612 and 1622 respectively, are the best, but although the fashion for madrigals lasted only about 40 years in England it had in that comparatively short space of time produced a remarkable quantity of fine music.

The tradition of madrigal singing was revived in England in the early 18th century. The Madrigal society (founded by John Immyns in 1741, and still in existence) and John C. Pepusch's Academy of Ancient Music kept the practice alive in London, and it also flourished among the lay clerks of cathedral and collegiate churches throughout the country. At the meetings of these groups both English and foreign madrigals were sung, together with later compositions written in imitation of their style. In the 19th century there appeared two studies of the madrigal repertory—T. Oliphant's *La Musa Madrigalesca* (1837) and E. F. Rimbault's *Bibliotheca Madrigaliana* (1847)—and G. E. P. Arkwright provided both historical studies of the composers and editions of their music in a more scientific way at the beginning of the 20th century. It was, however, the work of E. H. Fellowes, above all, that made this repertory available for study and performance; his complete edition of *The English Madrigal School*, 36 vol. (1913–24), is among the monuments of British musicology; and his book *The English Madrigal Composers* (2nd ed., 1948), and his edition of the poetic texts in *English Madrigal Verse* (2nd ed., 1929) form a worthy complement to it. The subject has most recently been surveyed in Joseph Kerman's *The Elizabethan Madrigal: a Comparative Study* (1962).

Studies and editions of the two Italian schools of madrigalists are too scattered and extensive to be listed here, but details of the earlier may be found in any bibliography of the Italian Ars Nova, while an indispensable guide to the later is Alfred Einstein's *The Italian Madrigal*, 3 vol. (1949). Einstein left the vast collection of manuscript scores on which he had based his comprehensive survey to Smith college, Northampton, Mass., where they form a unique library for any student of the subject. A general survey and detailed bibliography may be found in G. Reese, *Music in the Renaissance* (1954, rev. ed., 1959). (J. J. N.)

MADRÍZ, a small department in the northwestern part of the central highlands in Nicaragua. Area 531 sq.mi.; pop. (1960 est.) 43,417, of which 85% was rural. Somoto (pop. [1960] 3,471) is the largest town and departmental capital. Despite its rugged relief, and because of rather fertile valley soils and 60 or more inches of rain per year, the department is significant in the production of swine, cattle, horses, mules, coffee, brown sugar (panela), cotton, vegetables and subtropical fruits. Until the construction of the Inter-American highway across the department, giving it access to Managua, 136 mi. away, Madríz depended chiefly upon pack and air transportation. (C. F. J.)

MADROÑA (*Arbutus menziesii*), a handsome North American broad-leaved evergreen tree of the heath family (Ericaceae), called also madrone, madroño and laurelwood, native to the coast region from British Columbia to southern California. It is a widely branching tree, growing to a height of 125 ft., with a trunk diameter exceeding 4 ft.; polished crimson to dark-brown bark; large, lustrous, dark-green leaves, nearly white beneath; small, heathlike, white flowers in dense clusters; and bright orange-red, berrylike fruit.

MADURA (Dutch MADOERA), an island of Indonesia in East Java province, lying off the northeast coast of Java, opposite Surabaja, from which it is separated by a shallow strait of less than 1½ mi. The island is 100 mi. long and 24 mi. wide and has

an area of 2,113 sq.mi. Pop. (1957 est.) 1,883,401. It has an undulating surface but no mountains, 700 ft. being the greatest elevation in the west and 1,565 ft. in the east. In the north the hills run down nearly to the sea; in the northwest and south there are extensive alluvial plains, while the south coast is fringed with islets, shoals and mudbanks. The geological formation reveals the relation of Madura to northern Java (*q.v.*), since it consists largely of the same limestone rocks, of Tertiary formation, with low alluvial tracts. There are hot springs. Off the eastern coast are several islands—Sapudi and the Kangean group, Kangean Island being 25 mi. long and from 3 to 12 mi. wide, with hills reaching 1,197 ft.

The climate, flora and fauna of Madura resemble those of east Java. Vegetation is luxuriant, but the soil is less fertile than the average soil in Java; as an indication of this, rice has to be imported to meet the needs of the population. Maize and cassava are the main crops, but rice, coconuts, coffee, cacao, kapok and most of the usual Indonesian fruits and vegetables are grown. Kapok, copra and coconut oil figure largely in exports, as does teak from the extensive forests in the northwest. The island is well adapted for cattle breeding, which is engaged in extensively. The wide expanse of coast, well sheltered on the southern side, gives opportunity for fishing. The Kangean Islands and Sapudi yield timber, trepang and tortoiseshell. The principal industry is salt panning, a government monopoly. The salt is obtained from saline springs and from sea water; the largest pans are situated at Kalianget. Manufacture is according to European method and employs many. Petroleum has been found and is worked on a small scale.

The Madurese (Muslims) are keen traders, fishermen and sailors; they are less good as craftsmen.. They tend to be shorter but more sturdily built than the Javanese. Amusements are bull racing and bullfighting; the races, usually held in the month of September, attract huge crowds.

The capital of the island is Pamekasan, in the central southern part of the island, not far from the coast (pop. [1957 est.] 23,121). Other towns are Sumenep (pop. [1957 est.] 33,628), near which are the tombs of the princes of Sumenep; Bangkalan (pop. [1957 est.] 29,536), with the old palace of the sultan of Bangkalan, or Madura, and an interesting mosque; Sampang (pop. [1957 est.] 47,596); Kamal; and Kalianget.

A tram line crosses the island from west to east, from Kamal to Kalianget, connection being maintained with Java by means of a ferry service between Surabaja and Kamal; the line extends to Bangkalan, in the north, and passes through Pamekasan and Sumenep. There are roads along the north and south coasts, and across the centre of the island.

Dutch influence was established in Madura late in the 17th century, and the power of the ambitious prince of Madura was circumscribed by the division of the island into three regencies, Madura (or Bangkalan), Pamekasan and Sumenep, each having its own prince, or sultan. After much misrule, the regencies were united in 1885 under a residency attached to Java. In 1949 Madura became part of the Republic of Indonesia. (E. E. L.)

MADURAI, a city and district of Madras, India. The city, headquarters of the district, lies on the Vaigai river, 305 mi. S.W. of Madras. Pop. (1961) 424,810. It is an ancient historic city of south India, and has been a centre of Dravidian culture for more than 2,000 years. The standing monuments of Dravidian architecture are the Tirumala Nayak palace (restored and now used for public offices) and the Great temple comprising the twin temples of Meenakshi (Minakshi, "the fish-eyed goddess" and consort of Shiva) on the south and Shiva or Sundareswar on the north with the Sahasrasthambha Mandapam or the hall of a thousand pillars in the northeast corner of the temple complex. The immense precincts of the Great Meenakshi temple are dominated by nine exquisitely carved gopurams, or tower gates, the tallest of which is 152 ft. high. There are seven colleges, all affiliated to the Madras university; the oldest and biggest is the American college founded by the American mission. Other colleges include two for women and Government Medical college. In 1958 Madras university established a regional centre at Madurai with departments of study and research. The city is an important cotton-manufacturing centre of a rich cotton-producing area, and has nine mills. It is a junction on the Southern railway.

Madurai was the capital of the Pandyan kings from the 5th century B.C. to the end of the 11th century A.D. In 1310 it was plundered by a Muslim army under Malik Kafur. It formed part of the empire of Mohammed ibn Tughlak until 1334 when Sayyid Ahsan, the governor, revolted and established the independent sultanate of Madurai. After 1378 this was absorbed by the Hindu empire of Vijayanagar. In the middle of the 16th century the governor Viswanath established the Nayak dynasty which ruled for a century. The greatest of the Nayaks was Tirumala (reigned 1623–59) who adorned Madurai with many public buildings and extended his empire over the adjoining districts. Later, Muslims again invaded Madurai and compelled Tirumala to pay them tribute. After his death, the kingdom of Madurai gradually fell to pieces, being invaded both by Muslims and Marathas. About 1736 the district fell into the hands of the nawab of Carnatic, and the line of the Nayaks was extinguished. In 1764 British officers took charge of Madurai in trust for the last independent nawab of Carnatic, whose son finally ceded his rights to the East India company in 1801.

MADURAI DISTRICT (area 4,910 sq.mi.; pop. [1961] 3,211,227) has always been important because of its agricultural wealth, the result of the unique system of irrigation which diverts the waters of the river Periyar flowing into the Arabian sea through a tunnel across the Western Ghats into the Vaigai basin, to irrigate 150,000 ac. of land. On the Palni hills stands the famous sanitorium of Kodaikanal (*q.v.*), and on their slopes cardamoms, tea and coffee are cultivated. The Sirumalais (smaller hills) are famous for the exceptionally sweet variety of plantains; vines and grapes are found in a few favoured spots of the Periakulam taluka. There are numerous cotton-spinning, weaving, ginning and pressing mills. However, the production of raw cotton meets with only 15% of the local demand.

Gandhigram, about 40 mi. from Madurai, is the site of a new rural institute with facilities for higher studies in agriculture, engineering, hygiene, etc. Co-operative farming was being attempted in the mid-1960s, and on the success of this depends the future of co-operative farming in south India. Other projects include the Vaigai reservoir project to irrigate another 10,000 ac. and the Periyar power station to generate 105,000 kw. of hydroelectricity. (G. KN.)

MADURESE LANGUAGE, like most languages of Indonesia, is one of the Malayo-Polynesian languages (*q.v.*). It is most closely related to the languages of western Indonesia such as Javanese and Malay. It is the native language of about 8,000,000 Indonesians and thus shares with Malay third position among the languages of the country. Its speakers are distributed mainly over Madura and nearby islands, the Kangean and Sapudi Islands and the section of the eastern peninsula of Java which faces Madura. There are two main dialects: Western Madurese, which has two subdialects with centres respectively at Pamekasan and Bangkalan, and Eastern Madurese with its centre at Sumenep. Madurese has different status styles: the *alos* (literally "fine") for deferential address, the *kasar* (literally "coarse") for familiar address and the *tengngaqan* (literally "middle") for otherwise undefined address. The difference between the styles is not so great as that of the Javanese and Sundanese styles.

Madurese is traditionally written in an adapted form of the Javanese alphabet. Madurese formerly was rarely used in writings because of the domination by Javanese princes and then by the Netherlands Indies government. The chief original Madurese writings are some historical works, the remainder being mainly translations from the Javanese. (I. DN.)

MADVIG, JOHAN NICOLAI (1804–1886), Danish philologist, whose chief work was the study and teaching of Latin and Greek and the improvement of the classical schools, was born on the island of Bornholm on Aug. 7, 1804. He was educated at Frederiksborg and at the University of Copenhagen, where in 1829 he became professor of Latin language and literature. In 1848 Madvig entered parliament and became minister of education and

later (1852) director of public instruction. From 1856 to 1863 he was president of the council and leader of the National Liberal party. Madvig died at Copenhagen on Dec. 12, 1886.

Besides his unsurpassed edition of Cicero's *De finibus* (1839; 3rd ed., 1876), Madvig published *Der römische Stats Forfatning og Forvaltning*, 2 vol. (1881–82); *Livseringringer* (1887); and many works on Latin grammar and Greek syntax.

See J. E. Sandys, *History of Classical Scholarship*, 2nd ed., iii (1908).

MAEBASHI, industrial city and communications centre, is the capital of Gumma prefecture, Japan. The city grew rapidly in size and population after World War II. Pop. (1947) 90,432; (1960) 181,937. Maebashi remains a centre of sericulture and silk-yarn production in spite of the general decline of the silk industry. An old castle town, in the Muramachi period it was called Umayabashi and in the Tokugawa period it was the seat of the Matsudaira family. (C. A. Mr.)

MAECENAS, GAIUS (d. 8 B.C.), Roman statesman and patron of letters, was probably born between 74 and 64 B.C., perhaps at Arretium (Arezzo). He prided himself on his Etruscan lineage and claimed descent from the princely Cilnii of Arretium; Tacitus (*Annals*, vi, 11) actually calls him *Cilnius Maecenas*, though this does not appear to have been his name. His great wealth may have been in part hereditary, but he owed his position and influence to his close association with the emperor Augustus. He may have taken part in the battle of Philippi (42), but he first appears in history in 40, when he was employed by Octavian (as Augustus at this date is usually known) in arranging his marriage with Scribonia, and afterward in assisting to negotiate the peace of Brundisium and the reconciliation with Mark Antony. It was in 39 that Horace was introduced to Maecenas, who had before this received Varius Rufus and Virgil into his intimacy. In the "Journey to Brundisium" (Horace, *Satires*, i, 5) in 37, Maecenas and L. Cocceius Nerva are described as having been sent on an important mission, and they were successful in patching up, by the treaty of Tarentum, a reconciliation between the two claimants for supreme power. During the Sicilian war against Sextus Pompeius in 36 Maecenas was sent back to Rome and was entrusted with supreme administrative control in the city and in Italy. During the campaign of Actium (31) he was left in charge at Rome again and with great promptness and secrecy crushed the conspiracy of the younger Lepidus. He remained an *eques* and held no public offices, but he was one of the most important men around Augustus; an anonymous elegy composed after his death calls him "Caesar's right hand." In the latter years of his life he fell somewhat out of favour; he died in 8 B.C., leaving the emperor heir to his wealth.

Maecenas impressed ancient writers by the contrast between the great energy and ability he showed in public life and the luxury and hedonism of his relaxations. His character as a munificent patron of literature has made his name a household word. His patronage was exercised with a political object; he sought to use the genius of the poets of the day to glorify the new regime. The diversion of Virgil and Horace toward themes of public interest may be ascribed to him, and he endeavoured less successfully to do the same thing with Propertius. The relationship between Maecenas and his circle is largely a matter of conjecture, but he and Horace were certainly personal friends. It has fallen to the lot of no other patron of literature to have his name associated with works of such lasting importance as the *Georgics* of Virgil, the first three books of Horace's *Odes*, and the first book of his *Epistles*.

Maecenas himself wrote in both prose and verse; only fragments survive. His prose works on various subjects—*Prometheus*, *Symposium* (a banquet at which Virgil, Horace and Messalla Corvinus were present), *De cultu suo* (on his manner of life)—were ridiculed by Augustus, Seneca and Quintilian for their undisciplined style.

Bibliography.—The fragments are collected in R. Avallone, *Mecenate: I Frammenti* (1945); verse fragments alone in W. Morel, *Fragmenta poetarum Latinorum*, pp. 101 ff. (1927). *See* also V. Gardthausen, *Augustus und seine Zeit*, vol. i, pp. 762 ff., vol. ii, pp. 32 ff. (1891–1904); R. Syme, *The Roman Revolution*, 2nd ed., index (1951).

MAELDUIN (Maeldune), **VOYAGE OF:** *see* Irish Literature.

MAELIUS, SPURIUS (d. 439 B.C.), a wealthy Roman plebeian who during a severe famine bought up a large amount of corn and sold it at a low price to the people. Lucius Minucius, the patrician *praefectus annonae* (president of the market), thereupon accused him of courting popularity with a view to making himself king.

Maelius, summoned before the aged Cincinnatus (specially appointed dictator), refused to appear, and was killed by Gaius Servilius Ahala; his house was razed to the ground and the open space called Aequimaelium, on which it had stood, preserved the memory of his death. Despite later accretions, the basis of the story is probably historical, since it goes back to the annalist L. Cincius Alimentus (late 3rd century B.C.) and is not a fabrication by the annalists writing after the time of Tiberius and Gaius Gracchus, when corn became a political issue.

See Livy, iv, 13.

MAELSTROM, a term originally applied to the Moskenstrom, a strong current running between the islands of Moskenaes and Mosken in the Lofoten Islands off the west coast of Norway. Its power has been much exaggerated though it is dangerous in certain states of wind and tide. The original name occurs on Mercator's *Atlas* of 1595; the term has been used generically for large whirlpools elsewhere and figuratively for any turmoil of wide-reaching influence. It is probably from Dutch *malen*, "to grind," and *stroom*, "a stream."

MAENAD, one of the female attendants of Dionysus (*q.v.*); they also are called Bacchae, Lenae, Thyiades, Clodones and Mimallones.

MAE NAM CHAO PHRAYA (Chaupaya), the most useful river system in Thailand, enters the Gulf of Siam 25 mi. below Bangkok. The Chao Phraya is formed by four large tributaries which flow southward from north Thailand between alternate mountain ranges. These four rivers from west to east are the Ping, Wang, Yom, and Nan. The Ping, the largest tributary, is joined by the Wang near Tak (240 mi. N.N.W. of Bangkok) and the Nan is joined by the Yom near Chumsaeng. The Chao Phraya originates at the junction of the Ping and Nan rivers just north of Nakhornsawan (140 mi. N.N.W. of Bangkok). Because of the low relief of the central plain (which is an old filled arm of the Gulf of Siam), the Chao Phraya has many distributaries. Near Chainat, about 34 mi. below Nakhornsawan, a distributary branching off to the west continues southward and parallel to the Chao Phraya until it enters the gulf. This river is known by several names in different parts of its course, such as Supan and Tha Chin. Another large distributary called the Noi branches off to the west from the main stream below Chainat but rejoins the Chao Phraya at Sam Khok.

About 20 mi. below Chainat an eastern distributary, the Lopburi, branches off and after flowing by the cities of Lopburi and Ayutthaya (Phranakhorn-ayuthya) rejoins the Chao Phraya at Sam Khok.

From the east the Chao Phraya is joined by its largest tributary in the central plain, the Pa Sak. The Pa Sak flows south parallel to the Dong Phaya Yen range (which separates northeast Thailand from the central plain) to the Lopburi river.

For centuries the Thais have used the Chao Phraya system as a source of domestic, livestock and irrigation water and for transportation, drainage, fishing and recreation. The lower reaches of the rivers in the central plain have been joined with a network of canals that brings rice, teak and other products to Bangkok.

(T. F. B.)

MAERLANT, JACOB VAN (*c.* 1225–*c.* 1291), the pioneer of the didactic poetry that flourished in the Netherlands in the 14th century. A Fleming by birth, he was born in Vrije van Brugge (Damme?). The details of his life are disputed, but he was probably sexton at Maerlant near Brielle on Voorne between 1255 and 1265(?) and was employed by Albrecht van Voorne, Nicholas Cats, lord of North Beveland, and Floris V, count of Holland. About 1266 he became clerk to the court at Damme, where he died shortly after 1291. Maerlant reveals careful edu-

cation by his intimate knowledge of both Latin and French. His early works were versions of medieval romances—*Alexanders Geesten,* based on Gautier de Châtillon's Latin *Alexandreis; Historie van den Grale Merlÿn* (*c.* 1260), freely translated from Robert de Borron's early contributions to the Arthurian cycle; *Torec* (*c.* 1262); and, most important, the *Historie van Troyen* (*c.* 1264), from the *Roman de Troie* ascribed to Benoît de Sainte Maure. These chivalric epic romances belong to the period of Maerlant's contact with the world of nobility, but it is interesting that even in them he shows a tendency to treat his subjects historically and to correct and amplify his sources by reference to Latin texts.

When Maerlant began to write with the definite aim of providing instruction, he turned entirely to Latin sources, writing a scientific compilation, *Der Naturen Bloeme* (1266–69?), after Thomas of Cantimpré's *De natura rerum;* a life of St. Francis (before 1273), based on Bonaventura; the *Rijmbijbel* (1271), after Petrus Comestor's *Historia Scolastica;* and, finally, his most important work, *Spieghel Historiael,* an adaptation with additions of his own of Vincent de Beauvais's *Speculum Historiale,* begun *c.* 1282 and completed after his death by Philippe Utenbroeke and Lodewijk van Velthem.

These moralizing rhymed encyclopaedic works were written to satisfy the rising class of commoners who wished for instructive reading in their own language. Among Maerlant's many followers in this kind the most notable were Jan van Boendale, Lodewijk van Velthem and Jan de Weert. His own considerable gifts as a religious poet are also more fully shown in his strophic poems—especially *Wapene Martijn,* a dialogue poem in which he discusses the decadence of the period and treats moral problems with great earnestness—and in his fervent *Disputacie van Onser Vrouwen ende vanden Heilighen Cruce* and *Van den Lande van Oversee* which scourges the laxity of the church and calls for a new crusade.

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MAES (MAAS), **NICOLAES** (NICOLAS) (1632–1693), Dutch painter, a follower of Rembrandt, was born at Dordrecht. About 1650 he went to Amsterdam, where he entered Rembrandt's studio. Before his return to Dordrecht in 1654 Maes painted a few Rembrandtesque genre pictures, with life-size figures and in a deep glowing scheme of colour, as in the "Reverie" at the Ryks museum in Amsterdam, the "Card Players" at the National gallery, London, and the "Children With a Goat Carriage," in the J. P. Morgan collection, New York city. In his best period, from 1655 to 1665, Maes devoted himself to domestic genre on a smaller scale, retaining to a great extent the magic of colour he had learned from Rembrandt.

His favourite subjects were women spinning, or reading the Bible, or preparing a meal. He visited Antwerp between 1660 and 1670, and his Antwerp period coincides with a complete change in style and subject. He devoted himself almost exclusively to portraiture, and abandoned the intimacy and glowing colour harmonies of his earlier work for a careless elegance which suggests the influence of Van Dyck. The change gave rise to the theory of the existence of another Maes, of Brussels. Maes is well represented at the National gallery by five paintings: "The Cradle," "The Dutch Housewife," "The Idle Servant," "The Card Players" and a man's portrait. At Amsterdam, besides the splendid examples to be found at the Ryks museum, is the "Inquisitive Servant" of the Six collection. At Buckingham palace is "The Idle Servant," and at Apsley house "Selling Milk" and "The Listener." There are examples in New York, Boston, Philadelphia, San Francisco and other American cities.

MAESTRO: *see* WIND: *Local Winds.*

MAETERLINCK, MAURICE POLYDORE MARIE BERNARD (1862–1949), Belgian dramatist, critic and poet who created the Symbolist theatre; he received the Nobel prize for literature in 1911. Born at Ghent, on Aug. 29, 1862, he was educated at the Jesuit Collège de Sainte Barbe, and studied law at the University of Ghent. In Paris, 1885–86, he met Villiers de L'Isle-Adam (*q.v.*) and the leaders of the Symbolist movement (*see* SYMBOLISTS, THE). In 1886 he returned to Ghent, where he lived until 1889. His first volume of verse, *Serres Chaudes,* and his first play, *La Princesse Maleine,* appeared in 1889 (Eng. trans. 1915); the play was originally composed in metre, but rewritten in prose. In 1890 he published two more plays, *L'Intruse* and *Les Aveugles,* followed by *Les Sept Princesses* (publ. 1891). His leaning toward mysticism was defined or explained by a translation of *Die Zierde der Geistlichen Hochzeit* by the Dutch mystic Jan van Ruysbroeck (*q.v.*), as *L'Ornement des noces spirituelles* (1891). In 1892 came *Pelléas et Mélisande* (Eng. trans. 1894), set to music by Debussy, followed in 1894 by the "little plays for marionettes," *Alladines et Palomides, Intérieur* (Eng. trans. 1898) and *La Morte de Tintagiles.*

In 1895 Maeterlinck translated, as *Annabella,* John Ford's *'Tis Pity She's a Whore.* Two philosophical works followed, a study of Novalis (1895) and *Le Trésor des humbles* (1896; Eng. trans. 1897). In 1896 he returned to drama with *Aglavaine et Sélysette* and to lyric verse with *Douze Chansons,* to which three poems were later added. A monograph on the ethics of mysticism, *La Sagesse et la Destinée,* a kind of commentary on his own dramas, came out in 1898; and a volume of prose, *La Vie des abeilles,* which combined philosophy, fancy and natural history, in 1901 (Eng. trans. 1901). He found this form congenial, and *La Vie des termites* (1926; Eng. trans. 1927), *La Vie des fourmis* (1930; Eng. trans. 1930) and *L'Araignée de verre* (1932) are on similar lines, though they show an increasingly pessimistic view of nature.

Maeterlinck wrote several volumes of essays, among them *Le Temple enseveli* (1901; Eng. trans. 1902), *Le Double Jardin* (1904), *L'Intelligence des fleurs* (1907), which has an essay on *King Lear,* and *La Mort* (1913; Eng. trans. 1911). The plays *Monna Vanna* (1902) and *Marie Magdeleine* (1913; produced in Germany, 1910) are of importance. A translation of *Macbeth* appeared in 1910. This period suggests a development from mysticism. His most popular plays were *L'Oiseau bleu* (1908; Eng. trans. *The Blue Bird,* 1909), *Les Fiancailles* (1922) and a war play, *Le Bourgmestre de Stilmonde* (1919). *Le Miracle de Saint-Antoine* (publ. 1919, produced 1903) and *Les Sentiers dans la montagne* (1919) have charm. *Le Malheur passé* (1925) and *La Puissance des morts* (1926) deal with the recurrent themes of man's destiny in love, his relation to past and future, and the nature of death.

It is necessary first to attempt to see Maeterlinck in terms of his tradition and personality. He is indebted to many predecessors—Shakespeare, Jakob Böhme, Swedenborg, Carlyle, Edgar Allan Poe, Rossetti, William Morris, Puvis de Chavannes, Sir James Barrie. His early work was done under Symbolist influence, and the significance of some of his symbols remains controversial. His art is in some degree conditioned by his search for essences, for a drama that attempts communication by formal qualities stripped of what the dramatist regards as inessential. Even words are mistrusted as apt to obscure "the communion of soul with soul."

Maeterlinck's beliefs are to be found in part in the essay *"Le Tragique Quotidien"* in *Le Trésor des humbles.* Tragedy is a matter of everyday experience. Its statement in the theatre is a mystery, "the expression of those profound emotions that exist in solitude and silence." He is much possessed by death, its immanence in human life and man's fear of it. This theme, together with the exaltation of spiritual love, finds expression in many plays. The soul is the vital essence, capable of communicating and achieving unity with a "wisdom and spirit of the universe." There is a body of collective and intuitive wisdom, chiefly apparent in women and children and in "humble and rustic characters." Here Maeterlinck shows affinities with Wordsworth, and perhaps links with Freud's (and Jung's) "collective unconscious" and the "Great Memory" of W. B. Yeats.

Maeterlinck admired Aeschylus, and found in him examples of a "static theatre." Yet he relies not only on poetic speech, but on the active significance of symbols. These were, in theory, unconscious creations, rather than intellectual correspondences. In practice the symbolism is simple and usually traditional; light, darkness, doors, windows, sight and blindness, lamplight, grottoes,

fountains are used to produce an atmosphere intense rather than complex. Often the protagonists are waiting for something mysterious and fearful that will destroy them. The Invisible Presence is Death, and fate encircles the characters. This profound and moving atmosphere is subserved by a dialogue that is tentative, using half-formed suggestions, at times naïvely repetitious, occasionally sentimental, but sometimes of great subtlety and power.

Maeterlinck's theatre, and the concept of static drama, which he abandoned for a more active structure, achieved its greatest popularity in the early 20th century. *The Blue Bird*, an allegorical fantasy in the Barrie manner, had great success, particularly in the United States; in it Maeterlinck showed understanding of the child's fairy world, and a qualified optimism that diminished with age. It is not unfair to suggest that his lasting importance is mainly in relation to the history of dramatic theory. His characters have life, but it is a peculiar and remote life. The delicacy of shading and of atmosphere demand an audience smaller and more sympathetic than is usual; the symbols are tenuous and fragile. It is possible that his psychological theory, verging on a mystical attitude at times sentimental or whimsical, is out of sympathy with the modern age.

Maeterlinck twice visited the United States, where he lived from 1940 to 1947, writing *Jeanne d'Arc* (1940), *Les Trois Justiciers* (1942) (both publ. 1959), *Le Jugement dernier* (1944) and the unpublished *Le Miracle des mères*. In 1947 he returned to Orlamonde, near Nice, his home from 1930 to the fall of France, and he died on May 6, 1949, in a hotel at Nice. He had been created count in 1932.

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(T. R. Hn.)

MAEZTU Y WHITNEY, RAMIRO DE (1874–1936), Spanish political writer, a brilliant and belligerent journalist and a member of the so-called "generation of '98," was born in Vitoria on May 4, 1874. Maeztu's thought evolved from a nihilism deriving from Nietzsche to a rigid traditionalism; a strong nationalistic urge—despite his English mother and wife—dominated throughout his life. From 1905 to 1916 he worked in London as correspondent for Spanish newspapers, in close contact with guild socialism (*q.v.*). On returning to Spain, he supported the dictatorship of Primo de Rivera. Later he was a vehement opponent of the republic and wrote the standard work of traditionalism, *La defensa de la Hispanidad* (1934). His other works include *Hacia otra España* (1899), *Authority, Liberty and Function in the Light of the War* (1916), and *Don Quijote, Don Juan y la Celestina* (1926). Maeztu was shot by the Republicans at Aravaca, Madrid, probably on Oct. 29, 1936, in the early days of the Spanish civil war.

See Vicente Suárez Marrero, *Maeztu* (1955). (G. W. Rs.)

MAFEKING, a town in the northeast corner of Cape province, S.Af., close to the Bechuanaland border. It lies at 4,194 ft. altitude, 853 mi. N.E. of Cape Town by road (871 mi. by rail). Pop. (1960) 8,279; white, 4,159. Until early 1965 Mafeking was the administrative headquarters of the British protectorate of Bechuanaland. It is also the headquarters of the railway system between Kimberley and Bulawayo, Southern Rhodesia. Native Stad on the Molopo river 1 mi. distant is the chief place of the Barolong tribe. Founded in 1885, Mafeking was in the South African War besieged by the Boers from Oct. 12, 1899, to May 17, 1900. The Anglican church and a memorial in front of the town hall were erected in memory of those who died in the defense. The surrounding country supports important cattle farming and dairying industries. *See* also South African War.

MAFFEI, FRANCESCO SCIPIONE, Marchese di 1675–1755), Italian dramatist and scholar, who in his verse tragedy *Merope* (1713) attempted to introduce French classical simplicity into Italian drama, was born at Verona, June 1, 1675. After studying at Parma, he fought in the War of the Spanish Succession. Becoming interested in the archaeology of his native town, he wrote a valuable account of its history and antiquities, *Verona illustrata* (1731–32). He died in Verona, Feb. 11, 1755.

Besides *Merope*, his works include *Teatro italiano*, a collection of 12 plays (1723), translations of the *Iliad* and the *Aeneid*, and many scholarly studies. A modern edition of Maffei's works by A. Avena appeared in 1928.

See G. Gasperoni, *Scipione Maffei e Verona Settecentesca* (1955).

MAFIA (Maffia). A word of uncertain origin, anglicized as mafia, used to designate a specific form of criminality which arose on the great landed estates (*latifundia*) of Sicily as a result of bad government during a long period of the island's history, and more especially during the disorders consequent on the Napoleonic invasion of south Italy. Lawless conditions led the owners of large estates to place their lands in the charge of energetic ruffians who exercised almost despotic powers over a terrorized peasantry. The contiguity of the estates enabled these men to form an organization which gradually became very extensive and powerful, so much so that in time it turned against the landowners themselves. The members of the organization were not very numerous, but, bound by close ties of fellowship and capable of any crime, they compelled the landowners to employ persons of their choice, fixed the compensation they claimed for their services, and the rents and price of the lands and of the crops entrusted to their protection. Their activities sometimes extended to neighbouring towns; they made it practically impossible for lands or crops to be sold at open auction, and effectively hindered efforts likely to interfere with their interests.

On the other hand, fierce quarrels of all kinds arose among them leading to terrible acts of revenge, whence the formation of bands of outlaws, at feud among themselves, and all the crimes consequent on outlawry.

A complicated code of traditions regulated the Mafia, based on so-called *omertà* (from Sicilian *omu*, man), the obligation never, under any circumstances, to apply for justice to the legally constituted authorities, and never to assist in any way in the detection of crime committed against oneself or others. Absolute silence was required and enforced by ruthless reprisals, the right to avenge injuries being reserved to the victims or their families. Like the Camorra (*q.v.*), the Mafia was soon powerful in various social classes.

After the fall of the local Bourbon monarchy in 1860, the Italian government endeavoured with varying success to rid Sicily of the Mafia; but in the various Sicilian provinces the police authorities continued to tolerate it. When the fascist regime came into power, after 1922, it used its exceptional powers to capture and bring to trial the leaders of the Mafia. In a series of trials at Palermo and neighbouring Termini Imerese, in 1927, the accused, in batches of as many as 150, were brought before the courts; and their victims gave evidence against them. The leaders received life sentences and heavy punishment was meted out to their accomplices. Unfortunately, the fascist government used this occasion to get rid, at the same time, of honest Sicilians strongly opposed to it. And this fact became an advantage for the legend of the Mafia which, although composed of criminals, did not lack in its distant origins a certain chivalrous element, since it had once appeared to many as a force fighting Spanish misrule and feudal abuses.

In spite of all repressive efforts the Mafia persisted. Following World War II the land reforms weakened its power in the rural areas of central and western Sicily. Its strongholds, and its extortionary and other activities were then directed more to industrial, business and construction enterprises.

Organized crime in the United States, some observers have pointed out, bears many resemblances to the Mafia in its philosophy, methods of operation and local organization. In 1950–51, the U.S. senate special crime investigating committee reported that U.S. gangster syndicates had close business relations with the Mafia. Similar allegations were made in 1958 by witnesses before the U.S. senate select committee on improper activities in the labour management field.

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MAFRA, a town of Portugal in Lisboa district, 32 km. (20 mi.) N.W. of Lisbon by rail and road. Pop. (1960) 7,032. Mafra is remarkable for its monastery, church and palace, built by John V in 1717–32 in fulfillment of a vow. The building is in the form of a parallelogram measuring more than 800 ft. from north to south and 700 ft. from east to west; it is said to contain 866 rooms. Some of the sculptures are by Machado de Castro, others are by Italian artists or were imported from Italy. The beautiful library is one of the richest of its kind in Europe. The church is sumptuously built of a great variety of marbles and richly adorned with statues, low reliefs and other objects of art. In each of the twin towers is a carillon of 57 bells.

MAGADAN, a port and *oblast* centre of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the northern coast of the Sea of Okhotsk, at the head of the narrow Nagayeva bay of Tauiskaya gulf. Pop. (1959) 62,225. It was founded in 1933 near the fishing village of Nagayevo, which it later absorbed, and its sheltered position provides the best harbour on the Sea of Okhotsk. A highway leads over the mountains behind the town to the Kolyma gold fields. There is a fish cannery.

MAGADAN OBLAST was formed in 1953 out of Khabarovsk *krai.* Its huge area of 462,973 sq.mi. extends from the Sea of Okhotsk to the Arctic ocean and the Bering strait and includes the Chukot National Okrug (*q.v.*). Most of the area is highly mountainous. The main rivers are the upper Kolyma, Omolon and Anadyr. The south is in taiga forest of larch, spruce, pine, fir and birch, and the north and northeast in tundra of mosses and lichens. The population is only 235,578, of which 82% is urban. The majority are Russians, but the 42,357 rural dwellers are mostly indigenous peoples, Chukchi, Eveny, Evenki and Yakuts, who are engaged in reindeer herding, fishing and hunting. The only important occupation is mining, for gold in the upper Kolyma valley and for tin at Seimchan and Yagodnoye. Some timber is cut, and there is a little fishing along the Okhotsk coast. A mere 17 sq.mi. are cropped, chiefly with vegetables. (R. A. F.)

MAGADHA, an ancient kingdom of India, comprising originally the Patna and Gaya districts of modern Bihar. It was the nucleus of several larger kingdoms or empires between the 6th century B.C. and the 8th century A.D. Under King Bimbisara (*c.* 550–490 B.C.) of the Haryanka line the kingdom of Anga (east Bihar) was added to Magadha. Kosala was annexed later. The Nanda kings continued the supremacy of Magadha in the 4th century B.C. It retained this position during the Mauryan period (4th to 2nd centuries B.C.) when the empire included almost the entire subcontinent of India. The early centuries A.D. saw the decline of Magadha, but the rise of the imperial Guptas in the 4th century A.D. brought it once more to a position of preeminence. Not only did these imperial dynasties begin by establishing their power in Magadha but in each case Pataliputra (adjacent to modern Patna) was the imperial capital, thus adding to the prestige of Magadha. Lively accounts of Pataliputra and Magadha are available in the *Indica* of Megasthenes (fl. *c.* 300 B.C.) and in the travel diaries of the Chinese Buddhist pilgrims Fa-hsien and Hsüan Tsang (4th–5th and 7th centuries A.D.). The early importance of Magadha may be explained by its strategic position in the Ganges valley which enabled it to control communication and trade on the river. The river further provided a link between Magadha and the rich ports in the Ganges delta. Numerous places in Magadha, the scene of many incidents in Gautama Buddha's life, were sacred to Buddhism, and its early rulers were either Buddhists themselves or played a significant part in the spread and development of Buddhism.

See INDIA-PAKISTAN, SUBCONTINENT OF: *History.*

(R. TH.)

MAGALLANES (Spanish form of Magellan), the southernmost province of Chile, extending from 48° 40′ S. to Cape Horn and including the mainland west of the Argentine frontier, the numerous islands fronting the Pacific, the Fuegian archipelago and the western half of Tierra del Fuego (*q.v.*). Pop. (1960) 73,037. Area 45,081 sq.mi. The area to the west of the Andes is one of the most inhospitable regions of the world, with cool rainy conditions prevailing throughout the year. Many of the islands are barren and where forests occur the terrain prevents their commercial exploitation. The channels, fjords, mountains and glaciers make it a region of great scenic beauty. The area east of the Andes, both on the mainland and on Tierra del Fuego, consists of extensive glacial plains covered with tussock grass. Rainfall on these plains nowhere exceeds 40 in. annually.

For three centuries after its discovery by Magellan in 1520 the region was inhabited only by nomadic tribes, of which the chief survivors are the Alacaluf (*q.v.*) in the western channels. In 1843 the settlement of Fuerte Bulnes on the Strait of Magellan established Chile's claim to the area. Six years later Punta Arenas was founded as a penal settlement. The discovery of gold and of the region's pastoral possibilities in the 1880s speeded the occupation of the province. The principal settlements are Punta Arenas (*q.v.*), the provincial capital and chief distributing and administrative centre on the Strait of Magellan, Puerto Natales, serving Última Esperanza, and Porvenir, the port of Tierra del Fuego.

There are large *estancias* in the region east of the Andes where an estimated 2,500,000 sheep produce 80% of Chile's wool. Some frozen mutton is exported from four freezing plants to the United Kingdom but central Chile is the major market. The discovery of petroleum in northern Tierra del Fuego at Manantiales widened the economy of the province. (G. J. B.)

MAGAZINE: *see* PERIODICAL; LITTLE MAGAZINE.

MAGDALENA, a department in Colombia, lies on the northern coast between the Magdalena river on the west and the Sierra de Perijá and the Guajira peninsula on the east. Area 18,071 sq.mi. Pop. (1961 est.) 500,640. Much of the terrain is swamp, flood plain or high mountains including the Sierra Nevada de Santa Marta. The department is the oldest government jurisdiction in Colombia; its capital city, Santa Marta (*q.v.*; pop. [1961 est.] 62,650), was founded in 1525. In the second half of the 20th century the excellent natural harbour at Santa Marta experienced a boom as the construction of the Atlantic railway neared completion. The new railroad was planned to link Santa Marta with Bogotá via the Magdalena valley. It would connect with existing railroads to other major inland industrial centres. In the early 1960s the department had more than 150 small industrial enterprises, but the major economic activity is banana raising in the vicinity of Santa Marta. Very poor transportation facilities within the department limit development outside the Santa Marta area. (R. L. GE.)

MAGDALENA RIVER rises at the bifurcation of the central and eastern ranges of the Colombian Andes and flows north for 956 mi. to the Caribbean. The major tributaries of the river are the San Jorge, the César and the Cauca (*q.v.*), all of which enter at the northern lowlands and make that area a flood plain with many swamps. The mouth of the Magdalena must be dredged to enable ocean-going vessels to have access to the port of Barranquilla (*q.v.*) near its mouth. Other major river towns from south to north are Neiva, Girardot and Honda. The smaller ports of Puerto Berrío, Puerto Wilches and Barrancabermeja service adjacent highland areas. The river is navigable by shallow-draft steamboats between Neiva and the sea, interrupted only by the rapids at Honda. The course of the river is quite straight, the current is fast and the depth is subject to sharp variations. November is the month in which steamboat traffic is most liable to interruption.

The Magdalena has been a major commercial artery since the Spanish conquest. From colonial times to mid-19th century, goods were carried in keelboats manned by rivermen (*bogas*) who were as tough and dissolute as those of the Mississippi. Steamboats, first introduced in 1822, were profitably operated only after 1850 when the tobacco boom provided sufficient bulk cargo. The steamboat in the 20th century was subject to competition by air freight and highway, and the end of major steamboat cargo service seemed probable upon completion of the Atlantic railway. *See* also COLOMBIA: *Physical Geography.* (R. L. GE.)

MAGDALENIAN, in archaeology, the term given the last great major cultural tradition of the Upper (Late) Paleolithic stage in Europe, named after a site at La Madeleine, in the lower Vézère river valley, France. In England it is found at Cheddar and Kent's cavern. *See* ARCHAEOLOGY: *Culture History of the Pleistocene.*

MAGDEBURG, a city of Germany which after partition of the nation following World War II was located in the *Bezirk* (district) of the same name, German Democratic Republic. It lies mainly on the left bank of the Elbe, 88 mi. S.W. of Berlin, 177 ft. above sea level. Pop. (1961 est.) 262,437.

Magdeburg, which at the beginning of the 9th century was a small trading settlement on the frontier of Slavonic lands, owes its early importance to Otto I who established the Benedictine monastery of Bergen there about 937. In 962 it became the seat of an archbishop, but the boundaries of the new archbishopric were fixed six years later. It comprised the bishoprics of Havelberg, Brandenburg, Merseburg, Meissen, and Zeitz-Naumburg. The archbishopric played a great part in the germanization of Slavonic lands east of the Elbe-Saale line.

Although burned down in 1188, Magdeburg became a flourishing commercial town during the 13th century, and was an important member of the Hanseatic league. It became celebrated for establishing in the 13th century an autonomous municipal administration, a model of which, known as the "Magdeburg law" (*Magdeburger Recht*), was later widely adopted not only in Germany but also in many countries of eastern Europe.

From the 13th century the citizens were almost constantly at variance with the archbishops, and by the end of the 15th century had become nearly independent of them but failed to achieve the status of a Reichsstadt. Under Archbishop Albrecht, a member of the house of Hohenzollern, Magdeburg embraced the Reformation in 1524 and was thenceforth governed by Protestant titular archbishops. During the Thirty Years' War Magdeburg successfully resisted Wallenstein for seven months in 1629, but was taken by storm by Tilly on May 20, 1631. The city was sacked and almost entirely burned, and the great part of its 40,000 inhabitants were butchered. By the peace of Westphalia (1648) the archbishopric was converted into a secular duchy, to fall to the Hohenzollern electorate of Brandenburg on the death of the last administrator (August, of the Saxon house of Wettin), which happened in 1680.

On Nov. 11, 1806, the fortress of Magdeburg surrendered to Napoleon without fighting and until 1813 was part of the kingdom of Westphalia. Magdeburg became the capital of the former Prussian province of Saxony which was constituted in 1816. The fortress, established in the 17th century on an island in the Elbe between the old town and Friedrichstadt on the right bank of the river, was dismantled in 1912.

The most important building in Magdeburg is the cathedral, dedicated to St. Maurice and St. Catherine. This structure, with two 344-ft.-high towers, begun in the 13th and completed in the 16th century, exhibits an interesting blending of Romanesque and Gothic architecture. The Liebfrauenkirche, the oldest church in Magdeburg, is a Romanesque edifice of the 11th century, completed in the 13th century and restored in 1890–91. The Renaissance town hall (*Rathaus*) was built in 1691 and enlarged in 1866. In front of the town hall stood an equestrian statue of Otto I, erected about 1290. With the exception of the Breite Weg and the Otto von Guericke street running from north to south, the streets of the old town are narrow and crooked. Kloster Berge garden, in the south of the city, is situated on the site of the convent of Berge, which was founded in 968 and suppressed in 1809.

Toward the end of World War II Magdeburg suffered heavily from air bombing. Especially devastating was the R.A.F. attack on the night of April 15–16, 1945, followed by a daylight bombing by the USAF. On that day 65% of the city was destroyed. Captured on April 18, 1945, by the U.S. army, Magdeburg was later evacuated and included in the Soviet zone. With the exception of the industries little reconstruction was undertaken.

Magdeburg was before World War II an important industrial centre with ironworks producing armour and varied machinery. Of equal importance were a synthetic oil plant, chemical factories, textile mills and sugar refineries. By the 1960s these and other industries were working again at capacity level.

Six railway lines join in Magdeburg linking the city with Berlin, Dessau, Leipzig, Halberstadt, Helmstedt (Brunswick) and Stendal. Seven arterial highways radiate from the city. The Autobahn Berlin-Ruhr crosses the Elbe north of Magdeburg. The city is also a river port, the importance of which greatly increased when the Mittelland canal, linking the Rhine with the Elbe (slightly northward from Magdeburg), was inaugurated on Oct. 30, 1938. Another system of canals links Magdeburg with Berlin and the lower Oder. This makes Magdeburg the most important inland port of the German Democratic Republic.

MAGEE, WILLIAM (1766–1831), Protestant archbishop of Dublin, a controversial preacher who raised the standards of the Church of Ireland, was born on March 18, 1766, at Enniskillen, County Fermanagh, and educated at Trinity college, Dublin, where he was elected fellow in 1788. He was ordained in 1790. His *Discourses on the Scriptural Doctrines of Atonement and Sacrifice* (1801), a polemic against Unitarian theology, was answered by Lant Carpenter. Magee was appointed professor of mathematics and senior fellow of Trinity in 1800, but in 1812 he resigned and in 1813 became dean of Cork. In 1819 he became bishop of Raphoe and in 1822 archbishop of Dublin. Though generally tolerant, he opposed the movement for Catholic emancipation. He died on Aug. 18, 1831, at Stillorgan, near Dublin. His grandson was William Connor Magee (*q.v.*).

MAGEE, WILLIAM CONNOR (1821–1891), archbishop of York and one of the most brilliant controversialists of his day, was born on Dec. 17, 1821, at Cork and educated at Trinity college, Dublin. He was the grandson of William Magee (*q.v.*), archbishop of Dublin. In 1864 he became dean of Cork. His remarkable powers were shown in the defense of the Irish church at the time of the disestablishment proposals of 1868, when his brilliant speeches induced Disraeli to offer him the bishopric of Peterborough. He justified this appointment by his magnificent speech when the Disestablishment bill reached the house of lords in 1869. He took up the temperance question, and declared in the house of lords, "It would be better that England should be free than that England should be compulsorily sober," an utterance which the extreme advocates of total abstinence misquoted and attacked. Magee took a prominent part in the ritualist controversy, opposing what he conceived to be romanizing excess in ritual, as well as the endeavour of the opposite party to "put down ritualism," as Disraeli expressed it, by the operation of the civil law. He died in London on May 5, 1891, about four months after his appointment to the see of York.

See J. C. MacDonnell, *Life and Correspondence of William Connor Magee*, 2 vol. (1896).

MAGELANG, the name of a *kabupaten* (regency) in the province of Djawa Tengah (central Java), Indonesia, and of its capital. Magelang town, 25 mi. N.N.W. of Jogjakarta, is built on a bend of the Kali Praga, which drains into the Indian ocean south of Jogjakarta. Pop. (1961) 96,454 (municipality). Much damaged during the revolution, it is once again a tourist centre for persons visiting the Borobudur temple. The town has a large Roman Catholic seminary and a military academy. Fine views are to be had of Gunung Sumbing, an active volcano, in a crater of which is a sacred grave of archaeological interest.

The famous Buddhist temple of Borobudur, in the form of a pyramid rising more than 30 m. above the base, is about 8 mi. S. of Magelang. Built in the 7th or 8th century, it consists of a series of galleries joined by stairways, all leading to the platform at the top. The four lower terraces are square, the three upper circular with 72 bell-shaped shrines, in each of which is a figure of the Buddha. The terraces are richly decorated with statues and basreliefs. (*See* also INDIAN ARCHITECTURE: *Indonesia;* JAVA: *Archaeology.*) Other nearby places of interest are the smaller temples of Pawon and Mendut, dating from the same period.

MAGELANG KABUPATEN is a region of fertile land and one of the most densely populated parts of Java. Area 436 sq.mi.; pop. (1961) 719,903. Besides the rice, tobacco and sugar grown there, flourishing market gardens in the district supply the city of Jogjakarta.

MAGELLAN, FERDINAND (Portuguese FERNÃO DE MAGALHÃES; Spanish HERNANDO DE MAGALLANES) (1480–1521), often referred to as the first circumnavigator of the earth, is more correctly described as initiator and leader of the Magellan-Elcano expedition, since he died before the completion of the first voyage round the world, successfully terminated by the Basque navigator Juan Sebastián de Elcano (del Cano). Son of Rui de Magalhães and Alda de Mesquita, Magellan belonged to the fourth order of Portuguese nobility; his birthplace was most probably Oporto, which he left to serve as a page to Queen Leonor in Lisbon.

Indian Service.—In early 1505 he enlisted in the fleet of Francisco de Almeida, first Portuguese viceroy in the east, whose expedition, sent by King Manuel to check Muslim sea power in Africa and India, left Lisbon on March 25; at a naval engagement at Cannanore on the Malabar coast of India Magellan is said by the chronicler Gaspar Correia to have been wounded. Though Correia states that during this early period of his Indian service he acquired considerable knowledge of navigation, little is known of Magellan's first years in the east until he appears among those sailing in Nov. 1506 with Nuno Vaz Pereira to Sofala on the Mozambique coast, where the Portuguese established a fort. In 1508 he was back in India, taking part in the great battle of Diu, on Feb. 2–3, 1509, which gave the Portuguese supremacy over most of the Indian ocean. Reaching Cochin in the fleet of Diogo Lopes de Sequeira, he left as one of the men-at-arms for Malacca. Magellan is mentioned as being sent to warn the commander of impending attack by Malays, and during the subsequent fighting, courageously saved the life of Francisco Serrão, who later from the Moluccas sent him helpful information about those islands. At a council held at Cochin on Oct. 10, to decide on plans for recapturing Goa, he advised against taking large ships at that season, but the new viceroy, Affonso de Albuquerque, did so, the city falling on Nov. 24; Magellan's name does not appear among those who fought. There is no conclusive evidence that during his Indian service he attained the rank of captain.

The Portuguese victories off the eastern coast of Africa and the western one off India had broken Muslim power in the Indian ocean, and the purpose of Almeida's expedition—to wrest from the Arabs the key points of sea trade—was almost accomplished; but without control of Malacca their achievement was incomplete. At the end of June 1511, therefore, a fleet under Albuquerque left for Malacca, which fell after six weeks. This event, in which Magellan took part, was the crowning Portuguese victory in the orient. Through Malacca passed the wealth of the east to the harbours of the west, and in their command of the Malacca strait the Portuguese held the key to the seas and ports of Malaysia. It remained to explore the wealth-giving Moluccas, the islands of spice. Accordingly, early in Dec. 1511 they sailed on a voyage of reconnaissance, and after reaching Banda returned with spice in 1512. The claim made by some writers that Magellan went on this voyage rests on unproved statements by G. B. Ramusio and Leonardo y Argensola, and the want of evidence is against its acceptance. Even did he, in truth, reach the Moluccas, a further voyage—which he later commanded from Spain to the Philippines—was required to complete the circle of navigation.

In 1512 Magellan was back in Lisbon; the following year he joined the forces sent against the Moroccan stronghold of Azamor, and in a skirmish after its fall received a wound which caused him to limp for the rest of his life. Returning to Lisbon in Nov. 1514 he asked King Manuel for a token increase in his pension, signifying a rise in rank. (He was then *fidalgo escudeiro;* his coat of arms was that of Magalhães e Sousa [Arronches].) Reports (unfounded) of irregular conduct on his part after Azamor had reached the king, who, refusing his request, ordered him back to Morocco. Early in 1516 Magellan renewed his petition; the king, refusing once more, told him he might offer his services elsewhere.

Westward-Sailing Expedition to the East.—Magellan therefore went to Spain, reaching Seville on Oct. 20, 1517, whence, joined by the Portuguese cosmographer Rui Faleiro, he journeyed to court at Valladolid. There, having renounced their nationality, the two men offered their services to King Charles I (later, Emperor Charles V).

By decree of a papal bull, 1493, all new territories discovered or which should be discovered east of a line of demarcation (redrawn 1494) were assigned to Portugal; all that lay west to Spain. Magellan and Faleiro now proposed by sailing west to give practical proof of their claim that by true facts of longitude the wealth-giving Spice Islands lay within the Spanish, not the Portuguese, hemisphere. On March 22, 1518, their proposal received royal assent; they were appointed joint captains general of an expedition directed to seek an all-Spanish route to the Moluccas. The government of any lands discovered was to be vested in them and their heirs, and they were to receive a one-twentieth share of the net profits from the venture; both were invested with the Order of Santiago. Magellan was convinced that he would lead his ships from the Atlantic to the "Sea of the South" by discovering a strait through Tierra Firme. This idea did not originate with him; others had sought a passage by which vessels sailing continuously westward would reach the east, and thus avoid the Cape route, monopoly of the Portuguese; in the royal agreement Magellan and Faleiro were directed to find "the" strait. India house was instructed to furnish five ships for the expedition, prepared in Seville, where an unsuccessful attempt to wreck the project was made by Portuguese agents. Magellan's flagship, "Trinidad," had as consorts "San Antonio" (captain, Juan de Cartagena), "Concepción" (Gaspar de Quesada), "Victoria" (Luis de Mendoza), "Santiago" (João Serrão). Because of his unbalanced condition Faleiro did not sail.

Magellan, who in 1517 had married Beatriz Barbosa, daughter of an important official in Seville, said farewell to his wife and infant son Rodrigo before his ship left Sanlúcar de Barrameda on Sept. 20, 1519, bearing 265 men, among whom nine countries were represented; the only Englishman was the master gunner, Andrews, of Bristol. The fleet reached Tenerife on Sept. 26, sailing on Oct. 3 for Brazil; becalmed off the Guinea coast, it met storms before reaching the line; on Nov. 29 it was 27 leagues S.W. of Cape St. Augustine. Rounding Cabo Frio, Magellan entered the Bay of Rio de Janeiro on Dec. 13, then sailing south to the Río de la Plata vainly probed the estuary, seeking the strait. On March 31 he reached Port St. Julian in latitude 49° 20′ S., where on Easter day at midnight a serious mutiny broke out led by Spanish captains against the Portuguese commander. Magellan with resolution, ruthlessness and daring resourcefulness quelled it, executing one of the captains and leaving another to his fate ashore when, on Aug. 24, 1520, the fleet left St. Julian.

Discovery of Straits of Magellan and the Traverse of the Pacific.—After reaching the mouth of the Santa Cruz, near which "Santiago," reconnoitring, had been wrecked earlier, Magellan started south again, on Oct. 21 rounding the Cape of the Virgins, and at approximately 52° 50′ S. entered the passage which proved to be the strait of his seeking, later to bear his name. "San Antonio" having deserted, only three of his ships reached the western end of the passage; at the news that the ocean had been sighted the iron-willed admiral broke down and cried with joy.

On Nov. 28 "Trinidad," "Concepción" and "Victoria" entered the "Sea of the South," from their calm crossing later called the Pacific ocean. Tortured by thirst, stricken by scurvy, feeding on rat-fouled biscuits, finally reduced to eating the leather off the yardarms, the crews, driven first by the Humboldt current and throughout the voyage by the relentless determination of Magellan, made the great crossing of the Pacific. Till Dec. 18 they had sailed near the Chilean coast, then Magellan took a course northwestward; not till Jan. 24, 1521, was land sighted, probably Puka Puka in the Paumotu archipelago. Crossing the equinoctial line at approximately 158° W. on Feb. 13, the voyagers made first landfall on March 6, when at Guam in the Marianas they obtained fresh food for the first time in their traverse of 99 days. A *Memorial*, sent by Magellan to King Charles before leaving Spain, suggests that he knew (probably partly from Serrão's letters) the approximate position of the Moluccas; in sailing now from the Marianas to the Philippines instead of direct to the Spiceries, he was doubtless dominated by the idea of early revictualing and the advantage of securing a base before visiting the Moluccas.

Death; Estimation of Achievement.—Leaving on March 9, Magellan's course west-southwestward now brought him to islands later called the Philippines, where at Massava he secured the first alliance in the Pacific for Spain; at Cebu the conversion to Christianity of the ruler and his chief men; but on Mactán Island, April 27, 1521, Magellan was killed in a fight with natives.

After his death only two of the ships, "Trinidad" and "Victoria," reached the Moluccas; only one, "Victoria" (85 tons), returned to Spain, under command of Elcano, originally master in "Concepción," and participator in the mutiny at Port St. Julian. For bringing home, on Sept. 7, 1522, the leaking but spice-laden ship, with only 17 other European survivors and 4 Indians, "weaker than men have ever been before," Elcano received from the emperor an augmentation to his coat of arms, a globe with inscription "Primus circumdedisti me" ("You were the first to encircle me"). It had been left for Elcano, returning by the Cape route, to give practical proof of the sphericity of the earth.

The supreme distinction of Magellan lies not in any feat of circumnavigation but in his bold conception and masterly direction of the enterprise which achieved that feat. The first navigator to cross the Pacific from east to west, he disproved the prevailing idea that a few days westward sailing from the new world would bring ships to the Indies of the east, and he brought a fleet for the first time, sailing westward, within easy distance of them. Magellan, with a character so complex and of such extreme contradictions, will remain an enigma; psychologically he cannot have been at unity with himself. For his transference of allegiance many writers have denounced him, bearing in mind that in his time the loyalty of a Portuguese to his sovereign was only second to his loyalty to his God; others have pointed out that in offering his services to another ruler Magellan did what Columbus, Cabot and Vespucci had done, and that limitations imposed by nationality are irreconcilable with the advancement of knowledge. But on one thing all Portuguese are agreed: "he is ours."

The fullest account of the voyage is that of Antonio Pigafetta, knight of Rhodes, native of Vicenza, who sailed with Magellan and returned with Elcano. The true text of the Italian version, translated, edited and annotated by J. A. Robertson, is in *Magellan's Voyage Around the World* by Pigafetta, two volumes (1906). *The First Voyage Round the World by Magellan*, Hakluyt society, vol. lii (1874), includes, as well as Pigafetta's account, the following by other members of the expedition: *Diary of a Genoese Pilot* (believed to be Leon Pancaldo of Savona); the narrative of the *Portuguese Companion of Edoardo Barbosa* (probably Vasco Gomes Galego, of Bayona, Galicia); the *Log-Book of Albo the Pilot*, commencing Nov. 29, 1519, and recording on the return voyage the discovery in Cape Verde Islands that by sailing continuously westward a day had been "lost." This volume also contains the account of a contemporary writer, the *Discourse of Giovanni Battista Ramusio*, and Gaspar Correia's account of the voyage (taken from *Lendas da India*, vol. ii, cap. xiv).

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MAGELLAN, STRAIT OF (Spanish ESTRECHO DE MAGALLANES), a channel, named for its discoverer, Ferdinand Magellan (*q.v.*), at the southern extremity of South America between the mainland (Magallanes; *q.v.*) and Tierra del Fuego (*q.v.*). It connects the South Atlantic and Pacific oceans and follows a winding course of about 360 mi. with widths varying from 2 to 20 mi.

MAGELLANIC CLOUDS (named after Ferdinand Magellan), two cloudlike condensations of stars in the southern sky. The Large Cloud is in the constellation Dorado at right ascension 5 hr. 26 min., declination −69°; the Small Cloud in Tucana at right ascension 0 hr. 56 min., declination −73°. They are two companion galactic systems to the Milky Way, consisting of myriads of stars and many gaseous clouds; they are located at a distance of about 140,000 light-years from the sun, and are visible to the unaided eye for observers located in the southern hemisphere.

MAGEN DAVID (MOGEN DOVID), the "shield of David," a six-pointed star formed by two crossed triangles, is a Jewish symbol that appears on synagogues, tombstones and on the flag of the state of Israel. The symbol originated in antiquity when, side by side with the five-pointed star, it served as a magical sign or as decoration. In the middle ages the six-pointed star appeared with greater frequency among Jews without assuming a special religious significance; it is found, as well, on some medieval cathedrals. The term "shield of David" developed among medieval mystics who attached magical powers to King David's shield. Practical (magic) Cabala popularized the use of the *Magen David* as a protection against evil spirits. From the 17th century on, it became the official seal of Jewish communities and a generally used Jewish sign. Franz Rosenzweig interpreted the meaning of the two triads to be God, world, man and creation, revelation and redemption.

See G. G. Scholem, "The Curious History of the Six-Pointed Star," *Commentary*, vol. viii, pp. 243–251 (1949). (N. N. G.)

MAGENDIE, FRANÇOIS (1783–1855), French physiologist and father of experimental pharmacology, was born at Bordeaux on Oct. 6, 1783. He graduated M.D. at Paris in 1808 and, while prosector of anatomy, demonstrated in 1813 the passive role of the stomach in vomiting and investigated the action of emetics. His pioneer work on the localization of the site of drug action laid the scientific foundation for the introduction into medical practice of such drugs as strychnine and morphine. With P. J. Pelletier he discovered emetine in 1817. His announcement in 1822 that the anterior roots of the spinal nerves are motor in function and the posterior roots sensory led to prolonged controversy with Sir Charles Bell (*q.v.*), who claimed to have made the same discovery in 1811. From 1813 to 1831 Magendie taught experimental physiology privately, being appointed in the latter year professor of medicine at the Collège de France. Elected to membership of the Academy of Sciences in 1821, he was its president in 1837. A superb experimenter and a bold vivisectionist, Magendie founded the *Journal de physiologie expérimentale* (1821–31) and wrote *Précis élémentaire de physiologie* (2 vol., 1816–17) and *Formulaire pour la préparation et l'emploi de plusieurs nouveaux médicaments* (1821). Magendie is commemorated by the "foramen of Magendie" in the brain (1828). He died at Sannois, near Paris, on Oct. 6, 1855.

See J. M. D. Olmsted, *François Magendie* (1945). (WR. R. B.)

MAGENTA, a town of Milano province in Lombardy, Italy, lies 364 ft. above sea level and 16 mi. W. of Milan by rail in an industrial and agricultural region. Pop. (1961) 18,533. The town increased greatly after World War II. Its chief buildings are the cathedral, with a façade of Carrara marble, the commercial high school, the stadium, and the ossuary containing the remains of 9,000 killed at the battle of Magenta (June 4, 1859). There is a public park with a zoological garden. Magenta is a communications centre between Milan and Turin and its chief industry is the making of matches while other factories produce artificial silk and door locks.

Magenta derives its name from Marcus Maxentius, a Roman general and emperor (306–312), who had his headquarters there, at Castra Maxentia. Historically the battle of Magenta, which resulted in a victory for the Franco-Sardinians under Napoleon III over the Austrians, represented an important step toward Italian national independence. (G. Ct.)

MAGGIORE, LAKE (Italian LAGO MAGGIORE; ancient VERBANUS LACUS), the second largest lake in Italy, has an area of 212 sq.km. (82 sq.mi.). It is bisected by the border between Lombardy (east) and Piedmont (west). Its upper end, 42 sq.km. (16 sq.mi.), is in the Swiss canton of Ticino. Lake Maggiore is 40 mi. long; its greatest width is 5½ mi.; greatest depth, 1,220 ft. The surface is 636 ft. above sea level. The Ticino flows through the lake from north to south, on its way to the Po; the Toce comes in on the west from the Swiss Valle d'Ossola below the Simplon pass; the Tresa enters from the Lake of Lugano on the east. Locarno, at the northern or Swiss end, is 14 mi. S.W. of Bellinzona by rail on the St. Gotthard line. A railway was built along the southeastern shore, from Magadino, Switz. (10½ mi. S.W. of

Bellinzona), to Sesto Calende, Italy, at the southern end of the lake and 20 mi. by rail from Novara. The eastern shore is reached at Luino, Italy, by electric railway from Ponte Tresa on the Lake of Lugano (8 mi.), while the direct Simplon line runs along the western shore for 15½ mi. from near Pallanza past Baveno and Stresa to Arona, which is 23 mi. by rail from Novara. On the eastern shore are Luino and Laveno; on the western shore, from north to south, are Cannobio, Pallanza, Baveno, Stresa and Arona. Opposite (southeast) Baveno are the famous Borromean Islands (*q.v.*), while southwest of Baveno rises the glorious viewpoint of Monte Mottarone (4,892 ft.) between Lake Maggiore and the Lake Orta. (G. KH.)

MAGH, a term applied to immigrants from Burma long settled in the southeast districts of Bengal. Apparently of Tai origin, they entered Bengal from Arakan toward the end of the 18th century. Most of them came under Bengali influence, but in the south of the Chittagong Hill Tracts district of East Pakistan (*see* CHITTAGONG), where their culture remains comparatively pure, the script and dress are Burmese and the language an Arakanese dialect. Elsewhere the Bengali dress and language prevail. The religion of the Arakanese-speaking Maghs is animistic Buddhism; it persists especially in the Chittagong Hill Tracts district, where Buddhists numbered more than 275,000 (in a total population of 385,079) in the 1961 Pakistan census. The people are divided into endogamous clans and in modern times there were still strong traces of a political organization under clan chiefs, the most powerful of whom are known as the Bohmong and the Mong Raoja, the former being a lineal descendant of the Mon (*q.v.*) kings of Pegu. In the hills shifting cultivation was still preferred to plow agriculture in modern times, but the villages, containing from 10 to 50 houses, were invariably built on the banks of streams. The houses were flimsy structures on bamboo piles and a relic of the communal house for men was sometimes found in the form of a roofed platform built at the end of the village street.

See J. M. Ghosh, *Magh Raiders in Bengal* (1961); Office of the Census Commissioner, Karachi, *Population Census of Pakistan* (1961). (J. P. M.; X.)

MAGI (singular Magus), members of an ancient Persian clan specializing in cultic activities. Their name is the Latinized form of *Magoi* (*e.g.*, in Herodotus i, 101), the ancient Greek transliteration of the Iranian original. It is disputed whether the Magi were from the beginning followers of Zoroaster and his first propagandists. They do not appear as such in the trilingual inscription of Bisitun (Bisutun), in which Darius the Great describes his speedy and final triumph over the Magi who had revolted against his rule (522 B.C.). The Magi were a priestly caste during the Seleucid, Parthian and Sasanian periods; later parts of the Avesta, such as the ritualistic sections of the Videvdat (Vendidad), probably derive from them. From the 1st century A.D. onward the word in its Syriac form (*Magusai*) was applied to magicians and soothsayers, chiefly from Babylonia, with a reputation for the most varied forms of wisdom. As long as the Persian empire lasted there was always a distinction between the Persian Magi, who were credited with profound religious knowledge, and the Babylonian Magi, who were often considered as impostors (*see* also PERSIAN HISTORY: *Sasanian Empire*).

The connection of the Magi with astrology and their oriental origin is all that is known of the "Magi [rendered "wise men" in most English Bibles, "astrologers" in the New English Bible] from the east" who came, guided by a star, to worship the infant Jesus as king of the Jews (Matt. ii, 1–12). Christian theological tradition has always stressed the fact that gentiles as well as Jews came to worship Jesus, an event celebrated in the Eastern Church at Christmas and in the west at Epiphany. In early Christian art the Magi usually wear Persian clothes (*e.g.*, the catacombs of Priscilla in Rome, 2nd century). The names Gaspar, Melchior and Balthasar are first mentioned in the 6th century. Their number is generally 3 (that of their presents of gold, frankincense and myrrh) but is sometimes given as 12. In the Syriac apocryphal tradition some of those names are Persian and they are connected with Persian religious history. As early as the 3rd century they began to be thought of as kings. Their supposed relics were transferred from Constantinople to Cologne (*q.v.*) in the 12th century.

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MAGIC. Etymologically the term "magic" is derived from the Greek *mageia* and the Latin *magia*, used by classical writers to describe the occult learning and practice of the Persian Magi (*q.v.*). As this was supposed, for example by Plutarch, to have included offering sacrifices to Ahriman, the creator of evil in Zoroastrian belief, "magic" acquired a sinister significance and became associated with witchcraft and the "black arts" in their many grim manifestations. Sorcery, that is the use of spells or the illicit obtaining of predictions, and necromancy, that is the calling up of the dead for consultation, are terms that have acquired a similar meaning. While the article MAGIC, PRIMITIVE, deals with the subject as the anthropologist sees it, the present article will be concerned chiefly with magic in Europe considered as the illicit trafficking with the occult and with the supernatural forces in the perennial struggle between good and evil. Magic exercised to promote well-being is sometimes called white magic to distinguish it from black magic, which is exercised malevolently or with a deliberate appeal to demoniacal forces of evil. For the forces of evil *see* preliminarily DEMON; DEVIL. For "magic" as a form of theatrical entertainment, *see* CONJURING.

Irrational as it may be, the magic art yet has an efficacy beyond dispute within its own sphere of operation, namely where emotional and incalculable elements are predominant. It supplies powerful supernatural sanctions reinforced by a mythological tradition which, even in the higher civilizations, can exert a strange fascination, not least when it functions in a diabolical setting of hate, fear, cruelty and malice.

The pagan Roman emperors lived in terror of sorcery and took measures against it; and in the 2nd century A.D. Lucius Apuleius, author of the famous romance on the subject, *Metamorphoses* or *The Golden Ass*, was himself charged with the practice of malevolent and immoral magic. For the rationalists of the Greco-Roman world, however, whether Skeptics, Epicureans or Cynics, everything that savoured of the marvelous was to be attacked as magic, and all those engaged in any kind of traffic with the unseen were declared to be sorcerers, charlatans and rascals. The Christian church, on the other hand, was very far from denying the reality of the spiritual forces at the command of those who worked the magic arts. Since Persian Magi, through their astrology, had been among the first to discover Christ, the reality of magic was beyond question; but it was liable to grave abuse. Origen, St. Augustine and the early Fathers in general were convinced that magicians were in league with the Devil and his demons in a great struggle against the good; and indeed the pagan gods themselves were regarded by the Fathers as standing in the same magic tradition, together with the Gnostics and other contemporary heretics. Magicians therefore ought to be destroyed as malicious demons or their agents, and not merely dismissed as hypocrites or charlatans. Thus the Simon who, according to the narrative in the Acts of the Apostles (viii, 9–24, which may be an interpolation), had bewitched the people of Samaria by his sorcery and been severely rebuked by St. Peter and bidden to repent for trying to purchase miraculous supernatural power from the disciples, was regarded by Christians as early as the 2nd century as a false Messiah who practised magical arts (*see* SIMON MAGUS).

Believing itself to be challenged by an organized movement of adepts with Gnostic affinities who practised necromancy in opposition to Christianity and its doctrine of redemption, the church devised its own office of exorcism (*q.v.*); and on the fringes of Christendom, where Gnostic influences were firmly entrenched, as for example among the Copts, spells, sometimes containing the magical names of particular spirits, were employed to ward off attacks of demons. But the attempt to deflect the powers of evil by quasi-magical constraint and compulsion readily gave place to

methods of persuasion, which in turn led to making a bargain or pact with the Devil. Instances of the pact occur from the 4th century onward, but the most celebrated case in popular mythology is that of Faust (*q.v.*), to which moreover elements of the story of Simon Magus made some contribution. The identification of pagan deities with demons further resulted in the notion of aerial flights by women with Diana or Hecate, and this was readily extended to flights with Herodias and other diabolical figures. Incubi and succubae were demons supposed to visit women and men respectively for carnal intercourse.

The revival of Gnostic or Manichaean dualism in Europe by the Bogomils (*q.v.*) from the 10th century onward in the east and by the Cathari (*q.v.*) subsequently in the west is another factor to be considered in relation to the medieval development of demoniacal magic. These highly organized heretical movements insisted on the power of Satan over the material world and over the human body and denounced the church as "the synagogue of Satan," not least because of its sacrament of marriage, which they regarded as a preposterous disguising of the sinful as the holy. Whether or not these heretics were involved in magical practices (as the church alleged), their dogmatic condemnation of the flesh seems to have led to licentious practices, if not among their genuine converts at least among their more ignorant listeners, since the general subjection of the physical world to Satan could be interpreted to mean that particular acts were matters of indifference so long as they were not blasphemously "sanctified" by marriage. The widespread theory of courtly love (*q.v.*), with its emphasis on an extramarital relationship, had its roots in Languedoc, the very region where the Cathari were strongest.

In this climate of opinion, with Satan's power emphasized and sexual licence condoned, it is not surprising that manifestations of the witch cult (*see* WITCHCRAFT) included debaucheries, atrocities and the worship of Satan in the "black mass." Margaret Murray's contention that the witch cult was a "Dianic" fertility religion surviving in Christendom from pagan times does not preclude its having degenerated in many cases, as persecution drove it underground, into a diabolism that fed its hostility to the Christian faith on elements culled from the great heresies or on express retroversion of the church's own teaching, rites and commandments. It should be remembered, however, that sometimes the charges brought against individuals by the Inquisition or by secular authorities as evidence of heresy or witchcraft included offenses which might have had other motives in fact (orgies need not always be ritual).

Essentially, the black mass is a blasphemous and obscene burlesque of the true Mass: a renegade priest or some other "adept" performs it (with a validly consecrated Host surreptitiously abstracted from church for the purpose if the celebrant himself is not a priest), sometimes with a woman's naked back for his altar. For the private purposes of believers, whether aphrodisiac or lethal, procedures akin to the "sympathetic" magic of primitive peoples are followed by the Satanist: philtres or abortifacients can be compounded of *genitalia*, herbs and bones; and bones may be pointed or set in a symbolical pattern against an intended victim, or a waxen effigy of him, preferably containing something of his (such as a strand of hair or a nail paring), may be melted or skewered. Incantations and spells may comprise not only strange words perhaps derived from the extinct languages of pagan Europe but also names of Gnostic, Hebrew or Arabic origin, since Jews and Muslims were "infidels" in the eyes of the church (and the Cabala, in particular, could easily be perverted). The *Pater noster* can be recited backward to invoke the Devil. Likewise the tetragrammaton, that is, the four characters of the name of God in Hebrew, can be written backward for use as a supremely potent symbol. Other symbols exploited are the circle (ensuring the magician himself against the malevolence of the spirits invoked), the pentacle and the signs of the zodiac; and some terminology or ideas may be borrowed from alchemy. Before being initiated into this esoteric lore, one may be required to perform some outrageously degrading or even criminal act as a test of total submission to evil.

Black magic and the fear of it did not die out with the middle ages. In England an act of 1542 made witchcraft, sorcery and enchantment punishable by death; and though this act was repealed in 1547, a new one, passed in 1563, remained in force till 1736. In the France of Louis XIV the Affair of the Poisons (*q.v.*) was almost entirely concerned with recourse to black magic. Well-intentioned movements such as Rosicrucianism (*q.v.*) and the development of speculative masonry (*see* FREEMASONRY) may have diverted into philanthropy many who would otherwise have been tempted by the mystery of the magician; and the "enlightened" rationalism of the 18th century tended to reduce black magic to a joke in which freethinkers such as Sir Francis Dashwood and his friends of the Hell-Fire club could indulge. Yet on the one hand John Wesley in 1768 could maintain that to suffer a witch to live was to surrender belief in the Bible's infallibility, and on the other hand such wonder workers as Cagliostro enjoyed a high prestige. Romanticism in the 19th century counteracted skepticism, and the violinist Paganini was even reputed to owe his virtuosity and his successes to a pact with the Devil—a rumour that his sorrowful countenance did not belie. Of 20th-century magicians the most notorious was Aleister Crowley (1875–1947), who devoted his fortune to the practice and propagation of his doctrine "*Do what thou wilt* shall be the whole of the law."

For innocuous practices and vestigial beliefs that have outlasted explicit understanding of their magical significance *see* SUPERSTITION.

See also references under "Magic" in the Index.

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MAGIC, PRIMITIVE. Magical beliefs and practices are widespread in primitive society, and tend to persist even when primitive cultures are changed by contact with more complex industrial economies. The term "magic" covers a great range of activities, from practices intended to promote the fertility of crops or secure game to the hunter to the use of love philtres and other devices to attract members of the opposite sex and conjurations to cause the death of an enemy. The importance of magic in primitive societies has provoked an extensive theoretical literature in which E. B. Tylor, J. G. Frazer, E. A. Westermarck, H. P. E. Hubert, M. Mauss, R. R. Marett and B. K. Malinowski have taken a prominent part.

Many attempts have been made to distinguish between magic and religion. Frazer and others contrasted the direct control exercised by man through the use of magic with the propitiation he offers to higher powers in prayer. Magic has been supposed to rely upon powers of an impersonal order (such as mana [*q.v.*], a supernatural power that can inhere in both persons and things) which Marett, Hubert and Mauss regarded as the basis of magic, while religion was thought to call upon personal spirit powers. É. Durkheim postulated that magic is essentially an individual affair, whereas a congregation or church is characteristic of religious worship, and that the magician is an isolated man without the professional training and standards of a priest. To Malinowski magic was essentially a pragmatic art concerned with the attainment of practical needs, whereas religion related to more general and far-reaching affairs, which have no immediate solution but give meaning to the basic problems of human life, fate and death. However, it came to be realized that the distinction between magic and religion could not be drawn as sharply as these definitions suggest; for instance, some magical spells are addressed to spirit beings, many magic rites take place before an assembly of people, and many magicians receive training and are members of a respected profession. Some anthropologists, therefore, have preferred to speak of a "magico-religious" category of phenomena. Nevertheless, it is convenient to class together those ritual actions which hinge on the direct, commanding use of spells or of medicines believed to be efficacious in their own right, and concerned with some immediate objective which is thought unobtainable by technical means alone (*see* SOCIAL ANTHROPOLOGY: *Ritual Relations*).

In essence, magic is a symbolic mode of ritual; at every step theory and dogma are translated into action, both verbal and nonverbal. In *Coral Gardens and Their Magic* Malinowski gave an elaborate analysis of primitive magic among the Trobrianders, who live off the east coast of New Guinea. According to him every act of magic is characterized by things said, things done and a person officiating; hence the spell, the rite and the condition of the performer are the fundamental elements. Other writers such as E. E. Evans-Pritchard have pointed out that in many parts of Africa, for example, magical substances known as medicines are also of great significance.

Elements of the Magical Art.—*Spells.*—In Melanesia and many other communities the spell, the uttering of words in a set formula, is regarded as the vital part of the magical act. In fact, magic has even been defined as "all the formulae for doing things beyond one's personal powers." Among some peoples the virtue of the magic resides so entirely in the formula, believed to have been handed down from immemorial antiquity, that the word for spell may be used to mean magic as a whole, as the Maori *karakia* or the Trobriand *megwa*. In some communities a correct recital of the formula is regarded as necessary to make the magic effective; the Maori held that any slip in the recital not only nullified the magic but might even cause the death of the practitioner. (The actual situation was usually the reverse: if a magician died it was often thought to be due to his reciting the spells incorrectly.) Such fixed formulas are in contrast with the free formulas in vogue among some other Polynesians, such as the Tikopia (Solomon Islands). There the person reciting the spell uses conventional phraseology, but is allowed to modify it as seems best to him; this is not held to affect the virtue of the magic.

The language of magical formulas is sometimes archaic and not always understood by the reciter. Meaningless terms of the abracadabra variety are believed to be efficacious because of their traditional value. Much magical language, however, is clearly and directly correlated with the aim of the recital. In symbolic statement by analogy it represents and foreshadows the technical achievement, and metaphor and simile are freely used. A Maori spell to give speed and grace to a canoe, for instance, speaks of the swiftness of a bird on the wing, the lightness of a sea gull floating on the water, and gives the names of a number of woods noted for their buoyancy. An onomatopoeic effect is also introduced, such as speed noises or the wailing of the sea. A Tikopia formula to facilitate the manufacture of turmeric (a red dye) refers to the blood-red flowers of the coral trees, the red leaves of a palm, red ginger and blood-hued fish, all analogies designed to intensify by association the quality of the pigment. In some cases traditional and mythological events are mentioned and ancestral names recited; this, along with the cryptic and archaic language of some of the phrases, makes the spell obscure to all who have not been trained in its lore.

Although many magical formulas are compulsive or mandatory, some are intended to control by persuasion: in Tikopia spells used for fishing entice the fish with various flattering suggestions, including appeals to their pride. In other forms of magic, the verbal element is merely a descriptive explanation relating the magical acts to the desired end.

Medicines.—The term medicine is often applied to an object in which mystical power is supposed to reside and which is used in a magic rite; hence the term medicine man sometimes popularly used for a magician. Many such medicines are employed for their supposed therapeutic effect, but many are thought to have other virtues and some are actually poisonous. The magical practitioner and his clients are often unaware of the real nature of the "medicine" they are using; for example, a member of the Azande (*q.v.*) tribe of central Africa will observe tabus and ritually address fish poisons before throwing them into the water; in the same way he addresses a crocodile's tooth while he rubs the stems of his bananas with it to make them grow. The fish poison really does paralyze the fish, while the crocodile's tooth has no effect upon the bananas. Yet to the Azande the two are equally potent.

Although many medicines are made from vegetable substances, their sources are quite diverse. The Azande include as medicines magical wooden whistles which they use as a protection against witchcraft or to damage an enemy. Other types of medicines *e.g.*, some of those used in Africa and Malaya, are of animal bone, gallstone, tooth or horn, or of mineral substances such as quartz crystal. The magical substance is often associated symbolically with the desired object or quality; when magic rites are performed over a Trobriand canoe, pieces of dried banana leaf and other very fragile plants are used, symbolizing the idea that the canoe should be as light as possible in the water, to give it speed.

Rites.—Usually a magical formula is accompanied by a rite, or set of bodily actions, that functions primarily to associate the spell or medicine with its target. In a Tikopia rite to kill wood borers in the timber of a canoe the gunwale is struck lightly with a ritual adze. It is believed that the pests will be killed by the spirit guardians of the adze, but that the tapping is necessary to mobilize and direct their power to its objective. Sometimes the rite symbolizes the end desired, as when water is sprinkled on the ground during the recital of a rain-producing formula, or the burning of an image accompanies magic intended to afflict an enemy with burning pains. The rite, like the spell, is usually prescribed in a set form, and is often parallel to the verbal recital. It is then both the vehicle of the spell and the translation of word into action.

Conditions of Performance.—Since it is thought that magic must be treated with great care, because of its supposed supernatural associations and practical value, the condition of the performer is usually of great significance. He is commonly hedged around by tabus; for instance, he may have to refrain from eating certain foods, from sexual indulgence and from whatever might contaminate him. If he fails to conform, then he nullifies the power of his act; breach of tabu (*q.v.*) is the cause most frequently assigned for the failure of magic.

Malinowski laid great stress on the performer's simulation of the real act and held that magic is a ritualized expression of desire which cannot be fulfilled by technical means and which finds outlet in speech and gesture. For example, in the rite of black magic in which a bone or dart is pointed at a victim, the magician twists and turns, gestures in the air and assumes a state of excitement and fury as if he actually were stabbing his enemy. Malinowski perceived a spontaneous outburst of word and act as the germ of spell and rite, and in the illusion of subjective experience (the conviction that such actions have really had their effect) he saw the foundation of belief in magical efficacy. While belief in the power of symbolic action is undoubtedly basic in magical thought, he seems to have overstressed the individual and emotional aspects of much magical behaviour. It is often a routine, calmly performed and conforming to socially accepted rules, rather than a procedure in which the emotions of the performer are very manifest. Malinowski's view was a useful corrective to the earlier intellectual analyses, but it paid too little attention to the place of magic as a symbolic, ideational system.

Primitive Magic and Science.—According to Tylor, the great pioneer in anthropology, magic developed from the thought processes of primitive man by means of association of ideas, becoming organized into an elaborate and systematic pseudoscience. This position was more explicitly formulated by Frazer, who regarded magic as man's attempt to formulate a body of principle by which the future might be determined. In the popular view, magic is often thought of as a fraudulent art (*see* CONJURING) which pretends to an occult control of nature or of spirits, and the falsity of its claims is emphasized. Contrary to the latter view, magic normally is not performed in a spirit of pretense; some primitive magicians do occasionally cheat, but neither they nor their public regard this as invalidating the claim of magic as a whole.

Neither Tylor's nor Frazer's theory takes into account that, though the immediate context of magic and science may be the same, their procedures are different and they apply to different aspects of the same general problem. Malinowski, by his analysis of garden magic in the Trobriands, showed just how different the aims of the magical and agricultural processes are. The Trobriander has a good empirical knowledge of soils and plant growth,

of wind and weather, and is well aware that careful tillage, weeding, repairing of fences and replacement of damaged seeds are essential for a good harvest. On the other hand, there are conditions with which his knowledge and technique cannot cope, and to secure the right amount of rain and sun, to avoid insect pests or failure of the crop by disease, he uses magical aid. The islanders resort to magic where human knowledge and skill fail.

The outside observer knows that the sky will not produce rain in reply to sympathetic rites and that animals will not come to the hunter because of a spell; therefore, though he concedes that the field of operation of magic is often different from or beyond that of science, he will still ask why the fallacy of this "mumbo jumbo" is not exposed and why "the whole monstrous farrago," as Tylor called it, is not discarded as futile. One reason is that the false ritual of magic is often combined with valid technical practices; for example, the Azande use of fish poisons, described above, and others of a therapeutic character. Some primitive magic is experimental, rejecting one medicine in favour of another until the desired effect is obtained. Sometimes it may be difficult to say whether a procedure is magical or scientific, as when Polynesians use a rattle of coconut shells accompanied by a ritual formula to attract sharks. Sometimes success is simply a matter of chance, aided by the shrewdness of the magician in selecting an opportune moment for the exercise of his art. Moreover, when there is already a predisposition to believe in the validity of the claims advanced, men are prone to attach great significance to successful cases and ignore negative instances. In retrospect, one success may count more than a dozen failures. Important, too, is what Malinowski called the "current mythology of magic": stories of the prowess of particular magicians, which exaggerate their powers and credit them with causing events for which they were in no way responsible. Even when failure of magic is admitted in a particular case, men often protect the institution as a whole by explaining the failure as due to even more powerful countermagic.

Magic is thus not simply an irrational system of ideas and practices, an ineffective substitute for science by which it might be easily replaced. The difference between magic and science lies in their basic premises. Magic, unlike traditional science, is based on the assumption that words and actions technically unrelated to a phenomenon can exert a physical effect. All magical practices are derived quite logically from this belief.

Functions of Magic.—Though magic may not be capable of achieving the aims which its practitioners believe, it is not without effects of a different kind. It can be considered conveniently in three categories: productive, protective and destructive. By its ritual importance, productive magic, which is concerned with bringing about a good harvest, a catch of fish, etc., may help to organize the technical side of the activity, to stimulate the workers to keener effort and to give them more confidence that their efforts will be rewarded. Protective magic, that which aims to ward off danger and misfortune or to cure an illness, may give the confidence necessary for success or the reassurance which will speed recovery. Some of the effects of magic are negative: those who rely on productive magic fail to exert their scientific curiosity and to strive for technological developments. The ritual practice of destructive magic is often termed sorcery, in contrast with witchcraft, which is believed to spring from the specific endowment or disposition of an individual. It is often a source of social control, for sometimes those in authority fear it will be used against them; on the other hand, it may serve as a cathartic measure which, by allowing a person to destroy an enemy in imagination, averts a real act of violence. For these reasons, magic has occupied an important place in most primitive societies and maintains a certain degree of its influence despite the challenge offered by modern conditions. *See* also ANIMISM; EVIL EYE; SHAMANISM; WITCHCRAFT; MAGIC; SUPERSTITION; VOODOO.

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MAGIC SQUARE, an arrangement of numbers in the form of a square so that every column, every row and each of the two diagonals add up alike, this sum being called the constant. Strictly speaking the numbers used should be consecutive from 1 up to n^2, where n is the number of cells (or squares) in any side. Such an arrangement of n^2 numbers is called a square of the nth order.

8	1	6
3	5	7
4	9	2

A

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

B

	18	25	2	9	
17	24	1	8	15	17
23	5	7	14	16	23
4	6	13	20	22	4
10	12	19	21	3	10
11	18	25	2	9	

C

FIG. 1.—TYPES OF MAGIC SQUARE

Thus fig. 1(A) complies with all the conditions and is a magic square of the 3rd order. These squares are of great antiquity and appear to have been known from very ancient times in China and India, where, as at the present time, magic squares were worn engraved on metal or stone as amulets or talismans. They appear to have been introduced into Europe early in the Christian era; an early writer on the subject was Manuel Moschopoulos, a Greek of uncertain date who lived in Constantinople, probably about 1300 A.D. His work in manuscript is in the National library in Paris (manuscript no. 2,428). Heinrich Cornelius Agrippa (1486–1535) constructed squares of the orders 3, 4, 5, 6, 7, 8, 9, which were associated with the seven astrological "planets," Saturn, Jupiter, Mars, the sun, Venus, Mercury and the moon. The magic square of the 4th order shown in fig. 1(B) is to be seen in Albrecht Dürer's engraving "Melancolia." The date of the work (1514) is indicated in the two central cells of the bottom row, but whether this was intentional or a mere coincidence is not known. In later times the subject has been investigated as a mathematical curiosity, and more recently as an aid in the design of scientific experiments; it has large though scattered literature of its own. The three main lines of inquiry are construction, classification and enumeration.

Construction.—It is convenient to deal with these squares in three classes. Those of an odd order, those of a doubly-even order (that is where n is of the form $4m$) and those of a singly-even order (where n is of the form $2[2m + 1]$). These vary in difficulty in their order. The smallest possible square of an odd order is, of course, that of the 3rd order shown in fig. 1(A), to which there is that one fundamental solution only. Eight different arrangements may be obtained by merely turning the page around and also turning it around in front of a mirror. These so-called reversals and reflections are not usually counted as different. A square of the odd order may immediately be written down in the manner shown in fig. 1(C), described by Antoine de la Loubère after an old Hindu method. Begin with all cells in the square empty, and enter numbers in sequence starting with 1. Start at the central cell in the top row and proceed diagonally upward to the right. Since the 2 is outside the square bring it to the bottom of its column, thus giving it the position it occupies on the outside square. After the 3 is written, the 4 falls outside the square, and it is inserted at the opposite end of the row and the 5 is entered. Since the next square is occupied by the 1 write the 6 beneath the 5 and proceed until the 10 falls outside the square and so on. It will be noted that 16 falling outside the square at a corner is written beneath the 15 as in the case of an occupied square. This can be applied to any square of an odd order; but, as so many methods that have been adopted, it produces only one type of square, though it may be modified to form a limited number of other squares. Thus it is possible to start with the 1 in any cell and always get a square that has magic properties in rows and columns, but not necessarily in the diagonals. C. D. Bachet (1612) used a somewhat similar method. Another method, adopted from an

FIG. 2.—DE LA HIRE'S METHOD OF CONSTRUCTION

old Asian technique by Philippe de la Hire, may be used for the construction of squares of any order. He employed three subsidiary squares though one of these has been dispensed with by later writers. In fig. 2(A) the numbers 1, 2, 3, 4, 5, are arranged so that every number appears once and once only in every row and column, and in one diagonal, the other diagonal having repetitions of 3. In fig. 2(B), the numbers 0, 5, 10, 15, 20, are similarly treated only the repeated 10s are in the other diagonal. These squares superimposed and added produce fig. 2(C), which is a perfect magic square. Similar methods have been devised for the construction of magic squares; some of these will be found in the books named in the *Bibliography*. But most of the writers on the subject develop their own favourite schemes.

Classification.—This is a matter of individual taste and may be called the elegant branch of the subject. Taking the case of

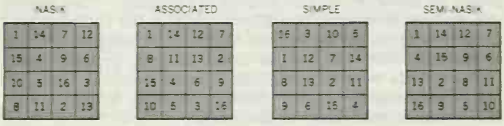

FIG. 3.—MAGIC SQUARES OF THE 4TH ORDER

the 4th order the solutions can all be classified under the four types shown in fig. 3.

The Nasik square (so named by A. H. Frost after the town in India where he lived, and invented by Islamic scholars in ancient Persia) is the most perfect type conceivable. Here all the broken diagonals sum to the constant 34. Thus, for example, $15 + 14 + 2 + 3$ and $10 + 4 + 7 + 13$ and $15 + 5 + 2 + 12$. As a consequence if the square is repeated in all directions, a 4×4 square may be marked off anywhere and it will have magic properties.

In the case of the associated squares every number if added to the number that is equidistant in a straight line from the centre gives 17; thus $1 + 16$, $2 + 15$, $3 + 14$ and so on. Dürer's square (fig. 1[B]) is also associated. The simple square is one that fulfills the simple conditions and no more. The semi-Nasik has the property that the opposite short diagonals of two cells together sum to 34; thus $14 + 4 + 11 + 5 = 34$, and $12 + 6 + 13 + 3 = 34$. In this order there are 48 Nasiks, 384 semi-Nasiks (which include 48 associated) and 448 simple, making a total of 880. The Nasik square is also sometimes called diabolique and pandiagonal and the semi-Nasik semidiabolique. Graphic illustra-

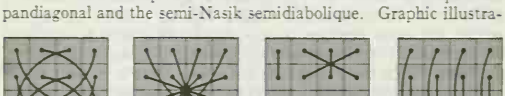

FIG. 4.—GRAPHIC SOLUTIONS OF TYPES OF THE 4TH ORDER

tions of each type are shown in fig. 4, if placed beneath the squares to which they apply.

Enumeration.—The very difficult question of enumerating the squares of the different orders has attracted the attention of many mathematicians but very little progress has been made during the last 250 years. Of the 3rd order there is only one fundamental arrangement as stated above. Of the 4th order there are 880 different fundamentals. These were all given by Bernhard Frénicle de Bessy in a posthumous work of 1693 and this has been frequently confirmed by later writers. It was shown in the *Queen* (Jan. 15, 1910) how the complete set might be so written out if desired (*see* also M. Frolow's *Carrés magiques*). No enumeration for larger squares has been completed. Particular types of squares, however, have been counted.

Greco-Latin Square.—A new type of magic square, the Greco-Latin square, was investigated in 1782 by the famous Swiss mathematician Leonhard Euler. Greco-Latin squares were shown to be useful for the design of statistically controlled experiments by R. A. Fisher in the early 1920s, and are widely used in agronomic, biological, medical, psychological and sociological research.

The two squares shown in fig. 5(A) and 5(B) respectively are

FIG. 5.—TWO ORTHOGONAL LATIN SQUARES OF ORDER 4 AND GRECO-LATIN SQUARE OF ORDER 4 OBTAINED BY SUPERPOSITION

examples of Latin squares of order 4. In the first of these squares each of the letters A, B, C, D occurs once in each row and once in each column. Similarly, in the second square each of the Greek letters $\alpha, \beta, \gamma, \delta$ occurs once in each row and once in each column. These two squares further have the magic property (called orthogonality in modern terminology) that when superposed they yield the Greco-Latin square shown in fig. 5(C) in which each Latin letter occurs with each Greek letter in one and only one of the 16 cells.

In general, a Latin square of order n is defined as an $n \times n$ square, the n^2 cells of which are occupied by n distinct symbols (which may be Latin or Greek letters, or just plain integers) such that each symbol occurs exactly once in each row and each column. Two Latin squares are said to be orthogonal if on superposition each symbol of the first square occurs exactly once with each symbol of the second square, and the square obtained by superposition is called a Greco-Latin square.

For example, suppose there were four regiments A, B, C, D and in each regiment there were four officers or ranks $\alpha, \beta, \gamma, \delta$. Then the Greco-Latin square (fig. 5[C]) may be regarded as a solution of the problem of arranging these 16 officers in a 4×4 square, such that each regiment and each rank is represented in every row and every column. A similar problem for 25 officers can easily be solved. The problem of 36 officers, however, is another matter.

Euler showed that the problem of n^2 officers requiring the construction of a Greco-Latin square of order n can always be solved when n is odd, or when n is an evenly even number (*i.e.*, n is of the form $4m$). On the basis of extensive trials Euler stated, "I do not hesitate to conclude that it is impossible to produce any complete square of 36 entries and the same impossibility extends to the cases of $n = 10$, $n = 14$ and in general to all unevenly even numbers." This became famous as Euler's conjecture, which may be stated as follows: There does not exist a Greco-Latin square of order $n = 4m + 2$ for any positive integer n.

In 1900 the French mathematician G. Tarry proved by exhaustive enumeration that Euler's conjecture was indeed true for the case $n = 6$, and the result was independently verified by R. A. Fisher and F. Yates. The amount of labour involved in the method of exhaustive enumeration increases extremely rapidly as n increases; to quote from a survey of combinatorial analysis by M. Hall: "Extensive searches on SWAC, the computer at UCLA, have failed to produce an orthogonal 10×10 pair. But even with more than 100 hours of high speed search, the part of the possible cases tried is so microscopic that no conclusion may be drawn." (M. Hall in *Some Aspects of Analysis and Probability* by I. Kaplansky *et al.*, John Wiley & Sons, Inc., New York, N.Y., 1958.)

Whether or not Euler's conjecture was true remained undecided for over 175 years. The question was finally settled in 1959 by the individual and collaborative efforts of three mathematicians, R. C. Bose, S. S. Shrikhande and E. T. Parker. To understand the developments which led to this result consider sets of more than two mutually orthogonal Latin squares. For example, the squares shown in fig. 5(A), 5(B) and 6 constitute a set of squares any two of which are orthogonal. Let $N(v)$ denote the maximum possible number of mutually orthogonal Latin squares of order v. H. F. MacNeish showed in 1922 that if v is a prime power then $N(v) = v-1$; for example, $N(4) = 3, N(7) = 6, N(9) = 8$. Let $v = p_1^{a_1}p_2^{a_2} \ldots p_m^{a_m}$ be the prime-power decomposition of v, and let $n(v) = \min(p_1^{a_1}, p_2^{a_2}, \ldots, p_m^{a_m}) - 1$. For example, $12 = 2^2 \cdot 3$, and $n(12) = \min(2^2, 3) - 1 = 3 - 1 = 2$. MacNeish gave a method of obtaining $n(v)$ mutually orthogonal Latin squares of order v (*see* H. B. Mann in the *Bibliography*) and thus proved that $N(v) > n(v)$. He conjectured that $N(v)$ is actually equal to $n(v)$ so that not more than $n(v)$ mutually orthogonal Latin squares of order v can be obtained. Since $n(v) = 1$ if $v = 4m + 2$, the correctness of his idea implies the correctness of Euler's conjecture. However, MacNeish's conjecture was disproved by Parker who, among other things, showed that if $v = k^2 + k + 1$, and k and $k + 1$ are both prime powers, then $N(v) > k - 1$. MacNeish's conjecture is contradicted by taking $k = 4$, since $N(21) > 3$, whereas $n(21) = 2$. Though Parker's work did not disprove Euler's conjecture it cast a grave doubt on its correctness. Bose and Shrikhande obtained the first counter example to Euler's conjecture by deriving a Greco-Latin square of order 22, and gave a method by which infinitely many squares of orders of the form $4m + 2$ could be obtained. Following this Parker showed how to obtain Greco-Latin squares of order $12t + 10$ when $8t + 7$ is a prime power. This includes the important case of order 10, the square for which is shown as fig. 7. Finally the three authors collaborated in establishing that a Greco-Latin square of order $4m + 2$ can be obtained for all positive integral values of m exceeding unity. Euler's conjecture thus turns out to be false for all orders exceeding 6. *See also* Combinatorial Analysis.

a	b	c	d
b	a	d	c
c	d	a	b
d	c	b	a

FIG. 6

00	47	18	76	29	93	85	34	61	52
86	11	57	28	70	39	94	45	02	63
95	80	22	67	38	71	49	56	13	04
59	96	81	33	07	48	72	60	24	15
73	69	90	82	44	17	58	01	35	26
68	74	09	91	83	55	27	12	46	30
37	08	75	19	92	84	66	23	50	41
14	25	36	40	51	62	03	77	88	99
21	32	43	54	65	06	10	89	97	78
42	53	64	05	16	20	31	98	79	87

FIG. 7.—GRECO-LATIN SQUARE OF ORDER 10

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MAGINDANAO, a Philippine language and a cultural group numbering about 200,000 persons in the 1960s, principally centred in the Cotabato river (or Rio Grande de Mindanao), Cotabato province, island of Mindanao. The word Magindanao denotes those who live near a flood area (the Cotabato floods daily and seasonally), and the name of the island derives from this group. There are three groups of Magindanao, each with its own dialect; those who live along the delta, the lower valley and the south branch of the river are known as Sa Ilud ("down-river"); those from the northern branch and the interior reaches of the river are the Sa Laya ("up-river"). A third group, the Ilanun, are primarily concentrated on the coast north of the river mouth; the dialect spoken there reflects intimate contact with the closely related Maranao of Lanao province (*see* Mindanao; Cotabato).

The language distinctions reflect other differences. The people of the lower valley are primarily sedentary wet-rice agriculturalists. Those in the upper valley are semisedentary, growing corn and dry rice. The Ilanun were formerly particularly active in trade and as pirates. The down-river area was dominated by the sultan of Magindanao before United States rule, while the ruler who controlled the up-river area was called the *radia* of Buayan; there were also a number of minor rulers. The Magindanao are Muslims (*see* Moro), having been converted to Islam in the 15th century. Until coming under Spanish control in the 19th century they were the most powerful group on the island, controlling a major portion of southern and central Mindanao and dominating the pagan groups for purposes of trade and tribute. They also had commercial and political relations with peoples in Borneo, Celebes and Malaya.

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MAGINOT, ANDRÉ (1877–1932), French statesman and one of the sponsors of the Maginot line, was born at Paris on Feb. 17, 1877. After studying political science and law, he entered the civil service and rose to be assistant to the governor general of Algeria in 1907.

In 1910 Maginot abandoned government service for politics, being elected to the chamber of deputies and, in 1913, becoming undersecretary of state for war. He was inducted into the army as a private at the outbreak of World War I, and was seriously wounded, being crippled for life. On his recovery, in 1916, he resumed his political career as a deputy and served as minister of colonies, pensions or war in six successive cabinets. During his last term as minister of war (Nov. 1929–Jan. 1931), he reorganized the army and directed the construction, on the French northeast frontier, of the system of fortifications named after him (*see* Fortification). He died at Paris on Jan. 7, 1932.

Maginot's name became a symbol of the belief in elaborate fixed defenses that dominated French military thought before World War II and stood in sharp contrast to German tactics that stressed rapid movement of tanks, planes and motorized infantry. (M. V.)

MAGISTRATE, a title derived from the Latin *magister* ("master"), the holder of a public office (*see* Consul). It is still used in this sense, as, for example, when the highest officer in a community is referred to as its chief magistrate. More generally it is used to denote a minor judicial official whose duties may include: (1) acting as a judge at the trial of minor criminal matters; (2) the determination of the sufficiency of evidence to hold an accused for trial or for grand jury proceedings; (3) the determination of the amount of bail for a person so held for further proceedings; and (4) the issuance of warrants for search and for arrest.

See Judiciary and Court Officers; Justice of the Peace; Magistrates' Courts. (P. B. K.)

MAGISTRATES' COURTS in England and Wales have a criminal jurisdiction covering a wide range extending from small traffic offenses and public health nuisances to serious crime. With some offenses they deal completely; for other more serious ones they hold preliminary hearings, committing the accused for trial by a higher court if satisfied that there is a prima-facie case. For an intermediate class of offenses an accused person over the age of 14 years may elect to go to a higher court for trial by jury. The terms of imprisonment that magistrates' courts may impose vary with different offenses but normally do not exceed 6 months, or an aggregate of 12 where there is more than one charge. If the

magistrates, having tried an indictable offense, think that the record of the accused calls for a penalty beyond their powers, they may send him to quarter sessions for sentence. The great majority of criminal cases are dealt with by magistrates' courts. They also deal with a variety of civil and administrative matters. Normally an appeal lies from their decisions by way of a rehearing at quarter sessions or on a point of law to the high court. Most magistrates are unpaid laymen, but counties and towns may ask for the appointment of qualified stipendiary magistrates. On all but a few occasions, including committal proceedings, there must be at least two lay magistrates sitting. They are advised on law and procedure by clerks who normally have a legal qualification. Stipendiary magistrates may sit alone. Magistrates are appointed by the lord chancellor (in Lancashire by the chancellor of the duchy). There are special juvenile and domestic courts. London has had stipendiary magistrates since the 18th century, as well as lay magistrates with narrowly limited powers. By the mid-1960s their work was being integrated to follow more closely the provincial pattern.

In Scotland four classes of lower courts (justice of the peace courts, burgh and police courts and the court of the bailie of the river and firth of Clyde) try certain summary common-law and certain statutory offenses (*see* SCOTS LAW).

See also COURT: *England*.

See L. R. Jones, *Magistrates' Courts* (1953). (J. E. ML.)

MAGNA CARTA, the great charter of English liberties granted by King John in 1215 under threat of civil war. It was reissued with omissions and alterations in 1216 and again with further changes in 1217. It was also reissued by King Henry III in 1225, after he had been declared of age by the pope. It is this Great charter of 9 Henry III and not its prototype of 1215 that is the Magna Carta of English law and history. This is the document that King Edward I "inspected" in 1297 and had enrolled on his new series of statute rolls. It is this *inspeximus* by Edward I of the Great charter of 9 Henry III that has been printed ever since as the first of English statutes. It is this document that Sir Edward Coke expounded in his famous account of Magna Carta. Whether the name Magna Carta itself was adopted under official instruction or was used casually at first to distinguish between the more inclusive grant covering a wide range of concessions and the charter of liberties touching the forest first granted in 1217 is of little moment. Thirteenth-century Englishmen regarded these two documents, the Great charter and the Forest charter, as together setting out in legal form the contract between king and people that had been won, and might well have to be preserved, by force of arms.

The Origin of the Great Charter.—As the conqueror of England, William I had secured for himself and his immediate successors a position of unprecedented power. He had been able to dominate not only the country he had conquered but the barons who had helped him win it and the ecclesiastics who served the English church. He had forced the pope to be content with indirect control over the church in a land which the papacy hitherto had regarded as bound by the closest ties to Rome. The Conqueror's son Henry I, whose accession (1100) was challenged by his eldest brother, Robert, duke of Normandy, felt himself bound to make, to both his clerical and lay baronage, concessions and promises that were expressed in the most solemn form of document known to contemporary law and practice, a charter sealed with the king's great seal. This was Henry's coronation charter. His successor, Stephen (1135), whose hold on the throne was threatened by Henry I's daughter Matilda, again issued a solemn charter (1136) with even more generous promises of good government in church and state. Matilda's son Henry II, who as duke of Aquitaine as well as king of England might well need from his tenants in chief much more service abroad, also began his reign (1154) by issuing a solemn charter promising to restore and confirm the liberties and free customs which King Henry, his grandfather, had granted "to God and holy church and all his earls, barons and all his men." There developed, in fact, through the 12th century, a continuous tradition that the king's coronation oath should be strengthened by written promises sealed with the king's seal. But as the volume of common law increased during this period, and in particular during Henry II's reign, no converse definition had been secured in regard to the financial liabilities of the baronage to the crown, and there had been no definition of the rights of justice over their own men which the baronage had inherited from the Anglo-Saxon or from their own feudal past. As the Angevin administration became ever more firmly established with learned judges, able financiers and trained clerks in its service, the baronage as a whole became ever more conscious of the weakness of its position in the face of the agents of the crown.

The increased taxation of Richard I's reign, resulting from his crusade, his ransom and his war with France, would in any case have made difficulties for his successor. John's position was made even weaker because of the rival claim to the throne of his nephew Arthur of Brittany and the determination of Philip II of France to end the English hold on Normandy. John did not issue a general charter to his barons at the beginning of his reign (1199). At Northampton, however, Hubert Walter, archbishop of Canterbury, William Marshal and Geoffrey Fitzpeter, the justiciar, had summoned to meet them there all those great men of whose loyalty they were not assured, and had promised, on behalf of the king who was still in France, that he would render to each his rights if they would keep faith and peace with him. As early in the reign as 1201, the English earls were refusing to cross the sea in the king's service unless he first promised them "their rights," and in 1205, in face of a threat of invasion from France, the king was compelled to swear that he would preserve the rights of the kingdom unharmed. After the loss of Normandy in 1204, backing for the king's foreign policy had to be found from English resources alone and a new urgency in the collection of money due to the crown soon began to be felt. The quarrel with Pope Innocent III over the election of Stephen Langton to the see of Canterbury resulted in the interdict (1208–13) and left the English church defenseless in the face of John's financial demands. The excommunication of the king in 1209 deprived him of some of his ablest administrators. It is not surprising to find that when peace with the church was made and a leader of the calibre of Stephen Langton became in fact as well as in name archbishop of Canterbury, he directed current baronial unrest into the demand for a solemn grant of liberties from the king to be founded on the coronation charter of John's great-grandfather, King Henry I.

THE GREAT CHARTER OF 1215

A detailed account of the momentous happenings in the months immediately preceding the sealing of the charter has been preserved by the historians of St. Albans abbey. Many, although not all, of the documents issued immediately before the charter have survived either in the original or in office transcripts to indicate the course of events. It is clear that the king already had realized that he must give way so far as to grant free election to ecclesiastical office and to meet the barons' general demands. It is equally clear that the archbishop and the most influential earl, William Marshal, earl of Pembroke, had considerable difficulty in bringing the extremists among the baronage to a frame of mind in which they would negotiate. They wanted to fight, although it is not clear what use they would have made of a military victory in 1215. The document known as the Articles of the Barons was at last agreed upon and to it the king's great seal was set. It became the text from which the final draft of the charter was hammered out in the discussions at Runnymede in June. The charter was a compromise, but it also contained important clauses designed to bring about reforms in judicial and local administration. They can hardly have been of major interest at that moment either to the king or to the barons, and their insertion in the charter can probably be ascribed to the determination of the archbishop and the advice of the experienced judges and administrators with whom he had been in close touch since the excommunication of 1209.

For ease of reference this charter, written continuously like any deed of conveyance, has traditionally been discussed as consisting of a preamble and 63 clauses. The precise interpretation of each clause has been a matter of controversy among historians. In

the following brief summary the arabic numbers in parentheses indicate the traditional number of the clause in the charter of 1215:

I. The church to be free and have the right of free election (1, 63).

II. Statements of feudal law of particular concern to tenants in chief of the crown. Inheritance and the amount of relief due from an heir (2, 3). Wardship, its profits and duties (3, 4, 37, 46). Marriage of heirs to be without disparagement (6) and the position and remarriage of widows (7, 8). Debt: protecting the debtor and his heirs from crown agents and Jews (9–11); procedure when the debtor has left a will (26) or died intestate (27). Financial aid due to the crown (12) and rules for the summons and conduct of the feudal great council for determining any additional aid (14).

III. Clauses which directly concern subtenants and free men rather than, or as well as, tenants in chief. All the customs and liberties which the king has promised to observe toward his men all other men shall observe toward theirs (60). The same restrictions in taking financial help from their men shall bind the tenants in chief as they bind the king (15). No one is to be distrained to do more service for a knight's fee or other free tenement than he owes (16). Regulation of castle guard service (29). "No freeman shall be taken or imprisoned, or disseised, or outlawed, or exiled, or in any way destroyed, nor will we go upon him, nor will we send upon him, except by the lawful judgment of his peers or by the law of the land" (39). "To no one will we sell, deny, or delay right or justice" (40). All persons are to be free to come and go and stay in the land in time of peace except outlaws, prisoners and enemy aliens (42).

IV. Clauses referring to towns, trade and merchants. The city of London and the crown (12, 13); other cities, boroughs, towns and ports (13). Regulation of weights and measures for wine, ale, corn and cloth (35). Kydells, that is, traps for fish which might impede traffic, to be removed except on the coast (33). All merchants to be free to come and go and stay in the land to buy and sell without unreasonable tolls and in accordance with ancient custom, except in time of war. Then merchants of an enemy country shall be held until the king or his justiciar learns how English merchants are treated in the enemy's land. If English merchants are safe there the foreign enemy merchants shall be safe (41).

V. Clauses touching the reform of justice and the law. Common pleas are not to follow the court, but to be held in some certain place (17). Recognitions of *novel disseisin, mort d'ancestor,* and *darrein presentment* are only to be held in their own shires: two justices to be sent to each shire four times a year, who together with four knights of each shire chosen by the shire court shall take these assizes in the shire court on the day and in the place of its meeting. If they cannot be taken on that day enough knights and free tenants of those present shall remain, through whom the business adequately can be carried out (18, 19). Amercements (fines) for slight offenses shall be in accordance with the measure of the offense. Amercements for serious offenses shall not be so heavy as to deprive anyone of his means of livelihood. Amercements to be assessed by honest men of the neighbourhood (20). Earls and barons are to be amerced by their peers according to the measure of their offense (21). Clerks are to be amerced according to the measure of their offense and their lay tenement, not according to the amount of their ecclesiastical benefice (22). The lands of those convicted of felony shall be held by the king for a year and a day only and then shall return to the lord of the fee (32). The writ called *praecipe* in future shall not be issued for anyone touching any tenement whereby a free man may lose his court (34). Nothing in future shall be given or taken for a writ of enquiry touching life or limb, but it shall be granted freely and not denied (36). No bailiff on his own bare word without credible witnesses is to send a man to the ordeal (38). No one is to be taken or imprisoned on account of a woman's appeal touching the death of anyone other than her husband (54). Clauses 39 and 40 (*see* III above) also can be regarded as falling under this heading.

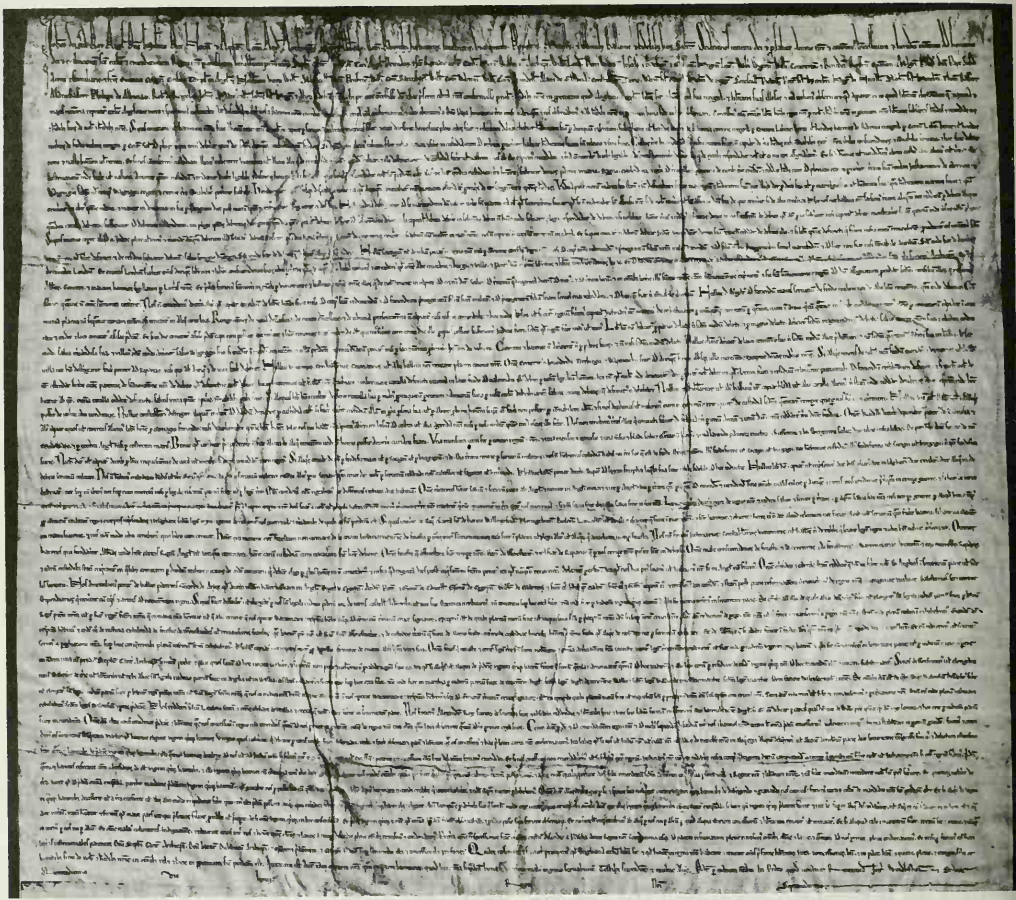
VI. Clauses to control the behaviour of royal officials, particularly those of local government. No town or individual shall be forced to make bridges or maintain river banks except those who ought to do it by ancient custom and by right (23). No sheriff, constable, coroner or other bailiff shall hold pleas of the crown (24). All counties, hundreds, wapentakes and ridings shall be at their old farms without any increment, except in the king's demesne manors (25). No constable or other royal officer shall take anyone's corn or other chattels without making immediate payment, unless the seller is willing (28). No sheriff or any other royal officer shall take any free man's horses or carts for carriage duty except with the owner's consent (30). Neither the king nor any of his officers shall take another's wood for castle building or other royal works without the consent of the owner (31). The king will not appoint any judges, constables, sheriffs or bailiffs, except such as know the law of the land and are willing to keep it well (45).

VII. Forest clauses. Men who live outside the forest shall not come before the forest justices on the general summons unless they are concerned as parties or sureties in a plea (44). All forests made by King John and all river banks put in defense in his time shall immediately be restored to their former state (47). Twelve knights elected in the shire court shall inquire at once in every county about evil customs touching forests and warrens and their keepers and immediately after the inquiry all evil customs shall be abolished, provided that the king is first informed (48). The king shall have the crusaders' respite allowed him in regard to the possible disafforestation made by Henry II or Richard I (52).

VIII. Clauses concerning political matters and correcting temporary abuses. All hostages and charters taken from Englishmen are to be returned (49). Welsh grievances are to be considered and justice done in cases of Welshmen disseised without the lawful judgment of their peers. Disseisins of this nature made by Henry II and Richard I are to be investigated (56, 57). Welsh hostages and charters are to be restored (58). The complaints of Alexander, king of Scots, shall be dealt with in the king's court by judgment of his peers, like those of the king's other barons (59). Certain named foreign mercenaries and their followers are to be removed from their offices (50). All foreign mercenaries are to be sent out of the land (51). Disseisins by the king without the lawful judgment of the tenant's peers, or disseissins similarly done by Henry II or Richard I, are to be restored and disputes in regard to them settled by the judgment of the 25 barons chosen to be guardians of the charter together with the archbishop of Canterbury. All financial agreements made unjustly with the king are to be dealt with in the same way. The king is to have the crusaders' respite (52–55).

IX. The form of security for the maintenance of the charter. The barons shall choose 25 of their number to be guardians of the charter. If the king or any of his officers shall do anything to infringe its terms the offense shall be notified to 4 of the 25, who shall go to the king or his justiciar to ask that the matter be put right. If by 40 days this shall not be done, the 4 barons shall refer the question to the whole body of the 25, who, together with the community of the whole realm, "shall distrain and trouble us in all possible ways by taking our castles, lands, and possessions." When redress has been forced upon the king former relations with him shall be resumed. Anyone who wishes can swear to obey the 25. The king shall enforce the oath on anyone who refuses to take it. On the death of one of the 25 the survivors shall appoint his successor. Disputed matters shall be settled by a majority vote. The king will not directly or indirectly do anything whereby these concessions may be revoked or diminished (61).

Much explosive material is set out in this Magna Carta sealed by King John "in the meadow called Ronimed between Windsor and Staines on the fifteenth day of June in the seventeenth year of our reign." The remarkable fact is not that war broke out between the king and his barons in the following months but that the king had ever been brought to agree to the sealing of such a document at all. That the king genuinely desired to avoid civil war, that he was prepared to accede to reasonable demands for a



S. J. HARROP, LINCOLN, ENG.

(TOP) REPRODUCTION OF MAGNA CARTA FROM THE ORIGINAL IN LINCOLN CATHEDRAL: (BOTTOM LEFT) OPENING OF THE PREAMBLE TO THE CHARTER WHICH BEGINS: "JOHANNES DEI GRATIA, REX ANGLIE, DOMINUS HYBERNIE, DUX NORMANNIE ET AQUITANNIE." TRANSLATION: "JOHN, BY THE GRACE OF GOD, KING OF ENGLAND, LORD OF IRELAND, DUKE OF NORMANDY AND AQUITAINE"; (BOTTOM RIGHT) THE 39TH CLAUSE OF THE CHARTER, WHICH BEGINS "NULLUS LIBER HOMO CAPIATUR VEL IMPRISONETUR . . ." TRANSLATION: "NO FREE MAN SHALL BE TAKEN OR IMPRISONED . . ."

statement of feudal law, that he had a basic desire to give good government to his subjects is strikingly shown by his submission to the humiliating conditions of these final clauses which, in effect, authorized his subjects to declare war on their king. Although it is profitless to speculate long about the origin of this "form of security," it is perhaps permissible to wonder whether it was the work of the barons themselves or of their adviser, Stephen Langton. There is a specious reasonableness about its eminently un-

practical rules that suggests the speculations of someone not fully in touch with the daily practice of the king's court. That there was much negotiation and argument, that the king's side was dissatisfied with the choice of the 25 and felt the need of other *observatores et obsecutores* ("guardians") to see that the barons on their side kept their word is evident from one version of Matthew Paris' chronicle. Nevertheless, it is immaterial whether this "form of security" was the work of Stephen Langton feeling his way toward a limited monarchy or of the barons expressing their feudal right of formal defiance after failure to get redress for a contract broken by their lord. This clause is of interest because it illustrates the way men were talking and thinking about kingship in 1215, but since it is omitted from all later versions of the charter, it is not from this clause that the magic of Magna Carta comes.

THE REISSUES OF 1216 AND 1217

King John died on Oct. 18/19, 1216, while Louis of France (afterward Louis VIII), supported by rebellious English barons, was trying to gain control of the land. Almost the first act of the council of the young king Henry III was to reissue the charter on Nov. 12 in the hope of recalling men to their allegiance to the rightful king. The charter of 1216 was a considerably shorter document than its predecessor—42 clauses against 63 in 1215—for the council omitted clauses dealing with purely temporary and political matters (sections VIII and IX above) as well as those which might limit its own power to raise money or forces to carry on the war. The church, while keeping a general promise of freedom, lost its specific guarantee of free election to office. But even in this moment of danger the council did not forget one main purpose of the charter, to provide a definitive statement of feudal law. It tried by individual verbal changes to clarify points in doubt, such as the position of a widow in relation to her dower and her residence and the precise year at which an heir should attain his majority, namely 21. Instead of the "form of security," the council stated that all omissions were postponed for future consideration. They were never replaced.

When the charter was reissued for the second time in the autumn of 1217 the council had reconsidered it clause by clause. They made further verbal changes for the sake of clarity and accuracy. They modified the promise of assize justices visiting every shire four times a year to the more practical suggestion of an annual visit and reserved difficult cases to be heard by the bench judges. The widow's position was yet more clearly set out. The vexed question of scutage, omitted altogether in 1216, was in 1217 glossed over by a promise to revert to the practice of Henry II. That the council in 1217 still wished to make the charter an authoritative statement of English law and practice is shown by the inclusion of three new clauses each dealing with a burning question: the possibility of a man giving away so much of his land that he could not perform his service to his lord from the remainder (39); the conduct of the shire court and view of frankpledge (42); and a first attempt at mortmain legislation (43). But the omission of section VII above and the expansion of these forest clauses into the separate Forest charter show that the council was beginning to realize that a full statement of the law on a single important subject cannot be compressed into a general charter of liberties however long.

HISTORICAL IMPORTANCE

The declaration of the pope in 1223 that Henry III was of age to make valid grants was followed in 1225 by the issue of the Great Charter of 9 Henry III. Only minor changes were made in the document as it had stood in 1217. The king stated that he had made the grant of his own free will and in return for a financial grant in aid. It would seem probable that as early as 1225 it had been realized that the effort to make the charter an up-to-date code of law that could be developed to suit changing conditions was impracticable. The Great charter was becoming a symbol, a battle cry against oppression, not a sober statement of the common law. But, as the generations came and passed, a document which had been read so many times in the shire courts up and down the land under orders from the king was bound to provide common speech with memorable phrases to be reproduced from time to time in courts of law. Whenever liberty seemed in danger, men spoke of the charter as their defense. It follows that the great and beneficent influence of Magna Carta in England and in every land across the sea in which Englishmen have settled has come not from the detailed expression of the feudal relationship between lord and man but from the more general clauses in which every generation could see its own protection. In England the Petition of Right of 1628 and the Habeas Corpus act of 1679 look directly back to clause 39 of the 1215 charter (*see* III above). When in 17th-century America individual states were shaping their own fundamental laws, the very words of Magna Carta were worked into them. The fundamental rights of man embodied in the federal constitution of 1787 have echoes of the charter. Even as late as 1868 the 14th amendment can trace its ancestry to Magna Carta. The word "charter" implies a grant in favour of the recipient, but it is Magna Carta and its centuries of history that have made the word inseparable from the language of freedom.

The essential virtue of Magna Carta, which transformed it into law comparable by a modern scholar to the Twelve Tables of ancient Rome, lies not in any individual clause or group of clauses but in the solemn circumstances of its first granting and the comprehensive nature of that grant. Hence the Magna Carta that the common man remembers is the Magna Carta of King John and the date that always has been commemorated as its granting is the year 1215. That many clauses were omitted from the charter as it finally appeared on the statute rolls, that new ones had been inserted and some original clauses redrafted has made no difference in the national memory of this venerable grant. Nevertheless, in trying to estimate the influence of the charter on constitutional development in England and overseas, it should be borne in mind that, while the drama has never faded from the field of Runnymede, the actual phrases studied by those who fought oppression in 17th-century England or 18th-century America came immediately from the charter of 9 Henry III.

Surviving Manuscripts.—There still exist four originals of the charter of 1215, two of them in the cathedral churches in which they were originally deposited, Lincoln and Salisbury, the other two in the British museum. The Lincoln charter was considered the most nearly perfect and was reproduced in the Statutes of the Realm in 1810. Lincoln also possesses the Forest charter of 1225, Durham possesses the 1216, 1217 and 1225 Great charter as well as the Forest charter of 1217 and of 1225. The Wiltshire copy of the 1225 charter was deposited at Lacock abbey and survives.

See also references under "Magna Carta" in the Index.

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(D. M. S.)

MAGNA GRAECIA ("great Greece"; Gr. *megale Hellas*), the name given (first, apparently, in the 6th century B.C.) to the group of Greek cities along the coast of the "toe" of southern Italy (or, more strictly, to those between Tarentum [Taranto] and Locri, along the east coast); the people were known in Greece as Italiotes, to the Romans as Graeci. The interior remained in the hands of the Bruttii, the native mountaineers, after whom the district was named in Roman times (Bruttii, Gr. Brettia).

There was trade between Greece and Italy in the Mycenaean

period (*see* GREECE: *History*), and there may be a reference to the copper trade in Homer (*Odyssey*, i. 184). In historical times the first Greeks to settle in the west were the Euboeans from Chalcis and Eretria, who founded Cumae (*q.v.*) in Campania *c.* 750 B.C. After this the Chalcidians went onward to Sicily, though they founded Rhegium (Reggio di Calabria) *c.* 720 B.C. at the request of their colonists at Zancle (Messina). Italy was colonized largely by the states of the Corinthian gulf—Sybaris (*c.* 720) and Crotona (*c.* 710) were Achaean settlements; Locri Epizephyrii (*c.* 680), Locrian. The only Dorian colonies in Italy were Tarentum, founded by Spartans *c.* 700, and its daughter cities Callipolis (Gallipoli), Hydruntum (Otranto) and later Heraclea (*q.v.*; 433). Ionian Greeks fleeing from foreign invasions founded Siris *c.* 650 and later Elea (Velia; *c.* 540).

The Italian colonies, planted among friendly peoples, grew much more rapidly than the Sicilian Greek states, which had to contend against Carthage. After the Achaean cities had founded Metapontum (*c.* 700) as a counterpoise to the Dorian Tarentum, there was little strife among the Italiotes. An amphictyonic league, meeting at the temple of Hera on the Lacinian promontory (Capo Colonne), fostered a feeling of unity. The Pythagorean and Eleatic systems of philosophy had their chief seat in Magna Graecia. Italiote competitors in the Olympic games included the famous Milo of Crotona, and in the 6th century the physicians of Crotona (especially Democedes) were reputed the best in Greece. Strife recommenced in the late 6th century; an Achaean coalition destroyed Siris *c.* 540, and in 510 the Crotoniates defeated the Sybarites and totally destroyed their city. The Athenian-sponsored Panhellenic colony at Thurii (443) was intended to replace Sybaris. Magna Graecia (unlike Sicily) took little part in the Peloponnesian War; Locri was strongly anti-Athenian but Rhegium, though the headquarters of the Athenian force in 427, remained neutral in 415. Henceforward foreign enemies pressed heavily on the Greek cities. The Lucanians and Bruttians on the north captured one town after another. Dionysius the Elder of Syracuse attacked from the south; after he defeated the Crotoniate league and destroyed Caulonia (389), Tarentum remained the only powerful city. Repeated expeditions from Sparta and Epirus tried in vain to prop up the decaying Greek states against the Lucanians and Bruttians, and when in 282 the Romans appeared in the Tarentine gulf the end was close at hand. The aid that Pyrrhus (*q.v.*) brought did little good to the Tarentines, and his final departure in 274 left them defenseless. Malaria increased as population diminished. Many of the cities disappeared, and hardly any were of great importance under the Roman empire, though some, like Tarentum, maintained their existence until modern times.

See T. J. Dunbabin, *The Western Greeks* (1948), for history to 480 B.C.; A. G. Woodhead, *The Greeks in the West* (1962).

MAGNARD, (LUCIEN DENIS GABRIEL) ALBÉRIC (1865–1914), French composer of symphonic music and operas. Born at Paris on June 9, 1865, he studied at the Paris conservatoire under Massenet and later privately under Vincent d'Indy. His four symphonies, written between 1894 and 1913, are remarkable for their lyrical qualities. His operas, *Yolande* (1892), *Bérénice* (1911) and *Guercoeur* (first complete production in 1931, with reconstruction by Guy Ropartz), for which he wrote the librettos himself, use the leitmotiv technique. He spent most of his life at Baron, near Senlis, where on Sept. 3, 1914, he perished when his house was burned by invading German troops. His work had little success in its day but was revived after World War I, when for a short time it had a considerable influence.

See G. Carraud, *La Vie . . . d'Albéric Magnard* (1921). (E. LE.)

MAGNASCO, ALESSANDRO (called LISSANDRINO) (1667–1749), Italian painter distinguished for his genre painting with small figures, was born at Genoa, where he studied under his father, Stefano. He afterward worked in Milan with an obscure Venetian painter, Filippo Abbiati. He began as a portrait painter, but only one self-portrait is known. His later scenes were from the lives of monks, nuns, gypsies or bandits, frequently set in romantic landscapes. These are extremely loosely painted in a dramatic, almost ecstatic manner, influenced by P. Morazzone and reminiscent of Salvator Rosa, Jacques Callot and M. Cerquozzi. Very few are dated or datable.

Some time between 1693 and 1698 he met Sebastiano Ricci through whom he exercised a marked influence on Venetian 18th-century painting. Later he moved to Florence, where he found employment at the court of the grand duke, and after traveling about Tuscany and Emilia he returned to Milan, where he remained from 1711 until 1735. He then returned to Genoa, where he died on March 12, 1749.

Magnasco was exceedingly prolific both as a painter and a draftsman and occasionally collaborated with C. Spera, C. Tavella, M. Ricci and Perugrini, inserting figures in their landscapes. Though he had no pupils, he had several imitators, notably the Neapolitan Ciccio and the Milanese Coppa.

See B. Geiger, *Saggio d'un Catalogo delle Pitture di Alessandro Magnasco* (1925) and A. Morassi, Catalogue of the *Mostra di Magnasco* (1949), both have full bibliographies. (F. J. B. W.)

MAGNATE, a noble, a man in high position, by birth, wealth or other qualities. The term seems originally to have been used to describe the chiefs of the barbarian tribes who invaded Europe in the dark ages. Later it was specifically applied to the Hungarian nobility, *maiores natu et dignitate, seniores*. The upper house in Hungary, the *Förendiház*, was called the house of magnates, and until its disappearance at the end of World War II. it was the only second chamber in Europe, apart from the British house of lords, to preserve a strong hereditary element. The popular application of the term to a wealthy man nowadays is almost invariably satirical. (S. B.-R. P.)

MAGNENTIUS (FLAVIUS MAGNUS MAGNENTIUS), usurping Roman emperor A.D. 350–353, was a pagan and a distinguished soldier of German descent. He assumed the purple at Autun on Jan. 18, 350, and, after having the emperor Constans (*q.v.*) murdered, he reigned over the west. In June he overthrew Nepotianus who had proclaimed himself emperor at Rome. He failed to win recognition from Constantius II (*q.v.*), but formed an alliance with Vetranio, commander of the Danubian troops, who had proclaimed himself emperor on March 1, 350. But Constantius easily overthrew Vetranio. Early in 351 Magnentius appointed his brother Decentius as Caesar and sent him to the Rhine frontier where Constantius had caused the Germans to undertake an offensive so as to divide Magnentius' forces.

But Magnentius repulsed the emperor at Atrans in 351 and advanced to Pannonia. Constantius, however, rallied and won the great battle of Mursa (*q.v.*) on Sept. 28, 351. In 352 Constantius invaded Italy. Magnentius fell back on Gaul and committed suicide on Aug. 11, 353. (E. A. T.)

MAGNES, JUDAH LEON (1877–1948), U.S. rabbi, founder and first president of the Hebrew university in Jerusalem, was born in San Francisco, Calif., on July 5, 1877. Educated at the University of Cincinnati, O., and Hebrew Union college, Cincinnati, he became a rabbi in 1900 and continued his studies in Germany. After a year as librarian at Hebrew Union college he went to New York where he was rabbi of a Reform synagogue in Brooklyn (1904–06) and then of Temple Emanuel on Fifth avenue (1906–10), which he left after conflict with the trustees. He then devoted himself to forming the various Jewish groups in the city into one community. During World War I he worked for the relief of Jews in eastern Europe. He left the United States in 1922 and made Palestine his home. In 1925 he founded the Hebrew university, becoming its first chancellor and then its president (1935). During World War II. in which he supported the Allied cause after a bitter internal struggle, having been previously a pacifist, he founded Ihud ("Unity"), a society working to form a commonwealth of Jews and Arabs in an undivided Palestine. Magnes died in New York on Oct. 27, 1948.

See N. Bentwich, *For Zion's Sake* (1954). (S. H. BE.)

MAGNESIA, in ancient geography a district in eastern Thessaly (*q.v.*) lying between the Vale of Tempe and the Gulf of Pagasae. The modern Greek *nomos* of Magnisia comprises the southern half of ancient Magnesia with the addition of much of ancient Achaea-Phthiotis round the Pagasaean gulf; its capital is

Volos. Magnesia was also the name of two Greek cities in Asia Minor.

MAGNESIA AD MAEANDRUM, an inland city of Ionia, situated on a small tributary of the Maeander (Buyuk Menderes) river about 12 mi. S.E. of Ephesus. According to Strabo, it was founded by some Thessalian Magnetes, who had collected fellow settlers from Crete en route. Accounted an Aeolian city, it was never, despite its early prosperity, included in the Ionian league. Destroyed in the Cimmerian invasion of *c.* 650 B.C., it slowly recovered and became the residence of Oroetes, the Persian satrap, who murdered Polycrates of Samos there about 522, and later of the exiled Themistocles, who received it, with other towns, from Artaxerxes I and issued some Magnesian coins about 460. Too far inland to enter the Athenian empire, it was occupied by the Spartan Thibron in 399 and transplanted to a more defensible site among the eastern foothills of Mt. Thorax, around the existing shrine of Artemis Leukophryene. The new city assumed a monumental form about 200 B.C. It continued to flourish under the kings of Pergamum and the Roman republic, and produced Hegesias, founder of the rhetorical school called "Asiatic." It resisted Mithradates VI of Pontus in 87 B.C., and was rewarded with political freedom by Sulla. It appears to have declined under the empire, though on a rare bronze coin of the time of Gordian III (A.D. 238–244) it still calls itself the seventh city of Asia.

The famous temple of Artemis Leukophryene was rebuilt about 200 B.C., following its old roughly east-west orientation. The building, rather strangely, faced westward, and the great altar to its west, yet more strangely, turned its back on it and roughly faced the agora. But the agora in its turn, though contemporary, ignored the orientation of temple and altar and was laid out as a long rectangle running due north and south. The rest of the city formed a grid, made out of insulae (blocks) each one-sixth of the agora in size. A. von Gerkan restored the altar, rather questionably, to copy the Great Altar of Pergamum. The main temple, designed by the famous Hermogenes, mentor of Vitruvius (*q.v.*), was Ionic. The carved frieze of the main order, unusual for Asia, shows its late date; and notable features are the doors inside its pediments and the floral acroteria with central grotesques. Apart from the agora, the rest of the city, largely defaced by a modern railway, is more ordinary. It includes a fairly perfect theatre and the shell of a large gymnasium.

The frieze of the temple was mostly carried to Paris by C. Texier in 1843. Further excavations of both temple and city were conducted between 1891 and 1893 by K. Humann, R. Heyne and O. Kern.

MAGNESIA AD SIPYLUM (modern Manisa), a city of Lydia, just south of the Hermus (Gediz) river. Though lying in a rich district and going back to the 5th century B.C., it is of little importance except for the battle of winter 190/189 B.C., described in Livy, xxxvii, when the Romans under Lucius Scipio decisively defeated Antiochus III and threw him back permanently to the other side of the Taurus range. It suffered severely from earthquakes, notably in A.D. 17, and has left rather scanty remains.

BIBLIOGRAPHY.—O. Kern, *Die Inschriften von Magnesia* (1900); K. Humann, *Magnesia am Mäander* (1904); A. von Gerkan, *Der Altar des Artemistempels in Magnesia am Mäander* (1929). (WI. H. P.)

MAGNESITE, one of the calcite group of rhombohedral carbonate minerals, consisting of magnesium carbonate, is a principal source of magnesium. It is mined in Austria, Czechoslovakia, Yugoslavia, Greece, the Ural mountains, India, Manchuria, Australia, California, Nevada and Washington. It is used for making refractory firebricks for lining steel furnaces; for magnesium oxychloride (Sorel) cement (*q.v.*), used mainly in flooring; for preparing magnesium chemicals, including those used as a component of fertilizer; and as a catalyst and filler in making synthetic rubber. The formula of magnesite is $MgCO_3$. Extensive substitution of iron, as well as lesser amounts of calcium and manganese, may occur in place of magnesium. It is rarely found in good single crystals, occurring either as crystalline aggregates or as earthy to compact masses. When pure it is white, with a hardness of 3.75 to 4.25 depending on direction, and a specific gravity of 3.0. Although found in some beds deposited from saline lakes, it more commonly occurs either as a replacement of limestones and dolomites or as a breakdown product of serpentine attacked by hot carbonate solutions. In the latter, it usually contains admixed opaline silica and magnesium silicates. (D. L. G.)

MAGNESIUM, a metallic chemical element, symbol Mg, of silvery white appearance, is the world's lightest structural metal. Because magnesium in its pure state is highly active, man's first knowledge of it came from its compounds. The sulfate, Epsom salts (*q.v.*), was isolated in 1695 by the English botanist Nehemiah Grew, while in 1707 M. B. Valentine prepared the carbonate, *magnesia alba*, from the mother liquors obtained in the manufacture of nitre. The oxide, magnesia, was confused with lime until 1755, when Joseph Black showed that the two substances were entirely different. Sir Humphry Davy in 1808 produced the amalgams of magnesium and isolated the metal by distilling off the mercury. In 1828 the metal was prepared (in a state approximating to purity) by A. Bussy who fused the anhydrous chloride with potassium.

Michael Faraday in 1833 was the first to succeed in producing metallic magnesium by electrolysis of molten magnesium chloride, using a voltaic cell. Robert Bunsen achieved the same result in 1852, his electrolytic cell corresponding in construction to the principle of the modern cell. In France, H. Sainte Claire Deville and H. Caron in 1857 accomplished the reduction of anhydrous magnesium chloride with sodium. In 1886 the electrolytic process was further developed by F. Fischer and R. Graetzel in Germany. Electrolytic methods entirely superseded the older ones until about 1941 when the carbothermic and ferrosilicon techniques, employing a thermal process, came into commercial use.

OCCURRENCE AND PRODUCTION

It is estimated that magnesium forms about 2.1% of the earth's crust, being the third most abundant of the industrial metals. It is found widely distributed in nature in a variety of forms. The carbonate, oxide and chloride are the ones most widely used and occur as dolomite, magnesite, brucite and carnallite. Magnesium also occurs in silicate minerals of which the most important are olivine, serpentine and asbestos. Although the silicate minerals are of world-wide occurrence, they are not suitable raw materials for magnesium metal manufacture because of the difficulties in separation.

Magnesium is found as chloride in sea water and in certain deep-well brines, such as those of Michigan. Magnesite, $MgCO_3$, is the most important solid source of magnesium and is widely distributed throughout the world, the largest deposits being in Austria, the U.S.S.R., Greece, Czechoslovakia, Manchuria and the Pacific coast of North America. Dolomite, or magnesian limestone, $MgCO_3 \cdot CaCO_3$, is also widely distributed, there being abundant deposits in the United Kingdom, Austria, Hungary, Germany, Switzerland, Italy, Spain and the United States. Carnallite, $MgCl_2 \cdot KCl \cdot 6H_2O$, forms a layer of the great salt beds at Stassfurt, Ger., and provided the raw material for the first electrolytic production of magnesium on a commercial basis, although it is not now an important raw material. Large deposits of the hydroxide, brucite, $Mg(OH)_2$, are found in Quebec and in Nevada.

Magnesium Minerals

Name	Nominal formula	% Mg contained
Magnesite	$MgCO_3$	28.7
Dolomite	$MgCO_3 \cdot CaCO_3$	13.8
Brucite	$Mg(OH)_2$	41.6
Serpentine	$3MgO \cdot 2SiO_2 \cdot 2H_2O$	25.9
Olivine	$(MgFe)_2\ SiO_4$	28.4
Talc	$3MgO \cdot 4SiO_2 \cdot H_2O$	20.7–26.9

Other magnesium minerals found in salt deposits from evaporation of ancient seas include:

Carnallite	$MgCl_2 \cdot KCl \cdot 6H_2O$
Schoenite	$MgSO_4 \cdot K_2SO_4 \cdot 6H_2O$
Polyhalite	$MgSO_4 \cdot 2CaSO_4 \cdot K_2SO_4 \cdot 2H_2O$
Kieserite	$MgSO_4 \cdot H_2O$
Epsomite	$MgSO_4 \cdot 7H_2O$
Kainite	$MgSO_4 \cdot KCl \cdot 3H_2O$
Langbeinite	$2MgSO_4 \cdot K_2SO_4$

Although brucite is richer in magnesium than any other ore, it is extremely local in occurrence.

Leading producers of primary magnesium in the second half of the 20th century were the U.S., U.S.S.R., Norway, Canada, Italy, the United Kingdom, France and Japan; of magnesite, the U.S.S.R., Austria, China, Czechoslovakia, the U.S. and Yugoslavia.

Two chief methods were in use in the second half of the 20th century for the commercial production of magnesium, one electrolytic, the other thermal, the former accounting for the bulk of industrial production. In Germany, where the magnesium industry was first developed on a large scale, the process was based on the electrolysis of molten magnesium chloride, a by-product from the potash and carnallite operations at Stassfurt. Magnesium chloride may also be produced from brines, sea water, processed dolomite or by chlorinating magnesite. During World War II the sea water electrolytic process, then (1941) the newest method of producing magnesium, accounted for the bulk of production in the U.S. In this process sea water, which contains about 0.13% magnesium, is pumped into huge settling tanks where it is mixed with lime. The calcium from the lime is exchanged with the magnesium in the sea water which precipitates as insoluble magnesium hydroxide, settles to the bottom of the tank and is filtered off. The magnesium hydroxide is then converted to magnesium chloride by reaction with hydrochloric acid prepared from natural gas and chlorine, $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$.

After thorough drying, which may be accomplished by means of spray or shelf driers or a combination of the two, the magnesium chloride or cell feed is fed to the electrolytic cells where electricity breaks it down into magnesium metal and chlorine gas, $MgCl_2 \rightarrow Mg + Cl_2$. A typical cell is a large rectangular steel pot which holds the fused salt bath, conducts the current to the internal cathodes and contains approximately 10 tons of molten salts. This stands in a gas-fired refractory brick furnace. The pot and its internal parts act as the cathode while graphite anodes are suspended in the top of the cell. Granular $MgCl_2$ is continuously fed into the top of the cell except when dipping metal or servicing the cell. The cell bath is a mixture of molten salts held at 700° C. During electrolysis the magnesium metal is liberated at the cathode and rises to the surface of the bath where it is guided by inverted troughs to the metal wells in the front of the cell. Metal of 99.9% purity is dipped out of the cell at 4-hr. intervals and poured into ingot molds.

The thermal process obtains magnesium by the direct reduction of its compounds with suitable reducing agents. In this process the reaction takes place above the boiling point of magnesium, permitting the metal to be separated from the residue by distillation and to be condensed in solid or liquid form.

The Pidgeon ferrosilicon process, an example of the thermal technique, was developed in Canada during 1941. It makes use of ferrosilicon and calcined dolomite which is fed into vacuum retorts, yielding a magnesium vapour which condenses in crystals on a water-cooled sleeve, $2(MgO \cdot CaO) + Si \rightarrow 2Mg\uparrow + 2CaO \cdot SiO_2$ (the iron does not react). The crystals are melted and poured into ingots.

Another thermal method, the carbothermic process, was invented in 1928 in Austria. The process centres around the reduction of magnesium oxide obtained by crushing and calcining magnesite. In the original process, the oxide after being mixed with anthracite was pressed into pellets and charged into electric-arc furnaces where the magnesium vapourized, $MgO + C \rightarrow Mg\uparrow + CO$. A chilling blast of hydrogen turned the vapour into a highly inflammable magnesium dust. The dust was tableted in a press, fed into retorts and vapourized again, yielding magnesium crystals which in turn were melted and poured into ingots. The process was modified in various ways after it was first designed, including the substitution of natural gas for hydrogen and petroleum coke for anthracite. As a safety measure, the dust is mixed with oil before being loaded into the retorts.

USES

Magnesium was formerly associated in the minds of many people almost exclusively with pyrotechnics, and for many years the chief production was used for this purpose, as well as for flash ribbon and flash powder in photography and, in wartime, for incendiary bombs. But the increasing emphasis upon weight reduction, both in industrial applications and in consumer goods, gave magnesium an importance far beyond these earlier uses.

Magnesium as a Structural Metal.—The basic crystal structure of magnesium is different from those of iron, copper or aluminum but similar to those of zinc and cadmium. The modulus of elasticity of magnesium and its alloys is relatively low, resulting in a comparatively high capacity for elastic energy absorption. Distortion or slipping in a magnesium crystal can take place on only one series of atomic planes at temperatures up to about 400° F. (about 204° C.). The material therefore tends to harden when worked at room temperature. More atomic planes become available for slipping above 400° F. and the metal can be readily worked without hardening. Magnesium is thus well adapted to hot forming methods. It is quite stable in ordinary inland atmospheres. Brightly polished metal will gradually assume a thin gray film after about one month's exposure. Magnesium is resistant to most alkalies, many organic chemicals, chromic and concentrated hydrofluoric acids, alkali metal fluorides, arsenates, chromates and dichromates. It is attacked to varying degrees by other acids and water solutions of salts. Being high in the electromotive series, magnesium is somewhat more susceptible to galvanic corrosion than other structural metals. Protective atmospheres and fluxes are employed during melting, heat treating and casting of the alloys in order to reduce oxidation and provide clean metal.

Pure magnesium has low structural strength; however alloys have been developed to meet increased property demands, to improve corrosion resistance and to facilitate production and fabrication, the first commercial ones having been placed on the market by the Germans in 1909. The principal constituents of the majority of the commercial alloys of magnesium are aluminum, zinc and manganese. The use of aluminum, the most important alloying constituent of magnesium, imparts hardness and also increases the tensile strength.

Zinc, the second most important alloying element, is usually combined with aluminum to form a ternary alloy and is used chiefly to give a general improvement in properties and to facilitate foundry work. It also improves elongation, especially in the wrought alloys, and is useful for nullifying the detrimental effects of such impurities as iron and nickel, which tend to increase the salt water corrosion rate of magnesium and its alloys.

Manganese, in small proportions, is used in practically all commercial alloys of magnesium because it greatly improves the resistance to salt water corrosion without materially affecting the other properties. Seldom used in a greater proportion than 2.5%, it has a small effect on the mechanical properties in the cast state. In the rolled condition, however, manganese increases strength. Improved tensile properties particularly at elevated temperatures can be obtained with magnesium-manganese wrought alloys, especially if small amounts of cerium or calcium have been added to produce fine grain. Magnesium-manganese alloys are of value also because of their good welding properties.

Cerium, calcium, zirconium, cadmium, silver, silicon, beryllium, lithium, thorium and tin are sometimes used as alloying ingredients for special purposes. After World War I, intensive research and development work produced strong, light alloys. The world-wide and rapid development of the aircraft industry played an important part in advancing the use of magnesium alloys for structural purposes, where their unusual advantages were quickly utilized. Perfection of alloys which could be fabricated successfully by casting, extruding, rolling and forging opened up many new fields of use. It possesses special properties which make it particularly desirable for certain types of applications which include exceptional machining qualities and good fatigue resistance and damping capacity under impact stress. The attainment of high standards in pressure die casting technique has presented new spheres of application in the instrument, tool, optical and other industries where designers are often able to substitute a single casting for parts formerly built up from sheet and sections, the die casting being stronger and more rigid but not heavier.

Mechanical Properties.—Pure magnesium in the sand cast state has a tensile strength of 14,000 p.s.i. (7 tons/in.^{2}) and in the extruded condition about 26,000 p.s.i. (13 tons/in.^{2}). The addition of suitable alloying elements doubles these values for cast and wrought alloys. When aluminum is used as an alloying constituent, casting alloys attain their maximum value for tensile strength and elongation in the cast state at approximately 6% aluminum. A substantial further increase in strength is possible by heat treating cast alloys containing 6% to 12% aluminum. Wrought alloys attain maximum strength with approximately 10% aluminum, although alloys with aluminum content as high as this are limited to simple shapes. Those with the lower aluminum contents of 3% to 7% are in more common use.

Aircraft and Spacecraft.—Because of their low specific gravity, magnesium alloys are widely used in the aircraft industry, this being especially true during and after World War II. Typical applications included: housings for camshafts, timing gears, superchargers, oil filters and pumps; landing wheels; forged radial engine crankcases and propeller blades for small planes; floor beams; frames for seats and many small parts such as die-cast instrument housings. Increased use has been made of magnesium sheet in the monocoque or stressed skin type of wing construction and it has been used on a considerable scale for fairings, cowlings and tanks. Magnesium missile sheet has been produced in volume quantities and various alloys have found a number of applications in spacecraft and in guidance systems. Magnesium tooling plate has been used for making memory disks in electronic computer systems.

Transportation.—Although in this field magnesium has found its greatest use in aircraft, there is a growing interest in applying its advantages to other types of transportation, especially in automotive equipment. In Europe, and especially in Germany, magnesium alloys are used in bodies and frames for motor buses and trucks, cast wheels for tramways and buses and in a variety of small parts. In the U.S., magnesium has also been used in the construction of truck bodies and auto-transport trailers. Its use in railroad equipment includes frames for seating, partitions in Pullman cars and instrument panels and housings.

Portable Equipment.—Magnesium is increasingly used for various types of portable goods such as tools, being employed in the housings and handles. Portable platforms and conveyor systems, dockboards, hand trucks, milk crates and similar items are examples of other uses in this field. It is also utilized for office equipment, such as typewriter and adding machine frames, and various types of instrument housings.

Industrial Equipment.—Both because of their light weight and their ability to absorb dynamic energy, magnesium alloys are being used in parts of high-speed and reciprocating machinery. Examples are warp beams, bobbins, spools and knitting bars used in textile machinery. Cast magnesium foundry flasks and molding and core boxes are used in foundries. Because of its high strength-to-weight ratio it is used for industrial gratings and pedestrian bridges.

Consumer Goods.—The use of magnesium in consumer goods of many different types is constantly expanding. This field includes such items as domestic vacuum cleaners, griddles, wheel toys, luggage, lawn mowers, step ladders and photographic and motion-picture cameras. It has also been successfully used in skis, baseball catchers' masks and rowboats.

Miscellaneous.—Magnesium is used as an important alloying element in aluminum alloys, its chief function being to increase the mechanical and corrosion-resisting properties. It also facilitates heat treatment. A growing use of magnesium is as an expendable galvanic anode for the cathodic protection of buried metal structures such as pipe lines, as well as for ship hulls and tanker compartments. Its high position in the electromotive series of metals enables it to perform this function.

Because of its high affinity for oxygen, magnesium is used as a deoxidizer in the manufacture of metals lower in the electromotive series of metals, such as nickel and nickel alloys. Increasing production and use of zirconium, hafnium, uranium and beryllium has resulted in greater demand for magnesium as a reducing agent.

For the various uses of the compounds see *Magnesium Compounds*, below.

PHYSICAL AND CHEMICAL PROPERTIES

The principal physical properties of magnesium (99.9% pure) are listed in the accompanying table.

Physical Properties of Magnesium

Symbol	Mg
Atomic number	12
Atomic weight	24.312
Atomic volume—c.c./gram-atom	14.0
Crystal structure	Close-packed hexagonal
Electron arrangement in free atoms	$1s^2, 2s^2, 2p^6, 3s^2$
Mass numbers of the stable isotopes	24 25 26
Relative frequency of the isotopes—%	78.60 10.11 11.29
Melting point (° C.)	650
Boiling point (° C.)	1,103
Density, g./c.c. at 20° C.	1.74
Latent heat of fusion, cal./g.	82.2
Latent heat of vapourization, cal./g.	1,337
Specific heat, cal./g./° C.	0.25 (25°)
Electrical resistivity microhms cm.	3.94 (0° C.)
Modulus of elasticity—lb./sq.in.	6.5×10^6
Modulus of rigidity—lb./sq.in.	2.42×10^6

Chemically, magnesium is a member of group II of the periodic system and has a valence of 2, forming magnesium ion (Mg^{2+}). In a finely divided form, it may be ignited in air and burns with an intense white light which is rich in the ultra-violet rays. The products are magnesium oxide (MgO) and the nitride (Mg_3N_2). Larger pieces must be heated above the melting point of the metal before they ignite.

Magnesium is a very strong reducing agent and reacts with most acids liberating hydrogen, $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$. With nitric acid it reduces both the nitrogen and the hydrogen, $4Mg + 10HNO_3 \rightarrow 4Mg(NO_3)_2 + NH_4NO_3 + 3H_2O$ and, $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$. It displaces hydrogen from boiling water but is not attacked by alkalies.

MAGNESIUM COMPOUNDS

Preparation and Uses.—The important magnesium compounds, their properties and uses are:

Magnesium oxide, MgO, prepared by calcining magnesite

$$MgCO_3 \rightarrow MgO + CO_2\uparrow$$

or by calcining magnesium hydroxide

$$Mg(OH)_2 \rightarrow MgO + H_2O\uparrow$$

MgO is a white powder and is sold in various grades: light (caustic burned) magnesia, calcined at about 650° C., and heavy (dead burned) magnesia, calcined at 1,650° C.

Uses: basic refractory brick, high-temperature electrical insulation, oxychloride cement, fertilizer, in rubber and plastics.

Magnesium hydroxide, $Mg(OH)_2$, a white powder. This compound is the key to recovery of magnesium from sea water. It is precipitated from sea water and Mg-containing brines by the simple addition of milk of lime:

$$Mg^{2+} + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow + Ca^{2+}$$

It is used in medicine as an antiacid and laxative and in the production of magnesium and the manufacture of other magnesium compounds.

Magnesium carbonate: The commercial product is a basic magnesium carbonate $4MgCO_3 \cdot Mg(OH)_2 \cdot 4H_2O$ and is made by heating the normal carbonate, obtained by carbonating $Mg(OH)_2$:

$$Mg(OH)_2 + CO_2 + 2H_2O \rightarrow MgCO_3 \cdot 3H_2O$$
$$5[MgCO_3 \cdot 3H_2O] \rightarrow 4MgCO_3 \cdot Mg(OH)_2 \cdot 4H_2O + CO_2 + 10H_2O$$

It is also made from dolomite by the Pattinson process. The rock is calcined, hydrated and then treated with carbon dioxide or kiln gas at several atmospheres pressure. Magnesium bicarbonate goes into solution. After filtration the pressure is released and on boiling, basic magnesium carbonate is precipitated.

It is used as an insulator for boilers and pipes, in table salt to prevent caking, in rubber and ink industries and in pharmaceutical and cosmetic preparations.

Magnesium sulfate, colourless crystals, is sold as Epsom salts, $MgSO_4 \cdot 7H_2O$ and kieserite, $MgSO_4 \cdot H_2O$. Kieserite comes from

the Stassfurt deposits and from British Columbia, Can., while Epsom salts are made by treating olivine with sulfuric acid or by the reaction of magnesium hydroxide, sulfur dioxide and air:

$$Mg(OH)_2 + SO_2 + \tfrac{1}{2}O_2(air) \rightarrow MgSO_4 + H_2O$$

It is a constituent of cements and is used in the leather industry, flotation, medicine, fertilizer and in the paper and textile industries.

Magnesium chloride, colourless deliquescent crystals, prepared by crystallization from brines and bitterns, decomposition of carnallite and by the action of HCl on $Mg(OH)_2$

$$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$$

It is used in magnesium metal production, in oxychloride cements and in textiles. Magnesium oxychloride cements are made by adding a strong solution of magnesium chloride to light (caustic) magnesium oxide. The resulting paste is magnesium oxychloride (approx. $3MgO \cdot MgCl_2 \cdot 11H_2O$). Fillers such as sand and limestone fines are added. The cement, which can be coloured, takes a high wax polish. It is used for heavy-duty flooring. An increasing use for magnesium oxide and magnesium sulfate is as a fertilizer in Mg-deficient soils, giving increased yields especially with citrus fruits and potatoes.

Organic Compounds.—Important organic compounds of magnesium are known as Grignard reagents (*q.v.*). They are of the composition RMgX (where R = an alkyl or aryl group and X = a halogen). One large-scale use is in the production of silicones:

$$SiCl_4 + CH_3MgCl \rightarrow \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{ClSiCl}} + \underset{\displaystyle Cl}{\overset{\displaystyle CH_3}{ClSiCl}} \xrightarrow{H_2O}$$

$$\left[\begin{array}{ccc} CH_3 & & CH_3 \\ | & & | \\ -Si-O- & & Si-O \\ | & & | \\ CH_3 & & O \end{array}\right]_n$$

Silicone Resin

Magnesium is a constituent of chlorophyll, $C_{55}H_{70}MgN_4O_6$, and apparently plays a role similar to that of iron in hemoglobin.

Detection.—Magnesium salts can be detected by precipitating magnesium hydroxide with a solution of sodium hydroxide. It is not soluble in an excess of sodium hydroxide, but readily soluble upon addition of a saturated ammonium chloride solution.

Magnesium is determined quantitatively by precipitation as magnesium ammonium phosphate by means of dibasic ammonium phosphate from an ammoniacal solution from which interfering elements have been removed. It is ignited and weighed as magnesium pyrophosphate.

See also references under "Magnesium" in the Index.

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(P. L. F.; A. W. S.; X.)

MAGNETIC RECORDING: *see* TAPE RECORDING, MAGNETIC; PHONOGRAPH.

MAGNETIC STORM, a period of relatively intense fluctuation in the strength of the earth's magnetic field. These storms seem to be associated with major changes in activity on the sun, particularly sunspot variations; however, their origin is incompletely understood. World-wide in their effects, and lasting from a few hours to several days, such geomagnetic disturbances markedly alter the brilliance and latitude of auroral displays (*see* AURORA POLARIS). The shifting intensity of the magnetic field can impair navigation based on forms of magnetic compass and may, in especially severe storms, induce so much current in metallic objects that electric power transmission systems break down or develop serious overloading. Telegraphic and telephone communication also may be interrupted. Increased instability in the ionosphere at these times plays havoc with long-distance radio signals (*see* GEOMAGNETISM). In 1964 J. A. Simpson and coworkers of The University of Chicago reported discovery of a high-energy proton beam that arises from a specifically localized region on the sun. They noted that magnetic storms tend to coincide with the 27-day period of rotation of the sun on its axis. It was suggested that disruption of earth's magnetic field every 27 days by the proton beam may be the basis for these storms.

MAGNETISM, in physics, refers to: (1) ferromagnetism, a property of iron and a few other substances that is characterized by strong attraction of one magnetic body to another; (2) paramagnetism, the quality of relatively weak attraction to magnetized bodies as shown by many substances such as magnesium and tin; and (3) diamagnetism, characteristic of materials such as antimony and bismuth that are repelled by magnetized objects. Ferromagnetism is sometimes considered as an intense form of paramagnetism, and is the most important of these magnetic phenomena for practical application. This discussion is organized as follows:

I. History
  1. Magnetostatics and the Nature of Magnetism
  2. Electromagnetism
  3. Modern Theory
II. General Description of Magnetism
  1. Magnetic Field
  2. Intensity of Magnetization and Magnetic Induction
  3. Magnetization and Permeability Curves
  4. Kinds of Magnetism
  5. Spontaneous Magnetization
III. Permeable Materials
  1. Elements. Iron-Silicon Alloys
  2. Iron-Nickel Alloys (Permalloys)
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IV. Permanent Magnets
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IX. Effect of Magnetization on Other Properties
  1. Magnetism and Resistivity
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  4. Specific Heat and Magnetocaloric Effect
X. Magnetization in Alternating Fields
  1. Effect of Eddy Currents
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  1. Langevin Theory
  2. Quantum Theory
  3. Rare Earths
  4. Ions of the Iron Group
  5. Paramagnetism at Low Temperatures
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  7. Paramagnetism of Free Electrons
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XIII. Theory of Ferromagnetism
1. Early Theories
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4. Atomic Structure of Ferromagnetic Substances
5. Theory of Ferrites
XIV. Measurement of Magnetic Quantities
1. Basic Relations
2. Common Methods
3. Special Methods

I. HISTORY

Centuries before the Christian era the Greeks knew that the mineral magnetite (*q.v.*), or lodestone, a magnetic oxide of iron (Fe_3O_4), attracts iron and other pieces of the same mineral. This natural magnet was mentioned by Thales of Miletus (*c.* 500 B.C.); and according to Plato in the *Ion,* Socrates stated that it would support a chain of iron rings, each held to the one above it by magnetic attraction.

The Roman poet and philosopher Lucretius stated in his *De rerum natura,* in the 1st century B.C., that ". . . iron can be drawn by that stone which the Greeks call Magnet by its native name, because it has its origin in the hereditary bounds of the Magnetes," the inhabitants of Magnesia, in Thessaly. The Romans knew also that magnetism can act to repel, as shown by a quotation from the same passage: "Sometimes, too, iron draws back from this stone; for it is wont to flee from and follow it in turn." No reference to the north-pointing property of the magnet, as used in the compass (*q.v.*), is found in old Greek and Roman literature. To account for magnetic attraction some of these ancients believed that there were hooks on the surface of the magnet and little rings on the surface of the iron to catch them; others held that particles were emitted by the magnet and created an empty space toward which the iron would move.

Beginning in the period A.D. 1000–1200 the history of magnetism is closely connected with the compass and its use in navigation. According to G. A. L. Sarton, the first clear mention in any literature of a magnetic needle for indicating direction appears to have been made by Shen Kua (1030–93), a Chinese mathematician and instrument maker, who mentioned only its use on land.

Soon after 1100 the Chinese Chu Yu reported that in the period 1086–99 the compass was used for navigation by "foreign" sailors going between Canton and Sumatra. Since the trade in this region was practically a Muslim monopoly it is concluded that they were the first to use the compass for directing ships.

The earliest known European reference to the compass is by Alexander Neckam (1157–1217), an Englishman. In 1269 Petrus Peregrinus de Maricourt, a French crusader, gave the first detailed description of the compass as an instrument of navigation. He wrote of the floating compass as an instrument in common use and described a new pivoted compass in some detail. Maricourt fashioned a sphere of lodestone and explored its surface with bits of iron, and applied the term pole to the places in which the magnetic power appeared to be concentrated. He believed that the magnet derived its power from the sky.

After Maricourt's time little progress in understanding magnetism was made for almost 300 years. In 1600 William Gilbert of Colchester, Eng., physician to Queen Elizabeth I, published his *De magnete* which summarizes the knowledge of magnetism at that time and reports some of his own experiments. He mentioned the dip and declination of the compass and propounded his own great contribution, the discovery that the earth itself is a magnet. Gilbert showed that magnetized iron lost its magnetism when heated to a bright red heat and regained it when cooled to room temperature. His chapter xii of book v is entitled "Magnetick force is animate, or imitates life; and in many things surpasses human life, while this is bound up in the organick body."

After the time of Gilbert, during the period when Isaac Newton was formulating the law of gravitation and Robert Boyle was investigating the laws of gases, little of importance for magnetism was recorded.

1. Magnetostatics and the Nature of Magnetism.—In 1785 Charles Augustin de Coulomb established with some precision the inverse square law of attraction (and repulsion) between unlike (and like) magnetic poles, a controversial proposition up to that time. This was made the basis of Siméon Denis Poisson's (1781–1840) mathematical theory giving the forces between magnetized bodies in terms of their intensities of magnetization. Poisson assumed magnetization to be a molecular phenomenon, but believed that a molecule became magnetic when two fluids it was supposed to contain became separated. In 1852 Wilhelm Eduard Weber proposed that each molecule is a permanent magnet, subject to a frictional force that tends to maintain it in its established orientation. This explained the limit of magnetization (saturation) and gave a rather unsatisfactory explanation of residual magnetization; *i.e.,* the magnetization remaining after the removal of the magnetizing field. Later James Clerk Maxwell (1831–79) improved upon Weber's explanation of residual magnetization by suggesting that the molecular magnet had no friction but had more than one fixed position of equilibrium.

Before the time of Weber, Hans Christian Oersted made the important discovery (1820) that an electric current would affect a magnetic needle. Quickly following up this lead, André Marie Ampère experimentally and mathematically investigated the mutual forces between currents and showed (1825) that a current in a circuit is equivalent to a magnetic shell of calculable strength. He considered magnetism as arising primarily from electric currents circulating within molecules. Though not accepted immediately because there was no way to verify or refute it, this concept stood the test of time and was elaborated with the advent of electron theory.

2. Electromagnetism.—Using Oersted's discovery, both Ampère and François Arago (1786–1853) magnetized steel needles by placing them in a helix of wire that carried an electric current. This was the prelude to the construction in 1825 of the first electromagnet which could be so called (fig. 1) by William Sturgeon (1783–1850). This was made of soft iron bent in the form of a horseshoe and wound with a loose helix of 18 turns of wire. When excited by a wet battery it could lift more than 20 times its own weight (*see* ELECTROMAGNET).

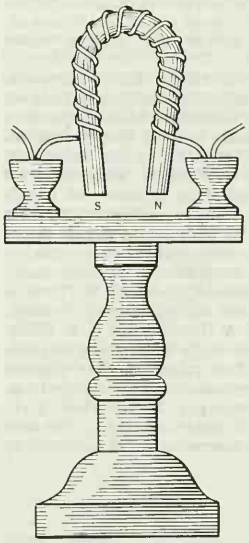

FIG. 1.—STURGEON'S ELECTROMAGNET

Several years later Joseph Henry built a much-improved electromagnet with many turns of wire efficiently applied. While experimenting with this in 1829 he noticed the spark that occurred when the circuit was broken and he was led to the discovery of self-induction, a treatise on which he published in 1832. The same phenomenon was independently discovered and published several years later by Michael Faraday (1791–1867). This great English experimentalist also shared with Henry the important discovery of electromagnetic induction, the conversion of magnetism into electricity. Although Henry is believed to have performed the experiment first and understood its significance, his results were unknown to Faraday who likewise made the crucial experiment and was the first to publish the results. Faraday and Henry made the first transformers (fig. 2) and prepared the way for the construction of the electric generator and motor (*see* GENERATOR, ELECTRIC; MOTOR, ELECTRIC).

The laws of electricity and magnetism were formulated systematically in mathematical language by Maxwell, and his famous treatise was published in 1873. (*See* ELECTRICITY: *Electromagnetic Waves.*)

3. Modern Theory.—One difficulty with Weber's theory was

that it gave no satisfactory explanation of residual induction and hysteresis (*q.v.*). Maxwell's suggestion of multiple fixed positions for the molecular magnet left unexplained the hysteresis that is found when a magnetizing force, after being once applied, is removed and reapplied. A. Ewing proposed (1890) that the constraints on the orientations of the molecular magnets were imposed by the magnetic forces of the surrounding molecules, and he showed by means of calculations and models that such forces can account qualitatively for the shape of the magnetization curve and the major and minor hysteresis loops. He first used the word hysteresis. J. Swinburne predicted on the basis of Ewing's theory that in a rotating magnetic field the hysteresis should disappear, and F. G. Baily's experiment (1896) confirmed this in a striking way (*see* fig. 25).

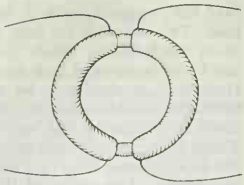

FIG. 2.—FARADAY'S TRANSFORMER HAS TWO WINDINGS OF COPPER WIRE ON AN IRON CORE. CONNECTION OF ONE WINDING TO A BATTERY CAUSES MOMENTARY FLOW OF ELECTRICITY IN OTHER WINDING CONNECTED TO A GALVANOMETER

The first important influence of modern concepts on the theory of magnetism came when P. Langevin (1905) used statistical theory to explain the variation of paramagnetic susceptibility with temperature. He assumed each molecule to have a definite magnetic moment that tended to be oriented by the applied field and at the same time disturbed by thermal agitation. In 1907 this idea was seized upon by P. Weiss who postulated that the molecules are exposed both to the applied field and to a so-called molecular field that is proportional to the intensity of magnetization; thus he developed the first important quantitative theory of ferromagnetism. This molecular field is co-operative in nature, in that it depends on the mutual action of many atoms, and is now attributed to the exchange forces derived from quantum theory by W. Heisenberg.

It is a consequence of the Weiss theory that ferromagnetic materials must be spontaneously magnetized, that is, small regions (or domains) of the material are magnetized to saturation even when the specimen as a whole has zero intensity of magnetization, in which condition the magnetic moments of the regions are oriented at random. Previously such regions were considered identical with the molecules or atoms of the substance, but Weiss's deduction was later supported by many experiments (*e.g.*, those on the Barkhausen effect) and is the basis for the domain theory now used in the interpretation of many magnetic phenomena.

By its clarification of atomic structure the quantum theory has had a great influence on magnetic theories. W. Pauli in 1920 showed that there is a natural unit of magnetic moment, the Bohr magneton, and in 1926 S. A. Goudsmit and G. E. Uhlenbeck proposed the spinning electron as the fundamental magnetic particle having a moment of one Bohr magneton. The quantum theory of paramagnetism and ferromagnetism was developed rapidly by the contributions of Heisenberg, J. H. Van Vleck, E. C. Stoner, H. A. Bethe, F. Bloch, J. C. Slater and others. The temperature dependence of saturation magnetization, as calculated by P. J. W. Debye (1925), was a notable success of the quantum theory of ferromagnetism. Advances in the theory of diamagnetism were also made after Langevin's pioneering work of 1905.

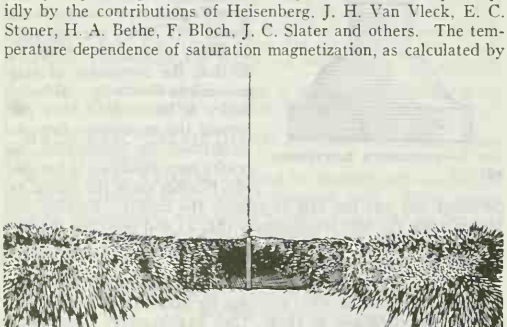

FIG. 3.—MAGNETIZED BAR AND IRON FILINGS

II. GENERAL DESCRIPTION OF MAGNETISM

The quality of magnetism first apparent to the ancients, and to us today, is the attractive force that exists between a magnet and a piece of soft iron. When a magnet is dipped into iron filings they cling to it, especially at the poles, usually near the ends of the magnet (fig. 3). The poles occur in pairs, and in a magnet used as a compass needle the pole that points to the north is the north-seeking pole, or simply the north pole, and the other the south pole. When a magnet is broken new poles appear near the break so that each piece has the same number of poles of each kind.

1. Magnetic Field.—A magnet will attract a piece of iron even though the two are not in contact; this action at a distance is said to be due to the magnetic field, or field of force around the magnet. This field may be explored by sprinkling iron filings around a magnet, whereupon they form in lines that converge on the poles and indicate also the direction a small compass needle would take if placed at any point (fig. 4).

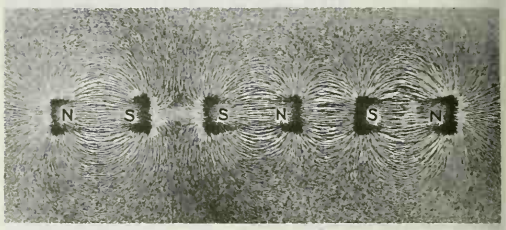

FIG. 4.—IRON FILINGS SHOW DIRECTION OF MAGNETIC FIELD NEAR BAR MAGNETS; NOTE LINES OF FORCE

Poles exert forces on each other: north and south poles attract each other and like poles repel with a force that varies inversely as the square of the distance between them. A unit pole is a convenient concept defined so that two unit poles of like kind, one centimetre apart, repel each other with a force of one dyne. The strength of the field of force, or simply the magnetic field strength or magnetizing force, may be defined in terms of magnetic poles: at one centimetre from a unit pole the field strength is one oersted. A magnetic field may be produced by a current of electricity as well as by a magnet and the unit of field strength can also be defined in terms of current. A magnetic field has direction as well as strength; the direction is that in which a north pole, subjected to it, tends to move, or that indicated by a small compass placed at the point. The field strength in oersteds is represented by the symbol H.

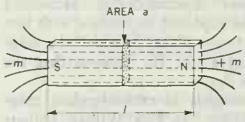

FIG. 5.—UNIFORMLY MAGNETIZED BAR. A POLE OF STRENGTH m AND AREA a CORRESPONDS TO AN INTENSITY OF MAGNETIZATION $I = m/a$, EQUAL ALSO TO MAGNETIC MOMENT PER UNIT VOLUME ml/v. LINES OF INDUCTION ARE ENDLESS, PASS INTO THE MAGNET AT THE SOUTH POLE AND LEAVE AT THE NORTH POLE

2. Intensity of Magnetization and Magnetic Induction.—To describe the magnetic properties of materials requires a quantitative measure of magnetization. Such a measure is the intensity of magnetization, defined in terms of the number of unit poles in a piece of given cross-sectional area. Suppose that a uniformly magnetized bar, of length l and cross-sectional area a, has m unit north poles at one end and m unit south poles at the other (fig. 5). The intensity of magnetization is then m/a, and is represented by the symbol I. It may easily be shown that I is also the magnetic moment per unit volume; for the magnetic moment is pole strength times interpolar distance ($M = ml$), and $I = M/v$, if v is the volume al.

Maxwell showed that some of the properties of magnetism may be likened to a flow, and conceived endless lines of induc-

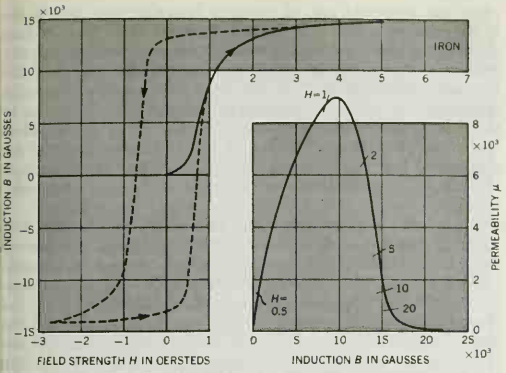

FIG. 6.—PROPERTIES OF MATERIALS ARE DESCRIBED BY MAGNETIZATION CURVES (SOLID LINE) AND HYSTERESIS LOOPS (BROKEN LINE) OBTAINED BY PLOTTING I OR B AGAINST H; THEY MAY ALSO BE DESCRIBED BY PERMEABILITY CURVES (μ PLOTTED AGAINST B)

tion that represent the direction and, by their concentration, the flow at any point. The lines pass from a magnetized material into the air at the north pole, enter again at a south pole, and pass through the material from the south pole back to the north to form a closed loop.

The total number of lines crossing a given area at right angles is the flux in that area. The flux per unit area is called the flux density or magnetic induction, and is represented by the symbol B. The lines of induction are due to both H and I, but in magnetic materials they are due mainly to the magnetization I. The magnetic induction is defined by the relation

$$B = H + 4\pi I$$

the unit of induction being the gauss. The factor 4π reflects the fact that a unit pole gives rise to a unit field everywhere on the surface of a sphere of unit radius enclosing the pole, and this sphere has an area of 4π. The lines of induction may be visualized with the aid of fig. 4 that shows the pattern obtained with iron filings.

3. Magnetization and Permeability Curves.—When a piece of iron is brought near a magnet, or subjected to the magnetic field of an electric current, the magnetization induced in the iron by the field is described by a magnetization curve obtained by plotting the intensity of magnetization I, or the magnetic induction B, against the field strength H. Such curves are of fundamental importance for describing the magnetic properties of materials, and many of them are shown on the following pages. A magnetization curve for iron is shown as the solid line of fig. 6 (left).

The behaviour of a material is also described by its permeability curve and hysteresis loop. The ratio B/H is called the permeability μ, and represents the relative increase in flux due to the presence of the magnetic material. The permeability curve is obtained by plotting μ against either I, B, H or $B - H$. In any case the curve rises from a point on the μ axis above the origin (the initial permeability) to a maximum (the maximum permeability) and falls off rapidly and then more slowly toward a value of one (not zero). When plotted against $B - H$ the curve ends at a definite point; *i.e.*, when $B - H$ reaches its highest possible value, the saturation.

If the field strength is first increased from zero to a high value and then decreased, as indicated by the arrows of fig. 6, it is observed that the original curve is not retraced; the change of induction lags behind the change in field and follows the characteristic curve shown by the broken line. This phenomenon was named hysteresis by Ewing, and the characteristic curve is called a hysteresis loop. On this loop the value of H for which $B = 0$ is called the coercive force H_c, and is often used as a measure of quality of the material. Sometimes it is desirable to have H_c large, sometimes small; for different materials H_c may be higher than 1,000 oersteds or lower than 0.01 oersted. The value of B for which $H = 0$ is called the residual induction B_r.

4. Kinds of Magnetism.—Materials that have magnetic properties similar to iron are ferromagnetic. They have permeabilities of considerable magnitude that vary with the field, they exhibit hysteresis and they lose these properties rather abruptly when heated to a temperature θ called the Curie point of the material. All solids, they usually contain iron, cobalt or other elements of the first transition series of the elements (titanium through nickel) or of the later transition series (rare earths). (*See* ELEMENTS, CHEMICAL.)

A larger class of materials with permeabilities only slightly greater than 1, usually between 1 and 1.001, does not show hysteresis. The permeability is generally independent of field strength, except at the lowest temperatures, and as a rule is either independent of temperature or decreases with increasing temperature. These materials are paramagnetic. Among them are many of the salts of the iron and the rare-earth families, the palladium and platinum metals, the elements sodium, potassium and oxygen, and the ferromagnetic materials when heated above their Curie points. The substances may be solids, liquids or gases.

In diamagnetic substances the magnetization is directed oppositely to the field; *i.e.*, they have permeabilities somewhat less than one. They are, therefore, repelled from the poles of an electromagnet and move toward a weaker field. Many of the metals and most of the nonmetals are diamagnetic.

Paramagnetic and diamagnetic substances are described more conveniently by their susceptibilities than by their permeabilities. The susceptibility is a measure of the increase in magnetic moment caused by the application of a field and is defined as

$$\kappa = I/H$$

or the equivalent,

$$\kappa = \frac{\mu - 1}{4\pi}$$

For diamagnetic materials the susceptibility is negative, and for bismuth has a relatively large value of -0.000013. For substances like iron the susceptibility may be as high as 500, or higher.

The kinds of magnetism denoted antiferromagnetism and ferrimagnetism are defined in terms of the arrangement of magnetic dipoles in the material. A simple paramagnetic material can be represented by fig. 7(A), the magnetism of the separate atoms being represented by arrows arranged in random directions with

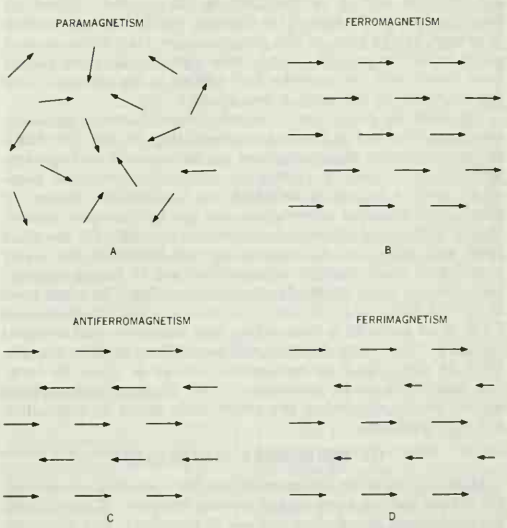

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FIG. 7.—TYPES OF MAGNETISM ASSOCIATED WITH VARIOUS KINDS OF ATOMIC INTERACTION

little or no correlation between the directions of the arrows in neighbouring atoms. In ferromagnetic materials neighbouring atoms are arranged so that neighbouring atomic moments are parallel (fig. 7[B]). In antiferromagnetic materials neighbouring atoms are antiparallel (fig. 7[C]) and the moments are equal; the material then has the low permeability of a paramagnetic substance. If neighbouring moments are antiparallel but unequal (fig. 7[D]), or if there are more atomic moments pointing in one direction than the opposite way, then there will be a net moment in a group of atoms, and the substance is ferrimagnetic; this is both antiferromagnetic in nature and ferromagnetic in properties (large permeability).

5. Spontaneous Magnetization.—A ferromagnetic substance has long been regarded as an assemblage of small magnets, each

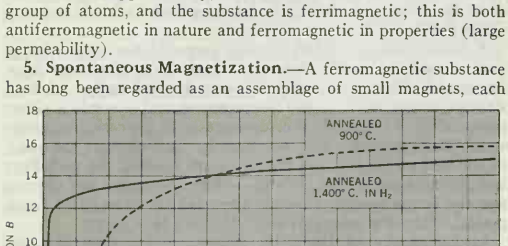


FIG. 8.—MAGNETIZATION CURVES OF IRON IN VARIOUS CONDITIONS (P. P. CIOFFI). *B* IS EXPRESSED IN KILOGAUSSES

magnet a group of atoms. When the material is unmagnetized the groups are arranged with haphazard orientations; when it is magnetized they are lined up with their axes approximately parallel. The nature of this small magnet (or domain) has been the subject of much consideration over a period of years, and now it is known that all ferromagnetic materials are composed of such domains, each of which consists of many atoms. Within a domain all of the atoms are aligned parallel, even when no field is applied, and they are therefore said to be spontaneously magnetized. When the magnetization of the material is changed, the atoms turn together in groups, or the sizes of the groups change (the atoms in each group remaining parallel to each other), so that they are aligned more nearly with the magnetic field applied to the material. The domain theory is discussed in detail later.

The magnetic properties of materials depend mainly on chemical composition and on the heat treatment they receive after fabrication; sometimes these properties are influenced in an important way by the method of fabrication. Some ferromagnetic properties, such as saturation induction and Curie point, change but slowly with chemical composition, and are usually quite insensitive to methods of fabrication and heat treatment. On the other hand such properties as permeability and hysteresis are highly sensitive to small amounts of impurities and to heat treatment; they are said to be extremely structure sensitive. In some cases the permeability (*e.g.*, of iron) will increase a thousandfold when 0.1% of an impurity is removed by heat treatment, and an equal change in the reverse direction will result from bending the material or stretching it to permanently change or strain its form. The susceptibilities of paramagnetic and diamagnetic substances are not usually affected to any considerable extent by fabrication and heat treatment.

III. PERMEABLE MATERIALS

Magnetic materials are essential for the operation of many of the devices and machines used in modern industry. Without them the production, distribution and use of electricity, and also communication by wire and radio, would be seriously limited or even impossible. After the use of iron in the compass became commonplace, the important uses of magnetic materials were first in the transformer and electric motor and generator, and later in such electromagnetic devices as relays, telephone receivers, loading coils, loud-speakers, indicating instruments, devices for switching and for the storage of information, and many other devices upon which industries depend. It is estimated that several million tons of metal are produced annually for use as magnetic material. Most useful magnetic materials either have high permeability and are magnetized and demagnetized easily, or are permanent magnets that magnetize with difficulty but retain their magnetism tenaciously.

As stated earlier, the magnetic properties vary mainly with chemical composition and heat treatment. Permeable materials are usually processed (or annealed) by heating to some temperature between 800° and 1,400° C., often about 1,000° C., and cooling at any specified rate to room temperature. Because the permeability will be lowered if they are deformed beyond the elastic limit, materials are made in final size and shape and are then heat-treated and assembled directly in apparatus for use or for testing, without bending. For each material a specific heat treatment must be used to develop the desired property to the greatest extent. Magnetization curves of iron as rolled, after a conventional anneal, and after a special anneal in hydrogen in which harmful impurities are removed, are shown in fig. 8.

Most of the known ferromagnetic substances are alloys containing one or more of the elements iron, cobalt and nickel; some are nonmetallic compounds of iron, cobalt, nickel or (rarely) manganese or chromium; some are alloys composed of manganese and other elements such as aluminum and copper (Heusler alloys); also, a number of the rare-earth elements and many of their alloys and compounds are now known to become ferromagnetic at temperatures below room temperature.

1. Elements. Iron-Silicon Alloys.—Iron, cobalt and nickel are the common ferromagnetic elements and were the only ones known until 1935 when gadolinium was also shown to be ferromagnetic. The magnetism of iron, as well as steel and lodestone, was known to antiquity, while cobalt and nickel were first investigated about the middle of the 18th century. Magnetization curves for iron, cobalt and nickel are shown in fig. 9. In this group is observed the highest magnetization at room temperature and also the highest permeability. Cobalt has a lower magnetization and the lowest value of maximum permeability. Of these materials iron is by far the most important and is the only one used to any

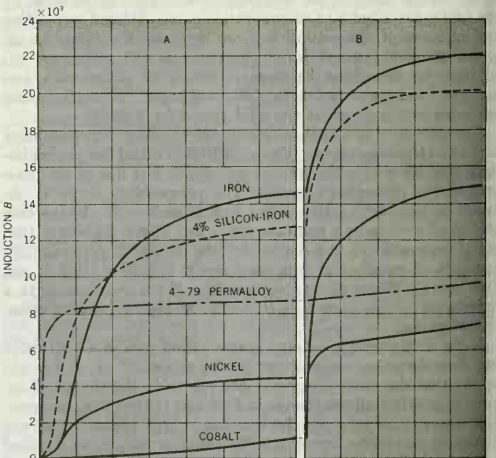


FIG. 9.—MAGNETIZATION CURVES OF SOME COMMON MATERIALS IN THE ANNEALED CONDITION IN LOW (A) AND HIGH (B) FIELDS

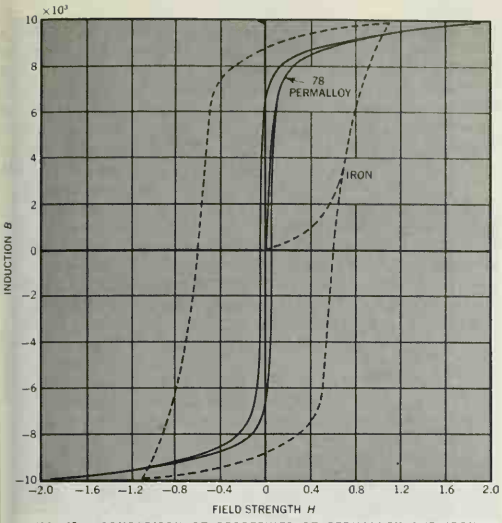


FIG. 10.—COMPARISON OF PROPERTIES OF PERMALLOY AND IRON

considerable extent in industry as a magnetic material in elementary form. Most frequently used, however, is an alloy of iron and silicon, sometimes called silicon steel or electrical sheet steel; it is not a steel in the strict sense of the word because it contains no essential carbon. The iron-nickel alloys are used for many purposes when very high permeability is desired and cost is not too important.

Iron-silicon alloys containing a few per cent of silicon were invented by Sir Robert Abbott Hadfield, and came into use in the period 1900–10, mainly through the efforts of E. Gumlich in Germany. These alloys usually contain 3% to 4% silicon, but occasionally range up to 6% silicon. They are made from pig iron and ferrosilicon melted and refined in the basic open hearth (*see* IRON AND STEEL INDUSTRY), or from ingot iron remelted with ferrosilicon in the electric furnace. Ingots are poured and rolled to slabs, and the latter are rolled either hot or cold to sheets of the required thickness, usually 0.014 in. These are cut to the appropriate size for transformers or other apparatus and are preferably annealed by heating to some temperature between 800° and 1,200° C., usually nearer 800° C.; or they may be annealed before cutting. A later development is the production of grain-oriented silicon iron in which a direction of easy magnetization is obtained in material by orienting the crystals of which the material is composed. This orientation (or texture) is obtained in the purified alloy by cold reduction of the sheet and subsequent annealing to produce the desired recrystallization texture. The material then has an especially high permeability when magnetized in the direction in which it passed through the rolls during fabrication.

The textures so obtained are of two kinds: (1) that in which the (cubic) crystals are aligned with an edge of the cube parallel to the direction in which the sheet was rolled, with a face-diagonal perpendicular thereto and lying in the sheet; and (2) that in which all cube edges are parallel to or perpendicular to the rolling direction and to the plane of the sheet.

Some magnetic and physical characteristics of commercial silicon-iron alloys are given in Table I. The power-loss column refers to the number of watts dissipated in the alloy when it is magnetized to a maximum induction of $B = 15{,}000$ by a 60-cycle-per-second alternating field. Such losses can be costly and objectionably raise the temperature of a transformer core in operation (*see* TRANSFORMER); they result partly from hysteresis and partly from eddy currents.

2. Iron-Nickel Alloys (Permalloys).—These alloys have properties that are unusual and interesting from both a scientific and a commercial point of view. It became generally recognized about 1920, as a result of the work of G. W. Elmen, that the alloys which contain from 35% to 90% nickel have permeabilities very much greater than those of iron. These alloys were named permalloys; a magnetization curve and hysteresis loop for 78 permalloy are shown in fig. 10, and curves for iron are given for comparison.

An iron-nickel alloy (hipernik) containing 50% nickel was investigated by T. D. Yensen. As distinguished from 78 permalloy, which is suitable for transformers that transmit the weak signals of communication apparatus, hipernik has high permeabilities and low losses in the stronger magnetic fields used in the transmission of power. These two commercial alloys have the compositions that are scientifically the most interesting of the binary iron-nickel series. This is illustrated in fig. 11(A) showing the induction of the alloys at low, intermediate and high field strengths.

The induction in strong fields has a minimum at 30% nickel and a maximum at 45% to 50% nickel. The maximum occurs not only when the field strengths are large but persists and is even more marked in weak fields. A second maximum appears for weak fields when the nickel content is about 80%, and corresponds to the commercially useful alloy, 78 permalloy. The high initial permeability (permeability for very low values of B) of 78 permalloy (fig. 11[B]) is associated with its very low magnetostriction (see *VI. Stress and Magnetostriction* below).

Molybdenum, chromium and copper have been added to permalloy to advantage. The most commonly used alloys of this kind are 4–79 permalloy, which contains 4% molybdenum, 79% nickel and 17% iron, and mu-metal, which usually contains 5% copper, 2% chromium, 75% nickel and 18% iron. These are both used in transformers that operate at high frequencies and are valued primarily for their high initial permeabilities, but also because they have higher resistivities and can be prepared with a simple heat treatment. Their permeabilities at various inductions are indicated by the curves of fig. 12; initial permeabilities of 10,000 to 30,000 are usually attained.

During World War II a great improvement was made in the permalloys by heat-treating them in pure hydrogen at 1,200° to 1,300° C. The most useful of these alloys, called supermalloy, contains 5% molybdenum and 79% nickel with the balance mainly iron. Initial permeabilities as high as 125,000 and maximum permeabilities of more than 1,000,000 were attained commercially in the 1960s even in thin sheet (fig. 12). Technical progress in magnetic materials may be measured by comparing these magnitudes with the permeabilities of the best materials available in the first decade of the 20th century; silicon steel made at that time had initial and maximum permeabilities about $\frac{1}{300}$ those of supermalloy.

Remarkable magnetic properties are exhibited by iron-nickel alloys that undergo a different kind of heat treatment. After being heated at a higher temperature the material is maintained for a short time at 400° to 600° C. in the presence of a magnetic field of several oersteds. When the alloy is cooled to room temperature the maximum permeability is greatly increased and the coercive force is diminished. This effect, often called magnetic anneal, depends on alloy compo-

TABLE I.—*Some Properties of Commercial Silicon-Iron Alloys in 0.014-In. Sheet, Annealed* ($B_m = 15{,}000$, $f = 60$ cycles/sec.)

Grade	Silicon (per cent)	Power loss (watts/lb.)	μ_m (gausses/oersted)	μ for $B = 100$	H_c (oersteds)	Resistivity (microhm-cm.)	Density (g./cm.³)
Armature	0.7	3.9	3,500	500	1.2	21	7.82
Electrical	1.5	3.3	5,500	700	1.0	30	7.77
Motor	2.4	2.5	6,500	900	0.8	41	7.71
Transformer 82	3.3	2.0	7,000	950	0.6	51	7.65
Transformer 72	3.6	1.8	7,500	1,000	0.5	54	7.63
Transformer 52	4.7	1.3	13,000	1,800	0.3	66	7.56
Oriented grain*	3.1	0.7	70,000	8,000	0.1	47	7.67

*Properties as measured in direction of rolling. Texture is of type (1) described above.

sition and is most pronounced when the nickel content is 65% to 70%, as illustrated in fig. 11(C). The hysteresis loops of material that has undergone magnetic anneal have the characteristic rectangular shape illustrated in fig. 13. The sides are vertical and the corners are often perfectly square; the coercive force is much smaller than that of the same material heat-treated in the absence of a field. Such square-loop materials of various compositions are useful as elements for the storage of information in electronic computers (*see* COMPUTING MACHINES, ELECTRONIC).

3. Iron-Cobalt Alloys.—In the 1960s there was no satisfactory explanation for the observation that some alloys of iron and cobalt can show greater intensities of magnetization than either of these elements alone. The saturation magnetization is highest for alloys containing 35% to 40% cobalt, and then is 10% to 15% higher than for pure iron. When the field strength is 1,000 oersteds or below, the highest inductions are attained in the alloy that contains equal proportions of the two elements, except that in fields weaker than 2 oersteds pure iron has the highest permeability.

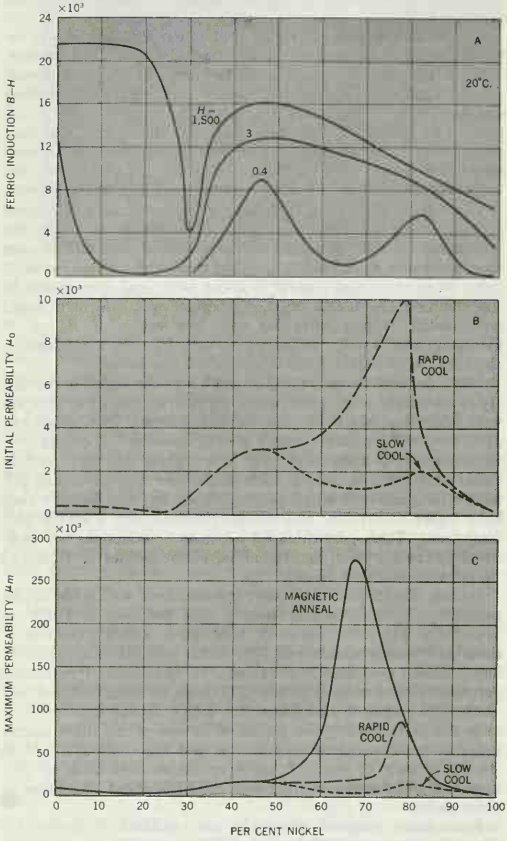


FIG. 11.—SOME MAGNETIC PROPERTIES OF IRON-NICKEL ALLOYS

The 50% alloy (permendur) is a useful component of the magnetic circuits of electromagnets and permanent magnets, where it is used for yokes and pole pieces. Since it is rather brittle and cannot be rolled to thin sheets, 2% vanadium is sometimes added and permits the fabrication of sheets a few thousandths of an inch thick. The properties of this vanadium alloy have been improved enormously by heat treatment in hydrogen and in a magnetic field; it is then called supermendur.

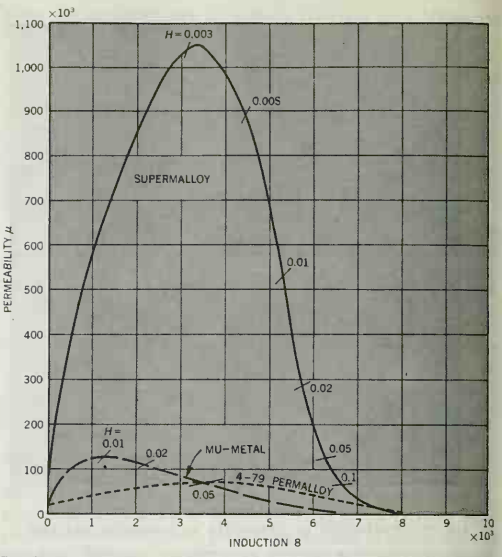


FIG. 12.—COMPARISON OF SUPERMALLOY WITH OTHER HIGH-PERMEABILITY ALLOYS (O. L. BOOTHBY AND R. M. BOZORTH)

Some alloys of iron, cobalt and nickel have permeabilities that are independent of field strength over a relatively large range. The same alloys have hysteresis loops of peculiar shape with low residual induction and a constricted middle portion. A representative alloy (perminvar) contains 30% iron, 25% cobalt and 45% nickel. The constancy of permeability with field strength in weak fields is brought out by annealing in the usual way at about 1,000° C. and then heat-treating for several hours at a relatively low temperature, 350° to 500° C. The hysteresis loss is then extremely small. The relationship between permeability and field strength, and a hysteresis loop for perminvar, heat-treated for 24 hours at 400° C., are shown in fig. 14. This material responds to heat treatment in a magnetic field, and a loop for a specimen so treated is also shown in the figure.

4. Ferrites.—After World War II the magnetic properties of

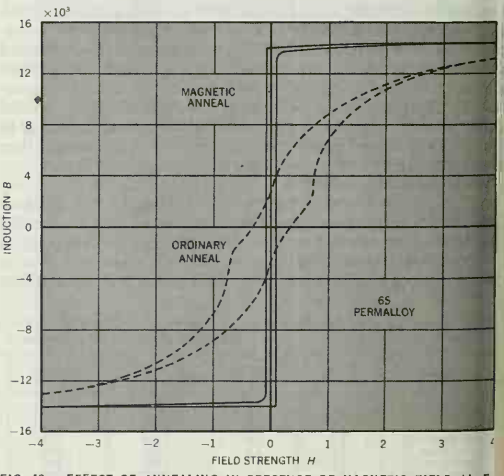


FIG. 13.—EFFECT OF ANNEALING IN PRESENCE OF MAGNETIC FIELD (J. F. DILLINGER AND R. M. BOZORTH)

a number of nonmetallic substances were investigated and subsequently found many applications in industry. The most important among these materials are the ferrites, which were developed largely as the result of the work of J. L. Snoek. Examples of important ferrites are nickel ferrite ($NiFe_2O_4$), manganese ferrite ($MnFe_2O_4$) and their combinations with zinc ferrite ($ZnFe_2O_4$).

The ferrites are nonmetallic refractory materials composed of the oxides of iron and other metals, usually manganese, cobalt,

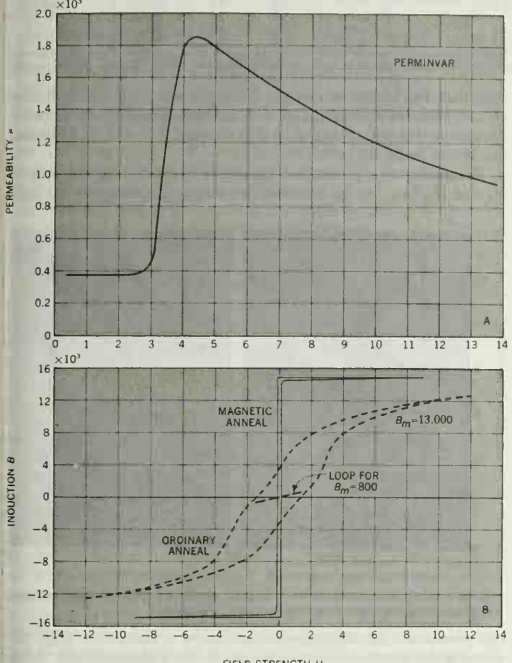
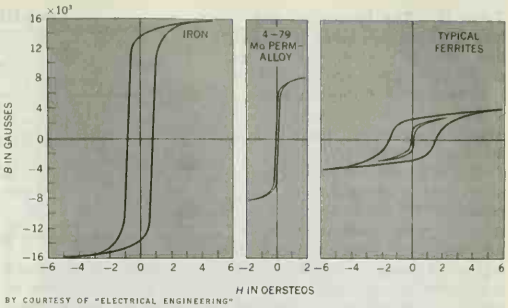


FIG. 14.—PROPERTIES OF PERMINVAR (G. W. ELMEN AND G. A. KELSALL)

nickel, copper, zinc or magnesium. The proper proportions of the oxides are pressed in powder form to the required shape and fired at 1,000° to 1,300° C. Chemical reaction occurs during the firing, and when the materials are cooled to room temperature they are hard, strong and brittle.

The maximum induction attainable in the ferrites is generally lower than in metallic materials, as shown by the hysteresis loops of fig. 15. The permeability is also below that of the best alloys. However, the resistivities of the ferrites are 10^6 to 10^9 times



BY COURTESY OF "ELECTRICAL ENGINEERING"

FIG. 15.—HYSTERESIS LOOPS OF NICKEL FERRITE AND ZINC MANGANESE FERRITE (SMALLEST LOOP) AS COMPARED WITH LOOPS OF METALLIC IRON AND MOLYBDENUM PERMALLOY

higher than for metallic materials, and greatly reduce the losses associated with changes in magnetization at high frequencies. For many applications, especially in communications engineering, the merit of a magnetic material is measured by the product μQ, μ being the permeability in weak fields and Q being inversely proportional to the energy loss per cycle. The variation of μ and μQ with

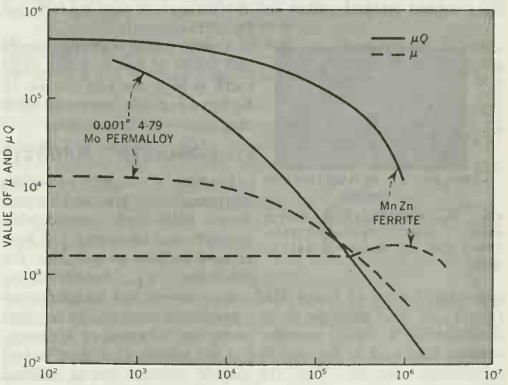


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FIG. 16.—EFFECTIVE LOW-FIELD PERMEABILITY μ AND PRODUCT WITH QUALITY FACTOR Q (RECIPROCAL OF ENERGY LOSS) AS DEPENDENT ON FREQUENCY

frequency is shown in fig. 16, where the μQ of manganese-zinc ferrite is seen to become increasingly valuable at frequencies up to one megacycle.

A number of materials of high permeability are described in

TABLE II.—*Some Properties of High-Permeability Materials*

Name	Composition* (per cent)	Heat treatment (° C.)	Initial permeability μ_0	Maximum permeability μ_m	Coercive force H_c (oersteds)	Saturation induction B_s (gauss)	Curie point θ (° C.)	Electrical resistivity ρ (microhm-cm.)	Density δ (g./cm.³)
Iron	—	900	200	5,000	1.0	21,500	770	10	7.87
Grain-oriented Fe-Si	3 Si	1,200†	7,000	50,000	0.1	20,000	740	47	7.67
Hot-rolled Fe-Si	4 Si	800	1,500‡	7,000	0.3	19,500	730	55	7.61
45 permalloy	45 Ni	1,050	2,500	25,000	0.2	16,000	400	55	8.17
Hipernik	50 Ni	1,200†	4,000	70,000	0.05	16,000	500	50	8.25
Monimax	3 Mo, 47 Ni	1,125†	2,000	35,000	0.1	14,500	—	80	8.27
Radio metal	5 Cu, 45 Ni	1,050	2,000	20,000	0.4	15,600	—	55	8.3
4-79 permalloy	4 Mo, 79 Ni	1,100§	20,000	100,000	0.05	8,700	460	55	8.72
Supermalloy	5 Mo, 79 Ni	1,300†§	100,000	1,000,000	0.002	7,900	400	60	8.77
Mu-metal	5 Cu, 2 Cr, 77 Ni	1,175†	20,000	100,000	0.05	6,500	430	62	8.58
Permendur	50 Co	800	800	5,000	2.0	24,500	980	7	8.3
Supermendur	2 V, 49 Co	800	800	70,000	0.3	24,000	980	26	8.2
45-25 perminvar	25 Co, 45 Ni	1,000, 400	400	2,000	1.2	15,500	715	19	8.7
Alperm	16 Al	600‖	3,000	55,000	0.04	8,000	400	140	6.5
Sendust	5 Al, 10 Si	Cast	20,000	120,000	0.05	10,000	500	60	7.0
Mn-Zn ferrite	11 Mn, 14 Zn, 27 O	Sintered	1,400	2,500	0.2	3,300	100	20(10)⁶	4.9
Ni-Zn ferrite	9 Ni, 17 Zn, 26 O	Sintered	650	2,500	0.4	3,600	125	10^{11}	4.9

*Remainder iron. †Annealed in hydrogen atmosphere. ‡Measured at $B=20$ rather than $B=0$.
§Controlled cooling rate. ‖Quenched from indicated temperature.

Table II. The fabrication and heat treatment are given in outline only; in practice well-controlled procedures must be used.

5. Magnetic Compounds.—There are a large number of other compounds and alloys that are ferromagnetic. As early as 1903, C. Heusler discovered that alloys near in composition to the compound Cu_2MnAl were ferromagnetic, with a saturation (B_s) of about 5,500 gausses, nearly as high as for nickel. Similar alloys are known in which the aluminum is replaced by samarium, arsenic, antimony, bismuth, indium or gallium; or copper may be replaced by a larger amount of silver. Later many intermetallic and nonmetallic compounds of iron, cobalt, nickel, manganese and chromium were discovered.

Other ferrites have been the subject of increasing research and development. One such class (orthoferrite) is typified by $GdFeO_3$, a combination of a rare-earth oxide and an iron-group oxide. Different structure (garnet type) and properties are obtained if the component oxides are combined in the ratio $3Gd_2O_3{\cdot}5Fe_2O_3$. Certain magnetic hexagonal ferrites have the formula $BaO{\cdot}6Fe_2O_3$; others are of the type $mBaO{\cdot}nMnO{\cdot}pFe_2O_3$, in which m, n and p have various integral values and the manganese may be replaced by other elements.

A great variety of compounds and alloys of the iron and rare-earth groups are now known to be ferromagnetic, many of them only at low temperatures.

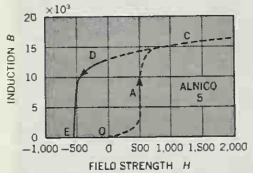

FIG. 17.—MAGNETIZATION CURVE (OAC) AND DEMAGNETIZATION CURVE (DE) OF ALNICO 5 (ALCOMAX)

IV. PERMANENT MAGNETS

Permanent magnets, as well as electromagnets, are used to produce fields of considerable strength and constancy. A host of devices depend on them for operation; *e.g.*, loud-speakers, magnetos, meters of many kinds, magnetrons and telephone receivers. In all of these the magnet necessarily contains an air gap; consequently it always operates under the influence of a demagnetizing field such as that existing at the middle of a short bar of magnetized material. Thus the magnet operates not at residual induction but at some lower value of the induction B.

The important curve for evaluating the quality and behaviour of material for permanent magnets is that portion of the hysteresis loop that lies in the second quadrant, between residual induction B_r and coercive force H_c, and is called the demagnetization curve. Magnetization and demagnetization curves for alnico 5 (Alcomax) are shown in fig. 17.

The quality of a permanent magnet is characterized not only by B_r and H_c, but also by the so-called energy product BH for various points on the demagnetization curve. The curve (fig. 18), showing this product as dependent on B, has a characteristic shape, and the maximum energy product is the best single criterion of magnetic quality for these materials.

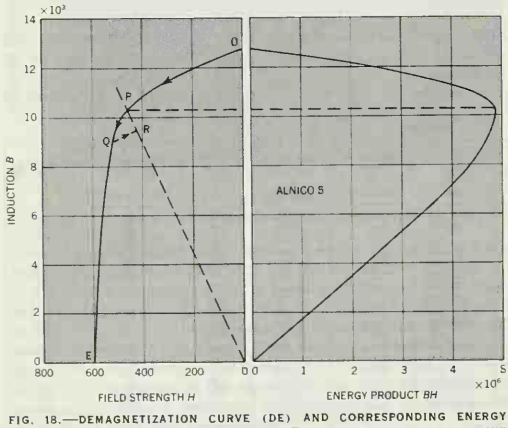

FIG. 18.—DEMAGNETIZATION CURVE (DE) AND CORRESPONDING ENERGY PRODUCT CURVE (BH PLOTTED AGAINST B), SHOWING DESIRABLE POINT OF OPERATION P, WHERE ENERGY PRODUCT IS MAXIMUM

TABLE III.—*Some Properties of Permanent Magnet Materials*

Name	Typical composition* (per cent)	Coercive force H_c (oersteds)	Retentivity B_r (gausses)	Energy product $(BH)_m \times 10^{-6}$	Fabrication	Heat treatment (° C.)
Cobalt steel	0.7 C, 36 Co, 4 Cr, 5 W	240	10,000	1.0	Forged	930†
Alnico 5	24 Co, 14 Ni, 8 Al, 3 Cu	600	12,500	5.0	Cast	1,300‡, 600§
Alnico 5 DG	24 Co, 14 Ni, 8 Al, 3 Cu	660	13,100	6.0	Cast	1,300‡, 600§
Alnico 6	24 Co, 15 Ni, 8 Al, 3 Cu, 1.25 Ti	750	10,100	3.8	Cast	1,300‡, 600§
Alcomax III	24 Co, 14 Ni, 8 Al, 3 Cu, 1 Nb	670	12,500	5.0	Cast	1,300‡, 600§
Platinum cobalt	77 Pt, 23 Co	4,000	6,000	9.0	Cast	..
Vectolite	16 Co, 28 O‖	900	1,600	0.5	Sinter	1,000‡
Ferroxdure	$BaFe_{12}O_{19}$	2,000	3,500	3.0	Sinter	..
Lodex	30 Co	1,050	7,500	3.6	Press	..
Bismanol	MnBi	3,400	4,300	4.3	Sinter	..

*Remainder iron. †Quenched from temperature indicated. ‡Must be cooled in strong magnetic field. §Baked. ‖Raw material composition.

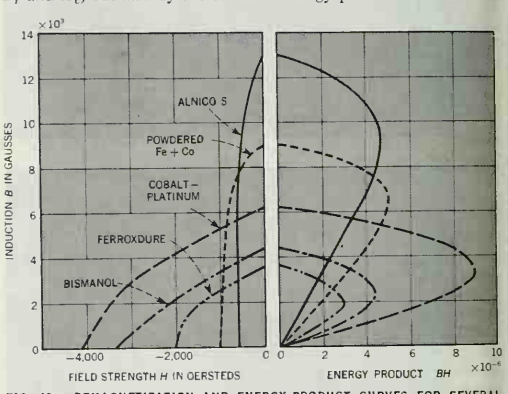

FIG. 19.—DEMAGNETIZATION AND ENERGY-PRODUCT CURVES FOR SEVERAL MATERIALS IMPORTANT FOR PERMANENT MAGNETS

1. Alloy Magnets.—From ancient times until about 1930 materials used as magnets were carbon steels. After 1855 alloying elements, especially tungsten, were used to improve the quality. In 1916–17 chromium began to displace tungsten, and cobalt was added up to 40% with very beneficial effect.

From the standpoint of magnetic quality the best materials for permanent magnets available since 1950 have been dispersion-hardened (precipitation-hardened) alloys with no essential carbon, rather than steels (*see* ALLOYS). The first materials of this kind to find commercial use were the iron-cobalt-molybdenum and iron-nickel-aluminum alloys. Their high coercivities result from the presence of very small particles of one kind highly dispersed in a matrix of another composition.

Important materials for magnets are listed in Table III, which indicates in outline the mechanical operations required in preparation and the heat treatment used to develop the best magnetic properties. Demagnetization curves for some of these alloys are reproduced in fig. 19. Special attention is called to the alloy called alnico 5 in the U.S. and Alcomax in England. To develop its remarkable properties it must be cooled at a definite rate in a strong magnetic field (about 1,000 oersteds) so directed in the specimen that it is parallel to the field required in use. At right angles to the direction of the field that has been applied during treatment the properties are not so good, the energy product being then only about one-tenth as high. Although alnico 5 is not forgeable and must be cast and ground to final form, its magnetic properties are outstanding and it has numerous uses.

2. Fine-Particle Magnets.—Among the other materials used or contemplated for use in permanent magnets the most interesting are in the class of fine-particle magnets. Theory indicates that when particles are small enough, of the order of one micron (10^{-4} cm.) or less in diameter, they are comprised of single domains (see *V. The Magnetization Curve; 5. Domain Theory of Magnetization* below). This means that it is more difficult to reverse the magnetization in them than in larger particles of the same material and that therefore they will make good permanent magnets.

Permanent magnets have been made of finely divided powder of barium ferrite ($BaFe_{12}O_{19}$, Ferroxdure), of iron, of manganese bismuthide (MnBi) and of iron-cobalt ferrite ($CoFe_5O_8$). In 1956 magnets of a finely powdered iron-cobalt alloy were prepared by T. O. Paine and his associates with an energy product of 5×10^6 (*see* fig. 19). In this material the shape of the particle is important (the length is several times the diameter) and the long directions of the particles are all aligned parallel to the direction in which the material is to be magnetized.

It has been proposed that such materials as alnico 5, although they are cast, fall into the category of fine-particle magnets because they are composed of particles of the requisite fineness embedded in a matrix of different magnetic quality.

3. Design of Permanent Magnets.—In the design of permanent magnets it is important to use the appropriate material and to shape it so that the minimum amount is used to produce the desired field strength in a given gap. As already pointed out, this result is accomplished when the energy product everywhere in the material has its maximum $(BH)_m$. The magnet of fig. 20 is designed with that in mind. Except for the iron pole piece the material is alnico 5. The length of the material along the curved path, in relation to the length of the gap, determines the position of the line OP of fig. 18, and this should be placed so that it cuts the demagnetization curve at $B = 10{,}000$, corresponding to $(BH)_m$. The cross-sectional area of the magnet is adjusted to take account of leakage; a heavier section is necessary at the lower part because all of the leakage flux must pass through this, and B must at the same time be maintained at its proper value.

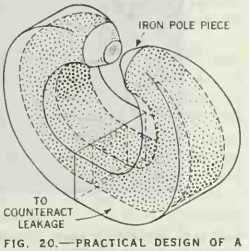

FIG. 20.—PRACTICAL DESIGN OF A PERMANENT MAGNET. THE MAGNET OPERATES AT $H = 5{,}500$, WITH $B_0 = 10{,}000$ ALMOST EVERYWHERE IN MATERIAL (P. P. CIOFFI)

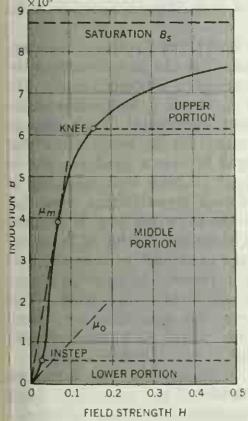

FIG. 21.—THREE SECTIONS OF NORMAL MAGNETIZATION CURVE. THE SECTIONS ARE SEPARATED BY KNEE AND INSTEP. μ_m IS LARGEST VALUE OF B/H, μ_0 INITIAL SLOPE OF CURVE

After a permanent magnet is designed and constructed it is magnetized with a high-strength field. After removal of this magnetizing field it is usually desirable to apply momentarily a relatively weak field in the opposite direction, whereupon the magnetic state of the material changes as indicated by the points PQR of fig. 18. This stabilizes the magnet against the effect of stray fields, mechanical shocks or changes in temperature, and the field in the gap is less likely to change.

V. THE MAGNETIZATION CURVE

1. Three Portions of Curve.—A typical magnetization curve, showing the relation between B and H in a specimen that is initially unmagnetized, may be divided into three main parts separated from each other by the knee and the instep (fig. 21). These three regions are identified with different mechanisms of change of magnetization, and also with different engineering uses of the materials. The initial portion of the curve, the toe, is not horizontal at the origin but has a definite slope called the initial permeability μ_0 equal to B/H for $H = 0$. For low inductions Lord Rayleigh found that the relation

$$B = \mu_0 H + aH^2$$

was obeyed. When the permeability μ is plotted against the field strength H the points usually lie on a straight line corresponding to the equation

$$\mu = \mu_0 + aH$$

Curves of this kind are used to determine the value of μ_0 by extrapolation.

The upper portion of the magnetization curve (fig. 21) bends over and approaches the horizontal line marked B_s. In strong fields, however, it is found that B approaches no definite limit but $B - H$ does approach a limit, called the saturation induction or simply saturation, designated B_s. Since $B - H = 4\pi I$, I approaches the limit I_s, the saturation magnetization.

The upper part of the curve may be represented fairly well by O. Fröhlich's equation

$$B - H = H/(a + bH)$$

in which $b = 1/B_s$, and a is a constant which measures the magnetic hardness and is larger the stronger the field necessary to attain any given fraction of saturation. When H is small enough to be neglected in comparison with B, this equation may be expressed in the equivalent form used by A. E. Kennelly

$$1/\mu = a + bH$$

and so a linear relation is found when $1/\mu$ is plotted against H. From a graph of this kind one can easily determine the constants a and b, and interpolate to find the value of μ for intermediate values of H. The slope b of the line may be used to estimate the saturation induction (since $b = 1/B_s$), but this method cannot be depended on for accuracy; in some materials such as iron the slope changes markedly at inductions close to saturation. The ratio $1/\mu$ is termed the reluctivity.

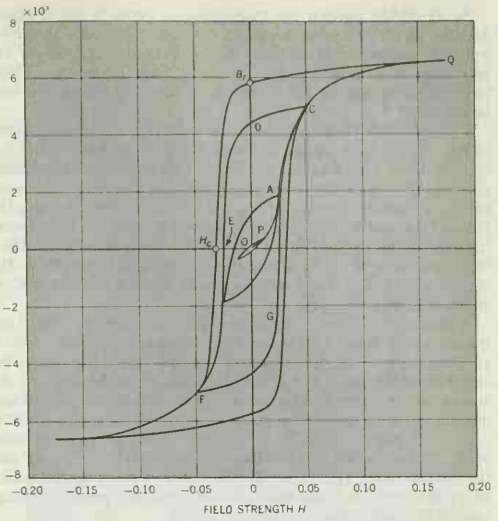

FIG. 22.—NORMAL HYSTERESIS LOOPS FOR LOW, INTERMEDIATE AND HIGH INDUCTIONS. RESIDUAL INDUCTION B_r, AND COERCIVE FORCE H_c, ARE VALUES OF B AND H WHERE CURVES CROSS AXES

In its middle portion the magnetization curve is the steepest, and the permeability has its greatest value. It is here that irreversible changes in magnetization are a maximum; curves for increasing and decreasing field strength differ markedly. These irreversible changes and the consequent losses in energy will now be discussed.

2. Hysteresis Loops.—A set of normal hysteresis loops is shown in fig. 22. In forming one of these the field strength is first increased from zero and the induction follows the magnetization curve OAC. H is then decreased, and the induction decreases slowly so that the hysteresis loop passes successively through the points D, E and F; then the field is reversed and the loop passes through G and back to C. At D the induction is called residual induction B_r and at E, when $B = 0$, the field strength is the coercive force H_c. The induction at the tip of a loop, as at C, is commonly designated B_m.

When the tip of the hysteresis loop lies on the first portion of the magnetization curve (OP in fig. 22), the loop is relatively narrow and the slope of the upper part of the loop, after it has just receded from the tip, is not greatly different from the slope of the magnetization curve at that point. If the tip lies in the middle portion of the magnetization curve, however, the slope of the loop (*e.g.*, at C, going toward D) is markedly different from the slope of the magnetization curve. These loops are relatively wide and the energy losses are large. In the upper portion of the curve, above the knee, the losses are again small and the process of magnetization is reversible.

The area enclosed by a hysteresis loop is proportional to the energy liberated as heat during traversal of the loop. When the area is in gausses $\times$ oersteds the energy loss due to hysteresis (Warburg's law) is

$$W_h = \frac{\text{area}}{4\pi} = \frac{1}{4\pi} \oint H dB$$

ergs/cm.^{3} for each traversal of the loop, or cycle. In strong fields the hysteresis loss in iron, about 10,000 ergs/cm.^{3}/cycle, is sufficient to raise its temperature about 0.0003° C. for each cycle; thus if the field is alternated 50 or 60 times a second, about one minute is required for the iron to heat one degree.

The hysteresis loss rises rapidly as the maximum induction B_m of the loop increases. The curve of fig. 23 shows the relation between W_h and B_m for ordinary iron with a maximum permeability of 4,500. When B_m is very small W_h varies as B^3, and in the range B_m = 1,000 to 15,000, of special interest for work on power transformers, it varies in accordance with the empirical law of C. P. Steinmetz

$$W_h = \eta B_m^{1.6}$$

in which the Steinmetz coefficient η is approximately constant for any one material. The B^3 relation at low inductions was derived by Rayleigh. He showed, as noted above, that the magnetization curve near the toe followed the equation

$$B = \mu_0 H + aH^2$$

and also that the hysteresis loop with tips at (B_m, H_m) and $(-B_m, -H_m)$ was described by parabolic equations

$$B = \mu H + (a/2)(H_m^2 - H^2)$$

$$B = \mu H - (a/2)(H_m^2 - H^2)$$

for the upper and lower halves of the loop, respectively. (Here $\mu = B_m/H_m$). Such a loop is shown with the corresponding magnetization curve in fig. 24. Measurements have been made for values of B_m as low as two gausses, and only slight deviations from the Rayleigh form have been observed. The area of a Rayleigh loop may be calculated from the above equations, and the corresponding hysteresis loss, expressed in ergs/cm.^{3}/cycle, is

$$W_h = \frac{aH_m^3}{3\pi} = \frac{aB_m^3}{3\pi\mu^3}$$

This equation corresponds to the lower part of the long curve of fig. 23, and is valid in iron when B_m is below about 500 gausses.

The hysteresis losses of various materials vary over a wide range. Losses of some of the common permeable materials are indicated by curves in fig. 23, and one of these has about $\frac{2}{1000}$ the loss of iron at the same value of B_m. Materials used for permanent magnets, on the other hand, have hysteresis losses enormously larger than iron, sometimes by a factor of 500. Thus the over-all range in loss in various materials is approximately 100,000 times; *i.e.*, the coefficient η of Steinmetz' equation varies from 0.6×10^{-5} to 0.6.

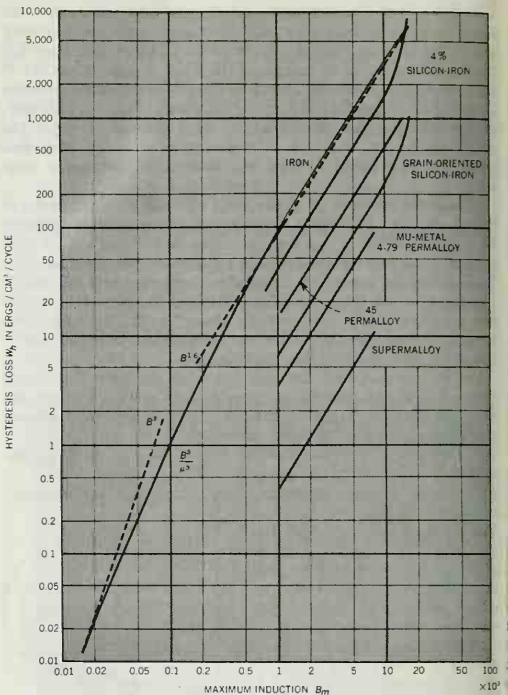

FIG. 23.—HYSTERESIS LOSS AS DEPENDENT ON MAXIMUM INDUCTION FOR SOME IMPORTANT MATERIALS

3. Distribution of Hysteresis Loss Over Cycle.—The energy loss and the attendant rise in temperature can be calculated satisfactorily as described above for a complete hysteresis loop. The question of where in the loop most of the rise in temperature takes place has been answered by direct experiment, measurements having been made of the very small rise in temperature that occurs when the induction is changed by only a small fraction of the total. Changes of about $\frac{1}{1,000,000}$° C. have been measured in these experiments. The results of such investigations show that the energy losses are largest where the hysteresis loop is steepest. In addition to this irreversible loss, there is a heating of the specimen in strong fields as the field is increased, and an equal cooling as the field is decreased. This reversible heat does not, therefore, contribute to the hysteresis loss over a complete cycle.

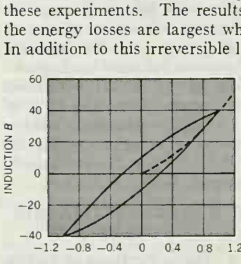

FIG. 24.—FORM OF HYSTERESIS LOOP FOR LOW INDUCTIONS (LORD RAYLEIGH)

4. Hysteresis in Rotating Fields.—The hysteresis loops mentioned so far have been measured with B and H either parallel or antiparallel to each other. A different result is obtained if the field acting on a specimen is maintained constant in strength

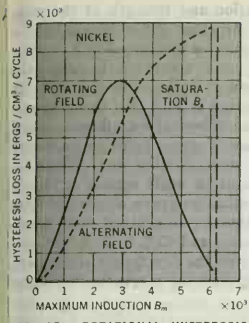

FIG. 25.—ROTATIONAL HYSTERESIS LOSS GOES THROUGH MAXIMUM, APPROACHES ZERO AT SATURATION (A. PERRIER)

and varied continually in direction. This is commonly called rotational hysteresis as compared with the usual alternating hysteresis. Measurement of rotational hysteresis is accomplished by rotating a disk of the material to be examined between the poles of an electromagnet so that H always lies in the plane of the disk. The force necessary to turn the disk is then a measure of the rotational hysteresis loss.

As the field strength increases from zero the rotational hysteresis first increases rapidly (fig. 25), more rapidly than the alternating hysteresis, but when the induction is one-half to three-quarters of saturation the alternating hysteresis goes through a maximum and decreases rapidly, approaching zero at saturation. The disappearance of hysteresis in a high rotating field was predicted as a result of Ewing's work, and its confirmation in 1896 indicated the fundamental soundness of his theory. Rotational hysteresis is of practical importance in the magnetic material that forms the segments or teeth of rotating dynamoelectric machinery.

5. Domain Theory of Magnetization.—Many of the phenomena of the magnetization curve and hysteresis loop can be described to advantage in terms of the domain theory. The theory that a ferromagnetic material is composed of many small regions (domains), each magnetized to saturation in some direction, was first stated by Weiss in 1907, and the description he gave at that time was accepted in the 1960s with but slight modification. The existence of such domains is evident from H. Barkhausen's experiments and even more definitely from the study of powder patterns (*see* below). In the unmagnetized state the directions in which the domains are saturated (the directions of easy magnetization) are distributed either at random or in some other way such that the resultant magnetization of the specimen as a whole is zero. Application of a magnetic field changes only the direction of magnetization in a given volume. The three main parts of the magnetization curve are distinguished from each other by the nature of this change in direction of magnetization, which may take place in any of several ways.

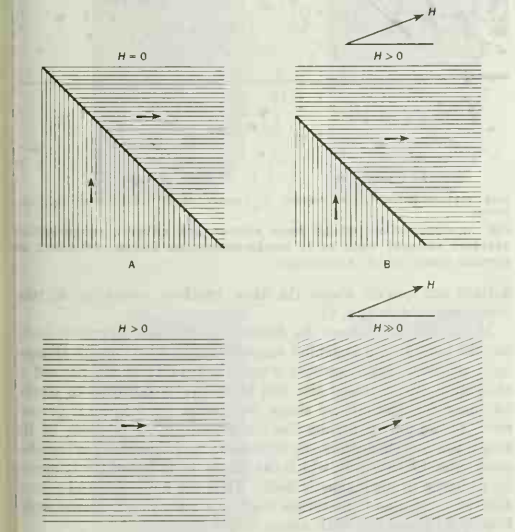

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FIG. 26.—MECHANISM OF CHANGE OF MAGNETIZATION. DOMAIN WALL MOTION IN WEAK FIELDS (A, B), DOMAIN ROTATION IN STRONG FIELDS (C, D)

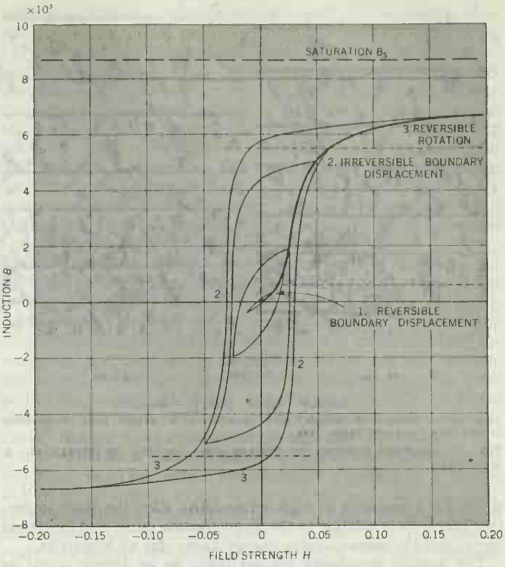

FIG. 27.—NATURE OF CHANGE IN MAGNETIZATION IN RELATION TO POSITION ON MAGNETIZATION CURVE AND HYSTERESIS LOOP

The magnetic moment of any one domain is specified by the magnitude and direction of its magnetization and by its volume. Ordinarily at constant temperature the moment of a domain, and therefore the magnetization of the ferromagnetic body of which it is a part, is changed by: (1) a change in the direction of magnetization of the domain (rotation); or (2) a change in the volume of the domain (moving boundary). These processes are indicated graphically in fig. 26. It has been shown by R. Becker that the moving boundary is particularly important for changes in low- and medium-strength fields. Processes may be classified also as reversible or irreversible accordingly as the energy dissipated in heat is a relatively small or large fraction of the potential energy.

In each of these portions of the magnetization curve, one type of process preponderates as follows: (1) initial portion—reversible boundary displacement; (2) middle portion—irreversible boundary displacement; (3) upper portion—reversible rotation. Fig. 27

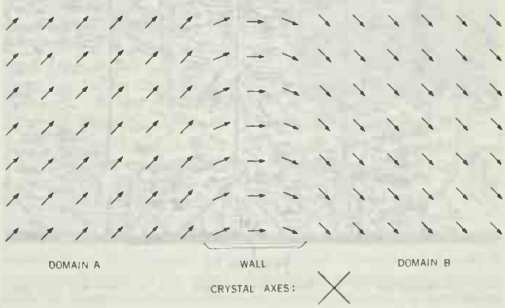

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FIG. 28.—SCHEMATIC OF DOMAIN WALL AS TRANSITION BETWEEN DOMAINS. ACTUAL WALLS MAY BE 1,000 ATOMS THICK

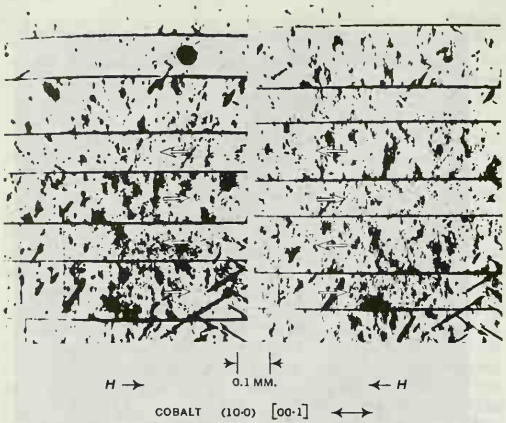

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FIG. 29.—POWDER PATTERN OF DOMAIN WALL MOTION IN COBALT (H. J. WILLIAMS)

shows for a specimen of high-permeability alloy the three important processes in relation to the magnetization curve and hysteresis loops, and the corresponding energy losses due to hysteresis.

The domain boundaries are not sharp on an atomic scale; as shown in fig. 28 the orientations of the atoms change progressively across the wall. In iron the wall is about 1,000 atoms thick instead of the three indicated in the schematic drawing.

If the dimensions of a magnetic particle are about the same as the wall thickness it is apparent that there can be no change in magnetization by wall displacement. Change in magnetization must then occur by domain rotation, and stronger fields are necessary to produce a given change in magnetization, provided that the particles are magnetically anisotropic. Consequently an agglomerate of fine particles will make a good permanent magnet.

The factors that determine the direction of magnetization in a single domain of a specimen are the crystal structure, the state of strain and, of course, the direction and strength of the magnetic field. The effect of crystal structure and of strain will be discussed in some detail later. It may be mentioned in a preliminary way that the nature of the crystal structure affects mainly the upper part of the magnetization curve of a permeable material. In iron, for example, the crystal structure is such that the magnetic properties of a single crystal vary considerably with direction, and as a result of this variation exceptionally strong fields are necessary to approach saturation in ordinary polycrystalline iron. The rotation of the domain by the field must be made against relatively powerful forces, and so the magnetization curve above the knee rises slowly over a considerable distance. In contrast, with permalloy, composed of 60% to 80% nickel and 40% to 20% iron, the magnetic properties vary but little with the direction in the crystal, the domains therefore rotate easily and the magnetization curve flattens out quickly above the knee, reaching saturation in relatively weak fields (fig. 9).

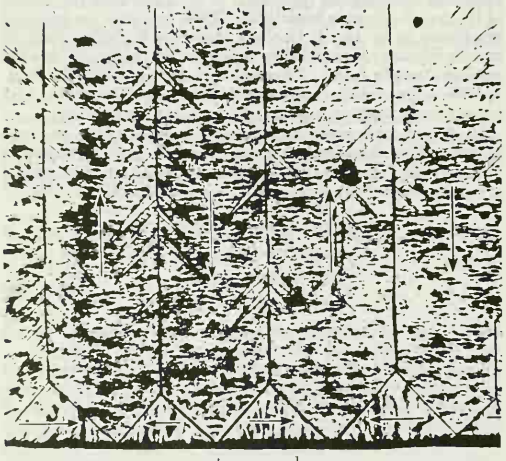

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FIG. 30.—DOMAIN STRUCTURE IN [100] PLANE OF IRON, SHOWING TRIANGULAR DOMAINS OF CLOSURE AT EDGE OF CRYSTAL. UNMAGNETIZED (H. J. WILLIAMS)

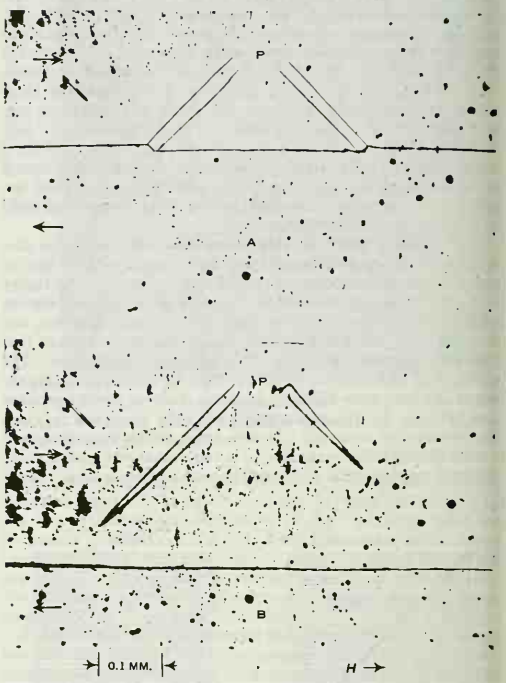

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FIG. 31.—SECONDARY WALLS FROM SUBSURFACE CRYSTAL IMPERFECTION RESTRICT PRIMARY WALL AS IT MOVES DOWNWARD UNDER INFLUENCE OF APPLIED FIELD (R. C. SHERWOOD)

Magnetization changes the dimensions of a ferromagnetic body, and the body is said to exhibit magnetostriction. If length changes by a relatively large amount when a substance is magnetized to saturation, this material also will be relatively sensitive to strain; *i.e.*, magnetostriction and strain sensitivity are reciprocal properties. Strain affects mainly the lower and middle portions of the magnetization curve, and the strain and magnetostriction together determine the ease with which the interdomain boundary is moved by a change in the magnetic field. Thus the highest initial permeabilities are found in materials that have very small magnetostriction; *e.g.*, permalloy with about 80% nickel.

6. Powder Patterns.—For many decades iron filings have been used to portray the directions of lines of magnetic force in air and to detect flaws or inhomogeneities in magnetic materials. (*See* NONDESTRUCTIVE TESTING.) In 1931 it occurred to L. von Hámos

and P. A. Thiessen to use fine magnetic powder to detect the local inhomogeneities in magnetization that the domain theory predicts. Independently F. Bitter applied a suspension of siderac (Fe_2O_3), with particles about 10^{-4} cm. in diameter, to a polished magnetized surface and observed under the microscope that the powder formed parallel lines regularly spaced about 0.1 mm. apart and approximately perpendicular to the direction of magnetization. The technique and interpretation of such patterns were then the subjects of study by a number of workers. A notable advance was made by H. J. Williams, R. M. Bozorth and W. Shockley, who used carefully prepared surfaces of single crystals of silicon iron and other substances. They and other experimenters confirmed many of the processes predicted by domain theory. Fig. 29 shows a domain pattern on a single cobalt crystal; the motion of the boundaries with change in direction of applied field can be seen. In fig. 30, a domain pattern near the edge of a crystal of iron, both 180° and 90° walls (between domains magnetized in opposite directions and at right angles) are observed. The small domains at the bottom are domains of closure and permit the flux to flow easily in the directions of easy magnetization indicated by the arrows. A discussion of the easy directions of magnetization is given in *VII. Properties of Single Crystals* below.

The effect of imperfections on wall movement is illustrated by the two parts of fig. 31. In (A) the imperfection is near a principal wall which moves under the influence of a field, and from the imperfection there are subordinate walls stretching from the principal wall. But when this wall moves too far from the imperfection the subordinate walls are stretched too far and ultimately break, thus releasing the energy stored in the subordinate walls, and the principal wall moves forward suddenly.

The structures of some powder patterns are simple and well understood. It is believed that the more complicated patterns are controlled by the same factors, illustrated in fig. 32.

The energies involved are: (1) magnetostatic energy, associated with magnetic charge or poles; (2) magnetostrictive energy, associated with the spontaneous change in dimensions of a domain when it is formed as a magnetic unit; and (3) the energy associated with the domain wall. In the various configurations of fig. 32, (A) shows a single isolated domain with a large amount of magnetostatic energy; in (B) this is reduced but some wall energy is added; in (C) the magnetostatic energy is further reduced but magnetostrictive energy, associated with nonparallel domains, is added; and in (D) the latter is reduced and some domain wall energy is added. The stable configuration is that for which the total energy is a minimum. The amounts of energy can be evaluated for simple configurations such as the one shown, and quantitative agreement with experiment is found. The resemblance between fig. 32(D) and fig. 30 is easy to see. Complex structures presumably are subject to the same principles.

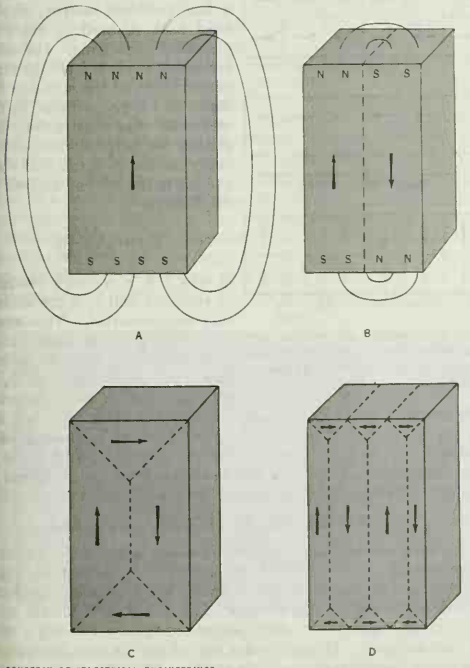

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FIG. 32.—POSSIBLE DOMAIN STRUCTURES (*see* TEXT EXPLANATION)

7. Barkhausen Effect.—In 1919 Barkhausen discovered the effect known by his name, and interpreted it as demonstrating that the magnetization of iron proceeds by steps and not in a continuous manner. This effect may be demonstrated simply with the aid of amplifier and headphones. As the field is changed slowly the succession of clicks heard in the headphones, or in a loud-speaker, persists only when the magnetization is changing along the steep part of the magnetization curve or hysteresis loop. The clicks are identified with irreversible changes in magnetization (process [2] above) and are direct evidence of the existence of domains.

It is now known that the discontinuities of the Barkhausen effect result from the sudden movement of a portion of a domain wall from one stable position to another, the positions of stability being determined by the location of crystal imperfections. During one discontinuity in magnetization the volume of the material swept over by the wall is on the average about 10^{-6} mm.^{3}, whereas the volume of a single domain is of the order of 10^{-3} mm.^{3}

VI. STRESS AND MAGNETOSTRICTION

The magnetic properties of many ferromagnetic materials are so sensitive to the application of stress that stress may be ranked with field strength and temperature as a primary factor affecting magnetic change. Stresses of two kinds should be distinguished: large stresses that permanently deform the material almost invariably produce a decrease in permeability; stresses within the elastic limit may either increase or decrease the permeability, depending on the nature of the material.

When moderate tension is applied to a specimen of nickel, permeability is decreased. The magnetization curve taken with tension applied always lies below that for the unstrained material (fig. 33), and the curve is always lower with greater tension. The effect of stress on the magnetization curve is greatest in the middle portion of the curve, and approaches zero when the specimen is unmagnetized or saturated.

With some materials, on the other hand, the effect of tension is to increase permeability. For example, in 68 permalloy (68% nickel and 32% iron) the maximum permeability is higher by a factor of 8 when the tension is 2 kg./mm.^{2} and by a factor of about 30 when the tension is 11 kg./mm.^{2} (about 15,600 lb./in.^{2}), the elastic limit of this material. As the stress exceeds the elastic limit the permeability of any material decreases rapidly.

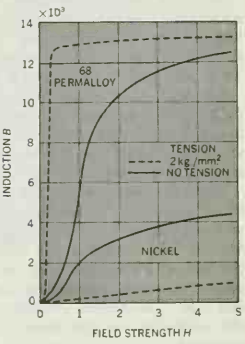

FIG. 33.—EFFECT OF TENSION ON MAGNETIZATION OF 68 PERMALLOY AND NICKEL. TENSION IS HELD CONSTANT WHILE FIELD IS INCREASED FROM ZERO

The effect of stress on magnetization is closely related to magnetostriction, the change of dimensions that occurs when a body is magnetized; that is, the effect of strain on magnetization and the effect of magnetization on strain are interdependent. When nickel is magnetized it contracts a small fraction of its original length l, at most 40 parts per 1,000,000. The fractional change of length $\Delta l/l$ with field strength H is first slow, then rapid, then again slow

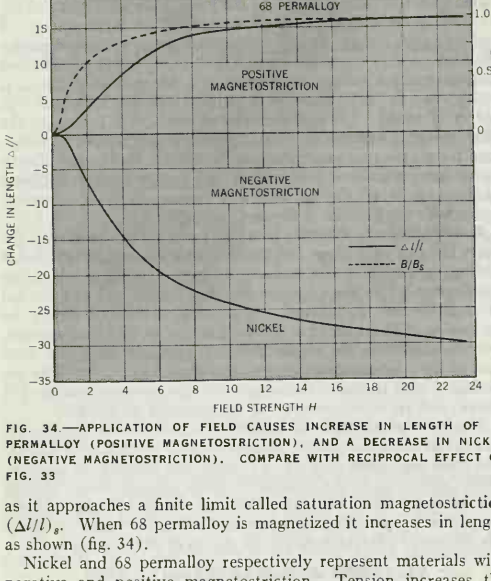

FIG. 34.—APPLICATION OF FIELD CAUSES INCREASE IN LENGTH OF 68 PERMALLOY (POSITIVE MAGNETOSTRICTION), AND A DECREASE IN NICKEL (NEGATIVE MAGNETOSTRICTION). COMPARE WITH RECIPROCAL EFFECT OF FIG. 33

as it approaches a finite limit called saturation magnetostriction $(\Delta l/l)_s$. When 68 permalloy is magnetized it increases in length as shown (fig. 34).

Nickel and 68 permalloy respectively represent materials with negative and positive magnetostriction. Tension increases the magnetization of a body that exhibits positive magnetostriction, and decreases the magnetization if it has negative magnetostriction. The effect of compression is opposite to that of tension; consequently the magnetization of magnetostrictively positive materials is decreased by pressure. In this discussion it has been assumed that tension and compression are applied parallel to the direction of the magnetic field; if pressure is applied at right angles to the field the effect on magnetization is the opposite; *i.e.*, compression applied to nickel at right angles to the field will decrease the magnetization measured parallel to the field.

Iron and some other materials have magnetostriction that is sometimes positive and sometimes negative. The magnetostriction of iron is positive in weak fields and negative in strong fields; the effect of tension is, as expected, to increase magnetization in weak fields and to decrease it in strong fields.

Generally the magnetostriction begins to increase rapidly with field strength at about the knee of the magnetization curve. The magnetization reaches one-half to two-thirds of its saturation value while the magnetostriction is still only one-fourth to one-third of its final value $(\Delta l/l)_s$.

Both the strain sensitivity and magnetostriction of the iron-nickel alloys are of special interest. The saturation magnetostriction (the greatest change in length) goes through zero at about 81% nickel, a composition close to that of the permalloys with the highest permeability; L. W. McKeehan has pointed out the close theoretical connection between the low magnetostriction and high permeability of these alloys. The strain sensitivity of the permalloys is also zero at about 81% nickel, as would be expected.

Large magnetostriction has been reported for iron-cobalt ferrite ($CoFe_2O_4 \cdot Fe_3O_4$) at room temperature: about 750×10^{-6}. At low temperatures so-called "giant" magnetostriction has been observed in the rare-earth elements holmium and dysprosium: 7000×10^{-6}.

Measurements of magnetostriction are commonly made with strain gauges, as proposed by J. E. Goldman. These are fine wires cemented firmly to the surface of the body to be measured. When the body expands or contracts, the wire expands or contracts with it and the resistance of the wire changes accordingly. The resistance can be measured with high accuracy so that the change in dimensions can be determined to 1 part in 10,000,000 to 100,000,000 (10^{-7} to 10^{-8}).

1. Changes in Volume.—When iron is magnetized in not too strong a field its length increases and its cross-sectional area decreases in about the same proportion, leaving the volume approximately constant. A small change in volume, usually an expansion, can be detected with sensitive apparatus. When a field of about 2,000 oersteds is applied, the fractional change in volume in iron is about 10^{-6}, and in nickel about one-third of this amount. It is relatively large in the iron-nickel alloys with about 30% nickel, amounting to about 40×10^{-6}.

Closely connected with the change in volume with field strength is the change of magnetization with hydrostatic pressure. As indicated by the magnitude of the volume magnetostriction, this change is small.

2. Domain Interpretation of Stress.—According to the domain theory, in a material with positive magnetostriction, the magnetization of a single domain will tend to be parallel to the direction of tension. In an unmagnetized material with domains oriented initially at random the domains are rotated by a sufficiently large tension, as shown in fig. 35(A) and (B), because the directions of easy magnetization in the various domains have been changed by the stress. If a field is then applied (fig. 35[C]), half of the domains reverse in direction and the material is saturated. (No magnetostrictive change in length accompanies such domain reversals.)

Compression makes the domains orient transversely (fig. 35[D]). If a material has negative magnetostriction, tension will have the same result, and a field subsequently applied will rotate the domains toward saturation.

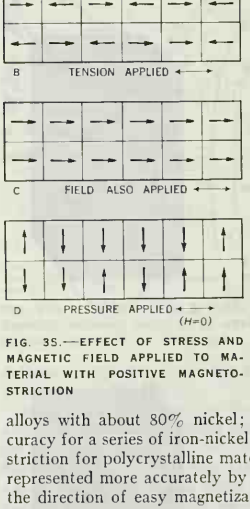

FIG. 35.—EFFECT OF STRESS AND MAGNETIC FIELD APPLIED TO MATERIAL WITH POSITIVE MAGNETOSTRICTION

The domain theory has been successful in predicting the highest value of the initial permeability that can be attained when impurities have been reduced to a minimum and internal strains have been relieved as much as possible by annealing. The small remaining strain is from the magnetostriction of the separate domains and is proportional to the saturation magnetostriction; the smaller the magnetostriction the larger the initial permeability according to the relation derived by M. Kersten

$$\mu_o = \frac{4I_s^2}{(\Delta l/l)_s^2 E}$$

in which E is Young's modulus of elasticity and I_s is the saturation magnetization. This equation, although by no means exact, is in agreement with the finding that μ_0 is large when $(\Delta l/l)_s$ is small, as it is in the iron-nickel alloys with about 80% nickel; the equation holds with fair accuracy for a series of iron-nickel alloys. For $(\Delta l/l)_s$ the magnetostriction for polycrystalline material can usually be used, but it is represented more accurately by the magnetostriction measured in the direction of easy magnetization in a single crystal.

VII. PROPERTIES OF SINGLE CRYSTALS

Improvements in the technique of growing large metallic crystals have opened to investigation the magnetic properties of single crystals of iron, cobalt, nickel and many alloys of these elements, as well as the nonmetallic ferrites. Crystals of some metals, such as nickel and nickel-iron alloys, are grown by slow-freezing a melt of pure material. This method is not adapted to iron, because of the phase transformation of iron at about 900° C.; single crystals of this element are grown by stretching a pure specimen a definite

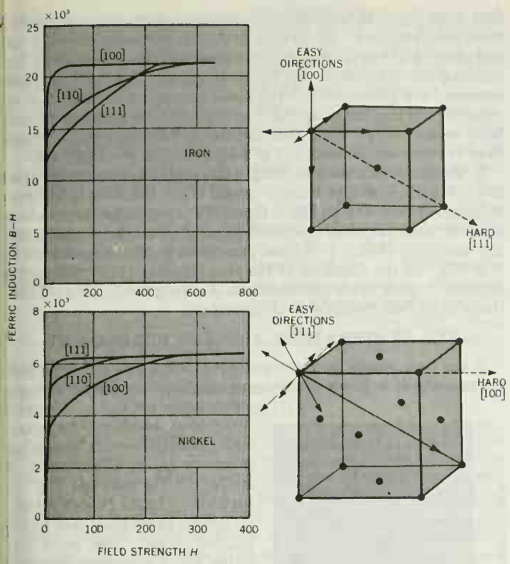

FIG. 36.—MAGNETIC PROPERTIES AND CRYSTAL STRUCTURES OF SINGLE CRYSTALS OF IRON AND NICKEL (K. HONDA AND S. KAYA, W. L. WEBSTER)

amount and then heating it for a long time just below the transformation temperature.

In the cubic crystals of iron and nickel the magnetic properties depend on the direction, with respect to the crystal axes, in which these properties are measured. Fig. 36 shows magnetization curves for iron and for nickel, with B and H measured in the three principal directions: (1) parallel to an edge of the cube—the [100] direction; (2) parallel to a diagonal of a cube face—the [110] direction; and (3) parallel to the space diagonal—the [111] direction. (*See* CRYSTALLOGRAPHY: *Translational Order in Crystals.*) The direction for which the magnetization curve lies highest is the direction in which magnetization is most easily acquired, and is called the direction of easy magnetization. In iron this direction is parallel to a cube edge; in nickel it is parallel to a cube diagonal.

According to the domain theory the direction of easy magnetization in a crystal determines the actual direction of magnetization in a single domain that is not subjected to magnetic field or strain. In unmagnetized iron the domains are oriented in each of the six directions parallel to a cube edge so that the net magnetization is zero. In nickel there are eight such easy directions.

Magnetization curves of single crystals of a silicon-iron alloy

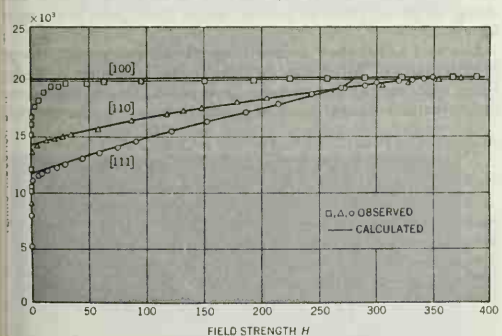

FIG. 37.—COMPARISON OF THEORY AND EXPERIMENT FOR MAGNETIZATION OF IRON-SILICON CRYSTAL IN THREE PRINCIPAL DIRECTIONS (H. J. WILLIAMS)

(3.8% silicon) are of special interest because this is the first case in which measurements were extended to very low inductions, and because the permeabilities obtained in these crystals are enormous compared with those in commercial silicon-iron sheet with the same silicon content. These data were obtained by cutting a single crystal in the form of a hollow parallelogram with all sides parallel to equivalent directions in the crystal (*e.g.*, parallel to diagonals of cube faces), so forming a closed magnetic circuit, and by measuring in the usual way. The highest permeability observed is about 100 times that of commercial transformer sheet.

1. Calculation of Magnetization Curves.—A theoretical study of the properties of crystals has made it possible to calculate the magnetization curve for any direction in a single cubic crystal like iron or nickel, provided that a single constant of the crystal (the anisotropy constant K) is known. This constant is a measure of the difference between the magnetization curves in different directions, and is numerically equal to four times the area between the curves showing the relationship between I and H for the [100] and [110] directions. The constant is positive for iron, negative for nickel, and is approximately zero for iron-nickel alloys with 65% to 80% nickel.

Comparison of theory and experiment is made in fig. 37 using Williams' data for a single crystal that contained 3.8% silicon, for which $K = 280{,}000$ ergs/cm.^{3}; the theory does not take account of the energy associated with the lower and middle portions of the magnetization curve; therefore, the calculated curves do not correspond to the true magnetization curve below its knee. In a polycrystalline material the magnetization curve is a combination of the separate curves for the many small single crystals of which it is composed. Such a composite curve has been calculated to show how the magnetization curve approaches saturation, and shows fair agreement with empirical data.

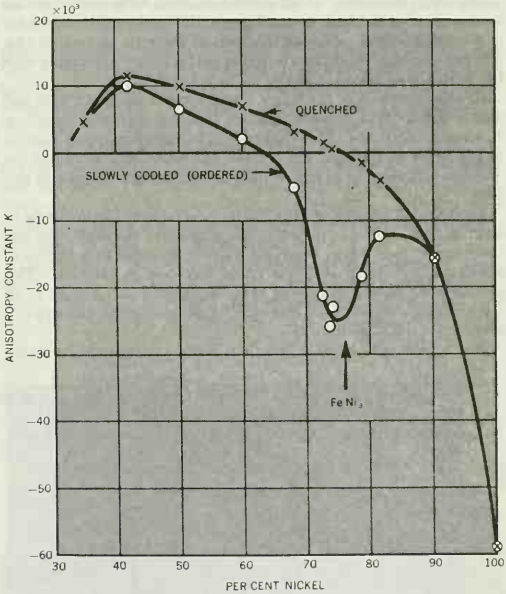

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FIG. 38.—CRYSTAL ANISOTROPY CONSTANTS OF IRON-NICKEL ALLOYS AFTER QUENCHING OR SLOW COOLING (R. M. BOZORTH AND J. G. WALKER)

In iron and nickel the anisotropy constants decrease as temperature increases; thus these metals are isotropic over a considerable range of temperature before they become nonmagnetic at the Curie point. At very low temperature (20° K.) the constant for nickel is 10 to 15 times what it is at room temperature, while for iron the corresponding ratio is only 1.5.

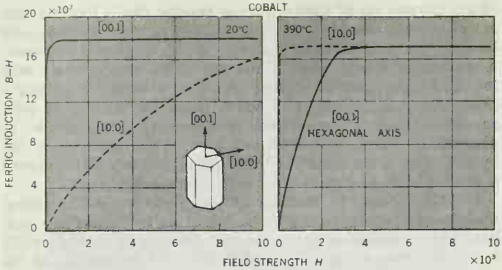


FIG. 39.—CRYSTAL ANISOTROPY OF COBALT REVERSES SIGN AT ABOUT 270° C., DIRECTION OF EASY MAGNETIZATION CHANGING FROM HEXAGONAL AXIS [00·1] BY 90° TO [10·0] (K. HONDA AND H. MASUMOTO)

2. Anisotropy.—Unusual magnetic properties are found in alloys with small anisotropy constants. Such alloys are the permalloys that contain between 60% and 80% nickel, in which range the constant goes from positive to negative (fig. 38). When the anisotropy is small, and the orientation of the domain therefore is controlled only weakly by the crystal structure, the material responds easily to magnetic field or to mechanical stress; thus it saturates in relatively weak fields and is unusually strain sensitive.

The small anisotropy of the permalloys with 60% to 80% nickel is associated with their unusual properties under heat treatment in a magnetic field. A hysteresis loop of material so treated (fig. 13) and the high values of maximum permeability associated with the permalloys have already been mentioned.

Cobalt differs from the other ferromagnetic elements, iron and nickel, by having a hexagonal rather than cubic crystal structure. At room temperature the direction of easy magnetization is parallel to the hexagonal axis of the crystal, and when unmagnetized the domains therefore lie in one of the two orientations parallel to this axis.

Such a small number of easy directions, compared with the six or eight in a cubic crystal, means that the domains are needlelike and that the whole magnetic structure may be regarded as a bundle of needles magnetized initially in either direction at random. This picture is supported by powder patterns (*see* fig. 29) and by L. H. Germer's measurements of magnetic fields close to the surfaces of a single crystal of cobalt.

The crystal anisotropy of cobalt is large; consequently a strong field is necessary to saturate a crystal in the direction of most difficult magnetization. More than 10,000 oersteds are required for this purpose at room temperature compared with 600 oersteds for iron and 300 for nickel. At higher temperatures cobalt becomes isotropic, and above 300° C. the hexagonal axis is the direction of most difficult magnetization, all directions at right angles to the axis being equally easy. Magnetization curves for the principal directions at room temperature and at 390° C. are shown in fig. 39.

3. Magnetostriction in Single Crystals.—The magnetostrictive change in length of a single crystal is not the same in all crystallographic directions. This is especially pronounced in iron which expands when the field is applied parallel to a crystal axis [100] and contracts when it is applied parallel to a cube diagonal [111] (fig. 40). In the direction of the face-diagonal [110] the crystal expands in weak fields and contracts in strong fields. Nickel contracts in all field strengths in all directions.

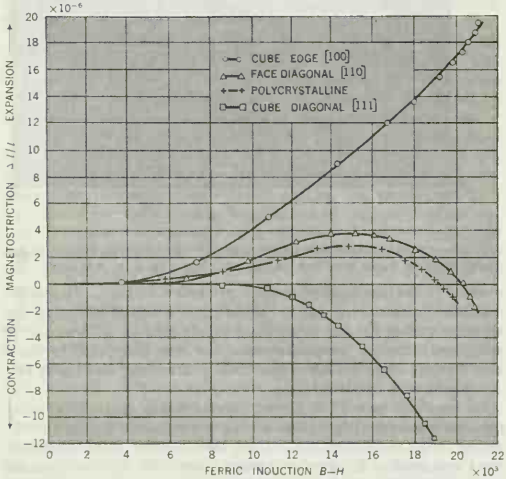


FIG. 40.—DEPENDENCE OF MAGNETOSTRICTIVE CHANGE IN LENGTH ON CRYSTAL DIRECTION IN IRON (W. L. WEBSTER)

VIII. TEMPERATURE AND THE CURIE POINT

It has been known for many years that when iron reaches a high temperature it loses its ferromagnetism and is no longer strongly attracted by a magnet. The temperature at which any ferromagnetic material loses its magnetism is known as the Curie point; it is 770° C. for iron and 358° C. for nickel. In the 1960s the highest known Curie point was 1,120° C., for cobalt. For some materials the Curie point lies near the absolute zero of temperature.

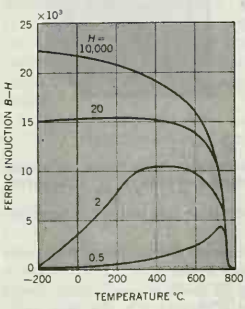


FIG. 41.—EFFECT OF TEMPERATURE ON MAGNETIZATION OF IRON SUBJECTED TO FIELDS OF VARIOUS STRENGTH. MAGNETIZATION DROPS TO LOW VALUE AT CURIE TEMPERATURE, 770° C. (E. M. TERRY)

When a magnetic material is subjected to a strong constant field, an increase in temperature brings about a continuously accelerating decrease in induction. At the Curie point the induction comes down abruptly, almost to zero, and the curve is retraced when the temperature is lowered again. Fig. 41 shows this behaviour in iron. On the other hand when the iron is subjected to a weak field the induction will first increase with temperature and after passing through a maximum will drop to a low value at the Curie point as before.

In iron and in other materials which may be called normal, the initial and maximum permeabilities first increase and then decrease with increasing temperature, and the coercive force and hysteresis loss continually decrease. The characteristic maximum in the initial and maximum permeabilities, just below the Curie point, is associated with the low magnetic anisotropy at this temperature. The way in which the size and shape of the hysteresis loop of iron change as the temperature approaches the Curie point is shown in fig. 42.

Iron and nickel show normal magnetic behaviour with change of temperature. No changes in their crystal structures occur between room temperature and the Curie point. On the other hand such structural changes do occur in many alloys; *e.g.*, the so-called

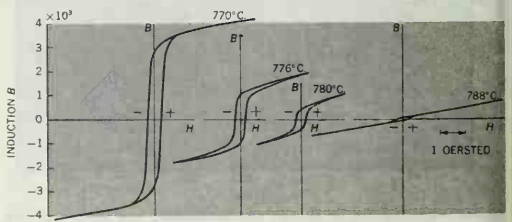


FIG. 42.—CHANGE IN FORM OF HYSTERESIS LOOP OF IRON NEAR THE CURIE POINT (H. KÜHLEWEIN)

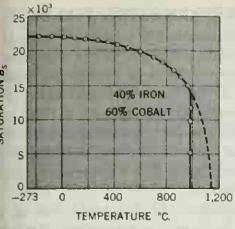


FIG. 43.—CURIE POINT DETERMINED BY CHANGE IN PHASE; AT 980° C., FOR IRON-COBALT ALLOY (A. PREUSS)

irreversible alloys of iron and nickel (5% to 30% nickel), investigated by J. Hopkinson, and some of the iron-cobalt alloys. In the 60% cobalt-iron alloy a change in phase (due to a rearrangement of the atoms in the crystal) from a body-centred cubic (α) to a face-centred cubic (γ) form occurs when the alloy is heated above 980° C. The α phase is ferromagnetic while the γ phase is nonmagnetic (*i.e.*, paramagnetic). Consequently the material loses its ferromagnetism when heated through 980° C., and the magnetization (measured in a strong field) drops toward zero precipitously (fig. 43) instead of in the normal fashion as it does for iron (fig. 41).

IX. EFFECT OF MAGNETIZATION ON OTHER PROPERTIES

Aside from producing magnetostriction, magnetization also effects changes in many other properties; and a ferromagnetic material, even though unmagnetized, has properties that are characteristic of its ferromagnetism. The more important of these properties are: (1) electrical resistance; (2) thermal expansion; (3) Young's modulus and other elastic constants; (4) magneto-caloric effect; and (5) specific heat. The resistivity of magnetic materials is affected also by stress; tension may either increase or decrease

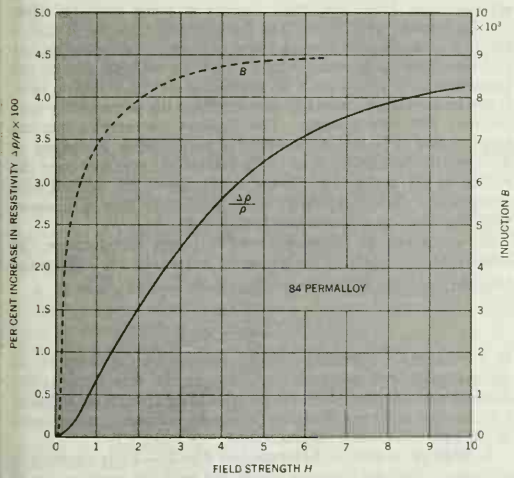


FIG. 44.—RESISTIVITY (ρ) OF MAGNETIC MATERIAL (PERMALLOY) INCREASES SLIGHTLY WITH MAGNETIZATION. MOST OF INCREASE OCCURS AFTER MAGNETIZATION IS WELL BEYOND KNEE OF MAGNETIZATION CURVE (L. W. MC KEEHAN)

the resistivity, depending on whether the material has positive or negative magnetostriction.

1. Magnetism and Resistivity.—When nickel is magnetized in a strong field, its electrical resistivity is increased by about 2%, and a similar but smaller effect is found in iron. Such changes were first reported by Lord Kelvin in 1851. A larger change in resistivity, as high as 4% to 5%, is shown by iron-nickel alloys with 70% to 85% nickel. The increase in resistivity with field strength for 84 permalloy (fig. 44) illustrates the general rule that most of the change occurs when the magnetization is well beyond the knee of the curve, and suggests that the change in resistivity (like the magnetostrictive change in length) is associated with rotations rather than reversals of domains. There is a close relation between changes in length and changes in resistivity; these quantities usually have a constant ratio.

Resistivity is abnormally low whenever a material exhibits ferromagnetism. This may be illustrated by comparing the resistivities of nickel and palladium, elements with similar positions in the periodic table. The resistivity-temperature curves (fig. 45) are drawn so that they coincide at a temperature just above the Curie

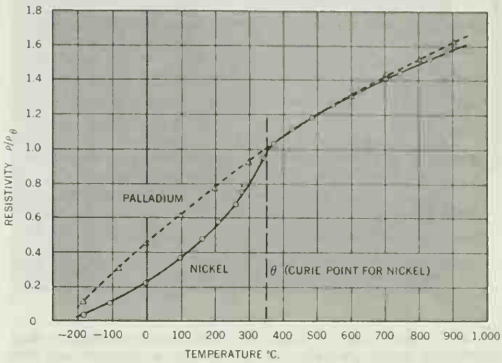


FIG. 45.—RESISTIVITY OF MAGNETIC MATERIAL IS ABNORMALLY LOW AS LONG AS IT IS FERROMAGNETIC (H. H. POTTER AND J. G. G. CONYBEARE)

point θ of nickel, when both metals are nonmagnetic; the separation of the curves below this temperature indicates ferromagnetic lowering of resistivity. The ferromagnetism becomes progressively weaker as the Curie point is approached, and the separation of the curves in the figure correspondingly diminishes.

2. Magnetism and Thermal Expansion.—The thermal expansion of magnetic materials is so abnormal that occasionally they will contract as the temperature is raised in the vicinity of the Curie point. In some alloys, such as invar, the expansion is very small over a range of temperatures that includes room temperature, a property of great technical importance.

The origin of the abnormal expansion lies in a change in interatomic forces that occurs when the material becomes ferromagnetic. The iron-nickel alloys show these changes in a striking way (fig. 46). As nickel and the alloys with more than 70% nickel cool through the Curie point, the expansion coefficients first increase and then decrease rapidly. In contrary fashion, the coefficients of alloys with 30% to 70% nickel first decrease sharply and then increase. These changes may be regarded as the result of the superposition of a magnetic expansion or contraction on the normal; in invar, which contains about 36% nickel, the anomalous and normal expansions neutralize each other at room temperature.

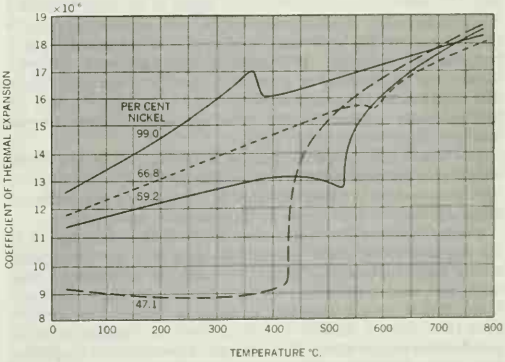


FIG. 46.—THERMAL EXPANSION CURVES OF MAGNETIC MATERIALS SHOW ANOMALIES NEAR AND BELOW CURIE POINTS (P. CHEVENARD)

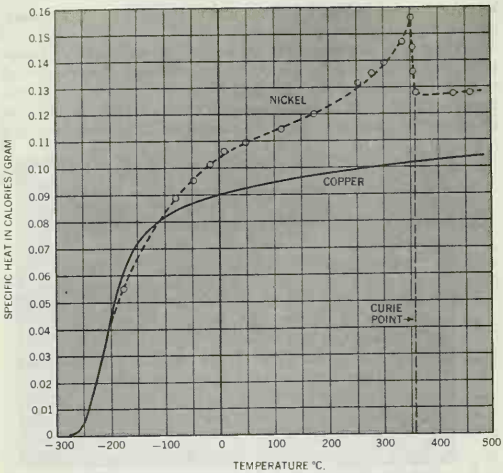


FIG. 47.—SPECIFIC HEAT OF A MAGNETIC SUBSTANCE IS UNUSUALLY HIGH. CURVES FOR NICKEL (E. LAPP) AND COPPER (H. KLINKHART) ARE COMPARED

When the nickel content is about 70%, there is no anomalous magnetic expansion or contraction at any temperature; at this composition the Curie point of these iron-nickel alloys is a maximum.

3. Abnormal Stress-Strain Relation.—In almost all substances a small mechanical stress σ (tension) will produce a strain ϵ (expansion) that is proportional to the stress, as required by Hooke's law

$$\epsilon = \sigma/E$$

in which Young's modulus E is constant. In an unmagnetized magnetic material, however, tension will change the direction of local magnetization (fig. 35), and produce a change in length equal to the magnetostriction of the material. Therefore, when tension is applied to a magnetic material, the whole expansion will be the sum of the normal expansion and the magnetostrictive expansion; consequently Young's modulus will vary with stress and deviations from Hooke's law occur (*see* ELASTICITY).

In a magnetic material Young's modulus will therefore vary both with the amount of strain and with the intensity of magnetization. The change of E with magnetization has been studied in a variety of materials and may be 10% or larger.

4. Specific Heat and Magnetocaloric Effect.—In comparing the specific heats of nickel and copper at various temperatures (fig. 47) there is an unusual effect in nickel in the neighbourhood of its Curie point. Such a rapid rise and still more rapid drop in the curve, occurring with rising temperature, is characteristic of a ferromagnetic material. In theoretical terms the heat necessary to raise the temperature of a magnetic material like nickel equals that for a similar but nonmagnetic material (*e.g.*, copper), plus the heat necessary to overcome the forces that hold the magnetic moments of neighbouring atoms parallel.

This characteristic specific heat of ferromagnetic bodies occurs whether or not the substance is magnetized in the usual sense. This phenomenon is strong evidence of spontaneous magnetization in certain regions or domains in ferromagnetic materials.

Similar evidence for spontaneous magnetization is supplied by the magnetocaloric effect. At temperatures near the Curie point, strong fields theoretically should increase the spontaneous magnetization, accompanied by a rise in temperature. Experimentally, Weiss and R. Forrer observed increases in temperature of more than 1° C. when a field of 18,000 oersteds was applied to nickel just below its Curie point. The change of spontaneous magnetization with temperature, derived from the data, is in good accord with the theory.

X. MAGNETIZATION IN ALTERNATING FIELDS

In many of their uses magnetic materials are subjected to an alternating field produced by an alternating current in the wire associated with the material. The primary effects of alternating fields are: (1) the effective permeability of the material is reduced; (2) the energy loss in the material is increased; (3) there is a time lag between change in field strength and the corresponding induction; and (4) at ultrahigh frequencies of alternation true permeability is less than at low frequencies. The distinction between effective and true permeability is discussed below.

1. Effect of Eddy Currents.—When the magnetic flux in a conducting medium changes with time an electromotive force is generated, and currents flow within the material. These Foucault currents (or eddy currents) depend on the geometry of the specimen, and on its resistivity and permeability; their direction is always such as to counteract the change in field that produced them (fig. 48). The effect of eddy currents is to prevent the field from penetrating immediately to the interior of the material, and when the applied field is varying continually, as it is in much of the apparatus in which magnetic material is used, the field strength inside the material may never be more than a small fraction of that at the surface. The magnetic induction, therefore, decreases from the surface toward the interior.

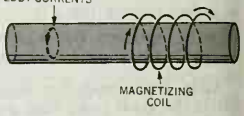


FIG. 48.—EDDY CURRENTS IN A SOLID BAR

To avoid this reduction in field strength and resultant decrease in alternating flux, the magnetic cores of transformers and other apparatus are laminated, each lamination being insulated electrically from its neighbour. The flux-carrying capacity of such a lamination depends on the thickness (t in cm.), permeability (μ) and resistivity (ρ in ohm-cm. $\times 10^9$) of the material and on the frequency (f in cycles/sec.) of alternation of the magnetic field. It can be calculated accurately provided that the permeability does not vary with field strength. This capacity for carrying flux can be expressed in terms of the effective permeability $\bar{\mu}$, defined as the ratio of the amplitude of the induction B (averaged over the section of the lamination) to the amplitude of the applied field strength H_a. When H_a varies sinusoidally with time, $\bar{\mu}/\mu$ varies with frequency as is shown graphically in fig. 49.

In laminations as commonly used in power transformers, the reduction in permeability is a negligible fraction of 1%. When the frequency is high, $\bar{\mu}/\mu$ is inversely proportional to $\sqrt{f}$, or

$$\bar{\mu} = \frac{\sqrt{\mu\rho}}{2\pi t} \cdot \frac{1}{\sqrt{f}}$$

In a transformer operating at radio frequencies the constants of the materials used are such that 95% of the true permeability is often lost. At these high frequencies the flux-carrying value of a material of given resistivity and thickness is directly proportional to the square root of its permeability.

2. Energy Losses in Alternating Fields.—Eddy currents in a magnetic material consume power and raise the temperature of the material. The power loss W_e may be calculated with some

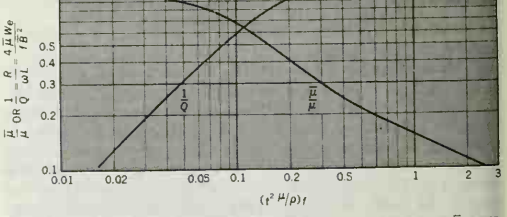


FIG. 49.—THEORETICAL CHANGE OF APPARENT PERMEABILITY $\bar{\mu}$, AND ENERGY LOSS W_e, DUE TO EDDY CURRENTS, WITH FREQUENCY $f = \omega/2\pi$ FOR SHEETS OF GIVEN THICKNESS t, PERMEABILITY μ AND RESISTIVITY ρ (OHM-CM. $\times 10^9$)

precision provided that μ does not vary with B; at low frequencies it is proportional to f^2. At high frequencies it is proportional to $f^{3/2}$, if the material is always magnetized to the same value of B

$$W_e = \frac{\pi t B^2}{\sqrt{\mu\rho}} \cdot f^{3/2}$$

If the amplitude of the magnetizing current is held constant, the loss is proportional to $f^{1/2}$. The hysteresis loss of a magnetic material at intermediate and high inductions is given approximately by Steinmetz' relation

$$W_h = \eta B^{1.6} f$$

The total loss due to hysteresis and eddy currents at low frequencies may then be written

$$W = W_h + W_e = \eta B^{1.6} f + A B^2 f^2$$

where A can be calculated theoretically under certain conditions, as shown above. This relation is sometimes used for the separation of the total loss (as measured with a wattmeter at a given value of B) into its hysteresis and eddy components.

When apparatus operates at low inductions, as it often does for transmission of the feeble signals used in communication, the energy losses incurred are usually measured with a Maxwell bridge, as described below under *XIV. Measurement of Magnetic Quantities*. The data obtained are the A.C. resistance R in ohms, and the inductance L in henries, of a coil surrounding the material under test. The ratio R/L is characteristic of the magnetic material and is related to the energy losses in ergs/cm.^{3} by the equation

$$\frac{R}{2\pi f L} = \frac{8\pi\mu W}{B^2}$$

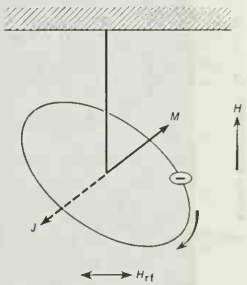
The reciprocal of $R/(2\pi fL)$ is often called the quality factor Q. When the frequency is low, the losses through eddy currents and hysteresis may be separated by plotting $R/(2\pi fL)$ or $R/(\mu Lf)$ against frequency. W_h varies as $B^3 f$, W_e varies as $B^2 f^2$ and

$$\frac{R}{\mu L f} = aB + c + ef$$

in which a and e respectively are called the hysteresis and eddy current constants, and c is a constant representing an energy loss of unknown origin, important only at very low inductions.

At moderately high frequencies and low inductions the losses in a material of high permeability usually result predominantly from eddy currents. These can be calculated as described above and for them $R/(2\pi fL)$, or $1/Q$, is shown by the curve of fig. 49.

3. Effects at High Frequencies.—In considering the effect of frequency on permeability it has been assumed that the permeability μ is independent of frequency and that only the effective permeability $\bar{\mu}$ diminishes as the frequency increases. However, at very high frequencies, of the order of 10^9 to 10^{10} cycles/sec., the permeability decreases to a small fraction of its value at low frequency. This decrease results primarily from the energy losses associated with rapid changes in magnetization. The losses stem from factors other than eddy currents, and may be associated, for example, with the bending of domain walls.



FROM "RECENT ADVANCES IN PHYSICS," M. H. SHAMOS & G. M. MURPHY (ED.), BY COURTESY OF NEW YORK UNIVERSITY PRESS, 1956

FIG. 50.—SPINNING ELECTRON IN ORBIT. MAGNETIC MOMENT M, AND ANGULAR MOMENTUM J, PRECESS UNDER INFLUENCE OF APPLIED FIELD H. RADIO-FREQUENCY FIELD H_{rf} IS APPLIED PERPENDICULAR TO H FOR RESONANCE

Experiments on ferromagnetic resonance at high frequencies have clarified the nature of the magnetic carriers and the forces between them, and have led to important applications of magnetic materials, especially the ferrites. The principle of the experiments and the experimental arrangements are as follows:

Imagine an electron traveling in an orbit and suspended in space as shown in fig. 50. The magnetic moment produced by the orbital motion and spin of the electron can be represented by the vector M. Antiparallel to M is the vector J, which represents the angular momentum of the electron. If a magnetic field H is applied as indicated, the vectors M and J will precess with the frequency $MH/(2\pi J)$.

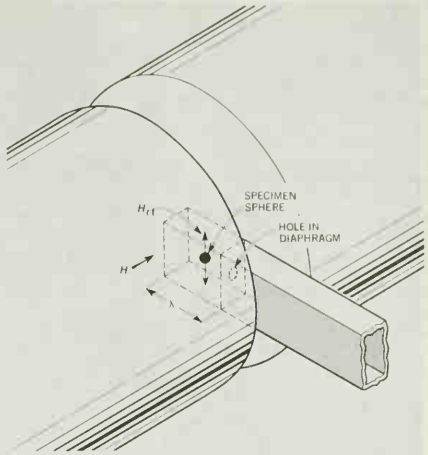


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FIG. 51.—ELECTROMAGNET WITH SECTION OF WAVE GUIDE SHOWING CAVITY USED FOR FERROMAGNETIC RESONANCE. HERE λ IS THE WAVE LENGTH OF THE MICROWAVES THAT EXCITE THE MAGNETIC FIELD H_{rf}

Now apply a small-amplitude alternating field H_{rf} with a direction perpendicular to H and a frequency equal to or near the precession frequency. The amplitude of the precessing magnetic moment will increase because it is continually pulled by the alternating field, until a final amplitude is reached which depends on the internal damping or energy loss associated with the precession. The amplitude of the magnetic moment obtained with a given alternating field is measured; by varying the frequency of H_{rf} until the amplitude is a maximum (at resonance) the natural frequency of precession and the ratio M/J can be determined. The results of the experiments give fundamental information concerning the nature of the magnetic dipoles and the forces acting on them in the solid state.

One way of observing resonance at microwave frequencies (*see* ELECTROMAGNETIC WAVES) is indicated in fig. 51. A wave guide is terminated at one end by a cavity one wave length long, and a small spherical specimen is supported at the centre of the cavity by a polystyrene rod. Under these conditions the alternating field, obtained by excitation of the wave guide, is perpendicular to the constant field H of several thousand oersteds which is supplied by an electromagnet. By measuring the standing wave pattern in the wave guide the effective permeability of the specimen, and in particular the maximum permeability at resonance, can be determined. The results of an experiment in which supermalloy was excited at 24,000 mc./sec. is shown in fig. 52. The position and sharpness of the peak give basic information about the gyromagnetic properties of the atoms and their interaction.

F. F. Roberts observed that if a piece of magnetized magnesium ferrite is placed in a microwave transmission line the plane of polarization of the wave is rotated through a large angle, *e.g.*, 90° or 180°, the amount of rotation (Faraday rotation) being governed by the intensity of magnetization of the ferrite. In manganese ferrite rotations of 90° to 180° can readily be observed. A device constructed on this principle by C. L. Hogan permits microwave transmission in one direction without appreciable loss but substantially prevents transmission in the opposite direction. Such a device can be used to prevent unwanted reflections in a transmission

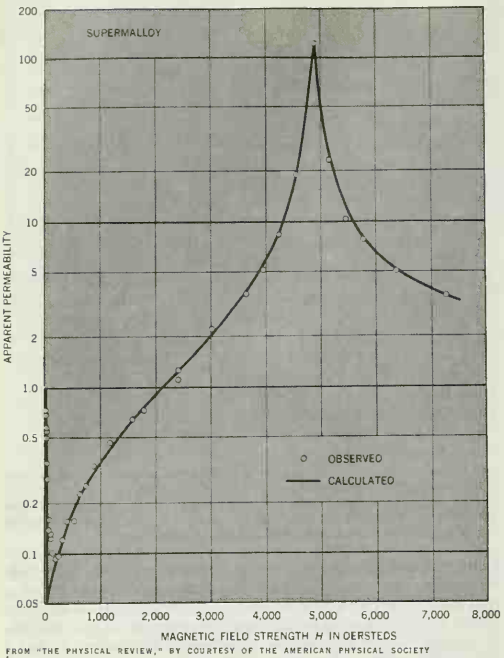

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FIG. 52.—PEAK IN PERMEABILITY AT RESONANCE (W. A. YAGER)

line, and similar devices can be adapted for many kinds of microwave switching.

4. Time Lag in Magnetization.—As already mentioned, eddy currents delay magnetization so that after a sudden change in H from one value to another, a perceptible time elapses before B reaches its final corresponding value. Another factor involved in this lag is metallurgical aging. This is usually observed in permanent magnets, the induction in which can be observed to change over a period of years, and is attributed to the slow precipitation of metallic phases from supersaturated solution at room temperature. Similar changes occur in ordinary annealed iron to an extent that the coercive force may eventually be doubled even though the material has not been heated above 100° C. Materials that have been severely cold-worked sometimes become magnetically softer as a result of slow relief of internal strains.

A more rapid change of induction with time has been observed repeatedly since Ewing's experiments of 1885. One method of experimenting is to change H suddenly, then observe the change in B with time. Another way is to measure the permeability at very low inductions, at various times after demagnetizing and after the measuring current has been applied. Such changes are associated with the impurities present, and disappear after purification at a high temperature in hydrogen. It has been suggested that the diffusion of traces of nitrogen or oxygen in iron will so impede the movement of domain boundaries as to account for the observed changes of permeability with time.

XI. DIAMAGNETISM

Faraday showed in 1845 that all substances may be classified as diamagnetic and paramagnetic (he felt ferromagnetism was a kind of paramagnetism). He distinguished between the paramagnetism and diamagnetism of feebly magnetic substances by suspending them in a strong inhomogeneous field and noting whether they were drawn into or repelled from the strongest part of the field. The force with which a diamagnetic material is repelled by a field is proportional to the strength H and gradient dH/dx of the field, and to the susceptibility κ and volume v of the material

$$f = \kappa v H dH/dx$$

The susceptibilities of solid diamagnetic substances are usually about -1×10^{-6} or -2×10^{-6}, and are normally independent of field strength. Bismuth has the exceptionally large value of -13×10^{-6}, but even this is millions of times less than that of the ferromagnetic metals. Bismuth is also exceptional in that its susceptibility varies with the field at low temperatures (50° K.).

While diamagnetic and paramagnetic materials have little practical use, a study of their behaviour is very important for an understanding of the nature of matter. Diamagnetism is an atomic property, and usually occurs when the atom has a symmetrical electronic structure and no permanent magnetic moment. In discussing diamagnetism it is appropriate to use the term atomic susceptibility defined as $\chi_A = \kappa A/d$, where A is the atomic weight and d is the density. Then $\chi_A H$ is the magnetic moment of one gram atomic weight; divided by Avogadro's number it is the average magnetic moment per atom resolved parallel to the magnetic field. Similarly $\chi_M = \kappa M/d$ is the molecular susceptibility, where M is the molecular weight.

As P. Curie showed in his classical researches (1895), diamagnetism is usually independent of temperature, and so is not disturbed markedly by atomic collisions or the positions of nearby atoms. However, some change in the diamagnetic susceptibility is generally noted when a substance changes from the solid to the liquid state.

Following the work of Curie, in 1910 and 1912 K. Honda and M. Owen reported measurements of the susceptibilities of many elements. Fig. 53 shows the atomic susceptibilities as dependent on atomic number according to more recent data summarized by P. W. Selwood. Here it is apparent that the rare-earth metals are strongly paramagnetic, that the metals of the transition groups containing palladium and platinum are rather strongly paramagnetic and that most good metallic conductors of electricity are weakly paramagnetic. This implies what is in fact the case, that in a metal the conducting electrons are paramagnetic. The other metals and the nonmetals are usually weakly paramagnetic or diamagnetic.

Most ionic and molecular compounds are also diamagnetic because their electrons are paired and their permanent moments tend to cancel each other; however, gaseous oxygen (O_2) is paramagnetic. Fig. 54 shows the atomic or molecular susceptibilities of some typical materials and the way they change with temperature.

1. Theory.—Modern understanding of the origin of diamagne-

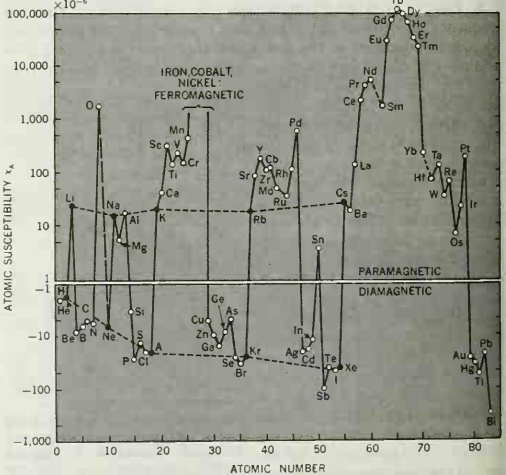

FIG. 53.—ATOMIC SUSCEPTIBILITIES OF THE ELEMENTS AT ROOM TEMPERATURE. DOTTED LINES CONNECT ALKALI METALS (PARAMAGNETIC) AND RARE GASES (DIAMAGNETIC)

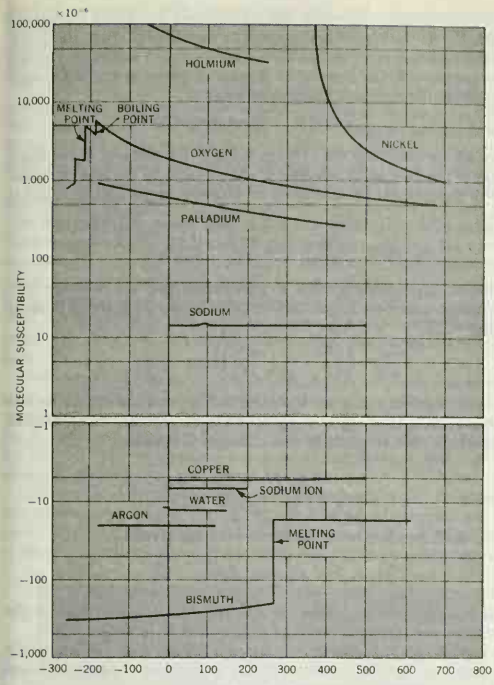

FIG. 54.—VARIATION OF ATOMIC OR MOLECULAR SUSCEPTIBILITY WITH TEMPERATURE FOR SOME REPRESENTATIVE MATERIALS

Susceptibilities of diamagnetic and weakly paramagnetic substances are normally independent of temperature; those of strongly paramagnetic substances decrease with increasing temperature

tism is due largely to Langevin, who published his celebrated paper on magnetism and electron theory in 1905. He considered an atom with a single electron of charge e and mass m traveling with velocity v in a circular orbit of radius r (fig. 55). This current gives rise to a magnetic moment M that is proportional to the current and the area of the orbit

$$M = \frac{ve/c}{2\pi r} \cdot \pi r^2 = \frac{ver}{2c}$$

where c is the velocity of light. As pointed out by Sir Joseph Larmor, application of a magnetic field H will create an electromagnetic force in the orbit, as a result of the flux threading it, and this will cause the electron to change velocity by

$$\Delta v = -\frac{eHr}{2mc}$$

in such a direction as to change the moment M by

$$\Delta M = \frac{er\Delta v}{2} = \frac{e^2Hr^2}{4mc^2}$$

The susceptibility of this atom is then $-\Delta M/H$, and the susceptibility of one gram atomic weight is

$$\chi_A = -\frac{Ne^2\overline{r^2}}{4mc^2}$$

where N is the number of molecules in a gram molecular weight. If an atom has many electron orbits, oriented in all directions with respect to the field, the atomic susceptibility becomes

$$\chi_A = \frac{Ne^2\Sigma\overline{r^2}}{6mc^2} = -2.83 \times 10^{10}\Sigma\overline{r^2}$$

in which the mean square orbital radius is summed over all the orbits.

The last equation, Langevin's equation of diamagnetism, applies to every diamagnetic or paramagnetic substance. If an atom has a permanent moment and the material is consequently paramagnetic or ferromagnetic, its susceptibility still has the diamagnetic component given by this equation.

Knowing the number of electrons in the atom, one may calculate from the diamagnetic susceptibility the average (root mean square) radius of an atom and compare this with the radius determined by other means. Values so obtained are consistent with present knowledge of atomic structure.

In quantum mechanics (*q.v.*) the Langevin formula still holds when the field of the nucleus is spherically symmetrical, as it is in atoms or ions. The meaning of the orbital radius r, however, is somewhat different, since the electrons are assumed to be distributed in less localized orbits. Calculation of diamagnetic susceptibilities by wave mechanics has been attempted for a number of the simple atoms and molecules and has been moderately successful for the rare monatomic gases helium, neon, argon, krypton and xenon, and for molecular hydrogen (H_2). For helium, theory indicates an atomic susceptibility ($\times 10^6$) of 1.65 to 1.90, depending on the method of calculation; G. G. Havens' empirical value is 1.91. For hydrogen the calculated and observed values respectively are 2.10 and 2.01. For the other elements listed, both theoretical and measured susceptibilities vary over a greater range.

Positive ions of the alkali and alkaline-earth metals and of the halogens have the rare gas structure and can also be treated theoretically. The lack of precision in calculation arises in the approximate nature of wave functions and the effective molecular charge assumed.

2. Compounds.—Most salts are diamagnetic because their ions (*e.g.*, Na^+ and Cl^-) have completed electron shells characteristic of the rare gases and consequently have no permanent magnetic moment. The susceptibilities of the separate ions can be deduced from a series of measurements on solid salts or solutions. There is some ambiguity in separating the susceptibility of the salt into its component parts, and there is also some change with concentration and state of aggregation, but each ion has a value of χ_A that is approximately constant. The observed increase of χ_A with the number of electrons n is to be expected according to simple theory. In ions with the same number of electrons but a different nuclear charge, as in the series I^-, Xe, Cs^+ and Ba^{2+}, diamagnetic susceptibility decreases numerically with increasing charge because the larger charge draws the electrons closer to the nucleus and so diminishes the value of Σr^2 in Langevin's equation.

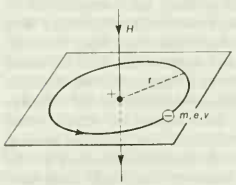

FIG. 55.—ELECTRON VELOCITY

Velocity of electron is changed by application of field H so that induced magnetic moment is in direction opposite to that of field

The principle of additivity of the diamagnetism of ions may be extended to include also the more complex ions NO_3^-, SO_4^{2-}, PO_4^{3-}, NH_4^+ and others. Values for these are less certain than those for the simple ions already considered.

In his early comprehensive experiments (1908–13) P. Pascal found the molecular susceptibility of many organic compounds to be the sum of the susceptibilities of the atoms composing them, plus additional terms characteristic of the various bonds occurring in the molecule.

While the Langevin theory is not very illuminating for a simple diatomic molecule like H_2, quantum mechanics can be used provided that the wave functions are known with sufficient accuracy. In the expression for χ_M there is a term, always positive, added to the negative term of the Langevin equation.

Van Vleck and N. H. Frank used the wave functions of molecular hydrogen to calculate both terms and found them to be -4.66×10^{-6} and $+0.51 \times 10^{-6}$. The net result of -4.15×10^{-6} may be compared favourably with the experimental values ranging from about -3.9 to -4.0×10^{-6}.

Calculation for heavier diatomic molecules cannot be performed so rigorously, and the approximate wave functions generally used for these substances give too high a value of χ_M. Knowledge of gases is also limited by the difficulty in making measurements with accuracy.

XII. PARAMAGNETISM

The paramagnetic susceptibility of materials examined by Curie decreased with increasing temperature. Subsequently a large class of weakly paramagnetic substances was found for which the susceptibility is practically independent of temperature (fig. 54); this class includes many of the metallic elements only when they are in the solid conducting state, and when the paramagnetism results from the conduction electrons. This is called weak paramagnetism; by contrast, strong paramagnetism depends on a permanent magnetic moment of the component atoms or molecules.

The origin of the two kinds of paramagnetism is shown schematically in fig. 56, where the curved lines represent electron

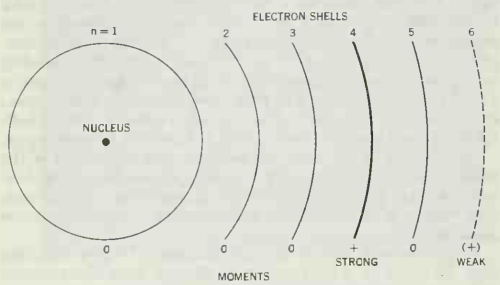

FIG. 56.—PARAMAGNETISM OCCURS WHEN INNER SHELL IS INCOMPLETE (HEAVY LINE) AND THEREFORE HAS PERMANENT MOMENT (STRONG PARAMAGNETISM), OR WHEN ELECTRONS OF OUTER SHELL (BROKEN LINE) BECOME CONDUCTION ELECTRONS IN METAL (WEAK PARAMAGNETISM)

shells in an atom. The outer line is broken to indicate that the electrons in this shell are loosely bound and become conduction electrons in a solid metal, or valence electrons in a compound. In a metal the spins of some of these electrons can be changed by an applied field in a way that can be explained by quantum mechanics, and can produce weak paramagnetism as in metallic sodium. Most of the other shells have their full complement of electrons, and the magnetic moments from their orbital and spin motions are self-neutralizing; thus they contribute only diamagnetism to the atom. On the other hand some of the shells in some atoms are incomplete and therefore have a large resultant moment compared with the spin of the conduction electrons or the diamagnetic moment of the closed shells. Such incomplete shells occur notably in the iron and rare-earth, palladium and platinum groups, and all show strong paramagnetism. In the extreme cases of the rare-earth elements dysprosium and holmium, the fourth shell electrons have spin and orbital moments that combine to give the largest magnetic moment of any atoms.

Before discussing the experimental results further it is desirable to outline the classical and quantum theories of strong paramagnetism, and the quantum theory of weak paramagnetism.

1. Langevin Theory.—Curie's measurements at various temperatures could be expressed by the law now known by his name

$$\chi_M = C_M/T$$

in which T is the absolute temperature and C_M the Curie constant characteristic of the substance. The classical theory of this kind of paramagnetism was developed by Langevin who investigated mathematically the behaviour of an ensemble of magnetic dipoles, each of moment μ_M, in a field of strength H. The effect of the field is to produce alignment, while thermal agitation tends to destroy alignment. Assuming that the molecules are so far apart that their mutual forces can be neglected, the energy due to the field is

$$W = \mu_M H \cos\theta$$

for each dipole so oriented that its moment μ_M makes the angle θ with H. If the ensemble is subject to thermal agitation, the Boltzmann equation from statistical mechanics (*q.v.*) shows that at any temperature T the number of dipoles oriented in the solid angle $d\omega$ about the direction θ is proportional to

$$e^{-W/kT}d\omega = e^{(\mu_M H\cos\theta)/kT}d\omega$$

For all the molecules the average value of the moment in the direction of the field $\bar{\mu}_M$ is calculated, and its ratio to the total moment, or to the moment present when all magnets lie parallel, is found to be

$$\frac{\bar{\mu}_M}{\mu_M} = \operatorname{ctnh}\frac{\mu_M H}{kT} - \frac{kT}{\mu_M H}$$

This is Langevin's equation of paramagnetism. At ordinary temperatures $\mu H << kT$, and this equation may be expanded in series form

$$\frac{\bar{\mu}_M}{\mu_M} = \frac{\mu_M H}{3kT} - \frac{1}{45}\left(\frac{\mu_M H}{kT}\right)^3 + \cdots$$

The moment of a gram molecule is $N\bar{\mu}_M$ and the molecular susceptibility is then $\chi_M = N\bar{\mu}_M/H$; thus at ordinary temperatures, for which the first term of this equation is sufficient

$$\chi_M = \frac{N\bar{\mu}_M}{H} = \frac{N\mu_M{}^2}{3kT} = \frac{C_M}{T}$$

This is Curie's law, with the Curie constant given by

$$C_M = N\mu_M^2/3k$$

Thus Langevin's work explained Curie's law and showed how the moment per molecule could be determined from experiment.

2. Quantum Theory.—Quantum theory has fundamentally changed concepts of atomic structure and revised the interpretation of paramagnetic phenomena in several ways:

1. Langevin assumed that any orientation of magnetic moment with respect to an applied field is possible; quantum theory requires that only discrete changes of angular momentum are possible, imposing restrictions on the orientations of magnetic moment. As a result the Langevin equation of paramagnetism is replaced by a more complicated expression. In the simplest case of an atom with a single electron that is free to change its direction of spin, the only two possible orientations are those parallel and antiparallel to the field, and the function becomes

$$\bar{\mu}_M/\mu_M = \tanh(\mu_M H/kT) = \mu_M H/kT + \cdots$$

the last part being applicable when H/T is not too large. When many orientations are possible the function approaches Langevin's equation as a limit.

2. There is a natural unit for magnetic moment, the Bohr magneton, substantially equal to the moment of one electron spinning about its own centre. Its value is

$$\beta = eh/4\pi mc = 9.27 \times 10^{-21}\ \text{erg/gauss}$$

Here e is the charge and m the mass of the electron, h is Planck's constant and c the velocity of light. It is convenient to convert susceptibility data to the apparent number of Bohr magnetons per atom, by dividing the moment per atom (determined from Langevin's expression for the Curie constant) by β. This is called the effective Bohr magneton number: $\mu_{eff} = \mu_M/\beta$. In terms of the Langevin theory it may be expressed

$$\mu_{eff} = \frac{\mu_M}{\beta} = \sqrt{\frac{3k\chi_M T}{N\beta^2}} = 2.83\sqrt{\chi_M T} = 2.83\sqrt{C_M}$$

and can be calculated if enough is known of the structure of the atom.

3. The effective moment of an atom may change with temperature or field strength in a calculable way, in which case Curie's law will not hold. Under certain conditions χ_M will be of the form

$$\chi_M = \frac{N\mu_M{}^2}{3kT} + N\alpha$$

Such an expression, with the constant α included, accounts quantitatively for the behaviour of some of the rare-earth ions, and applies in principle in other cases for which it cannot often be worked out in detail.

4. The temperature-independent or weak paramagnetism of many metals (fig. 54) and of some conducting oxides and salts was quite inexplicable with classical theory. Quantum theory, however, provides an explanation by showing that conduction electrons, behaving as an electron gas, have just this observed character.

The applications of these concepts to substances of various types will now be considered.

3. Rare Earths.—The ions of the rare-earth elements cerium (atomic number 58) to ytterbium (atomic number 70) are good examples of strongly paramagnetic substances. The permanent magnetic moment is due to the 4f electron subshell in the usually trivalent ions. This fourth shell is protected by the outer shells from the influence of neighbouring atoms and so the assumptions underlying the theory are fairly well satisfied (*see* ATOM; PERIODIC LAW).

Ionic susceptibilities are deduced from measurements on solutions, solid salts and oxides by subtracting the contributions of water and other ions. The susceptibilities decrease with increasing temperature, as expected, except that χ_M for the samarium ion Sm^{3+} is almost constant above room temperature and Eu^{3+} shows an almost constant susceptibility at low temperatures.

Calculation of the susceptibilities of the rare-earth ions by quantum mechanics is one of the important successes of the Van Vleck theory (fig. 57), based on the earlier work of F. Hund. Both terms of the last equations above, those dependent on and independent of

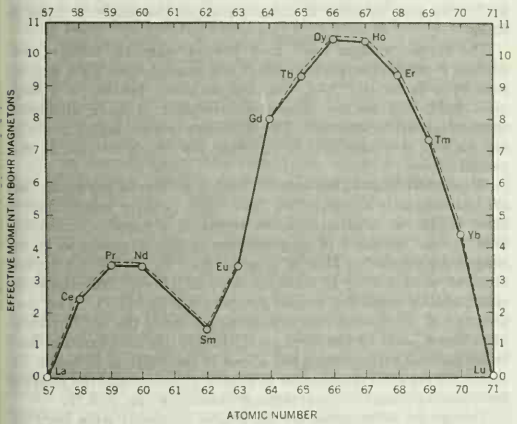

FIG. 57.—EFFECTIVE MOMENT OF THE TRIVALENT IONS OF THE RARE EARTH ELEMENTS AT ROOM TEMPERATURE. BROKEN LINE SHOWS VALUES CALCULATED BY VAN VLECK THEORY

temperature, were derived quantitatively from theory, and the unusual change of χ_M with temperature for samarium and europium were satisfactorily explained.

Rare earths in metallic form have large susceptibilities, and the elements from gadolinium to thulium are ferromagnetic at low temperatures. Above the Curie points important deviations from Curie's law are observed, and a law of the form

$$\chi_A = C/(T - \theta)$$

is closely followed. This is the Curie-Weiss law for many paramagnetic solids, particularly those in which the magnetic cores of the atoms are under the influence of magnetic or electric fields of nearby atoms, and the Langevin assumptions therefore are not satisfied. For gadolinium, as for the other ferromagnetic elements, θ is approximately the Curie point, but the appearance of θ in the Curie-Weiss equation does not mean necessarily that the material will be ferromagnetic below the temperature $T = \theta$; rather, the law breaks down before this point is reached.

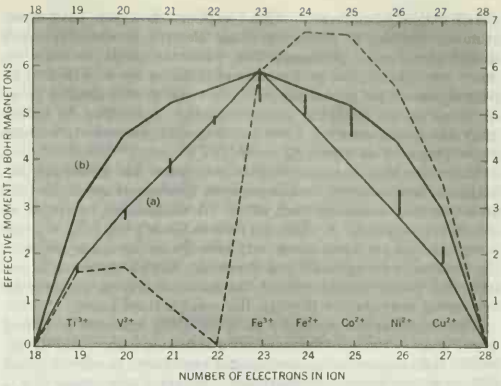

FIG. 58.—EFFECTIVE MOMENT OF IONS OF IRON GROUP OF ELEMENTS, PLOTTED AGAINST NUMBER OF ELECTRONS IN ION. VERTICAL LINES INDICATE RANGE OF OBSERVED VALUES. CONNECTING LINES INDICATE THEORETICAL VALUES BASED ON DIFFERENT ASSUMPTIONS

4. Ions of the Iron Group.—Strong paramagnetism occurs also in the ions of the elements lying between scandium and copper, and is most marked for manganese, iron and cobalt. The moments of the ions are generally less than those of rare-earth ions, because the shell responsible for the paramagnetism is smaller and has only 10 instead of 14 electrons when filled.

In calculating the moments from quantum theory the method used for the rare earths is not at all successful, as shown by the broken line of fig. 58. Results of calculations made with other assumptions are shown by the solid lines (a) and (b); the observed values lie between these curves. Stoner has indicated the reason for this. The outermost shell of the ion is responsible for the moment and is subject to the influence of surrounding ions. Their effect on the orbital motions is difficult to calculate, but if the effect is severe only the spin moments will be influenced by the magnetic field, and curve (a) results. On the other hand if interaction with neighbouring ions is weak, orbital motions will be affected and curve (b) is calculated; here the further assumption is made that the energy of thermal agitation can change the distribution of electron spins in the unfilled shell, an assumption consistent with modern knowledge of the structure of these ions. When the influence of surrounding ions on the unfilled shell is moderate, the empirical ionic moments may be expected to lie between the two theoretical limits; in fact they do.

5. Paramagnetism at Low Temperatures.—At ordinary temperatures the Langevin equation may be represented with sufficient accuracy by the first term of the series expansion noted above. However, at low temperatures and in strong fields $\mu_M H/kT$ may be so large that the complete equation, or its quantum equivalent, must be used. Under these conditions the susceptibility is no longer independent of field strength, and the magnetic moment of the material approaches a limiting value corresponding to alignment of the molecular magnets parallel to the field.

The first experimental test of this phenomenon was carried out at temperatures as low as 1.3° K. and field strengths up to 22,000 oersteds; the results confirmed the theory in a satisfactory manner. A slightly different relation was predicted by quantum theory, and has been verified entirely within the limits of accuracy of validating experiments.

The magnetic behaviour of certain paramagnetic salts is important in producing very low temperatures. A temperature just 0.0014° above absolute zero was reached in 1951 using the paramagnetic salt chrome aluminum alum. By the 1960s temperatures even closer to absolute zero were being obtained with the aid of nuclear magnetization (*see* LOW-TEMPERATURE PHYSICS).

6. Paramagnetic Gases.—Most monatomic gases, such as those in group VIII, the rare gases (*see* CHEMISTRY), are diamagnetic because with complete electron shells they have no re-

sidual magnetic moments. Metal vapours, however, have monatomic molecules in which the single electron in the outer shell should give rise to paramagnetism. Measurements on such vapours are difficult, but potassium and thallium are reported to be paramagnetic; potassium obeys Curie's law over a limited range of temperatures and has a susceptibility, according to rather inaccurate measurements, corresponding approximately to a single uncompensated electron ($\chi_M = 0.375/T$).

Molecules that have more than one atom are generally diamagnetic because they contain an even number of electrons with moments that neutralize each other. A well-known exception to this rule is oxygen (O_2). This gas follows Curie's law ($C_M = 1.00$) except at high pressures when the Curie-Weiss law is obeyed, with the constant θ being small and negative. Liquid oxygen also follows the Curie-Weiss law, and the susceptibility increases with decreasing temperature through the solidification point.

The molecular susceptibility of nitric oxide has been measured from 20° to −160° C. (below its normal boiling point), and the effective Bohr magneton number μ_{eff} has been found to vary by about 15% over this range of temperature. Accurate calculation of μ_{eff} and its variation with temperature was carried out by Van Vleck, who based his work on the electronic structure derived from spectroscopic data. The close agreement between calculated and observed values tends to validate the theory.

7. Paramagnetism of Free Electrons.—The weak temperature-independent paramagnetism of many of the metals (fig. 53 and 54) was inexplicable in terms of the Langevin theory, according to which all paramagnetism should decrease as temperature rises. According to modern theory the conduction electrons of a metal have spin moments that can be oriented slightly by a magnetic field. In the simplest case, with one free electron per atom, quantum theory predicts an atomic susceptibility of $1.88 \times 10^{-6} (A/d)^{2/3}$, where A is the atomic weight and d is the density in g./cm.^{3}; a smaller diamagnetism, also predicted by quantum theory, is equal to one-third the paramagnetic contribution when the electrons are free.

In actuality the electrons of metals are not wholly free but are partially bound to the atoms, and are influenced by so-called correlation and exchange forces that are quantum mechanical in nature. Also, the ionic core of the atom makes an important diamagnetic contribution to the susceptibility. The various components have been calculated for sodium, and when summed they come within about 10% of the observed susceptibility. For other elements the calculations are less satisfactory.

The paramagnetic contributions of the electrons will vary with the nature of the metal and the diamagnetism of the ionic cores will vary for different atoms; qualitatively, it is clear that such factors will make some metals weakly paramagnetic while others will be weakly diamagnetic. The order of magnitude of the susceptibility is explained by theory; more exact calculations await further quantitative development of atomic theory.

8. Ferromagnetic Materials Above the Curie Point.—All materials that exhibit ferromagnetism are paramagnetic when they are heated above the Curie temperature. As temperature continues to increase, the susceptibility decreases continually according to the Curie-Weiss law for strongly paramagnetic substances, unless there is a change in the phase structure of the material. If the Curie-Weiss law were followed exactly, a straight line would result when $1/\chi_A$ is plotted against temperature. The data for iron, cobalt and nickel show some variations from the expected linear relations. Definite breaks in the curve for iron result from changes in its crystal structure at 910° and 1,400° C.

One should be able to calculate from the slope of each of these lines the magnetic moment per atom, and to compare this with the moment calculated from the saturation magnetization found at lower temperatures when the material is ferromagnetic. For nickel the ferromagnetic moment is 0.61 Bohr magnetons per atom, and the moment calculated from the Curie constant is 1.6 in the same units. Similar discrepancies occur for iron and cobalt. These results show that there is not an integral number of electron spins per atom; therefore the atoms will not all have the same moment at any instant. This means that the calculation of magnetic moment from the Curie constant cannot properly be made by the relation used and that modifications of the theory are necessary.

9. Paramagnetic Resonance.—Experiments on resonance at high (microwave) frequencies are made in the same way for paramagnetic substances as for ferromagnetic materials, described above (*X. Magnetization in Alternating Fields:* fig. 50–52). Resonance occurs when the frequency of the field is

$$f = MH/(2\pi J)$$

where H is the strength of the steady magnetic field and M and J are the magnetic and mechanical moments of the atom (*see* fig. 50). This may also be written

$$f = g\beta H/h$$

where β is the Bohr magneton, h is Planck's constant, and g represents the spectroscopic splitting factor which is 2.00 for electron spin and 1.00 for the orbital motion of the electron.

In solids the electron orbits in a given atom are generally fixed by the strong electrostatic fields of neighbouring atoms so that only the spin moments of the electrons can precess in an applied magnetic field. However, the coupling between spin and orbital motion prevents the spin from being perfectly free, and g departs from the value 2.00. The amount of departure gives information about atomic forces and interactions in the solid state, and is a specific property of the material.

In a crystal the spin-orbit coupling depends on the direction in which the steady magnetic field is applied with respect to the crystal axes. Consequently g values found for differently oriented fields also give valuable information about the fields of force in solids.

The atomic nucleus itself may have a magnetic moment, expressed in nuclear magnetons which are smaller than Bohr magnetons by a factor of 1,840. Nuclear moments precess in a magnetic field, and nuclear magnetic resonance is quite analogous to paramagnetic resonance. The data obtained are useful in studying nuclear structure and in reaching low temperatures, as discussed above.

10. Antiferromagnetism.—There is a class of materials that are paramagnetic as judged by their small positive susceptibility; their behaviour is interpreted in terms of a negative molecular field, or the tendency of neighbouring atomic magnets to be arranged antiparallel. This is illustrated in fig. 7(C). A typical member of this class is manganous oxide (MnO) for which the susceptibility is plotted against temperature in fig. 59. The temperature of the susceptibility maximum is called the antiferromagnetic Curie point or the Néel point; below this temperature there is antiparallel arrangement but above it the thermal agitation destroys the regular arrangement of atomic moments and the material behaves like a normal paramagnetic substance (fig. 7[A]).

The spatial orientations of the atomic moments have been determined for a number of antiferromagnetic substances with the aid of neutron diffraction. Some of the best-known antiferromagnetic materials are chromium, copper chloride, ferrous fluoride,

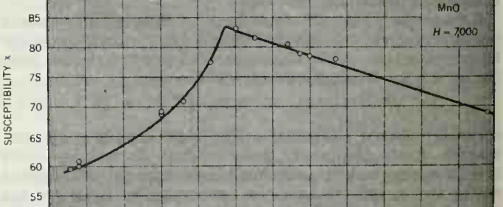

FIG. 59.—SUSCEPTIBILITY OF MnO AS DEPENDENT ON TEMPERATURE, TYPICAL OF ANTIFERROMAGNETIC SUBSTANCE. TEMPERATURE OF MAXIMUM IS NÉEL POINT (H. BIZETTE, C. F. SQUIRE, B. TSAI)

manganous oxide and nickel oxide; hundreds of others are known. Néel points are known to vary from less than 1° to 800° above absolute zero.

In these materials the force that produces the antiparallel arrangement between the atomic moments (*e.g.*, between Mn ions in MnO) generally is the quantum mechanical force of exchange that acts from one magnetic atom (Mn) through the intermediate nonmagnetic atom (O) to the next magnetic atom. Such indirect action has been designated by H. A. Kramers as superexchange.

Antiferromagnetic materials form domains in much the same way as ferromagnetic materials. Such a formation, including one wall, is shown schematically in fig. 60.

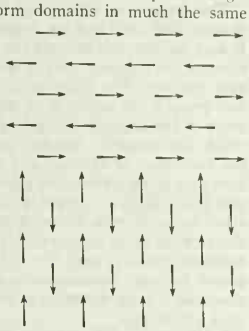

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FIG. 60.—DOMAIN STRUCTURE OF ANTIFERROMAGNETIC MATERIAL. DOMAIN WALL IS NOT AS SHARP AS INDICATED

XIII. THEORY OF FERROMAGNETISM

One requirement of a ferromagnetic material is that its atoms have permanent magnetic moments. The magnetic moment of an atom comes from its electrons, since the nuclear contribution is negligible. An electron has a magnetic moment because of its spin, and may have an additional moment from its orbital motion.

Another requirement of ferromagnetism is some kind of interatomic force that keeps the magnetic moments of many atoms parallel to each other. Without such forces the atoms would be disordered by thermal agitation, the moments of neighbouring atoms would neutralize each other, and the large magnetic moment characteristic of ferromagnetic material would not exist. The material would then be merely paramagnetic.

Current knowledge of these interatomic forces and of the structure of the atom permits a general description of the origin of ferromagnetism. The following steps in the theory may be enumerated: (1) the ultimate magnetic particle is the spinning electron, and a change in magnetization fundamentally results from a change in the directions of spin of certain electrons, not to any appreciable extent from a change in their orbital motions; (2) in iron, cobalt and nickel the electrons responsible for ferromagnetism lie in the incomplete third atomic shell; in the rare earths they are in the fourth shell. In complete shells the electrons are arranged symmetrically so that the spins neutralize one another and the combined moment is zero; and (3) in ferromagnetic materials the spins of neighbouring atoms are held parallel by strong quantum mechanical forces, whereas in the atoms of other substances the forces usually tend to make the spins of neighbouring atoms antiparallel and self-neutralizing. The circumstances under which these quantum forces effect parallel orientations and form ferromagnetic domains, or antiparallel orientations that lead to paramagnetism or antiferromagnetism, will be discussed in the following paragraphs. Before considering these steps in modern theory in detail, however, it is appropriate to recall the earlier theories and their development.

1. Early Theories.—Ewing was one of the first to attempt to explain ferromagnetic phenomena in terms of interatomic forces. He assumed as did Weber that each atom was a permanent magnet free to turn in any direction about its centre. Neighbouring atoms were assumed to be held parallel by the usual magnetic forces known from large-scale bar magnets. The I, H curve and hysteresis loop were calculated for a linear group of such magnets and were determined experimentally from models with as many as 130 magnets arranged at the points of a plane square lattice. The calculations for a linear chain show that as field strength is gradually increased from zero there is at first a slow continuous rotation of all the magnets together, then sudden change in orientation and finally a further continuous rotation until the magnets lie parallel to the field. The I, H curves calculated for such a group of magnets resemble in general form the actual curves of iron; they show permeability first increasing, then decreasing, as well as saturation and hysteresis.

G. S. Mahajani calculated the magnetic potential energy of a group of magnets arranged spatially in the same way as iron atoms in a crystal. In agreement with Ewing's theory the magnets tend to be parallel, and some directions in the space array are more stable or preferred than others. On the other hand present knowledge of the structure of atoms and crystals makes it clear that such magnetic forces between atoms are not large enough to keep the magnetic moments of neighbouring atoms parallel, as they must be for ferromagnetism to exist. Such weak forces would readily be disturbed by the thermal motion of atoms at room temperature and even at a few degrees above absolute zero.

It is now well established that very powerful forces, not contemplated when Ewing made his model and proposed his theory, keep the dipole moments of neighbouring atoms parallel. These are the electrostatic forces of exchange which will be discussed in connection with the quantum theory.

2. Molecular Field Theory.—To understand how atomic forces produce ferromagnetism it is desirable to review Weiss's theory of ferromagnetism, which introduces a so-called molecular field that presently will be identified with these forces. Using an approach different from Ewing's, Weiss did not try to explain the nature of interatomic forces but treated them empirically by assuming that they exerted a powerful effect that supported the applied field in lining up atomic moments. This is an extension of Langevin's theory of a paramagnetic gas, which culminated in a formula relating the magnetization I to the field strength H and the temperature T: the hyperbolic cotangent law

$$\frac{I}{I_0} = \operatorname{ctnh}\frac{\mu_A H}{kT} - \frac{kT}{\mu_A H}$$

noted in *XII. Paramagnetism* above. In deriving this, it is assumed that the elementary magnets, each of moment μ_A, are subject to thermal agitation and momentarily may have any orientation to the direction of the field, and that they are too far apart to influence each other. Quantum theory alters the first assumption by stating that in such an ensemble of elementary magnets (atoms) there will be only a limited number of possible orientations, in the simplest case only two, one parallel and the other antiparallel to the direction of the field. In this case the equation corresponding to Langevin's is

$$\frac{I}{I_0} = \tanh\frac{\mu_A H}{kT}$$

Weiss assumed that in a ferromagnetic material a molecular field exists proportional to the intensity of magnetization, and reinforces the magnetic field already present. He therefore replaced the H of Langevin's equation by $H + NI$, calling N the molecular field constant. The resulting equation

$$\frac{I}{I_0} = \tanh\frac{\mu_A(H + NI)}{kT}$$

is perhaps the most important in the theory of ferromagnetism. It indicates that even in zero field there is still considerable magnetization, provided that the temperature is not too high. Putting $H = 0$ and $\theta = \mu_A N I_0/k$, this equation reduces to

$$\frac{I}{I_0} = \tanh\frac{I/I_0}{T/\theta}$$

This purports to specify the magnetization at zero applied field by the same function for all materials, when the magnetization is expressed as a fraction of its value I_0 at absolute zero and the temperature is given as a fraction of the Curie temperature θ on the absolute scale. This magnetization-temperature relation, plotted as the upper solid line of fig. 61, means that at all temperatures below θ the intensity of magnetization has a definite value even when no field is applied.

According to this idea the I of the last equation represents the

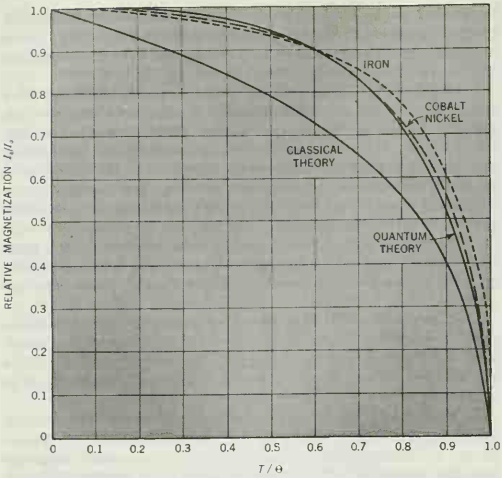

FIG. 61.—SATURATION MAGNETIZATION AS DEPENDENT ON ABSOLUTE TEMPERATURE IN RELATIVE UNITS. SOLID CURVES ARE THEORETICAL, FOR CLASSICAL (WEISS) AND QUANTUM THEORIES

magnetization of a domain, and is determined experimentally by measuring the magnetization of a specimen when all domains are parallel; *i.e.*, at saturation ($I = I_s$). This equation should then be written

$$\frac{I_s}{I_0} = \tanh \frac{I_s/I_0}{T/\theta}$$

However, a piece of iron may be apparently unmagnetized at room temperature. Weiss explained this by formulating the domain theory described above, according to which each part of a ferromagnetic material is magnetized to saturation, the magnetic moments of the separate parts being oriented in different directions to produce an over-all effect of zero.

These relations are also important for ferromagnetic materials above the Curie point, when they are paramagnetic. Then I is small compared to I_0 and

$$\frac{I}{I_0} = \frac{\mu_A(H + NI)}{kT}$$

If $\theta = \mu_A N I_0/k$ as before, and $C = I_0\mu_A/k$, this becomes

$$I = \frac{CH}{T - \theta}$$

the Curie-Weiss law. Thus θ is explained by the existence of the molecular field NI that supports the applied field H in orienting the elementary magnets. However, as pointed out above, the fact that a paramagnetic substance follows this law does not mean necessarily that it will become ferromagnetic at temperatures below $T = \theta$.

3. Quantum Theory.—The nature of the molecular field was unknown to Weiss when he developed his theory; he knew only that its power in orienting the elementary magnets was equal to that of a magnetic field of millions of oersteds (in iron, NI is as high as 7×10^6 oersteds). An interpretation of this was first proposed in 1928 by Heisenberg who showed that it can be explained in terms of the quantum mechanical forces of exchange acting between electrons in neighbouring atoms. Imagine two atoms some distance apart, each atom with a magnetic moment of one Bohr magneton from the spin moment of one electron. A force of interaction, the exchange force, has been shown to exist between them in addition to the better-known electrostatic and (much weaker) magnetic forces. It is known that such quantum forces are negligible when the atoms are two or three times as far apart as they are in crystals. It is supposed also, on the basis of discussions by Slater and by Bethe, that as two atoms approach each other, from a distance, these forces first act to make the electron spins in the two atoms parallel (positive interaction). As the atoms come closer the spin moments are held parallel more firmly until at a certain distance the force diminishes to zero; with still closer approach, the spins are set antiparallel with relatively strong forces (negative interaction). In fig. 62 the energies corresponding to these forces are shown as a function of interatomic distance.

The interaction curve was drawn originally for atoms with definite shell radii and for varying distances from atom to atom. It may equally well be used for a series of elements if account is taken of the different radii of the shell in which the magnetic moment resides. The criterion of interaction for the metals of the iron group is the radius R of the atom (half the internuclear distance in the crystal) divided by the radius r of the 3d shell, in which the magnetic moment resides. In fig. 62 this ratio R/r has been used as abscissa and the elements chromium to nickel have been given appropriate positions on the curve. Slater showed that the ratio R/r is larger in the ferromagnetic elements than in other elements with incomplete inner shells, and that the point at which the curve crosses from the nonferromagnetic to the ferromagnetic region is near $R/r = 1.5$. This also explains how manganese becomes ferromagnetic when the atoms are separated by abnormally large distances as they are in the Heusler alloys and some compounds.

In the rare-earth elements the magnetic interaction between neighbouring atoms is best explained as interaction by way of conduction electrons. Such an electron passes near one atom and is oriented by the atomic moment; then, as it passes near a neighbouring atom the electron influences the moment of this second atom so that the moments of the two tend to become parallel.

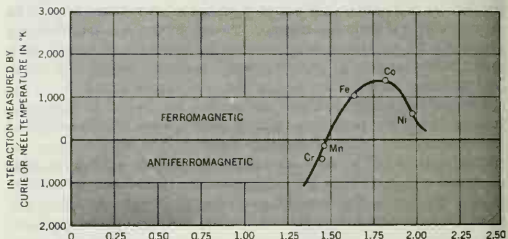

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FIG. 62.—FORM OF INTERACTION CURVE. INTERACTION MEASURED AS CURIE (OR NÉEL) POINT θ IN °K.

4. Atomic Structure of Ferromagnetic Substances.—It has already been stated that the fundamental magnetic particle is the spinning electron. It might be thought that the magnetic moments from orbital motions of the electrons would also contribute to ferromagnetism; but it has been established for the iron group of elements that when magnetization is altered the principal change is the direction of the spin of certain of the electrons in the atoms; the orbital motions remain practically unchanged. The basis for this conclusion is the ratio of angular momentum to magnetic moment, found experimentally by S. J. Barnett and others to be appropriate to the electron spin and definitely not to the orbital moment. On the other hand, in the rare-earth elements and in compounds, the orbital moments of the electrons contribute substantially.

The electrons that are responsible for the magnetic properties of iron, cobalt, nickel and their alloys lie in a definite shell in the atom. As shown in fig. 63 there are four shells or regions into which all the electrons circulating about the nuclei of these atoms may be divided when the atom is separated from its neighbouring atoms, as it is, for example, in a gas. Two of these shells are subdivided as shown. When the atoms come closer together to form the solid metal, the fourth or outermost shell of each

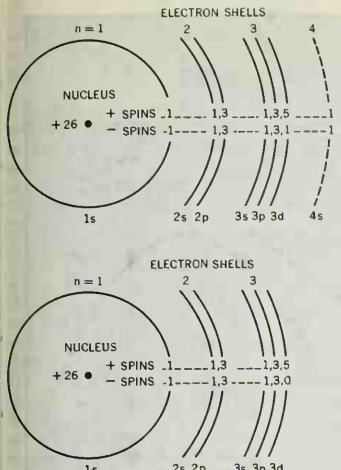

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FIG. 63.—ELECTRON SHELLS. SHELLS IN (A) FREE IRON ATOM, (B) Fe^{3+} ION. UNFILLED THIRD SHELL IS RESPONSIBLE FOR MAGNETIC MOMENT. ELECTRONS OF OUTER 4S SHELL OF ISOLATED ATOMS BECOME "FREE" ELECTRONS IN THE METALLIC STATE

becomes disrupted, and the two electrons which comprised it wander easily from atom to atom; these are the "free" electrons responsible for electrical conduction. The electrons in the outer part of the third shell are those responsible for the ferromagnetic moment. Some of these electrons spin in one direction and some in the opposite, as indicated, so that their magnetic moments partially neutralize each other and the excess of those spinning in one direction (+) over those spinning in the other (−) makes each atom as a whole behave as a small permanent magnet.

The average moment of the atom in a ferromagnetic material may be determined from the saturation magnetization I_0 at the absolute zero of temperature by dividing I_0 by the number of atoms in a cubic centimetre. Expressed in Bohr magnetons β this number is

$$n_B = \frac{I_0 A}{N\beta d}$$

where A is the average atomic weight, N is Avogadro's number and d is the density. Moments in Bohr magnetons, so calculated, are for iron 2.22; cobalt 1.70; and nickel 0.61.

The meaning of these nonintegral values may be discussed in either of two different ways used for many problems of the solid state. In the Heisenberg approach the atoms have their own electrons (some atoms necessarily more than others), and the disturbing effect of the interaction between neighbours is estimated as well as possible. The other approach, followed by Bloch, Stoner and others, is to consider the metal as composed initially of ions and free electrons, and to calculate how the ionic fields restrict the freedom of the electrons to move. According to the latter both the 3d and 4s shells of iron, cobalt and nickel atoms are incomplete and

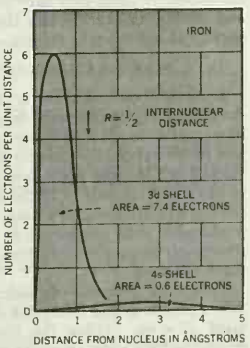

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FIG. 64.—DISTRIBUTION OF ELECTRONS IN THE 3D AND 4S SHELLS IN IRON

there is a distribution of electrons between them that is determined by the specific nature of the atomic fields. The calculations indicate that in iron the electrons in these shells are distributed (on the average) about the nuclei as indicated in fig. 64. The 3d shell is a rather dense ring of electrons, as contrasted with the 4s shell which extends so far from the nucleus that in the solid state the shells of neighbouring atoms overlap considerably.

This description of electron distributions in their relation to ferromagnetism is supported by experiments on the alloying of nickel with copper, zinc and other elements. The substitution of one copper atom for one nickel atom in the lattice is equivalent to adding one electron to the alloy. This electron seeks the place of lowest energy in the alloy and finds it in the $3d^-$ shell of a nickel atom rather than in the copper atom to which it originally belonged. This lowers the magnetic saturation of the alloy by one Bohr unit, since the added electron in the $3d^-$ shell just neutralizes the moment of one electron in the $3d^+$ shell. Addition of more copper decreases the average moment until the empty places in the $3d^-$ shell are just full; this should occur when 60% of the atoms are copper, and then the magnetic saturation at 0° K. should be just zero. The theory is well confirmed by the data (fig. 65). When divalent zinc, that has two available electrons per atom, is added to nickel the 3d shell is filled twice as fast as with monovalent copper, again in accordance with theory; metals of higher valence behave accordingly.

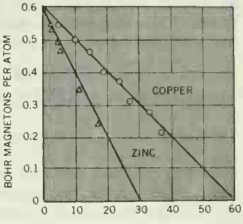

FIG. 65.—REDUCTION IN MAGNETIC MOMENT PER ATOM OF NICKEL RESULTS FROM ADDING COPPER (WITH ONE EXTRA ELECTRON PER ATOM) OR ZINC (TWO PER ATOM). EXTRA ELECTRONS GO INTO UNFILLED SHELL AND THEREFORE DECREASE ITS MOMENT (V. MARIAN)

5. Theory of Ferrites.—The relation of atomic moments and interaction to atomic structure and interatomic distance are well illustrated by properties of the spinel-type ferrites. Nickel ferrite, for example, has the chemical composition represented by $NiO{\cdot}Fe_2O_3$ or $Ni^{2+}Fe_2^{3+}O_4^{2-}$. The crystal structure is determined mainly by the oxygen ions, which are much larger than the metal ions and form a close-packed cubic array. Among the oxygen ions there are two kinds of openings in which the metal ions lie. In one kind (the A position) the metal ions are equidistant from four oxygen ions that are at the corners of a tetrahedron; in the other kind (B position) the metal ions are surrounded by six equidistant oxygen ions placed at the corners of an octahedron. In the magnetic ferrites $NiFe_2O_4$ half of the iron ions Fe^{3+} are in the A sites, the other half and all of the divalent ions Ni^{2+} are in the B sites.

The magnetic moments of the metal ions can be deduced from the number of electrons in the atom, as shown in fig. 63. The spin moment of Fe^{3+} is five Bohr magnetons, that of Ni^{2+} is two.

L. Néel showed that in the magnetic ferrites the interactions between the ions in the A and B sites are antiferromagnetic; thus the moments of A ions are antiparallel to those of the B ions. Since the moments are not equal the material is ferromagnetic (*see* fig. 7[D]). In the nonmagnetic zinc ferrites it is known that the Zn^{2+} ions are in the A sites and all of the Fe^{3+} are in the B sites. In magnetic $NiFe_2O_4$ and nonmagnetic $ZnFe_2O_4$ the situation can be represented as follows:

	Tetrahedral A sites	Octahedral B sites		Net moment (n_B)
$(Fe\ (NiFe)O_4$	Fe^{3+}	Ni^{2+}, Fe^{3+}	$O_4^{2-})$	
Moments	→ 5	← 2, ← 5		2
$(Zn(FeFe)O_4$	Zn^{2+}	Fe^{3+}, Fe^{3+}	$O_4^{2-})$	
Moments	0	← 5, → 5		0

with the moments expressed in Bohr magnetons per molecule. The net moment of $NiFe_2O_4$ is then expected to be two Bohr magnetons. Experimentally E. W. Gorter found 2.3. At room temperature $ZnFe_2O_4$ has random directions of the Fe^{3+} moments, but below 10° K. the Fe^{3+} ions go into an antiparallel arrangement and so show a weak antiparallel or negative interaction.

Similarly the moments can be estimated for the other ferrites in the series Mn, Fe, Co, Ni, Cu, Zn with increasing atomic number. The molecular moments are expected to be just those of the divalent ions of these elements, because the two Fe^{3+} ions in the A and B positions cancel each other. By using the known moments of the divalent ions and plotting the molecular moments of the corresponding ferrites the straight line of fig. 66 is produced. The observed moments, derived from the saturation magnetization at 0° K., are shown as points. The small discrepancy between calculated moments and those observed by Gorter and C. Guillaud has been attributed to the moments resulting from the orbital motions of the electrons. The agreement between theory and observation indicates a good understanding of the atomic structure and interatomic interactions in simple ferrites.

An interesting and useful material is made by combining a small amount of nonmagnetic zinc ferrite with magnetic manganese ferrite. The magnetic moment of a mixture of 90% $MnFe_2O_4$ and 10% $ZnFe_2O_4$ can be calculated as follows:

	Tetrahedral A sites	Octahedral B sites		Net moment (n_B)
$MnFe_2O_4$	Mn^{2+}	Fe^{3+}, Fe^{3+}	O_4^{2-}	
Moments	→ 5	← 5	← 5	5
$ZnFe_2O_4$	Zn^{2+}	Fe^{3+}, Fe^{3+}	O_4^{2-}	
Moments	0	5 (random)	5	0
0.9 $MnFe_2O_4$ + 0.1 $ZnFe_2O_4$	$Zn_{0.1}^{2+}$, $Mn_{0.9}^{2+}$	$Fe_{0.9}^{3+}$, $Fe_{1.1}^{3+}$	O_4^{2-}	
Moments	0 → 4.5	4.5 ← 5.5		5.5

If, therefore, some $ZnFe_2O_4$ is added to $MnFe_2O_4$, the Zn^{2+} ions will go in the A positions and the Fe^{3+} will remain in the B positions. The net moment of the chemical mixture is found to be 5.5, an increase of 0.5 over that for $MnFe_2O_4$. As long as added Zn^{2+} ions go into the A positions the moment should be expected to rise as indicated by the upper broken line of fig. 67 (ideal slope), which has this same increase of 0.5 Bohr magneton for each addition of 10% of $ZnFe_2O_4$. Actually the experiments of Gorter and Guillaud give the data of fig. 67 for additions of $ZnFe_2O_4$ to several of the simple ferrites. The first additions give

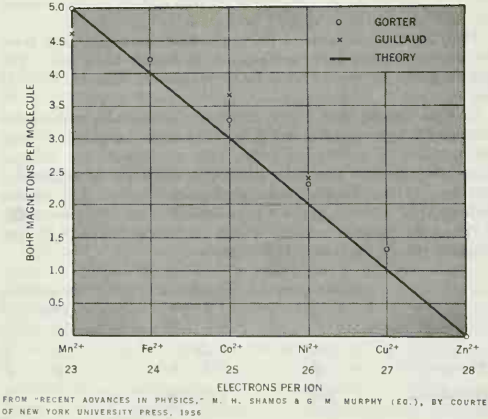

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FIG. 66.—THEORETICAL AND MEASURED MOLECULAR MOMENTS OF FERRITES OF IRON-GROUP ELEMENTS

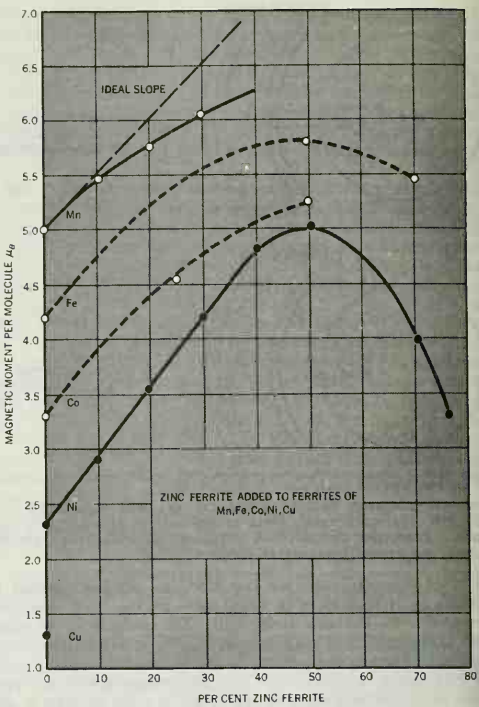

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FIG. 67.—OBSERVED CHANGE IN MOMENT OF SEVERAL FERRITES BY ADDITION OF ZINC FERRITE. IDEAL THEORETICAL INCREASE IS APPROACHED FOR SMALL ADDITIONS (E. W. GORTER, C. GUILLAUD)

curves starting with the ideal slope. Eventually the moments of ions in the A positions are too weak to influence the moments of ions in the B positions and the mixture becomes nonmagnetic like pure $ZnFe_2O_4$. By the 1960s a large number of other iron-group and rare-earth-group compounds had been prepared and were found to be ferromagnetic. Of special interest are ferrites that exhibit garnet structure; *e.g.*, gadolinium iron garnet $Gd_3Fe_5O_{12}$. Many rare-earth or other ions may be substituted for the gadolinium, and smaller ions can replace the iron; thus interactions among a variety of ions may be studied.

XIV. MEASUREMENT OF MAGNETIC QUANTITIES

1. Basic Relations.—As a prelude to a discussion of the production and measurement of magnetic fields, and the measurement of magnetization, it is desirable to consider quantitatively the fields and forces excited by currents and magnets. These may be considered as: (1) the fields produced by magnets; (2) the fields produced by currents; (3) the force on a magnet in a field; (4) the force on a current in a field; and (5) the electromotive forces produced in coils by changes in induction within them. Most of the measurements of induction and field strength are based on these relations.

Field of a Magnet.—Consider a bar magnet NS (fig. 68) of pole strength m and interpolar distance l to give a magnetic moment $M = lm$. Using the fundamental relation according to which the field strength varies inversely as the square of the distance d from a pole[1]

[1]This relation applies exactly when the magnet is surrounded by a vacuum; when the surrounding medium is air a very small modification may be necessary. When the magnet is surrounded by a medium of permeability μ the law is $H = m/\mu d^2$.

$$H = m/d^2 \quad (1)$$

and by adding vectorially the fields produced by both poles it may be shown that the field strength at distance r from the centre of the magnet is given by

$$H = (M/r^3)\sqrt{1 + 3\cos^2\theta}$$

provided that r is large compared with l. Here θ is the angle between the axis SN of the magnet and the line OP drawn from its centre to the point P at which the field is observed. The direction of the field at this point is defined by ϕ, the angle it makes with OP prolonged, and is determined by

$$2\tan\phi = \tan\theta$$

A graphical construction based on this relation may be made by trisecting OP so that OC = $\frac{1}{2}$ CP and by drawing CD at right angles to OP to cut SN produced at D. Then DP is the direction of the field at P. Here, as elsewhere in this article, H is expressed in oersteds, B in gauss, dimensions in centimetres, forces in dynes and currents in amperes.

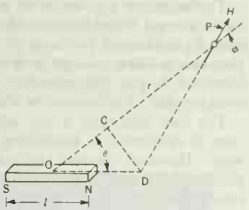

FIG. 68.—FIELD PRODUCED AT ANY POINT P BY PRESENCE OF BAR MAGNET NS DEPENDS ON DISTANCE r AND ANGLE θ

Important special cases are the end-on position (first Gaussian position) for $\theta = 0$, and the broadside position (second Gaussian) for $\theta = 90°$. For these the fields are respectively

$$H_1 = (2M/r^3)(1 + l^2/2r^2)$$
$$H_2 = (M/r^3)(1 - 3l^2/8r^2)$$

When two magnets are placed very close together end to end, with opposite poles m_1 and m_2 separated by a distance d that is small compared with the extent of the surfaces, the magnets are attracted with a force that may be very strong. For each portion of one of the nearby surfaces the corresponding part of the other has an attraction given by the fundamental relation

$$F = \frac{m_1 m_2}{d^2}$$

Summing for the effect of all parts of one surface on all parts of the other gives

$$F = AH^2/8\pi$$

proportional to the pole area A, but independent of the intervening distance as long as this is small.

Fields Produced by Currents.—The simplest way of producing a magnetic field of known strength and direction is with a long coil or solenoid of wire. The field is parallel to the axis of the coil, and when a current of i amperes flows in the windings (with n turns per centimetre) the field strength within the coil is

$$H = 4\pi ni/10 \quad (2)$$

When many layers of wire are used in a solenoid that is not very long in comparison with its diameter, the field strength varies with the position, and can be calculated with the help of the appropriate formula.

When a field is produced by the current in a long straight wire of radius a, the direction of the field is everywhere at right angles to the wire axis, and at distance x from the axis the field strength is

$$H = \frac{2i}{10x}$$

outside the wire, while inside it the field strength is

$$H = \frac{2ix}{10a^2}$$

To create a relatively uniform field in a large volume H. L. F. von Helmholtz proposed the arrangement of two thin circular coaxial coils of diameter $2a$ and axial separation a. At the centre of symmetry O the field strength is

$$H = 0.899\,Ni/a$$

where N is the total number of turns of wire in each coil.

Other forms of coil may be used, and the strength and direction of the field can be calculated by summing the fields produced by each current element. The magnitude of the field dH developed by a current i flowing in an element of wire dl cm. long, at a point r cm. from the current, is given by

$$dH = (i/10r^2)\,dl\sin\theta$$

where θ is the angle between the direction of the current and that of the line r which connects dl to the point. The direction of the field is at right angles to both the current and r.

Force on Magnet in Field.—The force on a single magnetic pole of strength m in a field of strength H is

$$F = Hm$$

dynes acting parallel to the field. In a uniform field a magnet of moment M' is acted on by a torque that tends to turn the magnet on an axis at right angles to its length and to the field so that it will lie parallel to the field. The magnitude of this torque is

$$L = M'H\sin\alpha$$

where α is the angle between the field and the long axis of the magnet. If the field is produced at P by a magnet of moment M placed at O (fig. 68), the torque acting on M' is

$$L = MM'\sqrt{1 + 3\cos^2\theta}\,(\sin\alpha)/r^3$$

If a pivoted magnet is suspended in a field it will have a natural period of oscillation equal to

$$T = 2\pi\sqrt{K/MH}$$

seconds, if K is the moment of inertia about its point of suspension. If an additional known moment of inertia k is added to that already present, without changing the magnet moment, and this increases the period to T_1, the expression

$$MH = 4\pi^2 k/(T_1^2 - T^2)$$

can be used to determine either H or M if one of them is known.

In a nonuniform field a magnet will undergo a translational force as well as a torque, because the force pulling one pole parallel to the field will be opposed by a larger force from a larger field acting on the other pole. If the gradient of the field is dH/dx, the force on a magnet of moment M is

$$F = MdH/dx$$

This may be expressed more accurately by

$$F_x = M_x\frac{\partial H_x}{\partial x} + M_y\frac{\partial H_y}{\partial x} + M_z\frac{\partial H_z}{\partial x}$$

in terms of the x, y and z components of F, H and M. When the moment is induced by the field and is therefore

$$M = Iv = \kappa Hv$$

the force acting on the volume v is

$$F = \kappa vHdH/dx \quad (3)$$

Force on Current in Field.—When a current i flows in an element of wire of length dl in a field of strength H, the force that acts on the wire is

$$F = Hidl(\sin\theta)/10 \quad (4)$$

Here θ is the angle between dl and H, and the direction of the force is at right angles to both. When current passes through two long parallel straight wires the field of each acts on the current in the other; an attractive force is produced if the currents are in the same direction, while a repulsive force develops if they are antiparallel. Both forces, between wires a centimetres apart, are

$$F = 2ii'/(100a)$$

dynes per centimetre length of wire.

Electromotive Force Due to Changing Flux.—When an electric circuit encloses a changing magnetic flux ϕ, an electromotive

TABLE IV.—*Demagnetizing Factors $N/4\pi$ for Rods and Ellipsoids Magnetized Parallel to Long Axis*

Dimensional ratio m (length/diameter)	Rod	Prolate ellipsoid	Oblate ellipsoid
0	1.0	1.0	1.0
1	.27	.3333	.3333
2	.14	.1735	.2364
5	.040	.0558	.1248
10	.0172	.0203	.0696
20	.00617	.00675	.0369
50	.00129	.00144	.01472
100	.00036	.000430	.00776
200	.000090	.000125	.00390
500	.000014	.0000236	.001567
1,000	.0000036	.0000066	.000784
2,000	.0000009	.0000019	.000392

force is generated in the circuit proportional to the time rate of change of flux $d\phi/dt$, and to the number of times N the circuit threads the flux. Thus if N turns of wire are wrapped around a piece of iron of cross-sectional area A, and a change in the induction B is produced in the iron, a voltage is produced at the ends of the wire equal to $10^{-8}\ NA$ times the rate of change of induction in gausses per second

$$E = 10^{-8}\ NA\ dB/dt$$

The total change in B that has occurred in a specified time may be evaluated by integrating this equation with the result

$$B = 10^8 \int E\ dt/NA \qquad (5)$$

2. Common Methods.—*Ballistic Method With Ring.*—In determining magnetization curves and hysteresis loops the ballistic method, employing a ring specimen, is generally the most satisfactory. H. A. Rowland used this method in 1873, and was the first to express the results of measurement in an absolute system. A ring is cut with a radial thickness that is small compared with its diameter and two windings of wire are applied (fig. 69); a secondary winding (S), usually consisting of many turns of fine wire, is wound close to the specimen and connected to a ballistic galvanometer or fluxmeter (G), and a primary winding (P) of evenly spaced turns is applied and connected to a current source. In the primary circuit means are provided for adjusting the current and for changing it rapidly from one value to another in the same or opposite direction. In the secondary circuit a mutual inductance (M) with an air core is provided for calibration and a switch is included for short-circuiting the galvanometer. The field strength H is calculated according to equation (2) from the number of turns and the dimensions of the coil and the current indicated by the ammeter (A).

When H is changed suddenly from one value to another the resulting change in B induces a voltage in the coil S and yields a deflection of the galvanometer that is proportional to the change in B, according to equation (5) above (the ballistic galvanometer has a deflection proportional to $\int Edt$ provided that the voltage impulse occurs in an interval of time that is short compared with the natural period of oscillation of the galvanometer coil and mirror). Since ballistic measurements always involve differences one must start with a known value of B. The commonest procedure for accomplishing this is first to reduce the magnetization to zero, or to demagnetize the core in an alternating field

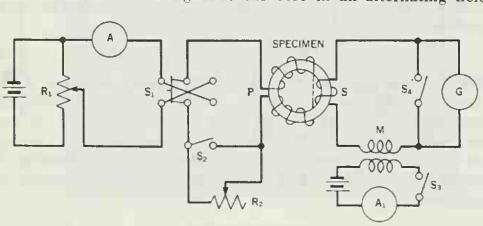

FIG 69.—BALLISTIC METHOD WITH RING. CURRENT IN PRIMARY WINDING P IS CONTROLLED BY RESISTANCES R_1 AND R_2 AND SWITCHES S_1 AND S_2, AND IS READ ON METER A. SECONDARY WINDING S IS CONNECTED THROUGH MUTUAL INDUCTANCE M TO BALLISTIC GALVANOMETER G. A_1 AND S_3 ARE USED FOR CALIBRATION

of high strength, gradually reducing the amplitude to zero. To determine a point such as M in fig. 70, current corresponding to H_1 is applied and reversed several times with the galvanometer short-circuited to establish a steady cyclic state; then the galvanometer is connected and the deflection for reversal of H_1 is noted. This deflection then corresponds to a change of $2B_1$, and B_1 can be easily calculated from the constant obtained by calibration. The point M on the normal magnetization curve is thus established and other points on the curve are determined similarly.

To determine a point N on a hysteresis loop the field is alternated several times between the points of the loop (*e.g.*, MM′), then H_1 is changed suddenly to $-H_2$ and the deflection is noted; the corresponding change in B is subtracted from B_1, already determined, to give the value of $-B_2$ at N. By varying H_2 a sufficient number of points on the whole loop can be obtained.

The ring specimen is not adapted to rapid testing, for some time is consumed in machining the ring and in winding it with wire. However, several methods are available for the rapid application of turns. Stiff wires may be held in fixed positions and arranged so that the ring will slip over many of them at once, with the wires interconnected by a plug-and-socket arrangement or by mercury contacts to make a single circuit. Also, toroidal winding machines are made that apply more than 25 turns a second to a closed ring.

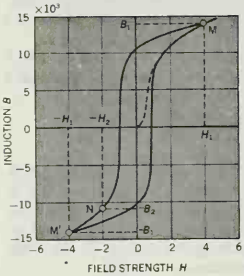

FIG. 70.—HYSTERESIS LOOP ILLUSTRATING BALLISTIC METHOD OF MEASUREMENT OF B. WHEN FIELD STRENGTH IS CHANGED FROM H_1 TO $-H_1$, B CHANGES FROM B_1 TO $-B_1$, AND GALVANOMETER DEFLECTION MEASURES THIS CHANGE IN B

Ordinarily the ballistic galvanometer and ring specimen are used for fields of intermediate strength. When the field strength is high, *e.g.*, 1,000 oersteds, the number of turns in the primary winding, or the current through it, must be large and the heat generated interferes with the measurements. If the field strength is too low many turns are needed on the secondary winding to obtain a sufficiently large galvanometer deflection; this winding process is tedious and under some circumstances there may not be enough space inside the ring. In very low fields A.C. methods should be considered.

Rod Specimens; Demagnetizing Factors.—The ballistic method may be used with a straight specimen in the form of a rod that is magnetized the same way as that used for a ring. The specimen may easily be slipped into a long solenoid that has been previously prepared, and the secondary winding or search coil should be placed around a small central portion of the specimen. Under these circumstances the more difficult quantity to determine is the field strength, because the field created by the solenoid will be disturbed by the magnetic poles of the specimen. The field created by the specimen itself is called the demagnetizing field ΔH and is proportional to the intensity of magnetization. It is usually specified by the demagnetizing factor N which depends on the ratio length/diameter of the rod

$$\Delta H = NI$$

The field acting on the middle of the rod is then the resultant of the field in the solenoid H_0 and the demagnetizing field ΔH and, when I is replaced by $(B-H)/4\pi$, is

$$H = H_0 - \frac{N}{4\pi}(B-H)$$

Values of $N/4\pi$ have been determined empirically and selected values are given in Table IV.

The term effective permeability μ' is often applied to the ratio B/H_0, and its relation to the (true) permeability μ can be derived from the above equation

$$1/\mu = 1/\mu' - N/4\pi$$

by considering $N/4\pi$ to be negligibly small compared with one. The relation between μ and μ' for rods of various dimensional ratios m = length/diameter is shown graphically in fig. 71. It is apparent that rods with m as large as 1,000 must be used to determine accurately the value of the permeability when it exceeds 100,000.

Induction varies from place to place in a bar, decreasing from the middle toward the ends. It is only when the specimen is in the form of an ellipsoid that the induction is uniform throughout. In such specimens the demagnetizing factor may be calculated accurately from the lengths of the three axes of the ellipsoid, and the direction of the induction may be determined. Equations are given below for the two most useful cases: (1) the prolate ellipsoid that has a major axis which is m times the two equal minor axes, and that is magnetized parallel to its major axis; and (2) the oblate ellipsoid or ellipsoidal disk with two long axes each of

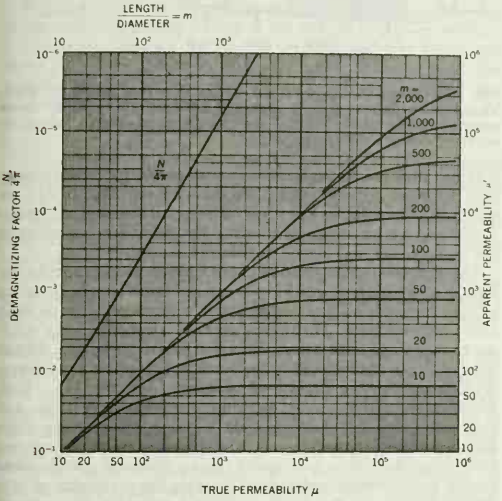

FIG. 71.—CHART FOR CONVERTING APPARENT TO TRUE PERMEABILITY, μ' TO μ, OF CYLINDERS OF GIVEN RATIO m OF LENGTH TO DIAMETER. ALSO DEMAGNETIZING FACTORS $N/4\pi$

which is m times the short axis, the specimen being magnetized parallel to a long axis.

$$\text{Prolate: } \frac{N}{4\pi} = \frac{1}{m^2-1}\left[\frac{m}{\sqrt{m^2-1}}\log_e\left(m+\sqrt{m^2-1}\right)-1\right]$$

$$\text{Oblate: } \frac{N}{4\pi} = \frac{1}{2}\left[\frac{m^2}{(m^2-1)^{3/2}}\arcsin\frac{\sqrt{m^2-1}}{m} - \frac{1}{m^2-1}\right]$$

Values of $N/4\pi$ for various values of m are given in Table IV.

Yokes and Permeameters.—When the specimen is in the form of a straight rod, tube or tape the demagnetizing field may be partially or completely annulled by connecting the two ends, outside the magnetizing solenoid, with magnetic material of high permeability and large cross-sectional area. Such a yoke may be used for specimens of high dimensional ratio, and measurements can be made with considerable accuracy.

More often, in the testing of permanent magnets or commercial materials in the form of bars or strips, it is desirable to use a yoke with a relatively short specimen; in this case the demagnetizing field must be taken into account or annulled in some way. One satisfactory way to accomplish both of these things is to measure the field with a ballistic galvanometer connected to a coil (H-coil) of many turns placed in the magnetizing coil near the middle of the specimen but not surrounding it (fig. 72), and at the same time to magnetize the yoke with the current that passes through the magnetizing coil. The turns through which this current passes are adjusted to overcome the reluctance of the

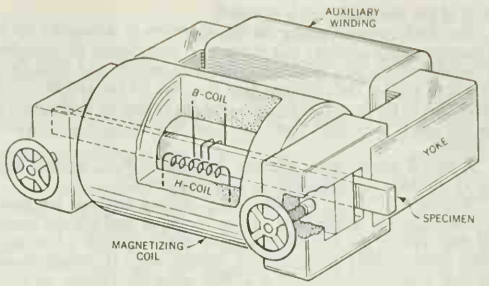

FIG. 72.—SIMPLE YOKE METHOD OF COMPENSATING DEMAGNETIZING EFFECT OF ENDS OF SHORT SPECIMEN

yoke and of the air gaps at each end of the specimen that are found no matter how much care is taken to obtain good joints at these points. The search coil used in determining B is wound on the middle of the specimen as usual.

A further step toward increased accuracy was taken in the construction of the Burrows and the Niwa permeameters. These are devices that use auxiliary magnetizing and search coils to effect uniform magnetization of the specimen by compensating for the air gaps. The induction is determined with a ballistic galvanometer.

Other methods of testing with a yoke (proposed by F. P. Fahy and by A. Koepsel) have been used extensively for routinely testing standardized materials of moderate or low permeability. In the Fahy permeameter, B and H are determined with the help of coils extending the full length of the specimen and connected to a galvanometer. An auxiliary magnetizing coil is used on the yoke. The Koepsel permeameter has the advantage of direct reading since it requires no galvanometer. To indicate the induction in the specimen a coil of wire is placed on a delicate bearing in an air gap in the yoke, and when a constant current is passed through this coil it deflects in accordance with equation (4) by an amount proportional to the field strength in the gap, which in turn depends on the flux in the specimen.

In determining the magnetic properties of materials in strong fields, of the order of 300 to 10,000 oersteds or more, it is usually desirable to use some kind of an electromagnet to create the field. One good method for determining B and H is shown in fig. 73. The specimen S is placed in the air gap of an electromagnet EM and surrounded by a small coil B, preferably a short single layer of fine wire. This is connected to a sensitive fluxmeter G_B, the deflection of which is a measure of the flux change when the

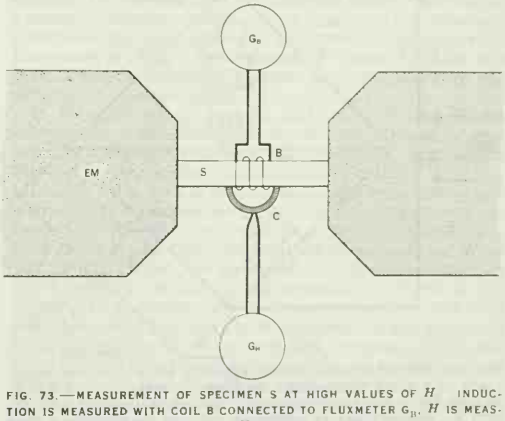

FIG. 73.—MEASUREMENT OF SPECIMEN S AT HIGH VALUES OF H. INDUCTION IS MEASURED WITH COIL B CONNECTED TO FLUXMETER G_B. H IS MEASURED WITH CHATTOCK COIL C. H IS CHANGED BY VARYING CURRENT THROUGH ELECTROMAGNET EM

field of the electromagnet is changed.

The field strength acting on the specimen is measured by a Chattock potentiometer; this is made of many turns of fine wire C wound evenly on a flexible nonmagnetic semicircular form that is placed against the specimen near the ends of the coil B. The deflection of the fluxmeter G_H measures the change of field strength as the coil C is brought from zero field into its place against the specimen.

A high-H permeameter was also designed by R. L. Sanford and E. G. Bennett for measuring B in strong fields.

Alternating Current Methods.—A.C. testing methods are principally used for determining (1) permeability and energy losses of thin sheet at low inductions, usually not more than a few hundred gausses, using an inductance bridge; and (2) energy losses at high inductions, usually $B = 15{,}000$, using the Epstein method.

A diagram of the inductance bridge is shown in fig. 74. Current of the desired frequency f is supplied by an oscillator and fed to opposite corners of the bridge through a transformer and a thermal ammeter A. Two equal fixed resistances R_1 constitute two arms of the bridge, and in the others are the specimen S, variable inductance L and resistance R. When the bridge is balanced by adjusting L and R until no voltage is detected through the headphones P or other instrument connected through a transformer and amplifier, then L and R are equal to the inductance and A.C. resistance of the winding that encloses the specimen. The permeability can be calculated from L, the dimensions of the specimen, the field strength from the current through the core winding, and the energy loss in the specimen from the resistance R, correction being made for the losses in the copper wire. In another common modification of the Maxwell bridge L is replaced by a variable condenser connected in parallel with the variable resistor.

To avoid the application of many turns of wire to the specimen, necessary when low inductions are measured, G. A. Kelsall has used a device indicated schematically at K in fig. 74. Instead of connecting the windings of a specimen directly to one arm of the bridge in the usual way, a transformer with a many-turn primary and a single-turn secondary is substituted. This turn is wound on the specimen also, and the bridge is balanced as before. The core of the transformer is of high-quality laminated material that has low losses which must be subtracted from the bridge measurement to calculate the loss in the specimen. This instrument has been adapted for use at high temperatures as well as at ordinary temperatures.

In interpreting the permeability and energy losses measured by A.C. methods one must consider the apparent reduction of permeability from skin effect or shielding that arises from eddy currents, and the separable losses attributable to eddy currents and hysteresis. These data obtained with the A.C. bridge are especially important in the study of materials used in communication engineering where small magnetic fields are important in the transmission of weak or undistorted signals.

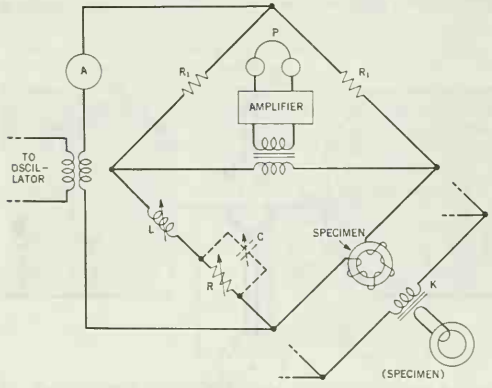

FIG. 74.—THE INDUCTANCE BRIDGE MEASURES RESISTANCE AND INDUCTANCE OF WINDING SURROUNDING SPECIMEN. ALTERNATIVELY, L MAY BE OMITTED AND A VARIABLE CONDENSER C MAY BE INSERTED IN PARALLEL WITH R. SPECIMEN MAY BE CONNECTED THROUGH TRANSFORMER K THAT HAS SINGLE-TURN SECONDARY LOOPED WITH SPECIMEN

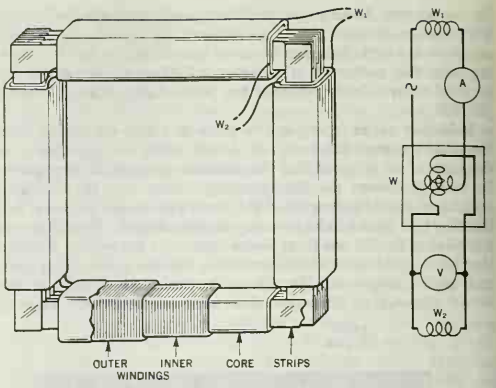

FIG. 75.—EPSTEIN OR LLOYD-FISHER APPARATUS. THIS APPARATUS MEASURES POWER DISSIPATED IN A SPECIMEN FORMED FROM STRIPS. COILS FORM-WOUND AS SHOWN IN (A) ARE CONNECTED AS SHOWN IN (B) TO VOLTMETER V AND WATTMETER W

The Epstein or Lloyd-Fisher apparatus is used primarily for measuring magnetic losses in material for transformers operating at high inductions. The material in the form of strips is built into a hollow square. An alternating field is applied in one winding to magnetize it to a high induction measured by the voltage induced in a second winding; the loss is indicated by a wattmeter W connected to the circuits of both windings (fig. 75). Both windings are placed evenly on forms with square sections, and four such forms are placed to make a hollow square. The strips are slipped into the forms and carefully clamped at the corners after being abutted or overlapped there. Standard specifications control the manner of cutting and stacking the specimens, of correcting for the air flux in the coils and of taking into account the wave form of the exciting current. Measurements are commonly made at $B = 15{,}000$ and at a frequency of 60 cycles/sec. in the U.S. and 50 cycles/sec. in England.

In principle a simple method of testing by A.C. is to determine the current-voltage characteristics of a specimen that has two windings, the current being a measure of H and the voltage a measure of B. The several methods for accomplishing this involve potentiometric measurements or rectification. From the results one can determine not only B and H, but also by taking account of the phase the total energy loss in the material can be found.

3. Special Methods.—Measurements of very small quantities of materials, of single crystals in definite directions, of paramagnetic or diamagnetic solids, liquids or gases all require specific arrangements for obtaining results of high accuracy with a minimum of effort.

Years ago the intensity of magnetization of a specimen was usually measured by the torque it exerted on a small magnetic needle of known moment suspended nearby. The deflection of a light beam by a mirror attached to the delicate suspended system is still a very sensitive indicator of magnetization, but for most purposes the uncertainty in the positions of the magnetic poles of the specimen gives the magnetometer low precision.

In principle the magnetometer measures field strength at a known distance from the poles of the specimen, in accordance with equation (1). It has been used for measuring, with not too great accuracy, the magnetic properties of very small specimens in the form of fine wires or thin films deposited by evaporation or electrodeposition.

Measurements of weakly magnetic substances usually depend on the translational force on a magnetized body in a nonuniform magnetic field. Faraday suspended the sample between the poles of an electromagnet, displaced from the central position so that the field gradient was large, and used a torsion balance to measure the force moving the material toward or from the stronger part of the field. This method was developed by Curie and used in his classical researches on the effect of temperature on paramagnetic and diamagnetic materials.

When the field gradient is dH/dx, the force on material of magnetic moment M is MdH/dx dynes; when expressed in terms of susceptibility and volume the force is given by equation (3). The force is zero at the central position between the poles of the magnet because here dH/dx is zero, and the force is a maximum at some point and falls off again toward zero at points distant from the magnet.

To avoid laborious mapping of the field to find HdH/dx, and to dispense with careful setting of the sample at a given position, C. Chéveneau proposed that the magnet be moved until the sample shows maximum deviation from its zero position against the restoring force of a torsion balance. The deflection is then proportional to the susceptibility and to the maximum value of HdH/dx, and the proportionality factor is determined by calibration with a substance of known susceptibility.

An ingenious quick-reading device designed by W. Sucksmith is shown schematically in fig. 76. The specimen M is suspended from a ring R made of a flexible strip of metal that deforms when the specimen is pulled into the inhomogeneous field of the electromagnet EM. The deformation of the ring is measured with a beam of light L reflected from two mirrors AB to a scale S. The deforming force is proportional to the intensity of magnetization of the specimen; the constant of calibration is obtained using a magnetic material of known magnetization. The method is applicable to ferromagnetic and paramagnetic substances.

Magnetization in strong fields may also be measured by the method of extraction, used first by Weiss and Forrer. The specimen is placed in the field of an electromagnet and then suddenly removed. During removal it induces a voltage in a coil fixed to the magnet, and the integrated voltage (proportional to the magnetization of the specimen) is measured by ballistic galvanometer.

Special methods have been adapted for use in cryostats for measurements at low temperatures (*e.g.*, 1° K.). Among these is the method of S. Foner (1959), in which a probing coil is placed near the vibrating specimen, and the voltage induced in the coil (proportional to the magnetization) is amplified electronically and recorded. In another method, used by Bozorth and Williams (1956), the sample is in an inhomogeneous field at the end of a vertical pendulum, and the horizontal deflection of the pendulum is measured with strain gauges.

The force exerted upon a magnetic material in an inhomogeneous magnetic field is also the basis of the methods of L. Gouy and G. Quincke for measuring the susceptibilities of liquids. There are numerous modifications of the original methods and adaptation has been made to the measurement of gases. The force on the liquid in the field is measured by its rise in a capillary tube, against the force of gravity. The force on a column of liquid (or gas) extending from a place where the field is H_1 to where it is H_0 may be obtained by integration of equation (3) to give

$$F = \kappa A(H_1^2 - H_0^2)/2$$

where A is the cross-sectional area of the column. If a column of liquid (susceptibility κ_1) is opposed by a column of gas (susceptibility κ_2) the relation becomes

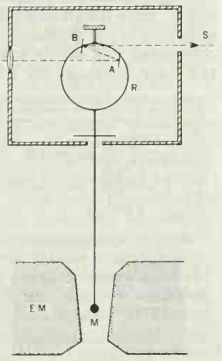

FIG. 76.—SUCKSMITH BALANCE (*see* TEXT)

$$F = (\kappa_1 - \kappa_2)A(H_1^2 - H_0^2)/2$$

Usually H_1 is the field strength directly between the poles of the magnet at the boundary between liquid and gas, and H_0 at the other end of the column is negligibly small. The susceptibility of gases has also been measured with a sensitive torsion balance.

Measurements of the saturation magnetization of ferromagnetic materials were made with great accuracy by Weiss and his students in fields up to 20,000 oersteds, at temperatures ranging from about −250° to +800° C. They used some modification of the scheme shown in fig. 77 in which the force is produced by a field gradient as in the Faraday method, but is measured as a translation instead of a torsion. Such a pendulum magnetometer has a light horizontal beam with the specimen mounted at one end in a region of strong field gradient. The force due to the field is annulled by adjusting a current in a solenoid in which a plunger is attached to the other end of the beam, and the point of zero deflection is indicated by a tilting mirror.

Other methods of measurement in strong fields deserve brief mention. H. DuBois measured the intensity of magnetization by

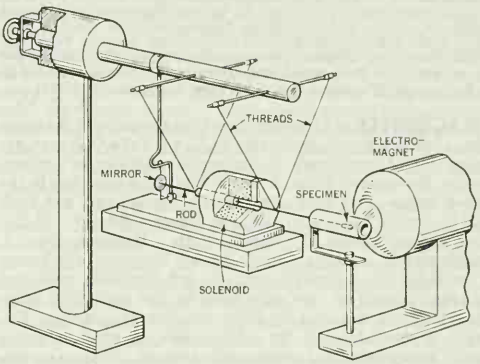

FIG. 77.—PENDULUM MAGNETOMETER. SPECIMEN IS HUNG FROM THREADS ON LIGHT FRAME. INHOMOGENEOUS FIELD OF ELECTROMAGNET (HALF OF WHICH IS SHOWN) PRODUCES HORIZONTAL MOTION OF FRAME, DETECTED BY TILTING OF MIRROR. MOTION IS COMPENSATED BY MAGNETIC PLUNGER IN SOLENOID, CURRENT THROUGH WHICH IS MEASURE OF MAGNETIZATION OF SPECIMEN (P. WEISS AND F. FOËX)

observing the rotation of polarized light reflecting from a magnetized surface (Kerr effect). The strength of a field can be measured by observing the force (opposing gravity) produced on a conductor carrying a known current (equation [4]) or by using a calibrated Hall-effect probe (*see* ELECTRICITY, CONDUCTION OF: *Conduction in Solids: Semiconductors*). Special methods have been devised for measuring magnetic properties that vary with direction, as in single crystals.

In the 1960s steady magnetic fields of more than 100,000 oersteds and pulsed fields that exceed 1,000,000 oersteds were produced in solenoids, sometimes with superconducting wire maintained at low temperature (*see* SUPERCONDUCTIVITY).

In weak fields, such as that of the earth, the methods of geomagnetism (*q.v.*) can be used. In 1936 an apparatus was constructed for measuring and recording rapid changes in fields as small as one gamma (10^{-5} oersted), and during and after World War II this method was developed to even higher sensitivity (10^{-7} oersted). A piece of high-permeability material is subjected to an alternating field of moderate amplitude, and if an additional steady field (that to be measured) is also present an alternating voltage of twice the exciting frequency will be produced that can be amplified and recorded. Its amplitude is proportional to the field strength to be determined.

The strength of high fields is now measured with high accuracy with the use of nuclear resonance. In principle this is the same as ferromagnetic resonance except that the magnetic moment of

the nucleus is much smaller than that of the electron; thus the frequency of resonance is correspondingly lower, and lies in the radio-frequency range for the nuclei of hydrogen and lithium atoms, which are most commonly used for measurement. The measurement of the field strength is then reduced to the measurement of a radio frequency, and can readily be done with a precision of a few parts in 1,000,000. A material that contains hydrogen or other nuclei with constants that are known with high accuracy is placed in the field to be measured, the weak radio-frequency field is applied at right angles to the principal field and the frequency is varied until resonance occurs.

A number of curve tracers have been made for taking magnetization curves and hysteresis loops so that a permanent accurate record may be obtained in a short time. Among the more accurate and convenient of these is P. P. Cioffi's device. For the investigation of magnetic properties at high frequencies special techniques of some complexity must be used.

See also references under "Magnetism" in the Index.

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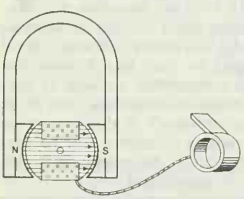
(R. M. B.)

MAGNETITE or MAGNETIC IRON ORE, a member of the spinel group of minerals with the formula Fe_3O_4 (or $FeFe_2O_4$), is an important ore of iron found in commercial quantities in northern Sweden, Norway and Rumania and in the Ural mountains; in the United States—New York, New Jersey, Pennsylvania and Utah (and in some of the ores of the Lake Superior district). It is a black, opaque mineral with metallic lustre. Hardness, about 6. Specific gravity, 4.9 to 5.2. Streak, black. Magnetite, also known as the lodestone, is strongly magnetic and frequently polar and has been known from very early times for this remarkable property which was described by Pliny (*see* also MAGNETISM: *History*). It crystallizes in the cubic system, in which it occurs usually in octahedra, and is frequently twinned. There is no distinct cleavage.

Magnetite is a mineral of wide distribution, especially as a constituent of igneous rocks, both intrusive and volcanic. It appears to have crystallized from the magma at an early period of consolidation, and marginal segregation has led in many cases to the formation of ore deposits. Being a mineral not prone to decomposition, it is also found in detrital deposits, sometimes in a concentrated form, as magnetite sand. The existence of pseudomorphs of magnetite after hematite (*q.v.*) and vice versa, however, prove that these minerals may be converted into one another by a change in the state of oxidation. Oxidation and hydration in the zone of weathering lead to limonite (*q.v.*). Titaniferous magnetite or titanomagnetite is a variety containing titanium. It consists of an intergrowth in various proportions of the minerals magnetite and ilmenite (*q.v.*).

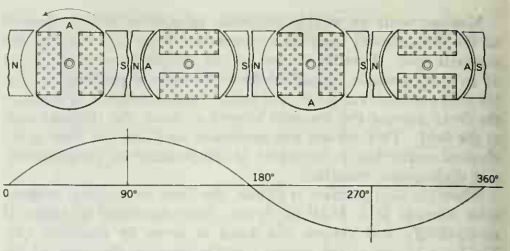
See also IRON: *Compounds of Iron;* NATURAL RESOURCES: *Minerals.*

MAGNETO, HIGH-TENSION. The magneto is a special application of the electric generator employed where the output of energy required is very small. It is used to furnish energy for ignition of compressed gases in various types of internal-combustion engines. The elements of construction comprise a permanent magnetic field, an armature rotated within that field, a circuit breaker and a distributing mechanism which serves to convey the generated voltage to a desired point. The low-tension magneto consists merely of a permanent magnet of inverted U form and, rotating between its poles, a shuttle-wound armature containing a number of turns of comparatively coarse wire, as shown in fig. 1.



BY COURTESY OF J. H. CROWNE

FIG. 1.—SIMPLE MAGNETO SHOWING MAGNET PRIMARY WINDING



BY COURTESY OF J. H. CROWNE

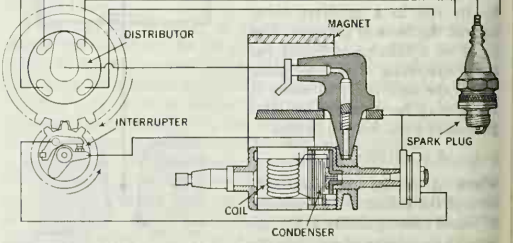
FIG. 2.—SIMPLE ELECTRIC WAVE FORMED IN A MAGNETO, SHOWING POSITION OF THE ARMATURE AND THE CURRENT PHASE FOR EACH POSITION

The changes of flux in the armature core, caused by its rotation in the permanent field, generate in the armature winding an electromotive force, the magnitude of which is proportional to the field strength, the speed of rotation and the number of turns of wire on the armature. As the armature core rotates into a position in a plane with the flux lines, the flux in the core increases to a maximum. As the rotation progresses, the flux in the core decreases for one-half cycle. In the second half cycle, the coil direction is reversed with relation to the flux.

The generated electromotive force, consequently, is alternating in direction and magnitude and follows the variation of flux in the core. The change of electromotive force with change of position of the armature is shown in fig. 2. The low-tension magneto has been used in conjunction with an induction coil as an ignition source, the coil serving to transform the voltage to a value sufficient to cause a spark across the terminals of a spark plug.

High-Tension Magneto Construction.—The high-tension magneto has a secondary winding, comprising a great many turns of fine wire superimposed upon the primary winding. The primary winding is short-circuited by means of an auxiliary device during the building up of the field in the armature core. When the energy in the primary circuit has reached a maximum, this circuit is opened, and at the same instant, as a result of the rotation of the armature, the magnetic field is removed. The energy of the primary winding is discharged through the secondary, and as a result of the ratio of primary to secondary turns, a considerable increase in voltage is effected. This value may vary between 7,500 and 18,000 v. The high-tension magneto when employed as a source of ignition for gas engines is operated synchronously with the engine by direct connection.

Fig. 3 shows the construction of a shuttle-armature type of high-tension magneto. The circuit breaker is operated by means of a cam, upon which the bumper, or cam follower on the breaker bar, bears. Since the armature is directly connected to the engine, the frequency of the discharges through the secondary circuit is thus determined. (A shuttle armature, having two poles, can generate two spark discharges per revolution.) The distributor serves to



BY COURTESY OF J. H. CROWNE

FIG. 3.—UNIT COIL FOR GASOLINE MOTOR IGNITION SYSTEM

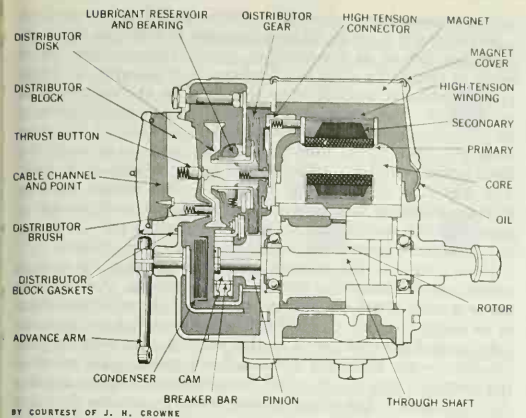


FIG. 4.—CROSS SECTION OF INDUCTOR MAGNETO

convey the voltage to each of the spark-plug cables, in a desired sequence. Operating in synchronism with the armature, from which it is driven by means of a gear and pinion, the brush or firing pin of the distributor arm makes contact with a segment in the distributor block each time the secondary discharge occurs. By this means, the high-tension energy is carried to each spark plug in order. For a four-cylinder engine, the distributor block carries four segments, and since the shuttle armature generates two sparks per revolution, the gear ratio between armature and distributor is 2:1. The primary and secondary windings are common at one point and are there connected to the frame of the magneto. The return circuit of the secondary is thus completed through the body of the engine. The contact points of the circuit breaker, or interrupter, are made of an arc-resistant alloy.

An improvement in magneto design was offered in the inductor-type instrument in which the coil is stationary and the flux changes are brought about by means of magnetic shunt segments which rotate between the magnet poles and bridge between them and the coil core. A cross-sectional drawing of this type is shown in fig. 4. By the use of four rotor segments, spaced 90° apart, four sparks per revolution may be generated. In addition, the flux direction through the coil core is reversed each quarter revolution. The direction of current through the contact points of the interrupter is thus alternated, and the excessive point pitting caused by a unidirectional arc is eliminated.

In order to vary the time of occurrence of the spark in the engine cylinder, the magneto cam, or the circuit breaker, is made rotatable through part of a revolution, and is connected, by means of a linkage, to a convenient advance-retard lever. This makes it possible to alter the relationship between the engine crankshaft and the magneto, and to ignite the charge either before or after the piston has reached its dead centre position. Since the spark intensity of a magneto varies directly with engine speed, there is available an increase of energy at high speed when the requirements for ignition are most severe. At low speeds of rotation such as accompany the cranking or starting of automotive engines, the magneto will sometimes fail to produce a voltage sufficient to spark across the gap. There have been in use various impulse devices, such as "impulse couplings," which serve to couple the magneto to the engine and to accelerate its rotation in starting.

The magneto is employed on aircraft engines, where the highest engine efficiency must be maintained; on tractor engines, motorcycles, marine engines and to a great extent on motorbuses and motor trucks. Stationary engines are also magneto equipped. Minor commercial uses are found in the igniting of blasting charges (detonators), in igniters, for oil or gas burners; and, in conjunction with neon lamps, as stroboscopic indicating instruments.

See also AUTOMOBILE; INDUCTION COIL. (I. H. C.)

MAGNETOCHEMISTRY. Because it is strongly attracted by a magnet, iron is said to be ferromagnetic. There are relatively few ferromagnetic materials, but other substances show either a weak attraction or a very weak repulsion by a magnet. Substances thus weakly attracted are said to be paramagnetic, those repelled are diamagnetic. Magnetochemistry is the branch of chemistry in which these and other magnetic properties are used to solve chemical problems.

There are at least four major applications of magnetism to chemistry. These are (1) qualitative and quantitative chemical analysis; (2) the study of free radicals; (3) the structure of inorganic compounds; and (4) the mechanism of catalysis. Since about 1950 the range of such studies has been greatly extended owing to the development of two new experimental methods, nuclear magnetic resonance and electron magnetic resonance.

Magnetic apparatus may be used for the detection of paramagnetic impurities in diamagnetic substances, and especially for ferromagnetic impurities. The sand used for making glass must often be as free as possible from iron. Use of the magnetic balance will often detect a very small trace of iron in such sand. Similarly, traces of iron or of other ferromagnetic substances may be detected in metals such as magnesium. The term "magnetically pure" is sometimes used for substances which have been shown, by magnetic tests, to be free from impurities. Another analytical application is that of measuring the concentration of oxygen (which is almost unique among gases in being paramagnetic) in a mixture of gases. The magnetic method is a useful tool for a variety of chemical and metallurgical tests, including precipitation studies, and granulometry or the measurement of the radius and shape of extremely small particles. This subject is often called "thermomagnetic analysis."

Another use of magnetism in chemistry is in the study of free radicals. These substances, of which triphenylmethyl is one, possess an odd number of electrons (except for a few special cases) and are paramagnetic. Most chemical substances possess an even number of electrons and are diamagnetic. Electron magnetic resonance is especially useful in this field. An active area for magnetochemical study is the atomic and molecular relationships in inorganic compounds. Hemoglobin, the red matter in blood, is a good example. Hemoglobin serves as the carrier of oxygen. It is composed in part of a complex compound containing iron. This substance is paramagnetic but when the hemoglobin takes up oxygen, as it does in passing through the lung tissues, the hemoglobin becomes diamagnetic. Studies of a related nature are made on substances called ferrites, of which nickel ferrite is one. Ferrites are used in electronic equipment.

A field of usefulness and promise is the application of magnetic methods to catalysis. Certain elements such as chromium and nickel and their compounds, which show catalytic activity, show also interesting magnetic effects. In some cases it is reasonably well established that catalytic activity and paramagnetism (or ferromagnetism) have a common underlying basis in the presence of unpaired electrons in certain atoms. This correlation has proved fruitful in the study of chemisorption (*see* ADSORPTION), that is, the way in which molecules adhere to the surface of the catalyst prior to and during catalyzed chemical reaction.

See P. W. Selwood, *Magnetochemistry* (1956). (P. W. S.)

MAGNETOHYDRODYNAMICS, or hydromagnetics, in its most general sense is the study of the motions of electrically conducting fluids (liquids and gases) in the presence of electric and magnetic fields. Occasionally the term has been restricted to liquids, with magnetogasdynamics and plasma physics used in the case of gases. In physics, plasma is a gas of electrically charged particles (*see* ELECTRICITY, CONDUCTION OF).

Principles of magnetohydrodynamics have assumed importance in efforts to design reactors for generating power from thermonuclear sources; it is hoped that appropriately designed magnetic fields will serve to confine the plasma of hydrogen isotopes in which fusion occurs. The behaviour of particle accelerators, electrical propulsion devices for space vehicles, the aurora and Van Allen radiation belts, as well as related phenomena or equipment also may be described in magnetohydrodynamic terms. *See*

ATOMIC ENERGY: *Peacetime Applications;* ACCELERATORS, PARTICLE; AURORA POLARIS; VAN ALLEN RADIATION BELTS.

Early magnetohydrodynamic studies (for example, those of Michael Faraday in 1832) dealt with liquid metals. Liquid mercury was used by Y. Nakagawa (1957) to determine the effect of a magnetic field in inhibiting thermal convection; at higher temperatures, molten sodium has been used. It is believed that the earth's core, below about the 1,800-mi. depth, is composed largely of molten iron and nickel. The connection of earth's magnetic field with this conducting, liquid core has been a magnetohydrodynamic problem of interest in geophysics (*see* GEOMAGNETISM). However, most of the magnetohydrodynamic problems of interest in the 1960s involve gases. At ordinary temperatures and pressures gases are groups of electrically neutral atoms or molecules and therefore do not conduct electricity. However, at temperatures of several thousand degrees centigrade and above (depending somewhat on the gas pressure), the thermal motions of the particles are energetic enough to dislodge some of the outer electrons from the atoms. The electrons thus freed, and the resulting positive ions, are easily made to move by an electric field, so that such ionized gases (plasmas) are usually good conductors of electricity. Natural plasmas occur in the sun and other stars, in the upper parts of earth's atmosphere, and in the extremely low-density gas clouds in interplanetary and interstellar space. Plasmas also have been studied extensively in the laboratory, the chief interest being in their possible use as sources of power (*see* ENERGY CONVERSION, DIRECT).

Basic Principles of Magnetohydrodynamics.—All fluids are groups of particles in varying states of aggregation, and the motion of a fluid is therefore given by the motions of its particles. If each particle is labeled with an index $i = 1, 2, 3, \ldots N$, where N is the total number of particles (very large usually), then Isaac Newton's equation governing the motion of the ith particle is

$$a_i = \frac{f_i}{m_i} \tag{1}$$

Here a_i is the acceleration of the ith particle, and the equation states that the acceleration is proportional to the force f_i acting on the particle and inversely proportional to its mass m_i. The forces acting on the particles are generally: (1) gravitational forces; (2) forces exchanged during collisions among particles; and (3) forces from electric and magnetic fields.

The weak gravitational forces sometimes can be important in stellar and geophysical problems, but usually may be ignored in magnetohydrodynamic studies on a laboratory scale. The collisional forces are atomic in origin, and the exchange of momentum in collisions is connected with the phenomenon of pressure. A gas exerts pressure on its container through multitudinous impacts of its atoms with the wall. In the same way, neighbouring volume elements in a gas or liquid exert pressure forces on each other.

A charged particle in an electric field E and a magnetic field B is subject to the Lorentz force

$$f = q(E + v \times B) \tag{2}$$

Here q is the electric charge of the particle and v is particle velocity. While the electric field exerts a force in the direction of the electric field, the magnetic field exerts a force at right angles to both the magnetic field and the particle velocity, as is implied by the cross ($\times$) product (*see* VECTOR ANALYSIS: *Products of Vectors*).

Equations (1) and (2) together determine the motions of the particles, given the electric and magnetic fields. The fields, however, are determined in turn by the motions of the particles. If at some time, for example, there happen to be more positive than negative particles in a small volume element, the element has a net positive charge that gives rise to an electric field. Also, moving charged particles constitute an electric current, and currents give rise to magnetic fields. Mathematically, the relation of the fields to the charges and currents that produce them is expressed by James Clerk Maxwell's equations (*see* ELECTROMAGNETIC WAVES: *Maxwell's Field Theory*). These, together with equations (1) and (2), are sufficient to determine the behaviour of the entire system of particles and fields if the initial conditions are specified.

In practice it is rarely (if ever) possible to solve the equations of motion for all of the particles, simply because there are so many of them. To make any headway, it is necessary to forego precise reckoning, and be content with knowing average properties of the fluid. Thus, instead of hoping to specify the positions of all the particles, the investigator settles for knowing the mass density μ, that is, the total mass of the particles in small but finite volume elements (cells) divided by the volume of the cells. The cells must be sufficiently large to contain enough particles to make statistical fluctuations unimportant, but small enough to keep density from changing too much from cell to cell. It is usually possible to select a cell size that satisfies both criteria.

Next, instead of the velocities of all the particles, the average velocity u of the particles in each cell is accepted. A cork floating in a creek shows the average velocity of the water molecules in its neighbourhood. It must not be assumed that all the molecules around the cork travel at this velocity. At ordinary temperatures water molecules dash randomly about with velocities the order of 1,000 ft./sec., aside from whatever average velocity they may have. The mean random velocity (average deviation from the average velocity) must also be used in the simplified description of the fluid. It is the essence of the property called temperature: the higher the random velocity, the higher the temperature. It is important in determining fluid motions, because the pressure depends on it: collisional forces are larger when random velocity is higher.

The density μ, the average or fluid velocity u and the temperature T are sufficient parameters to describe a situation in ordinary hydrodynamics. Magnetohydrodynamics also requires the electric and magnetic fields, the electric charge density ρ and electric current density j. The charge density is the net excess of positive over negative charge per unit volume, and the current density is net charge times velocity per unit volume; clearly these are also averages.

Equation (1), when averaged over all particles moving in a cell, becomes

$$\dot{u} = \frac{1}{\mu}[\nabla p + \rho E + j \times B] \tag{3}$$

Here $\dot{u}$ is the acceleration (time rate of change of the average velocity u in some cell). The pressure (which depends on T and μ) is represented by p, and ∇p is the difference of the pressure forces acting on opposite faces of the cell. The other two terms in the bracket are the electric and magnetic forces acting on the cell. In writing equation (3) the gravitational forces have been assumed to be negligible; they could be included in the bracket. Equation (3) is the equation of motion of the most rudimentary form of magnetohydrodynamics.

All the forces in equation (3) are of fairly common experience. The pressure is the force felt in trying to stop the flow of water from a faucet by holding a finger over the opening. The electric force can be observed by rubbing a plastic hairbrush handle with wool cloth and then holding the handle near a very thin stream of water; the electric force will deflect the stream toward the plastic. The magnetic force on currents is the driving force in electric motors.

In many applications of equation (3) the electric force is negligible, because concern is often with fluids that are very good conductors of electricity. In such cases even small electric fields generate very large electric currents, which rapidly neutralize the excess charge that produced the electric fields. Thus, charge densities and electric fields are small, but the currents and magnetic fields they produce are large.

As a further simplification, it can be shown in this case of high electrical conductivity that the magnetic field lines can be regarded as moving with the fluid. This is of great help in providing an intuitive feeling for the changes in the magnetic field patterns that accompany various motions of the fluid.

An intuitive grasp of the magnetic forces is provided by Michael Faraday's concepts of magnetic field lines. Faraday observed that the field lines can be regarded as transmitting a tension along

the lines and a pressure in directions perpendicular to the lines, the magnitude of both tension and pressure being equal to $B^2/8\pi$. These ideas help in understanding the attraction of two opposite magnetic poles and the repulsion of like poles. In fig. 1(A) the field lines are all perpendicular to the central plane; thus a tension is transmitted across this plane as if a stretched spring connected the north and south poles. In fig. 1(B) the field lines run parallel to the central plane, so that a pressure is transmitted across the plane as if a compressed spring connected the two north poles. Magnetic forces can be understood either as forces on currents or as tensions and pressures in the field; the two descriptions are completely equivalent.

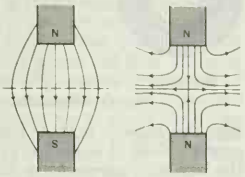


FIG. 1.—ATTRACTION AND REPULSION IN TERMS OF MAGNETIC STRESSES

Hydromagnetic Waves.—To understand some simple hydromagnetic phenomena consider first two types of hydromagnetic wave: transverse and longitudinal.

Transverse Waves.—Suppose there is a homogeneous fluid of density μ with a uniform magnetic field B as in fig. 2(A). Then let alternate vertical layers of the fluid be displaced upward and downward, transverse to the original field. If the fluid is a good conductor, the field lines will be displaced with the fluid as in fig. 2(B). Since the field lines are in tension, they tend to shorten

FIG. 2.—TRANSVERSE HYDROMAGNETIC WAVE

by straightening to their original position, carrying the fluid with them. However, when the field lines reach the straight configuration, the fluid layers have some velocity and fluid inertia will carry the field lines farther until the crests and troughs of fig. 2(B) are precisely interchanged. The action then reverses and continues, to produce a standing wave. Calculation shows that the frequency f and the wavelength λ of these waves are related by the expression

$$f\lambda = \frac{B}{\sqrt{4\pi\mu}} \qquad (4)$$

The quantity on the right is the propagation velocity of the waves (called the Alfven velocity after the Swedish astrophysicist who first discussed hydromagnetic waves).

Longitudinal Waves.—Again start with uniform fluid and magnetic field as in fig. 3(A). Now let alternate vertical layers of the fluid be displaced to the right and left so that the fluid becomes denser in some regions and less dense in others (fig. 3[B]).

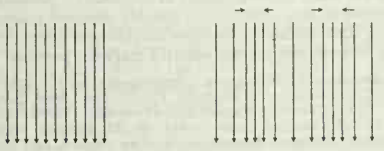


FIG. 3.—LONGITUDINAL HYDROMAGNETIC WAVE

Again, if the fluid is a good conductor, the field lines will be compressed and rarefied with the fluid. In the compressed regions the magnetic pressure will be larger than in the rarefied regions, tending to force the fluid back to the uniform configuration. Again, the inertia of the fluid will carry the field beyond the uniform configuration to produce oscillations. If the fluid pressure is negligible compared to the magnetic pressure $B^2/8\pi$, the frequency f and wavelength λ of these waves are also related by equation (4). When the fluid pressure is much higher than the magnetic pressure these longitudinal waves become ordinary sound waves.

In general, for every problem in ordinary hydrodynamics there is a corresponding problem in magnetohydrodynamics. Usually the addition of the magnetic field complicates the problem because of the peculiar tendency of the field to have tensions in some directions and pressures in others.

Hydromagnetic Dynamo Theory of Earth's Magnetic Field.—The mechanism responsible for earth's magnetic field has been a long-standing scientific puzzle. Some source of energy is needed to maintain the field. A system of electric currents could produce the field, but since the earth has electrical resistivity these currents would slowly die away and the magnetic energy would be spent as heat. From the known resistivity of iron, the field should decrease by an estimated factor of 10 every 1,000,000 years. The earth is believed to be several billion years old; thus either its field was inordinately large in the beginning or some source replenishes the energy dissipated in the resistance.

Probably the most commonly accepted idea at present is that the energy comes from motions of molten iron in the earth's core across the magnetic field. The fluid motions may be convective, driven by rising temperature with depth and influenced by the rotation of the earth. In moving across the magnetic field, the fluid is held to generate an electromotive force (as does the armature of a dynamo) that maintains the current. The energy to maintain the currents then would come from the fluid motions, in turn supplied from the earth's heat energy (and possibly from the earth's rotational energy). The earth's heat is a much larger store of energy than the magnetic field; the field contains on the order of 0.1 erg/c.c., while the heat represents on the order of 10^{10} erg/c.c.

The specific form of the fluid motions held to maintain the field is not known. As one example of fluid motions that increase magnetic energy, start with a uniform magnetic field (fig. 4[A]). Imagine the fluid above the plane xy is displaced to the left with respect to the fluid below the plane. If the field lines are carried along, the field is distorted as in fig. 4(B). The field lines are

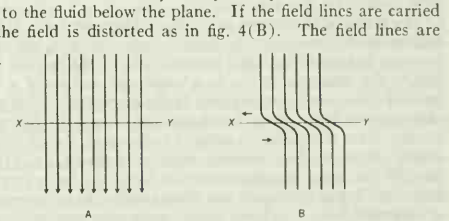


FIG. 4.—INCREASE OF MAGNETIC ENERGY BY A SHEAR FLOW

then closer together in the region of shear. This means that the magnetic field and the magnetic energy are greater there than elsewhere; the fluid has done work in stretching the field lines.

In this example the additional field tends to be at right angles to the original field. The question of how or whether the new field becomes aligned to reinforce the original field is not fully answered.

Many stars, including the sun, have magnetic fields attributed to the same type of mechanism. In many stars the field is strong (several thousand gauss) and reverses polarity at intervals as short as a few days; sunspots reverse polarity with a half-period of $11\frac{1}{2}$ years. There is also good geologic evidence that earth's field has reversed many times in prehistory; the reasons are not understood.

Magnetohydrodynamics in the Solar System.—In addition to the magnetic fields in and near the earth and sun, variable magnetic fields permeate interplanetary space. It is likely that these fields are carried from the sun by jets of hot solar plasma. The surface of the sun often shows violent eruptions of visible hot gases accompanied by magnetic fields. Presumably these eruptions result from turbulence of the convective region that normally lies just below the visible solar surface. It is believed that in at least some of these eruptions, invisible jets of low-density gas are shot out as far as the earth and farther. This solar wind of ionized

gas distorts and shakes earth's magnetic field in much the same way that a windstorm affects a tree; instruments on earth then record a magnetic storm (*q.v.*). The magnetic storm usually begins about a day after an eruption is seen on the sun, indicating that the velocity of the gas is about 10^8 cm./sec.

Two successive stages of the gas motion and the magnetic field carried with it from the sun are illustrated in fig. 5. Evidence for the gas-borne magnetic field is found in the decrease in cosmic-ray intensity just prior to a magnetic storm. Called the Forbush decrease, it arises when continuously falling cosmic rays are deflected from earth as a result of the magnetic field accompanying

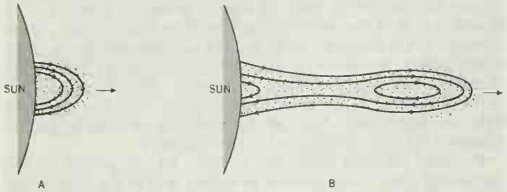


FIG. 5.—MAGNETIC FIELD PULLED OUT BY IONIZED SOLAR GAS JET

the gas. Experiments in the U.S. satellite Pioneer V showed that the Forbush decrease results not only from modification of earth's field but occurs over much larger volumes of space (*see* COSMIC RAYS: *Nature and Origin of Primary Rays*).

High-energy protons that often accompany the gas cloud are further evidence for the magnetic field. It is believed that these protons come from solar flares (which can be timed by the bursts of radio noise they generate). The energy of the protons corresponds to velocities on the order of 10^{10} cm./sec. Thus, if unimpeded, they should reach earth in $\frac{1}{100}$ the time required for the gas jet. Yet experiments suggest that many of the protons arrive only when the gas reaches earth. In explanation, it is supposed that these high-energy protons are trapped in the magnetic field carried by the gas.

The trapping of charged particles by magnetic fields is basic in magnetohydrodynamics. As noted in equation (*2*), the magnetic force on a charged particle is perpendicular to the particle velocity and to the magnetic field. As a result, the motion of a charged particle (in a plane perpendicular to the magnetic field) is circular, the magnetic force always being directed toward the centre of the circle. Since it also moves parallel to the field, the particle has a helical trajectory in a uniform magnetic field (fig. 6[A]). The particle can move in either direction along the field, keeping the same field line as the centre, and always encircling the same amount of magnetic flux. This holds approximately for nonuniform fields: fig. 6(B) (curved field lines) and fig. 6(C) (diverging field lines).

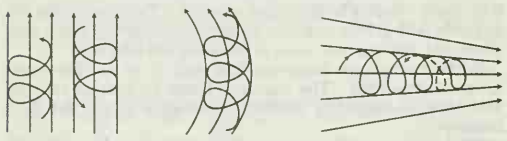


FIG. 6.—CHARGED PARTICLE ORBITS IN MAGNETIC FIELDS

The latter figure shows how a particle can be turned back by a region of higher field intensity; such a configuration is called a magnetic mirror.

Similarly, energetic protons can be confined by the field accompanying the solar gas jet in fig. 5(B). Once it enveloped the earth, the jet would be in effect a magnetic pipeline along which the protons could travel freely from sun to earth.

Magnetic Implosions.—A simple example of experiments in magnetohydrodynamics is the production of very intense magnetic fields by implosion. A magnetic field is first established inside a cylindrical copper shell (fig. 7). The shell is then made to implode (collapse violently) by symmetrically detonating the surrounding high explosive. As the shell implodes, the field lines are compressed

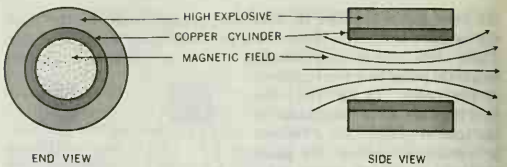


FIG. 7.—APPARATUS FOR MAGNETIC IMPLOSION

until the magnetic pressure rises enough to stop the fast-moving copper. Fields of as much as 15,000,000 gauss have been produced this way, with corresponding magnetic pressures about 10,000,000 times atmospheric (roughly 100,000,000 lb./in.^{2}).

Controlled Thermonuclear Reactors.—Fusion of atomic nuclei has produced the hydrogen (thermonuclear) bomb; it also offers a practically limitless supply of constructive power, since the fuel comes from water. However, efforts in the 1960s to produce reactors that would control the release of thermonuclear energy were facing difficulties. One aspect of the problem, magnetohydrodynamic instability, is of general interest here.

One proposal for containing the very hot ($10^{8\circ}$ C.) plasma needed in a thermonuclear reactor is the magnetic mirror sketched in idealized form in fig. 8. The pressure of the plasma is supposed to be balanced exactly by the magnetic pressure on its surface. Such an equilibrium is in fact possible, but this equilibrium configuration is unstable. If initially present on the plasma surface, some types of irregularity will grow in time until the configuration is destroyed. Furthermore, there will always be initial surface irregularities arising from imperfect symmetry of the coils that produce the magnetic field and from thermal fluctuations in the plasma itself.

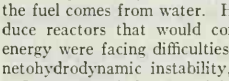


FIG. 8.—IDEALIZED MAGNETIC MIRROR CONFIGURATION FOR HOLDING PLASMA

The cause of the instability is easily seen. The magnetic field lines are stretched like rubber bands around the plasma. The innermost field lines tend to go straight down the axis rather than skirt around the plasma. On the other hand, being a gas, the plasma can have any shape as long as its volume is fixed. Thus, by adopting a fluted shape as sketched in an end view in fig. 9, the plasma can preserve its own volume and at the same time satisfy the tendency of the magnetic field lines to shorten as they fill in the troughs of the flutes. The magnetic pressure will then be greater in the troughs than at the peaks and the flutes will become more pronounced. In effect, the plasma will squirt out between the field lines.

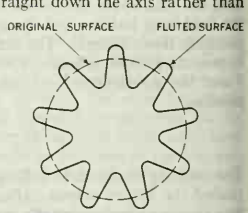


FIG. 9.—FLUTE INSTABILITY

There are many different forms of instability. Although a few particles can be kept orbiting in a suitably designed magnetic field for a long time, instability becomes troublesome when the plasma pressure becomes comparable with the magnetic pressure.

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MAGNETOMETER, an instrument for measuring a magnetic force. Although the term is often applied to any instrument for measuring the external field caused by a magnet, it has become attached more specifically to instruments for measuring the earth's magnetism. Such instruments can be used for measuring the intensity of one or more components, the direction of the total field vector or one of its components. In practice, usually one of the

intensity components is measured together with the direction of the total field vector, and the field or other components are then computed.

Magnetometers can be classified as (1) absolute magnetometers; (2) relative magnetometers; and (3) variometers. Absolute magnetometers measure the magnetic force without reference to any other standards except those of mass, length and time. Relative magnetometers require comparison with absolute instruments to determine certain fundamental constants that can be determined only with great difficulty, or occasionally not at all; or involve the use of standards of electric current, resistance or voltage. Variometers are used for measuring the variations in the force from time to time between two points in space. A set of variometers for recording time variations of the magnetic field is called a magnetograph.

The absolute magnetometers in use at the majority of magnetic observatories are those that measure the horizontal intensity of the earth's magnetic field by the classical method of C. F. Gauss. Gauss's method permits the measurement of the intensity through two experiments. The first observation is the determination of the period of oscillation of a magnet. The magnet is suspended on a fibre of negligible torsion in a closed housing free from air currents. The period of oscillation is measured, and is a function of the strength of the magnet, its magnetic moment and the strength of the horizontal component of the field. In the second experiment, this magnet is used to deflect a second magnet suspended in a similar manner. Gauss made these deflection observations by keeping the magnet in a fixed position at right angles to the magnetic meridian. Johann von Lamont later revised this procedure, and by means of a theodolite magnetometer could keep the two magnets at right angles during the experiment. In the first experiment, the relationship between the values of the horizontal field and the magnet are expressed as:

$$MH = \frac{4\pi^2 I}{T^2}$$

where H is the horizontal intensity of the earth's field; M is the moment of the magnet; I is the moment of inertia of the magnet and supporting holder; and T is the time of one oscillation.

The moment of inertia of the magnet and its support cannot be computed readily because the shape is irregular and dissimilar materials are used. It is therefore determined experimentally by attaching a cylindrical bar or ring whose moment of inertia can be computed from its dimensions and mass.

In the second experiment, following Lamont's method, the relationship between the field and the deflection angle is:

$$\frac{H}{M} = \frac{2}{r^3 \sin \delta}$$

where H and M are as above; r is the distance between the centres of the two magnets; and δ is the deflection angle. By combining these two equations, the final value is:

$$H^2 = \frac{8\pi^2 I}{T^2 r^3 \sin \delta}$$

In practice, various corrections are applied to allow for the effects of torsion in the fibre, induction in the magnets, coefficients of distribution of magnetism in the magnets, temperature coefficients of the magnet and the deflection bar, etc. Errors are kept down to 0.00008 gauss, where one gamma (γ) is $\frac{1}{100,000}$ gauss.

Relative magnetometers are finding increased usefulness for magnetic survey work and as control instruments at magnetic observatories. The reliability of these instruments has been greatly enhanced by virtue of the new magnetic steels and by the use of modern techniques in measuring electrical quantities on some instruments that operate on electromagnetic principles.

One of the most widely used relative magnetometers, known as the QHM (quartz horizontal magnetometer), was developed by D. La Cour of the Danish Meteorological institute. It consists of a magnet with an attached mirror suspended by a quartz fibre. It operates on the principle of balancing the torque exerted on the magnet by the earth's horizontal magnetic field against the torque exerted by the fibre when twisted through exactly 2π (360°) radians. The torsion coefficient of the fibre and the moment of the magnet are so related that for the value of horizontal intensity in most latitudes, $HM > 2\pi\phi$ (H is horizontal intensity; M, the moment of the magnet; ϕ, the coefficient of torsion). The suspended system is so arranged that when the magnet is in the magnetic meridian, the mirror is perpendicular to the axis of the telescope attached to the instrument. The image of the scale in the Gaussian eyepiece of the telescope may be viewed through the mirror, and the telescope set perpendicular. To make a measurement, the instrument is first set in the magnetic meridian by bringing the central mark on the scale into coincidence with its image as seen in the mirror. The magnet is left unclamped and the instrument is then rotated slowly through an angle $2\pi + \delta$ to coincidence of the two lines. The instrument is then rotated in the opposite direction through an angle $4\pi + \delta$ to coincidence. The horizontal intensity is then given by:

$$H = \frac{2\phi}{M \sin \delta} = \frac{C}{\sin \delta}$$

C is a constant determined by comparison with standard instruments. Corrections must be applied for the temperature coefficients of the magnet and the quartz fibre.

The QHM is also widely used at fixed observatories for the determination of the magnetic declination by sighting at a mark whose azimuth is known.

A companion instrument of the QHM is the BMZ (magnetometric zero balance) for measuring the vertical intensity. It is similar to the local vertical intensity variometer in principle. The instrument is equipped with two auxiliary magnets, the upper one for establishing the mean value at which the instrument will operate, and a lower magnet used to reach a balanced condition. The indicating or balanced magnet is made from one piece of magnet steel and consists of the magnet, mirror and steel knife-edges. The knife-edges of the magnet rest on cylindrical quartz bearings. A small telescope with Gaussian eyepiece similar to that used in the QHM is used to determine the balanced or horizontal position of the magnet. The observation is made by freeing the balanced magnet and rotating, about a horizontal axis, the lower or turn magnet. The angle through which this lower magnet must be turned to reach a balance is a measure of the vertical intensity. The constants of the instrument also must be determined by comparison with standard instruments. Corrections are applied for the temperature coefficients of the two magnets.

Electromagnetic Magnetometers.—Electromagnetic instruments constitute a large class of relative magnetometers. They all depend upon the comparison of the magnetic field of the earth with the magnetic field produced by a coil through which a measured electric current is flowing. As the electrical standards are accurate to about 1 part in 100,000, they are inferior to the accuracy of standards of length and time. These electromagnetic types of instruments are gradually replacing the older magnetometers and are becoming increasingly important.

The sine galvanometer designed by S. J. Barnett consists of a Helmholtz coil (a system of circular coils giving a uniform field near the axis between them) with the windings in spirals upon a marble cylinder. The dimensions of the coil are accurately measured so that the field produced by this coil can be computed. A small magnet is suspended at the centre of the coil for determining the magnetic meridian as well as the resultant direction after the field from the coil is applied.

In making the measurement, a fixed current is applied and the sine galvanometer is rotated about its vertical axis until the resultant field (*i.e.*, between the coil and the horizontal component of the earth's field) is perpendicular to the axis of the coil. The sine of the angle (δ) between the axis of the coil and the direction of the earth's field is a measure of the horizontal intensity and is given by:

$$H = \frac{Ci}{\sin \delta}$$

in which i is the current and C is the coil constant which has been

accurately calculated from the measurements of the dimensions of the coil.

The Schuster-Smith coil magnetometer, used extensively in England and Canada, is similar to the sine galvanometer except that the current applied to the coil is adjusted so that the field produced by the coil is slightly greater than the horizontal component of the earth's magnetic field. The coil is then turned on its vertical axis nearly 180° with the direction of the earth's magnetic field until the suspended magnet is at right angles to the magnetic meridian. Then $H = H_e \cos \alpha$, where H is the value of the horizontal component of the earth's field, H_e is the field produced by the coil and α is the angle between the magnetic meridian and the axis of the coil.

Other electromagnetic instruments have been designed for the measurement of the vertical intensity, such as the instrument designed by D. W. Dye, a counterpart of the Schuster-Smith magnetometer. The coil is a Helmholtz system on a precision-ground marble form, similar to the coils of the instruments mentioned above. The current in the coil is adjusted till the magnetic field at the centre just nulls the vertical intensity. Then $Z = Ci$, where Z is the vertical intensity of the earth's magnetic field; C is the coil constant determined from measurements of the dimensions of the coil; and i is the current. A number of devices have been applied for determining the condition of neutralization of the component being measured. In the Dye coil magnetometer, a small flat coil free to swing about a horizontal axis is used. A comparatively strong alternating current, of frequency equal to that of the mechanical resonance vibration of the coil, is applied to the coil through the suspension wires. This coil acts as a small magnet except that the axis is being continually reversed by the alternating current. The coil will vibrate about the suspension under the action of the vertical magnetic field except when the earth's vertical component has been exactly nulled by the field of the Helmholtz coil.

Another type of null indicator for the electromagnetic instruments is a small coil rotating about a suitable axis within the fixed coil. The output from this coil is usually amplified and the output from this amplifier fed into a suitable detector. This method is capable of high accuracy, since the coupling between the fixed coil and the rotating coil may be calculated accurately to correct for their finite dimensions.

Military requirements of World War II led to the development of a number of devices usable as null detectors which employed a new principle. These detectors depend upon the ability of very weak fields to produce magnetic saturation of certain alloys of iron, nickel and cobalt. If an alternating and symmetrical magnetic force is applied lengthwise to a rod of suitable dimensions and composition, the magnetic flux changes in the rod will be symmetrical. But if there is a small ambient magnetic field parallel to the rod, the flux changes will exhibit pronounced asymmetry. The sensitivity of this effect is sufficiently great that it may be used for the detection of extremely small fields.

Several different methods have been devised for applying this principle to the measurement of magnetic fields. In one of these methods, an alternating magnetomotive force is applied to the permeable material through a coil. Asymmetrical flux changes in the material are revealed by the appearance of voltages in the exciting coil at twice the frequency of the exciting current, voltages which may be filtered out and measured. Another device employs two such units with the axes parallel, side by side or in line, the exciting coils being connected in series opposition. A connection is made between the bridge connecting the two coils and the transformer winding which energizes the coils. When there is no ambient magnetic field, there is no voltage across this bridge, but if there is an ambient field, the flux changes in one element lead those in the other in phase so that sharp voltage peaks occur on each half cycle. In another type of detector, the two elements have a secondary coil wound about them which, when the proper adjustments are made, picks up only the asymmetrical flux changes which appear as voltages across the secondary. Electronic circuits are used with all these types of instruments to amplify and detect the output voltages, although the last type of instrument has been used successfully with a conventional galvanometer as the detecting member.

Although the greatest sensitivity may be realized when these devices are used as null detectors, they may be used as direct reading instruments to measure the intensity of any component of the field. In most cases, however, the major part of the components of the field to be measured is neutralized by electric currents or balanced out by application of biasing voltages applied to the detecting circuit.

These detectors possess several advantageous characteristics: they comprise no moving parts which are subject to errors resulting from accelerations; they may be mounted in one place and the readings taken in another; they are fast in operation and response; and their outputs may be readily applied to operate various control devices. Electronic control circuits employed to excite the elements and to amplify and detect their outputs are rugged. By suitable amplification small changes in the ambient magnetic field may be made to produce large deflections of rugged recording meters. These characteristics make the induction-type detectors particularly suitable for use on aircraft.

Originally intended for the detection of submarines during World War II, these devices later found extensive application in geophysical prospecting. The great mobility of aircraft and their ability to fly over areas which are accessible for ground surveys only with great difficulty encouraged the use of these induction-type instruments for geophysical surveys. To escape magnetic effects of the plane, the measuring and orienting mechanism is sometimes mounted in a "bird" which is trailed well beneath the plane, the control circuits and indicating meters being mounted within the plane and connected to the bird by electric cables.

In most geophysical surveys conducted on the ground, the vertical component of the intensity is measured since that component uniquely defines the magnetic potential over the area being investigated, subject to certain limitations. Measurements of total intensity do not uniquely define a magnetic potential. However, if the variations in total intensity caused by the magnetic anomaly being surveyed are small relative to the total intensity of the earth's uniform field, a satisfactory solution can be derived.

Nuclear Resonance Magnetometer.—After the end of World War II there was considerable work accomplished on the various nuclear resonance phenomena that are associated with a magnetic field. One of the first instruments developed using these new methods was a nuclear resonance magnetometer, frequently termed a proton precessional magnetometer. The instrument consists essentially of a means of initiating precession of protons having gyromagnetic properties in a magnetic field. Nuclei may have spin or angular momentum, and will act like small gyroscopes. In a constant magnetic field the nucleus, having a magnetic moment, may be expected to behave like a compass needle. But because of the spin, the behaviour of the nucleus is slightly more complex. The system has angular momentum and a torque caused by the interaction between the nuclear magnetic moment and the external field. Since the value of the angular momentum of the nucleus is fixed, the only possible change caused by the torque is a change in orientation. This orientation of the angular momentum vector changes steadily, but always maintains a constant angle with the magnetic field, so that the momentum vector moves on the surface of a cone with axis parallel to the magnetic field. This motion is commonly called precession, and is exactly similar to that of a gyroscope acted on by gravity, the axis making a constant angle with the vertical as it precesses. Just as friction or other damping causes the gyroscope to assume a position of lowest potential energy in the gravitational field, so the damping forces acting on the nucleus eventually suppress the precession and allow the nuclear magnetic moments to line up with the magnetic field. The time required for these damping forces to act has been called the relaxation time and may be of the order of microseconds or minutes depending on the material used for the sample.

In the nuclear precession magnetometer, the nucleus is polarized in a direction at an angle to the earth's magnetic field. When this polarizing current is suddenly cut off, the protons precess back to the normal (ambient) magnetic field. The frequency of

precession is directly related to the strength of the magnetic field being measured. The instrument consists essentially of a sample containing protons and a coil of wire wound around this sample. The sample may be water or a hydrocarbon such as kerosene. When a strong direct current is applied to the coil, the protons are magnetized or oriented in this new direction. The current is then cut off rapidly, and the protons start precessing back to their normal direction. The coil previously used for polarizing the sample is now connected to an amplifier and suitable electronic counter, and the frequency of precession is measured. This frequency is directly related to the strength of the magnetic field.

$$H = Cf$$

where H is the value of the magnetic field; f is the frequency of precession; and C is a constant.

In 1950 A. Kastler, in Paris, suggested the technique of optical pumping for orienting nuclei and for detecting nuclear magnetic resonance signals in gases at low pressures. This technique has been developed and expanded and is the basis of a type of magnetometer capable of measuring extremely low fields of the order of a few gammas.

The magnetometer consists in its simplest form of a light source, a filter to pass only one of the strong optical lines in the spectrum of the alkali metal being used, a device to circularly polarize the light, an absorption cell and a photocell to monitor the light transmitted through the cell. The light beam is oriented roughly parallel to the magnetic field. Under proper conditions, the atoms will tend to line up with their magnetic moments along the direction of the magnetic field. In this condition, the atoms will absorb less light than normally, and the amount of transmitted light will be greater than if the atoms were randomly oriented. If a radio-frequency field is now applied at right angles to the magnetic field, and at a frequency corresponding to the Zeeman transitions, the atoms will become disoriented, and the amount of light transmitted will decrease. If the applied radio frequency is swept through the resonance value, the resonant frequency will be observed as a dip in the output of the photocell. The above instrument has been used successfully to measure the earth's magnetic field and the results have been of the same order of accuracy as the proton precessional magnetometer or the electromagnetic types of instruments.

See also GEOMAGNETISM: *Elements of the Geomagnetic Field;* MAGNETISM.

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MAGNIFICAT, the song of praise of the Virgin Mary in the house of Zechariah (Luke i, 46–55), with which she answered the greeting of Elizabeth: "Magnificat anima mea Dominum" ("My soul magnifies the Lord"). It constitutes the most important canticle of the vesper service in the Roman Catholic Church and of the evening office in the Anglican Church; it is used on certain days in the morning office in the Orthodox Church. Besides having been set to plainsong melodies in all the eight church modes, it has received countless settings by later composers.

MAGNITOGORSK, a town of Chelyabinsk *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the eastern flank of the southern Urals, on the banks of the Ural river, about 250 km. (150 mi.) S.W. of Chelyabinsk city. Pop. (1959) 311,101. Just east of the town is Mt. Magnitnaya, rich in magnetite iron ores, and it was to exploit these that Magnitogorsk was founded in 1930, under the first five-year plan; U.S. engineers rendered technical assistance during the early planning. Its vast integrated metallurgical plant is one of the world's largest, with coke ovens, blast furnaces, open-hearth steel furnaces, blooming mills, rolling mills, tin-plating shops, coke-chemical works and a thermal power station. Coking coal is brought from the Kuznetsk Basin (Kuzbass) or from Karaganda in the Kazakh S.S.R. Subsidiary engineering industries produce mining equipment and crane and transport parts, while slag is used in cement and glass works. There are also food and other light industries. The Ural is dammed to form a reservoir there, and although the town first developed on the left bank, most subsequent growth has been on the right bank where air pollution is less. Magnitogorsk has pedagogic and mining-metallurgical institutes. The population was 150,000 in 1939, and in 1961 was estimated at 328,000.

(R. A. F.)

MAGNITUDE of a star is the measure of its brightness adopted in astronomy. The higher the number expressing the magnitude the fainter the star. A step of one magnitude corresponds to a decrease in light intensity in the ratio 2.512:1, so that five magnitudes correspond to a decrease in the ratio 100:1. The absolute magnitude of a star is the apparent magnitude it would have if placed at a standard distance of ten parsecs or about 33 light-years.

The bolometric magnitude is an analogous measure of the heat intensity of a star.

See PHOTOMETRY, CELESTIAL; STAR.

MAGNOLIA, the common and generic name for evergreen or deciduous shrubs or trees, of the family Magnoliaceae, several species of which are grown for their showy spring blossoms. It includes about 75–80 species, in two centres: about 50 in the old world (Japan to the eastern Himalayas, south to Java) and about 25 in the new world (southern Ontario, the eastern United States, the Greater Antilles and Mexico to Venezuela).

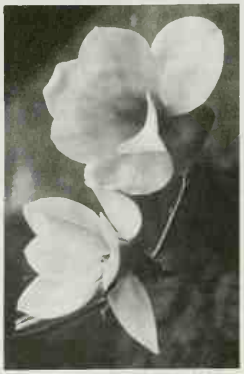
Magnolias have large, simple leaves with stipules. Most magnolias bear showy, fragrant, white to pink or purple, or green to yellow flowers singly at the tips of the branches. The perianth is composed of 9–15 petallike tepals in series of 3 each; the 3 outermost are differentiated as sepals in some species. The numerous stamens and carpels are borne spirally on the elongated floral axis. The conelike fruit is composed of the many carpels, each of which splits along the outer side releasing two scarlet to pink seeds which dangle by slender threads. Essential-oil cells give most tissues of the plant a spicy fragrance when crushed.

Eight species, cultivated as ornamentals in both the United States and England, are native to eastern North America. Five are closely related trees or shrubs with rather large deciduous leaves, clustered near the tips of the branches (whence the name umbrella tree), and large white flowers: *Magnolia fraseri*, of the southern Appalachians; *M. pyramidata*, with a Gulf coast distribution; *M. tripetala*, the original umbrella tree; the spectacular *M. macrophylla*, with leaves up to three feet long (the largest in the genus); and *M. ashei*, restricted to western Florida. Closely related to these are three Asian species, all in cultivation: *M. obovata* (Japan), *M. officinalis* (eastern China) and *M. rostrata* (northwestern Yünnan and adjacent areas). The best-known American magnolia is *M. grandiflora* (bull bay), a handsome evergreen tree, bearing large white flowers, native to the southeastern coastal plain but cultivated in other warm temperate areas. Excepting the tenderer *M. delavayi* (from Yünnan), *M. grandiflora* is the only hardy evergreen species. *M. virginiana* (sweet bay), with small white, very fragrant flowers and leaves whitened beneath, has a wide range along the coastal plain (Massachusetts to southernmost Florida and Texas), and was the first magnolia to be grown in England (1688). *M. acuminata* (called cucumber tree, from the appearance of the young fruits) is a large deciduous tree which occurs from Ontario and New York to Florida, Missouri and Arkansas. Its green to yellow flowers are in striking contrast with those of its only close relative, the purple-flowered *M. liliflora* of China.

BY COURTESY OF UNITED STATES DEPARTMENT OF AGRICULTURE

STAR MAGNOLIA (MAGNOLIA STELLATA) IN BLOOM

More than half of the Asian magnolias are evergreen trees and shrubs of the tropics, and only about 20 are suitable for cultivation in temperate areas. Among the hardy and showy ornamental species are the Chinese *M. denudata* and *M. liliflora* and the Japanese *M. stellata, M. kobus* and *M. salicifolia*. Unfortunately, *M. sprengeri, M. sargentiana* and *M. campbellii*, among the most beautiful trees in the genus, are far less hardy. In all of these species, flowering occurs before the leaves appear, in contrast with the American species which flower with or after the unfolding of the leaves.



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LARGE WAXY BLOSSOMS OF A HYBRID MAGNOLIA (MAGNOLIA SOULANGIANA)

No wild hybrids of *Magnolia* have been found, although a number of garden hybrids are known. Probably the most widely cultivated of any of the Asian group is *M. soulangiana*, a hardy and vigorous hybrid (originated near Paris, 1820) of the white-flowered *M. denudata* and the purple *M. liliflora*.

Magnolias prefer well-drained but moist, rather loamy, slightly acid (pH 6) soil. Propagation is by layers, cuttings, grafts or seeds. The seeds have a short period of viability, especially if allowed to dry out, and usually a period of moist cold is necessary to promote germination. Attempts to send seeds from Asia to England were mostly unsuccessful until the practice of coating the seeds with paraffin was tried; the storage and transport of seeds in bags of polyethylene film is a more modern development.

Much attention has been focused on *Magnolia* as one of the most primitive of living flowering plants, particularly on account of the woody habit, the numerous, free and spirally arranged floral parts, the primitive stamens and the single-grooved pollen grains. Although the group is undoubtedly ancient (more than 80 fossil "species" have been described) and formerly had a much wider distribution in the northern hemisphere, a number of other extant flowering plants show evolutionarily much more primitive structures; *e.g.*, some of the species of the genus *Drimys* (of the family Winteraceae).

BIBLIOGRAPHY.—For a description of the principal species under cultivation *see* L. H. Bailey, *Standard Cyclopedia of Horticulture* (1943), *et al., Manual of Cultivated Plants*, rev. ed. (1949); G. H. Johnstone, *Asiatic Magnolias in Cultivation* (1955). *See* also J. G. Millais, *Magnolias* (1926); A. Rehder, *Manual of Cultivated Trees and Shrubs*, 2nd ed. (1940). For classification see *Camellias and Magnolias*, Royal Horticultural Society Conference, 1950 (1950).

(C. E. W.)

MAGNUS, the name of many kings of Norway.

MAGNUS I OLAFSSON THE GOOD (1024–47), king from 1035, was an illegitimate son of Olaf the Saint; he was named after Charlemagne (Old Norse Karla-Magnús). Taken by his exiled father to Russia at the age of four, he remained there until 1035, when the chiefs of Norway, chafing under the rule of Sweyn (Svein), son of Canute the Great of Denmark, summoned Magnus to Norway and made him king.

After Canute's death in 1035, his son Hörda-Knut, or Hardicanute (*q.v.*), became king of Denmark and laid claim to the throne of Norway; but it was agreed that if he or Magnus died, the other should rule both kingdoms. When Hardicanute died in 1042, Magnus thus became king of Denmark. He appointed Canute's nephew Sweyn Estrithson as viceroy and himself defended Denmark against the incursions of the Wends or Slavs, whom he crushed in the battle of Lyrskog in South Jutland (1043). Sweyn and his Danish supporters afterward rose against Magnus.

In 1046 Magnus and his uncle Harald Hardraade, who had come home from Constantinople, agreed to share the kingdom. They attacked Denmark, but Magnus died during the campaign on Oct. 25, 1047.

MAGNUS (*c.* 1048–69), son of Harald Hardraade, succeeded with his brother Olaf III in 1066, but died in April 1069.

MAGNUS II BARFOT or BARELEG (*c.* 1073–1103), succeeded his father, Olaf III, in 1093. He set off for Orkney in 1098 and then raided the Hebrides, the Isle of Man and Anglesey, where he defeated the Norman earls Hugh of Chester and Hugh of Shrewsbury. In later years he engaged in campaigns against Ingi, king of the Swedes, but their differences were resolved in 1101 and Magnus married Ingi's daughter Margaret. In 1102 Magnus embarked on another expedition to the west. He visited the Hebrides and Man, but fell fighting in Ulster in Aug. 1103. It was said that his nickname "Bareleg" was given because he affected the kilt.

MAGNUS III THE BLIND (*c.* 1115–39), son of Sigurd I Jorsalafar, succeeded to the throne jointly with Harald IV in 1130. In 1135 Harald seized Magnus, maimed and blinded him and put him in a monastery. Later released, Magnus was killed in battle in 1139.

MAGNUS IV (1156–84), the son of Erling the Crooked and Kristin, daughter of Sigurd Jorsalafar, was made king on the death of Ingi I in 1161. His coronation, the first in Norway, took place in Bergen in 1163. His father was the effective ruler until he died in 1179. Magnus then defended his title against his rival Sverre until he was defeated and killed at Norefjorden on June 15, 1184.

MAGNUS V LAGABOETER OR LAW-MENDER (1238–80), succeeded his father in 1263. One of his first acts was to make peace with the Scots (treaty of Perth, 1266), ceding the Hebrides and Man to Scotland. He introduced important legal and constitutional reforms both in Norway and in Iceland. He died in Bergen on May 9, 1280.

MAGNUS VI ERICSSON (1316–74) was the son of Haakon V's daughter Ingibjörg or Ingeborg and of Eric, brother of the Swedish king Birger (d. 1318). Because of a dynastic accident, Magnus was proclaimed king of both Norway and Sweden when Haakon V died in 1319. Government was conducted at first by his unpopular mother, later by a regent. Magnus assumed his powers in Norway in 1332. He showed greater interest in Sweden than in Norway, which he left for long periods without government; and in 1343 his infant son Haakon VI was designated king of Norway. Haakon VI attained his majority in 1355, but Magnus remained king of Sweden, though he had many enemies. He died on Dec. 1, 1374.

(G. T.-P.)

MAGNUS, OLAUS (Swedish OLAF MANSSON) (1490–1557), Swedish ecclesiastic and author of an influential history of Scandinavia, was born at Linköping in Oct. 1490. A Catholic priest, he went to Rome in 1523, during the Swedish reformation, and thereafter lived in exile, first in Danzig and later in Italy, with his brother Archbishop Johannes Magnus (1488–1544), on whose death he was appointed Catholic archbishop of Sweden. After 1549 he was also director of St. Brigitta's, a religious house in Rome. Magnus died in Rome, Aug. 1, 1557.

Olaus Magnus' *Carta marina* (1539) was the first detailed map of Scandinavia with any pretensions to accuracy. His foremost work, however, is the *Historia de gentibus septentrionalibus* (1555), a history of the northern peoples inspired by humanist historiography and imbued with patriotic warmth, which gives a picture of the countryside and people of Sweden on the threshold of a new era. It appeared in many editions and translations during the 17th century—the first English translation being the *History of the Goths, Swedes and Vandals* (1658)—and for long influenced the European idea of the Scandinavian people. (S. H. L.)

MAGNUS MAXIMUS: *see* MAXIMUS.

MAGNÚSSON, ÁRNI (1663–1730), Icelandic antiquarian and philologist, who built up the most important collection of early Icelandic literary manuscripts, was born at Kvennabrekka on Nov. 13, 1663, and matriculated at the University of Copenhagen in 1683. He graduated in theology in 1685, but was interested chiefly in the early history and literature of Scandinavia. He traveled extensively in Norway, Sweden and Iceland, collecting books and manuscripts. In 1697 Magnússon was appointed secretary of the secret archives and, in 1701, professor of philosophy and Danish antiquities. In 1702 he went to Iceland on a royal

mission to value estates and report on economic conditions. Magnússon was engaged on this task until 1712, and spent much of the time gathering Icelandic manuscripts. His collection was sent to Denmark in 1720. A large part of it perished in the fire of Copenhagen (1728), but the remainder passed to the University of Copenhagen, where it is still housed. Magnússon's published works were few and of minor importance. He died at Copenhagen on Jan. 7, 1730.

See F. Jónsson, *Árni Magnússon's Levned og Skrifter* (1930); H. Bekker-Nielsen and O. Widding, *Arne Magnusson* (1963; with summary in English). (G. T.-P.)

MAGO (MAGON), a common Carthaginian name, shared by a number of important members of the aristocratic Magonid family. The first of these flourished between 550 and 500 B.C. and was responsible for reforms in the army and for extending the influence of the Carthaginians in Sardinia, the Balearics and possibly Spain (*see* CARTHAGE: *History*). A second Mago took part in the war against Dionysius I of Syracuse (396 onward), and another took part in an unsuccessful Punic expedition against Syracuse in 343. Another admiral of the name Mago was sent to Rome in the spring of 278 with 120 ships to persuade the Romans to continue the war against Pyrrhus (*q.v.*) and to make a treaty with Carthage.

The most famous of the bearers of this name was, however, the youngest of the three sons of Hamilcar Barca. He accompanied his brother Hannibal (*q.v.*) to Italy and held important commands in the great victories of the first three years of the Second Punic War. After the battle of Cannae (216), he was sent to help his other brother, Hasdrubal, in Spain. There he carried on the war with varying success, but was defeated in 206 by Scipio Africanus at the battle of Ilipa (*q.v.*). After staying for some time in Gades (Cadiz), he carried the war into Liguria; he was finally defeated in Cisalpine Gaul in 203 and died of wounds on the return voyage to Carthage.

Mago was also the name of the author of a great work on agriculture written in Punic in 28 volumes. Captured by the Romans after the destruction of Carthage, it was taken to Rome and translated by order of the senate and was regarded as an authoritative work of reference for Roman agriculture and viticulture.

See B. H. Warmington, *Carthage* (1960). (WM. C.)

MAGPIE, the common name for several strikingly coloured birds of the crow family (Corvidae); with the jays, magpies comprise the subfamily Garrulinae. They are world-wide in distribution. The commonest species in the northern hemisphere is the black-billed magpie (*Pica pica*), well known in western North America and in all of Europe. It is about 20 in. long, including the 10-in. tail, and is distinctively marked with stark white shoulders, flanks and belly against a deep glossy black body and wings; the wedge-shaped tail, which streams out behind the body in flight, is lustrous with greenish and purplish iridescence.

The nest is a large, elaborate structure, placed either in trees or bushes. Its foundation consists of stout sticks, turf and clay, made into a deep, hollow cup, plastered with earth and lined with fibres; around this is erected a basketlike weave of thorny sticks, forming a dome over the nest, and leaving a hole in the side for entrance and exit. Within the nest are laid from six to nine eggs, of a pale bluish-green colour, freckled with brown and blotched with ash. The magpie, in common with the raven, the jay and many birds of prey, has a remarkable capacity, when its mate is killed, for obtaining a new mate within a day or two.

JOHN MARKHAM

BLACK-BILLED MAGPIE (PICA PICA)

The yellow-billed magpie (*Pica nuttalli*), found resident in California, is similar in most respects to *P. pica* except for the bright yellow bill and bare yellow skin around the eyes. Other more exotic species include the Asian red-billed blue magpie (*Urocissa erythrorhyncha*), the size of a pigeon, with blue and black colouring and central tail feathers up to 17 in. long, blue with white tips. The green magpie (*Kitta chinensis*) is another red-billed, long-tailed species of Asia.

MAGSAYSAY, RAMÓN (1907–1957), Philippine soldier and political leader who as secretary of defense and president defeated the communist-led Hukbalahap (Huk) movement after World War II, was born on Aug. 31, 1907, at Iba in Zambales province on Luzon. He worked his way through the University of the Philippines at Manila (1927–31) and José Rizal college, from which he received a degree in 1933. Rising from his first job as an automotive mechanic, he became by 1941 branch manager (later general manager) of a transportation company.

He fought with U.S. forces against the Japanese until the surrender of Bataan in April 1942, when he joined the guerrilla forces in Zambales province. After the reconquest of the islands by U.S. troops Magsaysay was named military governor of Zambales. Released from military service, he was elected to two terms in congress as a member of the Liberal party (1946–50). In 1950 Pres. Elpidio Quirino appointed him secretary of defense. The Huks, then at the height of their power, derived much support from the peasants, who felt the local constabularies oppressed them and were representatives of the landlords. Magsaysay replaced the constabulary with army units, reformed the army and fought the Huks, offering them "complete force or complete fellowship"; to those who surrendered he gave land and tools. In 1953 he resigned as secretary of defense and also left the Liberal party. He joined the Nationalist party, charging President Quirino with obstruction of his anti-Huk campaign and with a corrupt administration.

The Nationalist party nominated Magsaysay to oppose Quirino for the presidency; Magsaysay won the election and was inaugurated Dec. 30, 1953, for a four-year term. He also served as secretary of defense until May 1954, when the surrender of the Huk leader Louis Taruc climaxed the anti-Huk campaign. Despite Magsaysay's great personal popularity, congressional and intraparty opposition slowed the progress of his program of land and governmental reform. His opponents considered his friendship with the United States extreme, but he held firm in foreign policy. In July 1955 congress gave the president power to break up large landed estates and carry out basic land reform; in August a Nationalist party convention completely endorsed the president's program and nominated a slate of candidates to remove the president's strongest opponents in congress. This slate won in November, but congressional opposition to his reform measures continued. Magsaysay died in an airplane crash on March 17, 1957, while returning from Cebu city to Manila, and was succeeded by Carlos P. García, vice-president and foreign minister.

See Carlos P. Romulo and Marvin M. Gray, *The Magsaysay Story* (1956).

MAGWE, a district and division of Upper Burma. The division includes the districts of Thayetmyo, Minbu, Magwe and Pakokku. Pop. (1962 est.) 2,137,029. The district has an area of 3,724 sq.mi. and a population (1962 est.) of 711,449 and lies entirely east of the Irrawaddy in the centre of Burma's Dry Belt. Along the river the land is undulating, with a marked development of river terraces. It is seamed with nonperennial stream courses or *chaungs* which come down in flood after sudden storms but are normally dry and give rise to some badland type of country. Two such streams are the Yin and Pin; only the Yanbe is perennial. Where the soil is suitable, millet, sesame, peanuts and some rice are grown, but there are large areas of semidesert scrub. In the heart of the district is a broad plain, extensively cultivated, through which a branch railway from Pyinmana was constructed. The eastern part of the district is occupied by valuable forests at the northern end of the Pegu Yoma. Magwe town is on the Irrawaddy nearly opposite Minbu but is overshadowed by the oil-field town of Yenangyaung. The district also includes the Singu-Chauk oil fields. (L. D. S.)

MAGYAR, the name of the dominant people of Hungary. The article HUNGARY surveys their origin and history, and the article HUNGARIAN LANGUAGE describes the Magyar language, which belongs to the Finno-Ugric family. They themselves call

Hungary Magyarország ("land of the Magyars"); but this name before World War I was sometimes reserved to denote historic Hungary, that is to say the lands under the crown of St. Stephen (including Slovakia, the Banat and Transylvania) without the theoretically distinct kingdom of Croatia or Croatia-Slavonia. Croatia, however, was understood to be comprised with historic Hungary under the name Magyarbirodalom ("realm of the Magyars").

Before World War I, under the Austro-Hungarian dual monarchy, the Magyars formed barely half of the population of the Magyarország (without Croatia-Slavonia), numbering 9,345,000 out of 20,890,000 (44.7%) at the census of 1910. At the time of the same census, however, the Magyars living within the frontiers later to be drawn for the postwar Hungary under the treaty of Trianon (*q.v.*) numbered 6,250,000 out of a total population of 7,540.000. Still according to the census of 1910, there were 955,000 Magyars in the territory that went to Czechoslovakia under the treaty of Trianon, 1,550,000 in the territory that went to Rumania and 560,000 in the territory that went to Yugoslavia.

After World War II, when the frontiers of Hungary, expanded during the war, were reduced again to those of the treaty of Trianon with the further loss of a bridgehead south of Bratislava, there were 425,970 Magyars in Czechoslovakia (census of 1961), 1,587,675 in Rumania (census of 1956), 502,175 in Yugoslavia (census of 1953) and 149,000 in the Ukraine (*i.e.*, in Sub-Carpathian Ruthenia; census of 1959). In Hungary according to the census of 1960 there were 8,657,102 Magyars (92.8%) out of a total population of 9,977,870.

See also references under "Magyar" in the Index.

MAHABAD (MEHABAD; formerly SAUJBULAQ or SAVAJBOLAGH), a town and *shahrestan* (district) in West Azerbaijan *ostan* (province), Iran, south of Lake Rezaiyeh. The population of the *shahrestan* in 1956 was 233,751. In 1959 Iran's districts were reorganized resulting in an adjusted pop. of 162,511. Many of the inhabitants pitch tents in summer and farm the hilly land during the winter from many tiny villages. Ethnographically the district forms part of Iranian Kurdistan, comprising the bulk of the Mukri tribal areas. The town (pop. [1956] 20,332) stands in a fertile narrow valley, at 4,272 ft. above sea level. It is connected by road with Tabriz, Rezaiyeh and Mosul, Iraq, via Rawanduz. The town and district suffered greatly under repeated political strife. The area formed a short-lived, Soviet-backed autonomous republic after World War II. Mahabad is now in Iranian hands but retains its position as a centre of Kurdish nationalism. (H. Bo.)

MAHABHARATA, "the great (tale) of the descendants of the prince Bharata," and one of the two great epic poems of India, is a vast compilation of over 100,000 couplets (about eight times the length of the *Iliad* and *Odyssey* combined). The central matter of the epic, the struggle for supremacy over Kurukshetra (with its capital at Hastinapur, northeast of the modern Delhi) between the two rival families, the Kauravas and the Pandavas, is based on historical events which took place not later than the 10th century B.C. The Mahabharata contains numerous episodes, emphasizing themes in the main narrative, which have gained individual renown, such as the tales of Nala and Damayanti, of Savitri, and the discourse, the Bhagavad Gita (*q.v.*). Traditionally the sage Vyasa ("the arranger") is the author, though it is more likely that he compiled existing material, which reached its present form by A.D. 400. *See* also SANSKRIT LITERATURE.

MAHALLAH AL KUBRA, AL, a textile manufacturing town of lower Egypt. It is situated in the east of Al Gharbiyah *muhafazat* (governorate) on the Bahr Mallah channel, 8 km. (5 mi.) W. of the Damietta branch of the Nile river and 113 km. (70 mi.) N. of Cairo by rail (75 mi. by road). Pop. (1957) 149,590, (1962 est.) 188,000. Its growth from a small market town took place after 1927, when the Misr group established there a cotton textile mill, superseding much domestic hand-loom weaving. Al Mahallah al Kubra is the centre of Egypt's textile industry and accounts for about 40% of the country's mechanized spinning and weaving production. Besides producing cotton goods (including dyeing and printing), the works manufacture rayon, flannelette, woolen cloth, blankets, linen, knitwear and hosiery; the payroll is about 20,000. The company has created a model workers' town with wide tree-lined streets and housing estates, quite unlike older Egyptian towns, while the mills are equipped with all modern recreational and welfare facilities.

There are also cotton ginneries, and mills for rice and flour. The main railway from Cairo to Damietta links Al Mahallah al Kubra with the capital of the governorate, Tanta, 26 km. (16 mi.) S.S.W. (A. B. M.)

MAHAN, ALFRED THAYER (1840–1914), U.S. naval officer and historian, an early exponent of sea power, was born on Sept. 27, 1840, at West Point, N.Y., where his father was professor of military engineering at the U.S. Military academy. Columbia college and the U.S. Naval academy at Annapolis, Md., qualified him for the U.S. navy, in which he served 40 years. He saw active service in the Civil War and when 21 designed a "mystery ship" and volunteered to command it. After acting as lecturer on naval history and strategy at the Naval War college, he became its president in 1886. An indefatigable student with a prodigious memory, he steeped himself in the strategy of Antoine Henri Jomini, Napoleon and Nelson and made critical analyses of the conclusive battles of the world on land and sea. *The Influence of Sea Power Upon History, 1660–1783*, published in 1890, was inspired by a conviction that the historic significance of the control of the sea had never been fully revealed. It was followed in 1892 by *The Influence of Sea Power Upon the French Revolution and Empire, 1793–1812*. These classic works were widely acclaimed by naval men, statesmen and scholars and have been credited with stimulating the growth of navies between 1900 and 1914. No previous writer had so convincingly argued the case for the dominating influence of sea power. The famous trilogy was completed by *The Life of Nelson* in 1897.

Mahan was recognized as an authority on naval strategy, especially in Great Britain, and his doctrines have been said to have governed the naval political thought of the world. Degrees were conferred upon him by Oxford and Cambridge universities in 1894 and later by leading U.S. universities. He commanded the cruiser "Chicago" in European waters, 1893–95, and served on the naval war board during the Spanish-American War of 1898 and as delegate to The Hague peace conference in 1899. In 1900 he was awarded the Chesney gold medal for his three works, which were translated into several foreign languages. He was president of the American Historical association in 1902 and chairman of a commission on naval affairs in 1908.

Mahan, who excelled as a strategist rather than as a tactician, attempted chiefly to make clear the paramount importance of the sea as a decisive factor in history. He analyzed the elements of sea power in all its bearings, military, national, territorial and commercial. With masterly touch he dissected the strategic features of the Caribbean. He stressed the interdependence of the military and commercial control of the sea and held that commerce dominates war. In *The Interest of America in Sea Power, Present and Future* (1897) and in most of his 20 volumes he sought to arouse his countrymen to a realization of their maritime responsibilities. He doubted the infallibility of arbitration in international disputes and in Anglo-U.S. naval supremacy saw the surest hope of peace.

Mahan died on Dec. 1, 1914, having foretold the defeat of the Central Powers and the surrender of the German navy. Discussion of sea power compels recourse to his works, which are invaluable to students of international affairs. (*See* SEA POWER.)

For a complete list of works and bibliography *see* Charles Carlisle Taylor, *The Life of Admiral Mahan* (1920). (C. C. TAY.; X.)

MAHANADI ("the Great River"), a river of India, rises 25 mi. S. of Raipur town in the wild mountains of the Bastar district in Madhya Pradesh. At first an insignificant stream, taking a northerly direction, it drains the eastern part of the Chhattisgarh plain. Above Seorinarayan it receives its first great affluent, the Seonath; thence flowing for some distance due east, its stream is augmented by the drainage of the hills on both north and south. It then turns south and, struggling through masses of rock, flows past the town of Sambalpur to Sonpur. Just above Sambalpur

is the site of the Hirakud dam which India claims as the world's largest earth dam, completed in 1957 and resulting in a man-made lake 35 mi. long. From Sonpur the Mahanadi pursues a tortuous course among ridges and rocky crags toward the range of the Orissa hills (the Eastern Ghats), which it pierces by a gorge flanked by forest-clad slopes. There the Tikarpara dam was constructed. After the opening of the Bengal-Nagpur railway, the Mahanadi was little used for navigation. It reaches the Orissa deltaic plain at Naraj, about 7 mi. W. of Cuttack town, and after traversing Cuttack district from west to east and throwing off numerous branches, it enters the Bay of Bengal at False point by several channels.

The Mahanadi has an estimated drainage area of 75,000 sq.mi. It is also one of the most actively depositing streams in the subcontinent of India. Flow in the delta before the construction of the modern dams varied from a maximum of approximately 2,000,000 cu.ft. per second to 1,125 cu.ft. per second in drought. Liability to flooding was one of the greatest hazards to the region round the delta but the deposition of silt which results from the flooding is a major asset. There has long been a series of canals in the delta, designed primarily for flood control and for protective irrigation in years of deficient rainfall. All these have been improved. *See* also ORISSA. (L. D. S.)

MAHAR, a group of over 50 endogamous castes in Maharashtra state, India. In the 1960s the Mahar community of several million comprised roughly 9% of the total population of Maharashtra (*q.v.*) and is by far the largest, most widespread and most important of all scheduled castes (formerly untouchables) in the region.

Traditionally, Mahars supplied one of the 12 hereditary officials in the distinctive Maharashtrian village organization. Mahar duties included those of village watchman, policeman, messenger and guide; adjudicator of boundary disputes; street sweeper and remover of carcasses. As payment, Mahars received cash, a share of village grain and produce and scavenging rights. Sometimes they received land, but they have never been primarily a cultivating community. Consequently, in modern times Mahars have found it relatively easy to migrate to urban centres (Bombay, Nagpur, Poona and Sholapur) and to become industrial labourers, railway workers, mechanics, bus and truck drivers.

The most eminent 20th-century Mahar, Bhimrao Ramji Ambedkar (*q.v.*), stimulated his caste-fellows to militant political consciousness and to great educational improvement. Before his death in 1956, Ambedkar led over 500,000 Mahars into Buddhism in an effort to escape the disadvantages of being low-caste Hindus. *See* also CASTE (INDIAN); UNTOUCHABLES. (M. L. P. P.)

MAHARASHTRA, a state of the Republic of India, with Bombay as its capital city. It has, according to the redefined boundaries laid down in the Bombay Reorganization act, 1960, an area of 118,717 sq.mi. and a population (1961) of 39,553,718. When India became independent in 1947, the province long known as Bombay Presidency became Bombay state. The following year a number of former princely states (notably Baroda) were merged into the new state, and on Nov. 1, 1956, the major reorganization of the states of peninsular India resulted in the addition of large parts of the former Hyderabad and Madhya Pradesh. From 1956 to 1960, with an area of 190,668 sq.mi. and a population of 48,265,221 (1951), Bombay was the largest state in area in the republic and second in population. In the north it comprised most of the Gujarati-speaking peoples and in the south most of the Marathi-speaking. It was on this linguistic basis that the state was split into two on May 1, 1960, with Gujarat in the north and a state that was at first named Maharashtra in the south. The latter resumed the name Bombay a few weeks later, but before the end of the year, despite opposition, the central government declared Maharashtra the official name. As now defined, with minor boundary adjustments, this comprises 26 districts, which are, in effect, all those parts of India where Marathi is the dominant language. It stretches along the west coast between the former Portuguese territories of Damão and Goa, comprising an area known as the Konkan (*q.v.*), and far inland beyond Berar and the city of Nagpur to include the districts of Bhandara and Chanda. It is bordered by Gujarat and Madhya Pradesh in the north and east and by Andhra Pradesh and Mysore on the south.

Physical Features.—Maharashtra comprises the coastal strip backed by the high crest of the Western Ghats beyond which is a rolling plateau with flat-topped hills indicating the presence of the successive lava flows, almost horizontal, of the Deccan basalts, formerly known as traps. The lavas cover practically the whole surface; the underlying complex of metamorphic rocks is rarely seen. Spurs from the Western Ghats reach the coast, which renders north-south communication difficult; neither motor road nor railway has been constructed through the west coast districts south of Bombay city. The coast is rock-bound and dangerous when the southwest monsoon is blowing onshore. There are havens for small vessels, but there is only one major inlet, that protected by the island on which Bombay city has been built and which is one of the most magnificent and spacious harbours of Asia.

The climate shows the typical monsoon regime of cool dry season with light northeasterly winds from the land (about November to February), the hot dry season of March, April and May followed by the rainy season when the southwest monsoon blows directly against the west coast and Western Ghats. Apart from preliminary showers (mango showers) in May and early June, the rains break suddenly about mid-June. The Konkan is very wet; no part receives less than 80 in., while Mahabaleshwar, in the Western Ghats, with an annual average of more than 250 in., has one of the highest recorded rainfalls in the world. The winds lose their moisture in rising to cross the Ghats, and eastward on the plateau the average rainfall declines rapidly so that over most of the plateau districts it is less than 40 in. a year. The coastal districts enjoy equable temperatures, monthly averages ranging, as at Bombay city, only a few degrees above or below 27° C. (80° F.). A range of more than 7° C. between day and night temperatures is unusual. Stations like Poona, high up on the plateau but sufficiently near its edge to get a good rainfall, benefit from the elevation to be cooler throughout the year but remain equable. Mahabaleshwar, at 4,534 ft., has long been used as a hill station. Eastward on the plateau, with the lower rainfall, both daily and annual ranges of temperature increase.

The wet coastal districts have swift mountain torrents, sometimes with spectacular waterfalls when in spate but greatly hindering land communication and useful mainly for floating down timber. Except in the extreme north, where it is trenched by the westward-flowing Tapti, most of the plateau is drained by seasonal, eastward-flowing tributaries of the Godavari and Krishna in broad open valleys. Many rise very close to the edge of the plateau, the crest of the Western Ghats, which varies from 2,500 to 4,500 ft. in height, with some points exceeding 5,000.

The basaltic lava flows of the plateau break down into the famous regur or black cotton soil of India. It is a heavy, dark, almost black, clayey loam, which holds moisture well and is especially suited to Indian varieties of cotton and to dry zone grains. Some irrigation is practised in the broad open valleys, but care has to be taken in the use of irrigation water as the soil easily becomes a pasty mud.

The natural vegetation of the state reflects in the main the amount of rainfall. There are evergreen rain forests of large trees on the wet western slopes of the Ghats, giving place to a somewhat narrow but valuable belt of the monsoon forests, leafless in the dry season but including teak and the useful sal tree (*Shorea robusta*), and then eastward to the scrub forests and savanna lands so typical of much of the plateau. (L. D. S.)

History.—The present state comprises more than the ancient Maharashtra, which did not include the Konkan coastal strip and did not stretch so far south as Pandharpur, the celebrated Vaishnava shrine, nor as far east into the Deccan. For the history of early dynasties who ruled over this area between the 6th and 10th centuries A.D., *see* CHALUKYA; RASHTRAKUTA. By the beginning of the 13th century Maharashtrians or Mahrattas, speaking the forerunner of Marathi, were infiltrating into regions occupied previously by Telugu- and, more notably, Kanarese-speaking peoples. With the exception of the Konkan, which tended to be rich and

easygoing, all Maharashtra, including the Ghats, was hard and severe, and the earliest ruling families of which there is any record were occupied largely in invading and attempting to exploit wetter, easier regions, such as Gujarat, Vengi and the Tamil country. Patronage of religion, letters and architecture was virtually unknown until in the 13th century, under the Yadavas, success outside Maharashtra brought an accumulation of resources. Poona was, and remains, in the cultural heart of the country. Under the Yadavas, too, Maharashtrian schools of Vaishnavism became prominent.

After the defeat of the last Yadava by the troops of the sultan of Delhi in 1310, a period of unrest followed, during which Maharashtra was partitioned between the sultanates of Ahmednagar and Bijapur, two of the successor states of the Bahmani (*q.v.*) empire. When the sultanates were absorbed by the Moguls, some Maratha officials attempted to carve out separate fiefs and to challenge Muslim authority. For the rise of Hindu autonomy in this area and for the history of the period of Maratha ascendancy and of the Maratha Wars, *see* MARATHA.

The essence of Maharashtra has been its possession of a common language, and an active, restless people. Participation in Hindu Sanskritic culture came rather late but was embraced the more fervently for that reason. The feelings of independence, and even superiority to the inhabitants of the easier, wealthier regions in the north, west, east and southeast, can be explained on historical grounds. The neighbours to the south were equally poor but not equally successful. Maharashtrians show no great aptitude for commerce and have no great artistic traditions, but the blending of cultures, particularly in Bombay and similar centres, has ushered in a more fruitful era. (*See* also INDIA: *History.*)

(J. D. M. D.)

Population, Administration and Social Conditions.—At the 1961 census the population was 39,553,718. There are many Adibasi communities in the state, like the Agaris, the Warlis, the Katkaris, the Thakurs of the Thana and Kolaba districts, the Bhils of Dhulia and the Gonds of Vidarbha, who live in dense forests or on the mountain perches of the Western Ghats.

The state is divided into 26 districts grouped in 4 divisions: Jalgaon and Dhulia (formerly East and West Khandesh), Nasik, Thana, greater Bombay, Kolaba, Ratnagiri (Bombay division); Ahmednagar, Poona, Satara, Sangli, Kolhapur, Sholapur (Poona division); Aurangabad, Parbhani, Bhir, Osmanabad, Nanded (Aurangabad division); Buldana, Akola, Amravati, Yeotmal, Wardha, Nagpur, Chanda, Bhandara (Nagpur division).

There are more than 380 towns and nearly 36,000 villages in the state. The more important cities and towns with their populations at the 1961 census, are as follows: Bombay (4,146,491); Nagpur (643,659); Poona (597,562); Sholapur (337,583); Kolhapur (187,442); Nasik (131,103); Akola (115,760); Amravati (137,875); Ahmednagar (119,020) Ulhasnagar (107,760); Malegaon (121,408); Thana (101,107). (S. CH.)

With about one-eighth of the population attending educational establishments and about 30% of the people literate, Maharashtra is one of the educationally advanced states of India. In 1958–59 there were 45,000 schools and higher educational institutions, including five universities—Bombay, Nagpur, Poona, Marathwada and Shreemati Nathibai Damodar Thackersey Women's university. Free compulsory primary education for children between the ages of 7 and 11 is available in all villages with a population of more than 1,000 in western Maharashtra. The Marathi (*q.v.*) language and its various dialects are widely spoken.

Nearly 900 hospitals and dispensaries generally provide free medical aid. Under the contributory social insurance plan many industrial workers in greater Bombay and the Vidarbha region are protected against sickness, maternity and employment injury.

Maharashtra is one of the pioneer states in providing welfare facilities for children, including the care and rehabilitation of juvenile delinquents and destitute and neglected children. Welfare centres offer recreational, cultural and educational facilities to industrial workers. Under a Sarvodya plan, free educational facilities and medical aid are available to backward classes and tribal people. (S. B. L. N.)

The Economy.—Rice, which occupies about 10% of the cultivated area, is grown mainly in the small alluvial basins that lie between the hills of the west coast; on the plateau cotton sometimes predominates, followed by wheat on the better lands, but the great staples in the poorer parts are jowar and bajra. Oilseeds, fodder and grain occupy large areas. Sugar cane is more local, and coconuts are typical only of the coast. The Konkan is famed for its mangoes and cashew nuts. Forests of the varied types mentioned in *Physical Features* cover large areas; products include timber, fuel, sandalwood, bamboos and grasses.

Production of manganese ore is of major importance. Other minerals include limestone and salt, which is produced in some coastal areas by evaporation.

Maharashtra can claim to be the most industrialized state in India, with about 8,000 registered factories employing two-thirds of 1,000,000 workers. Bombay city is the great centre, but the former dominance of the cotton textile industry has given place to a marked diversification, with general and electrical engineering, a considerable motion-picture industry, the making of rayon fabrics, ceramics, glassware (especially at Ogalewadi), drugs, chemicals, antibiotics (at Pimpri, near Poona), soap, sugar and agricultural implements and pumps (at Kirloskarvadi) and the refining of oil (at Thana). There are government printing works at Nasik and hydroelectric plants at Khopoli, Bhivpuri, Bhira and Koyna and a thermal power station at Trombay.

With an excellent harbour and highly developed industries, Bombay city is an important trading entrepôt for the whole of India. To the east of the city lies one of the relatively easy passes through the Ghats, which facilitated the early construction of railway links with other parts of India. Under the railway grouping of 1947 Maharashtra is served by three of the systems: the Western railway northward into Gujarat, the Central from Bombay eastward and the Southern southeastward to Madras. The state has more than 2,600 mi. of railway line. The use of motor transport as a feeder to the railways continues to extend with the metaling and tarring of roads. The Konkan is the only part of the state not well served with rail and road. Bombay city has an international airport, and much use is made of local air services.

(L. D. S.)

MAHASU, a district of Himachal Pradesh, India, was formed by the integration of several small hill states, and is wholly mountainous, reaching elevations of about 22,000 ft. Area 2,171 sq.mi. Pop. (1961) 358,969. It is drained by the tributaries of the Jumna (Yamuna) and the Sutlej. The latter enters from Tibet, runs in a southwesterly direction, forming the boundary between Mahasu and Mandi districts for a short distance, then winds through Bilaspur on its way to Punjab. Dense forests of pine, silver fir and cedar occur on the lower slopes. The people depend mainly on agriculture. Wheat, barley and maize (corn) are the chief crops. Solan (pop. [1961] 6,564) has a brewery and a government college affiliated to Punjab university. The district is divided into eight *tehsils* and two sub-*tehsils*. Chini *tehsil*, bordering Tibet, and a small portion of the Rampur *tehsil* were formed into Kinnaur district on May 1, 1960. (S. S. BH.)

MAHAVAMSA: *see* PALI LITERATURE.

MAHAVIRA, VARDHAMANA JNATRIPUTRA (6th century B.C.), a contemporary of Buddha, was the 24th and last *tirthankara* ("prophet") of the Jains and the founder of the present form of their creed. Mahavira is an honorary title meaning "great hero." According to Jain tradition, his dates were 599–527 B.C., but the two Jain sects, Shvetambaras and Digambaras, differ in their accounts of his life, which is confused with many legends. The historical facts are that he was born in Vaishali, the younger son of a king named Siddhartha and of his wife Trisala. He married a noble lady by whom he had a daughter, but at about the age of 30 he renounced the world and for 12 years led a life of self-mortification as a wandering beggar, even discarding his clothes. At the end of this period he reached the state of omniscience, and for the rest of his life he taught his doctrines to his ascetic disciples and to an ever-increasing number of laymen. Although he was of a reserved nature, his personality seems to have left a deep impression.

Mahavira's teaching was a systemization of that of Parshvanatha, the 23rd *tirthankara,* who is said to have lived about 250 years earlier. Recensions of some of Mahavira's discourses are extant in the sacred books of the Jains, written in Prakrit dialects, their final redaction dating probably from the 5th century A.D. It is uncertain how far any of the sayings there attributed to him are genuine: the Shvetambaras acknowledge their authenticity but the Digambaras deny it. As, however, the doctrines of the two sects differ only in matters of minor importance and bear the stamp of a very archaic mode of thinking, it seems not improbable that their leading ideas may go back to his teaching. *See* also JAINISM.

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MAHAWELI GANGA (Sinhalese for "Great Sandy river"), the longest river in Ceylon. It has a complicated and tortuous course. Rising on the westward side of the north-south axis of the highland which bisects the hills of Ceylon, and flowing northwest, it drains an important tea-growing area. The river then changes course, flowing east of north through the villages and estates round Kandy, whence it turns east and plunges down through a mighty valley which cuts through the north-south axis and receives the drainage of the Uva basin. The Mahaweli, joined by its main tributary the Amban Ganga (left), then flows north through the lowland dry zone, in largely undeveloped territory, till it reaches its deltaic lowlands on the east coast, and discharges into Koddiyar bay south of Trincomalee. These lowlands have a large area of paddy fields which, with others along the river's dry zone course, benefit from the fact that, unlike most dry zone rivers, it is perennial by reason of its wet zone headwaters and tributaries. *See* also CEYLON: *Physical Geography.* (B. H. F.)

MAHAYANA (GREAT VEHICLE) is one of the two major schools of Buddhism, the other being Theravada. As a "vehicle," *i.e.,* conveyance, it is "great" because it teaches, by its cardinal doctrine, the broad path to salvation: all sentient beings possess the Buddha-nature and hence are capable of attaining enlightenment. The Mahayana aspect of Buddhism, which is followed in Tibet, China and Japan, probably developed during the two centuries before the Christian era, with its starting point very likely furnished by the speculations on the nature of the Buddha developed by the Mahasanghikas, a group of dissident monks who broke away from the orthodox community at the second great Buddhist council *c.* 383 B.C. According to this school, the Buddha was no longer a human teacher but a *lokottara* or supramundane being who appeared on earth in an apparitional form as Sakyamuni (*see* GAUTAMA BUDDHA).

The Mahayana stresses the importance of faith and devotion to the Buddha and the Bodhisattvas (*see* BODHISATTVA), and love for all creatures, manifested by compassion and charity. According to the Lotus (Saddharma Pundarika) Sutra, one of the important Mahayana scriptures, anyone who hears the Master's teachings, who worships an image or relic of the Buddha or who makes a statue even of sand will attain enlightenment; according to the Pure Land (Sukhavativyuha) Sutra, it is necessary only to utter the name of the Buddha Amitabha (*q.v.*) in loving adoration. The Mahayana scriptures were composed mainly in Sanskrit and survive largely in Tibetan and Chinese translations.

For a study of Mahayana Buddhism as it is practised in the modern world, it is necessary to go to Japan. *See* JAPAN: *The People: Religion;* BUDDHISM. (K. K. S. C.; X.)

MAHBUBNAGAR, a town and district of Andhra Pradesh, India. The town, formerly called Palmur and headquarters of the district, lies 55 mi. S.W. of Hyderabad on the Secunderabad-Dhone metre-gauge line of the Central railway. Pop. (1961) 35,588. There are several cotton-ginning and -pressing factories, a college, an American Baptist Mission high school and the district jail.

MAHBUBNAGAR DISTRICT has an area of 7,119 sq.mi. and a pop. (1961) of 1,590,686. It is occupied by Archean gneiss except along the banks of the Krishna (Kistna) river, where the rocks belong to the Cuddapah and Kurnool series. It is held that the famous Golconda diamonds were obtained from these rocks. The district also contains large tracts of forests. The average annual rainfall is 34 in. The staple food crops are jowar (sorghum), bajra (millet), rice and oilseeds. Coarse cotton cloth is woven.

Narayanpet, a trading town in the west, is well known for manufacture of superior silk and cotton saris and coloured leather slippers which are largely exported. Coarse rugs and blankets are woven in Makhtal, Devarkonda, Nagarkurnool and Amrabad. There is a hill fort at Pangal with a perennial spring of sparkling water. The fort of Koilkonda, 14 mi. S.W. of the town, stands on an 800-ft. hill and was constructed in the 19th century by Ibrahim Kutb Shah, one of the Golconda kings. Mananore is a hilly place set amid a scenic landscape. On a hill nearby is a state prison for political prisoners. (S. AH.)

MAHDI (AL-MAHDI, Arabic, literally "the [divinely] guided one"), a figure in Islamic eschatology. The Koran does not mention him, and almost no *hadith* or saying attributed to the Prophet Mohammed concerning the Mahdi can be adduced which is free of the suspicion of being a later fabrication. Mahdist beliefs have accordingly been questioned by many orthodox Sunni Muslim theologians, though such beliefs form a necessary part of doctrine for the sects of the Shi'a, or "faction," of 'Ali (the Prophet's cousin and son-in-law; *see* SHI'ISM).

Regardless of the opinions of the theologians, the Muslim masses have long believed in and hoped for a messianic deliverer who as the Mahdi will fill the earth with justice and equity "even as it is now filled with oppression," restore true religion and usher in a short golden age lasting seven, eight or nine years, before the end of the world. Other accounts add that he will slay *al-Dajjal,* the Deceiver, or assist Christ to slay him. According to some accounts, the Mahdi will be Jesus ('Isa in the Koran), the son of Mary, who will descend to earth, rule according to the Islamic law and confound both the Jews who would not recognize his prophethood and the Christians who blasphemously worshiped him.

Other accounts state that he will be a descendant of the Prophet, and such a descendant, variously identified, is awaited by the Shi'a. The "Twelver" Shi'a of Iran hold that he will be their 12th imam, Mohammed ibn al-Hasan al-Askari.

The doctrine of the Mahdi seems to have gained currency during the confusion and insecurity of the religio-political upheavals of early Islam, in the 7th and 8th centuries A.D. Probably the first attempt to make use of the doctrine occurred in year 66 of the Hegira (A.D. 686) when one Mukhtar ibn Abi 'Ubayd put forward the claim to allegiance of Mohammed ibn al-Hanafiyya, a son of 'Ali by a wife other than Fatima, daughter of the Prophet. As the two sons of Fatima and 'Ali had died, leaving no mature heirs, many pro-'Alids were at this time disposed to follow this Mohammed, though he himself refused to lead their faction. When he died, Mukhtar taught that his Mahdi remained alive in his tomb on Mt. Radwa in a state of occultation (*ghayba*), and would reappear to vanquish their enemies. It seems clear that Mukhtar borrowed the idea from the Jews or the Christians, or both, who were expecting a first or second coming of the Messiah. Following this, other Shi'a sects preached other Mahdis. The Abbasid revolution of 132 A.H. (A.D. 750) made use of eschatological prophecies current at the time that the Mahdi would rise in Khurasan in the east, carrying a black banner.

As a repository of hopes, belief in the Mahdi has tended to receive new emphasis in every time of crisis. Thus after the battle of Las Navas de Tolosa (A.D. 1212) when most of Spain was lost for Islam, Spanish Muslims circulated traditions ascribed to the Prophet foretelling a reconquest of Spain by the Mahdi. During the Napoleonic invasion of Egypt, a person claiming to be the Mahdi briefly appeared in Lower Egypt.

Because the Mahdi is seen as a restorer of the political power and religious purity of Islam, the title has tended to be claimed by social revolutionaries in Islamic society, who desired thus to acquire power against an existing government. North Africa in particular has seen a number of self-styled Mahdis. Among the most important of these are the Mahdi 'Ubaydullah, who in 297 A.H./A.D. 909 assumed power in Tunisia as first ruler of the important Fatimid caliphate (*see* FATIMIDS), from which the Aga

Khan claims descent; the Mahdi Mohammed ibn Tumart, founder of the Almohad movement in Morocco in the 12th century (*see* ALMOHADS; IBN TUMART); and Mohammed Ahmed, the Mahdi of Sudan, who in 1881 raised a revolt against the Egyptian administration and defeated before his death in 1885 several mixed British and Egyptian forces sent against him, thus becoming a forerunner of Sudanese nationalism (*see* MOHAMMED AHMED).

The title has also naturally been a chosen instrument for founding new religious movements. In India, Mirza Ghulam Ahmad of Qadiyan in the late 19th century announced that he was Christ and the Mahdi, and founded the Ahmadiya sect of Muslims so active in missionary enterprises (*see* ISLAM: *Sects: Ahmadiya*). The Baha'is trace their origins to the activities of Mirza 'Ali Mohammed of Shiraz, in Iran, who around 1844 put forward his claim to be Mahdi; but his writings also speak of one "whom God shall make manifest," to come after him: this is Baha'ullah in the Baha'i system. (*See* BAB; BAHA'I FAITH; BAHA'ULLAH.)

It may be seen then that Mahdism has formed an important element of folk-Islam for the masses, even though it is not a part of official Sunni Islam. Among the Shi'a schools, disagreement on the identification of the Mahdi has been one of the chief factors separating sect from sect.

Finally, Muslim rulers have often sought to appropriate something of the *charisma* of the name by taking it for themselves; *e.g.*, the caliph al-Mahdi, father of Harun al-Rashid the Abbasid.

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MAHDIA, a north African fishing port on the Sahel (coastal strip) in Sousse governorate, eastern Tunisia. It lies on the narrow rocky peninsula of Ras Mahdia or Cape Africa (Africa being the name by which Mahdia was known to historians in the middle ages) and is 42 mi. S.E. of Sousse town by road. Pop. (1956) 10,842. The seaward end of the peninsula contains only ruins and cemeteries, being dominated by a 16th-century Turkish fort. The oldest quarter surrounding the large 10th-century mosque is becoming derelict. The town is developing more to the west beyond a monumental gate (part of the remains of the ancient wall), toward the neighbouring villages and southwest toward the port. Many of the inhabitants own olive groves and gardens in the hinterland; the larger proprietors have oil mills and there is an oil-cake factory. Traditional handicrafts include wool and silk weaving, embroidery and the manufacture of fine garments. During the summer months nocturnal fishing with the use of lanterns to attract the shoals (sardines, mackerel) occupies hundreds of families; the town has several fish canneries. All communication is by road, as the small port is used only by the fishing craft.

Mahdia, probably on the site of the ancient Gummi, owes its name to the mahdi (Arab., "the [divinely] guided one"), 'Ubaydullah, founder of the dynasty of the Fatimids (*q.v.*). He established the town in A.D. 912 and in 921 made it his capital, but it was abandoned in favour of Kairouan by the caliph al-Mansur in 947. For a short period at the end of the 11th century it was the refuge capital of the Zirid dynasty and from 1148 to 1160 it was occupied by the Normans of Sicily. Thereafter, although for a time the base of the 16th-century Turkish corsair Dragut, Mahdia was no more than a small town and the principal place of the southern Sahel.

Mahdia was created a *commune* in 1887 and is the headquarters of a *délégation* (administrative district) for the cheikhat (sheikhdoms) of Ayaicha, Chiba, El-Mendra, Houmt-es-Souk, Mahdia-Ville, Mahdia-Banlieue, Rejiche and Sidi-Said. (J.-J. Ds.)

MAHÉ, on the Malabar coast of India, a territory of Pondicherry and formerly a French settlement, lies 35 mi. N.W. of Kozhikode and 451 mi. S.W. of Madras. Pop. (1960 est.) 18,298. Area 23 sq.mi. The territory, an enclave in the Cannanore district of Kerala, consists of two parts: the quaint picturesque town of Mahé with all its buildings situated on the left bank of the Mahé river close to its mouth; and the isolated tract known as Naluthara on the right bank, comprising the four villages of Chambara, Chalakara, Palour and Pandaquel. Rice is the chief crop.

The French under Bertrand François LaBourdonnais, comte de Mahé (whence its name), captured the town in 1726, and in 1751 they acquired Mt. d'Eli (mountain of rats) and a few outposts in the north, all of which fell to the English in 1761. Mahé was taken by the English three times, but was eventually restored to the French in 1817. *De facto* transfer of the former French possessions to the Union of India took place on Nov. 1, 1954, and *de jure* transfer in May 1956. Now it is directly administered by the government of India through a chief commissioner at Pondicherry. (G. Kn.)

MAHER PASHA, ALI (1882–1960), Egyptian statesman and prime minister. Born in Cairo, of which his father was a one-time governor, in 1882, Ali Maher took a law degree in 1902 and, after three years practice, became a judge in the native court. In 1923 he was appointed director of the Royal Law school and played an important part in drawing up the Egyptian constitution of that year.

He soon returned to politics. In various administrations he was minister of education and minister of finance. A professed constitutionalist, he was inclined to authoritarianism and was the first to be chosen by King Fuad, in 1935, for the new role of chief of the royal cabinet. At the end of 1935 he became prime minister in a caretaker government. During the next two years (1936–37) he served King Faruk first as prime minister and later as chief of the royal cabinet. He became prime minister again in 1939 and on the outbreak of war took the measures required by the Anglo-Egyptian treaty. But he remained friendly toward the Italians and when Italy declared war in 1940 he was replaced, at British insistence. In April 1942 he was interned and remained in custody until the end of the war. In Jan. 1952 he formed a ministry in succession to that of Nahas Pasha, but this government lasted no more than two months. On July 24, 1952, one day after the military revolution, Ali Maher formed, at the request of the officers, a government largely composed of independents, but he soon fell from power and retired from politics within a year. He died at Geneva on Aug. 25, 1960. *See* also EGYPT: *History.* (H. S. D.)

MAHESHWAR, a town in the Nimar West district of the Indore division of Madhya Pradesh, India, 60 mi. S. of Indore. Pop. (1961) 8,089. It lies on the north bank of the Narmada river at the site of ancient Maheshwari, mentioned in the epics, *Ramayana* and *Mahabharata*, known as the capital of Haihaya king Sahasrarjun, who, according to the *Puranas*, lived about 2000 B.C. Broad ghats on the river sweep upward toward the fort and temples, behind which towers the lofty palace of Ahalya Bai, the famous Holkar queen, who in 1767 selected Maheshwar as her capital.

Facing Maheshwar on the opposite bank of the Narmada is Navdatoli, where excavations have revealed traces of an early settlement containing, besides other relics, pieces of painted pottery and unique channel-spouted cups. *See* INDIA-PAKISTAN, SUBCONTINENT OF: *Archaeology.*

See H. D. Sankalia, B. Subbarao and S. B. Deo, *Excavations at Maheshwar and Navdatoli, 1952–53* (1959). (S. M. A.)

MAHI, a river of western India, rising in southwestern Madhya Pradesh and flowing through southern Rajasthan and Gujarat states, enters the sea by a wide estuary past the old port of Cambay. The silt brought down by this river, together with that of the Narmada and Tapti to the south, has contributed to the shallowing of the Gulf of Cambay and the abandonment of its once prosperous ports. The total length of the Mahi is 350 mi. and its estimated drainage area 17,000 sq.mi. (L. D. S.)

MAHICAN AND MOHEGAN, cognate Algonkian tribes (*q.v.*) that respectively inhabited the upper Hudson valley above the Catskills in New York and the Thames valley in Connecticut. Both names refer to "wolf," with many variants, as in James Fenimore Cooper's *The Last of the Mohicans* (mistitled: mixed-blood descendants of both tribes survived in the 1960s near Norwich, Conn., Stockbridge, Mass., and at Oneida, Wis.). The Mahican became known as River Indians to the Dutch and English; their importance in the fur trade faded with the rise of the Mohawk (*q.v.*). Originally one with the Pequot tribe under Chief Sassacus,

the Mohegan became independent in 1637 under the rebel subchief Uncas, who enjoyed English favour for a time. Surviving King Philip's War (*see* PHILIP, King), the Mohegan settled near New London, Conn.

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MAHILLON, VICTOR CHARLES (1841–1924), Belgian musical scholar and authority on wind instruments. The son of Charles Mahillon (1813–87), the founder of a firm of wind-instrument makers, he was born in Brussels, March 10, 1841, and entered his father's business (1865). As curator of the museum of the Brussels Conservatoire, he formed a collection of over 1,500 instruments of which he published an analytical catalogue (1880–1922), containing demonstrations of the theories of instrument construction and a methodical classification of ancient and modern instruments. He had copies made of rare instruments, and adapted some of them, notably the Bach trumpet, for modern use.

Mahillon published *Les Éléments d'acoustique musicale et instrumentale* (1874), and numerous monographs on instruments and organized concerts of historical works played on old instruments.

Mahillon died at St. Jean, near Cap-Ferrat, June 17, 1924.

See E. Closson, *La Facture des instruments de musique en Belgique* (1935).

MAH-JONGG, a western version of a Chinese game, is played with 136 or 144 tiles or *p'ais*, similar to dominoes but engraved with Chinese symbols and characters and divided into suits and honours. A fad in England, the United States and Australia in the mid-1920s, the game was revived in the U.S. after 1935 but never regained its initial popularity. The game that came to be known as mah-jongg is probably of 19th-century origin. Before World War I, each Chinese province had its own style of play and dialect name for it. Signifying "sparrow" or hemplike bird, the name has been variously transliterated as *ma tsiang, ma chiang, ma cheuk* and *ma ch'iau*. The sparrow or a mythical "bird of 100 intelligences" appears on one of the tiles. The name mah-jongg was coined and copyrighted by Joseph P. Babcock, a U.S. resident of Shanghai who is credited with introducing mah-jongg to the west after World War I. He wrote a modified set of rules, gave English titles to the tiles and added index letters and numerals familiar to western card players.

Pieces.—Modern mah-jongg sets are usually made of plastics instead of bone or ivory. A full mah-jongg set contains 136 or 144 tiles depending on whether the flowers or seasons are used. Some sets include 20 flowers. The pieces are named and numbered as follows:

1. Bamboos, numbered 1 to 9, four of each number.....36 tiles
2. Circles, numbered 1 to 9, four of each number.....36 tiles
3. Characters, numbered 1 to 9, four of each number.....36 tiles
4. Honours, 4 red dragons, 4 green, 4 white dragons.....12 tiles
5. Winds, 4 east winds, 4 south winds, 4 west winds, 4 north winds.....16 tiles

136 tiles

In addition:

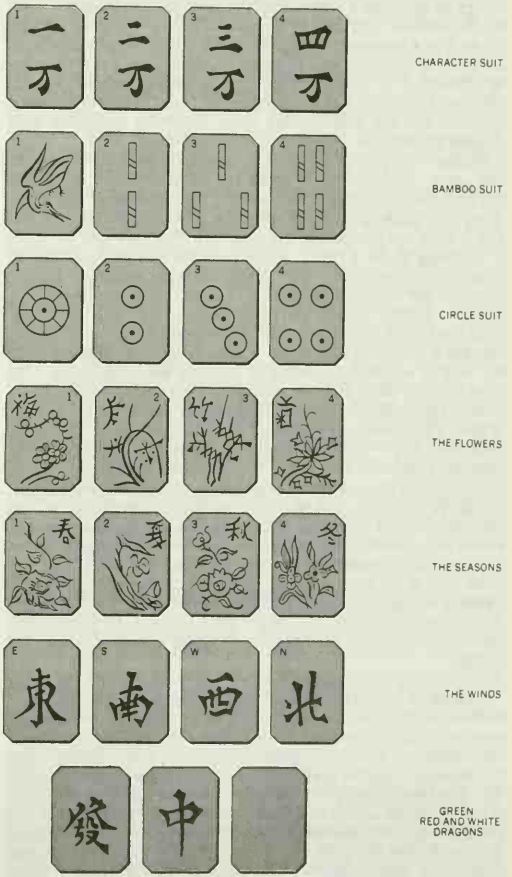
6. Flowers and seasons, 4 of each or 8 of either.....8 tiles

144 tiles

The bamboos are often called sticks or bams, the circles dots, the characters cracks or craks. The set also includes two dice, a quantity of tokens or plastic chips used for scorekeeping and a rack for each player whereon he can place 14 tiles with their faces visible only to himself.

The Game.—The usual game is for four, each playing for himself (there are no partners). The object of play, similar to that of the rummy card games, is to obtain sets of tiles. There are three kinds of sets: "chow," a run or sequence of three tiles of the same suit in numerical order; (2) "pung," a sequence of three like tiles of the same suit and rank, three dragons of the same colour or three identical winds; and (3) "kong," a pung plus the fourth matching tile. The winner is the first player to hold a complete hand; *i.e.*, four sets and a pair of like tiles (14 tiles). The strategy of mah-jongg, like that of rummy, is both offensive and defensive: to complete a "woo" or winning hand as quickly as possible; to block other players by not discarding tiles useful to them; and to build a high-scoring hand. Beginning with "east wind" (who collects or pays double according to whether he or another player wins), each player draws his "hand" and places it in his tile rack, east taking a total of 14 tiles and the others 13. The flowers or seasons are not counted as part of a 13-tile hand; on drawing such a tile, the player immediately "grounds" it face up and draws another tile. East begins the play by discarding one tile, reducing his hand to 13. Thereafter, the other players, in counterclockwise rotation, each draw one tile, which may be the last discarded tile or a loose tile from the "wall" (comparable to stock in rummy). Any player, regardless of whether it is his turn, may claim the previous discard if it completes his set. (If two or more players claim the same discard, there is a detailed order of precedence.) The losing players settle with the winner and with each other according to the accepted schedule of values for the sets or combinations of sets. A concealed set held in the hand scores differently from an exposed set on the table.

Under certain rules, exceptionally complete hands or "limit hands," picturesquely named "the three scholars," "four small blessings," etc., are scored differently. In U.S. play the emphasis on limit hands eventually far exceeded that under Chinese rules until high scores were accented over playing skill. A certain



TILES OF COMMON SUITS AND HONOURS USED IN MAH-JONGG
A full set contains 144 tiles, divided into 6 suits; sometimes only 5 are used

school of players restricted the winning hand to a very narrow list and made the flowers wild. Various other innovations followed. One was the "clear-handed" rule: woo hand may contain only tiles of one suit plus honours. The conflict led to publication of *Laws of Mah-Jongg* (1925) by Babcock and others, giving an option between the Chinese game and the clear-handed variant. Shortly after, the Mah-Jongg fad collapsed.

In 1937 Viola Cecil organized the National Mah Jongg league in the U.S. to standardize a new version of the game. Its innovations included the "Charleston," or exchange of tiles between players before the start of play, and the use of 22 flower tiles (wild or jokers except in certain winning hands).

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MAHLER, GUSTAV (1860–1911), Austrian composer and conductor, was born at Kalischt (Kaliste), July 7, 1860, the son of a poor Jewish innkeeper in a Bohemian outpost of the Austrian empire. He studied at the Vienna conservatory, winning piano and composition prizes, and became a provincial opera conductor to earn a living, rising through important posts in Budapest (1888–91) and Hamburg (1891–97) to the position of artistic director at the Vienna opera (1897). For ten years through his will and energy he achieved a superlative standard of performance. During the summer vacations of this period he also tirelessly pursued his work as a composer. The consequent strain brought on a heart condition in 1907, the year in which his unpopularity as a taskmaster, fomented by anti-Semitism, compelled his resignation. He then spent three seasons conducting the New York Philharmonic orchestra and the Metropolitan opera, returning to Austria each summer to compose. He died in Vienna, May 18, 1911.

Mahler's compact mature output consists entirely of symphonies and songs. Most of the 40 songs are not true *Lieder* but rather are embryonic symphonic movements; their character, and sometimes their materials, provide the stylistic basis of the ten symphonies. Song and symphony, together with *Das Lied von der Erde* ("The Song of the Earth"), which fuses the two genres, make up a continuous, consistent *oeuvre*, a spiritual autobiography. Mahler inherited the romantic conception of music as an expression of a quest for spiritual reality; and partly because of his unhappy childhood and his Jewish sense of exile, he expressed a four-sided conflict between a devouring love of life, a spiritual need, a skeptical intellect and an existentialist dread of ultimate meaninglessness. He drew together many different strands of romanticism: Beethoven's conflict symphony; Liszt's and Tchaikovsky's program symphony; Wagner's and Bruckner's enlarged time scale, expanded orchestra, prominent brass tone and emotional intensity; Bruckner's and Schubert's Austrian folk style. Yet his vivid musical personality and orchestral imagination allowed him to remain entirely himself, though he drew on elements from many composers and on the realistic effects of bird song, military signals and marches, country dances (the *Ländler*), and café music (the Viennese waltz). These latter features, original stylizations very like the real things and often used in the manner of collage in painting, give a peculiar dimension to Mahler's art, a Hoffmannesque irony that challenges the prevalent romantic idealism. Thus each of the symphonies becomes a struggle to create idealistic values in face of intractable reality.

Of Mahler's three periods, the first comprises the folklike songs "Des Knaben Wunderhorn" and "Lieder eines fahrenden Gesellen," and the symphonies 1–4, the last three of which use voices and have mystical associations. Then follows the sterner, more realistic trilogy of purely orchestral symphonies 5–7, together with the haunting songs on poems of Friedrich Rückert (which include the "Kindertotenlieder"). The gigantic, fully choral Eighth Symphony stands alone, the real third period comprising *Das Lied von der Erde*, the Ninth Symphony, and the unfinished Tenth. In these dark works, written under the shadow of death, certain tendencies in Mahler's music come to a head—dissolution of tonality, spare dissonant counterpoint, continuous variation and chamber orchestration; they exerted a considerable influence on Arnold Schoenberg, Alban Berg, Anton Webern, Dimitri Shostakovich and Benjamin Britten.

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MAHMUD I (1696–1754), Ottoman sultan of Turkey, the elder son of Mustafa II, was born at Edirne (Adrianople) on Aug. 2, 1696. A mob rising led by Patrona Khalil deposed his uncle Sultan Ahmed III and put Mahmud on the throne on Oct. 1, 1730. Although he had lived in seclusion all his life and had had no training in administration, he succeeded in restoring order. Patrona Khalil was assassinated at the meeting of the divan (the council of state) on Nov. 15, 1730, and a military mutiny was suppressed in 1731. A war with Persia that lasted, with intervals, until 1746 was unsuccessful, but Russia and Austria were forced in 1739 to sign a peace treaty at Belgrade on terms favourable to Turkey. Russian designs on the Crimea and Moldavia, and Austrian designs on the Danubian principalities received a check.

Following the wise advice of the Comte de Bonneval (Ahmed Pasha), a French convert to Islam, Mahmud took an active interest in political and military affairs. He maintained friendly relations with France, Great Britain and Sweden and attempted a partial westernization of the Turkish army. He died of heart disease at Istanbul on Dec. 13, 1754. A patron of music and literature, he himself wrote poetry in Arabic. *See* also TURKEY: *History*. (E. Z. K.)

MAHMUD II (1785–1839), Ottoman sultan of Turkey, son of Abdul-Hamid I, was born on July 20, 1785, and succeeded his brother Mustafa IV on July 28, 1808. Influenced by the reforming zeal of a former sultan, Selim III, he devoted himself during his reign to solving the internal and external problems of his country. In 1808 the janizaries revolted against him and his grand vizier, Bairaktar, who was carrying out reforms. Mahmud allowed them to kill Bairaktar and he strangled his own brother Mustafa, the former sultan, who was the only prospective heir to the throne. In 1812 the war with Russia, which had continued fitfully after a truce in 1807, was ended by the treaty of Bucharest. Three years later, Mahmud had to recognize the virtual autonomy of Serbia.

These events were followed by the revolt of Ali Pasha in Albania (1820–22) and by the rising of the Greeks in the Morea (1821–27). Being unable to crush the Greek rebellion, Mahmud was compelled to summon to his assistance the pasha of Egypt, Mohammed Ali, whom he had already employed to suppress the Wahhabi rebellion in Arabia. The Egyptian army had partially restored the authority of Mahmud in the Morea by 1826, but the united British, French and Russian fleets destroyed the Turkish and Egyptian fleets in the Bay of Navarino (Oct. 10, 1827). After vainly attempting to obtain an apology and reparation for "this revolting outrage" Mahmud proclaimed a holy war against the infidels. This resulted in the Russo-Turkish war of 1828–29, the defeat of the Turkish army and the conclusion of the peace of Adrianople (1829).

In 1831 a new crisis arose. Mohammed Ali Pasha, already governor of Egypt and Crete, demanded the pashaliks of Syria and Tarsus which had been promised him as a reward for his help against the Greeks. When Mahmud refused this demand, Mohammed Ali sent an army into Syria. During the next two years, this army, under the command of Ibrahim Pasha, conquered southern Palestine and captured Acre and Damascus. It routed the main Turkish army at Konya (1832) and advanced toward the Bosporus. To save his throne Mahmud was forced to seek foreign aid. France, which had taken Algeria in 1830, favoured Mohammed Ali. Great Britain was unwilling to intervene alone. Only Russia, the hereditary enemy of Turkey, offered help. This Mahmud accepted with the words "a drowning man clings to a serpent." The Russian expedition to the Bosporus, the convention of Kütahya and the treaty of Unkiar Skelessi followed (1833). By the convention of Kütahya, Mahmud agreed to appoint Mohammed Ali as governor

of Syria and Tarsus and his son Ibrahim as governor of Adana, but Mahmud was determined on revenge. In April 1839 a Turkish army invaded Syria, but it was defeated by the Egyptian army at Nizip on June 24. Mahmud died at Constantinople on July 1 without hearing the news.

Although Mahmud was unfortunate in his wars and foreign policy his efforts as a reformer were successful. The inefficiency of the janizaries during the Greek rising convinced him of the inherent superiority of European methods. In 1826 he destroyed the janizaries, who had risen in revolt, and set to work to establish a national army with the help of German instructors. A military academy was established. Other reforms included the introduction of compulsory primary education; the opening of a medical school; a census of the population of Anatolia and European Turkey; and the exchange of oriental for European dress. Students were sent to Europe. He abolished the sultan's right to confiscate the property of deceased officials; adopted the cabinet system of government; and established permanent embassies in the European capitals. Before his death, he attempted to introduce political equality, declaring that Muslims, Christians and Jews all had the same rights under his fatherly protection. During his reign Mahmud lost territories, but when he died he left his empire stronger than he found it. He was a great reformer who did much to introduce western civilization into Turkey.

See also TURKEY: *History;* EASTERN QUESTION; GREEK INDEPENDENCE, WAR OF. (E. Z. K.)

MAHMUD OF GHAZNI (971–1030), Turkish creator of a Ghaznavid empire stretching, at the end of his reign, from Ray and Isfahan in Iran to Lahore in India, from the Oxus (Amu-Darya) river to the coasts of Makran; plunderer of Hindustan, legendary hero of Islam in India. The eldest son of Subuktigin, Mahmud took part as a youth in campaigns against the hill chieftains of Ghor (*q.v.*) and against the Hindu-Shahi ruler Jaipal and assisted his father in Khurasan in his struggles against rival Turkish officers of the Samanid kingdom of Samarkand and Bukhara. In 994, the Samanid Amir Nuh appointed Mahmud to command his troops in Khurasan with the title of Saif ud-Daula ("sword of government").

On the death of his father in 997, Mahmud did not acquiesce in Subuktigin's nomination of a younger brother, Ismail, as his successor at Balkh and Ghazni (*q.v.*), but defeated him outside Ghazni and imprisoned him.

Although Mahmud is famous for his campaigns in Hindustan, his main political achievement, short-lived though it proved to be, was the creation of a Ghaznavid empire in eastern Iran and Afghanistan. Until 999 Mahmud, like his father, acknowledged the overlordship of the Samanids, but in that year the Qarakhanid Ilak Khan took Bukhara and captured and exiled the remaining members of the Samanid family. Before this extinction of his nominal suzerains Mahmud had, however, effectually excluded the Samanid forces from Khurasan. His assumption of an independent rule clearly dates from this year, the year when the caliph, al-Kadir, conferred upon him the title of *Yamin ud-daula wa Amin ul-Milla* ("right hand of government and guardian of the community").

Master of the chief cities of Khurasan, Mahmud had to defend himself against the Qarakhanid empire centred in Turkistan east of the Jaxartes (Syr-Darya) river. In 1005–06, returning rapidly from an expedition against Multan in Sind, he repulsed an attempt by the Ilak Khan to conquer Khurasan. He was obliged to repeat his success in Jan. 1008, defeating the Qarakhanid forces on the plain of Katar near Balkh. Under the Ilak Khan's successors friendly relations with the Qarakhanids were generally maintained. In 1025, however, Mahmud intervened in Transoxiana with a large army which made the crossing of the Amu-Darya on a bridge of boats. In April 1025 he ceremoniously met Qadir Khan of Kashgar, "the chief of all Turkistan," and concluded an alliance with him. A wary *modus vivendi* between the two great powers, founded on the maintenance of Transoxiana as a buffer region between them, lasted until Mahmud's death in 1030.

Elsewhere, Mahmud annexed Gharjistan, in the area of the upper Murghab, in 1012, and in 1017 asserted his suzerainty over Khwarizm. To the south and west of Ghazni he annexed Seistan (1002–03), subdued the chiefs of Ghor (1009 and 1020) and in 1011–12 asserted his overlordship over Qusdar, the northeastern half of modern Baluchistan. In the farther west, in 1029, he conquered the Buyid principality of Ray. The last years of his reign however were darkened by the threat of the Seljuks (*q.v.*). Mahmud was able to control them in his lifetime, but within ten years of his death they had swept away the power of his son Mas'ud in Khurasan.

Mahmud's Indian campaigns opened in 1000 with the capture of some fortified places around Lamaghan. In 1001 he defeated Jaipal, the raja of Waihind, near Peshawar, capturing him and concluding a peace with booty. Further defeats of the Hindu-Shahis followed in 1006 and in 1008–09 when Nagarkot (Kangra) was plundered. Earlier, in 1004 Mahmud had taken the fort of Bhatinda, in 1006 the Ismaili stronghold of Multan. In 1014 he captured Thanesar. The way was now open for the penetration of the Ganges-Jumna doab; in 1018 Muttra was sacked; in this and the following year, Mahmud swooped down the Ganges to Kannauj and Kalinjar whose rajas had formed a temporary league against him. In 1022–23 Ganda of Kalinjar was reduced to a tributary. In 1025, Mahmud embarked upon his most famous Indian exploit, the crossing of the desert from Multan to Somnath on the Kathiawar peninsula to sack the city and temple there. His only permanent territorial acquisition in India was the Punjab (1021) but its incorporation in the Ghaznavid kingdom was to make Hindu India vulnerable to future Muslim incursions.

Following the precedents and traditions of the Samanid polity, the Ghaznavid empire under Mahmud was founded on a broad functional division of power between a predominantly (though not exclusively) Turkish military élite, often of slave origin and promoted, after service in the royal household, to army commands and provincial governorships, and a bureaucratic hierarchy, staffed mainly by Persians, responsible for collecting revenue.

Mahmud's reign coincided with a remarkable flowering of Perso-Islamic literature, which revived and sought to make Mahmud the focus of many of the traditions of pre-Muslim Iran. At his court were to be found the poets Firdausi, Unsuri and Asadi and the scholar al-Biruni. He became the hero of many legends and anecdotes, particularly centring around his relationship with his favourite slave Ayaz. As plunderer of Hindu temples and destroyer of idols, and as a persecutor of the Karmatians, posthumously Mahmud enjoyed a great reputation as a warrior for the faith and an archetype of the pious Muslim ruler in an age when the Sunni caliphate had visibly failed to fulfill Islamic ideals. Indeed, it may be said that, for all his courage, energy, military skill and self-reliance, Mahmud's role in Muslim historiography and "political" theory as this archetype outweighed and outlasted his actual achievement in Muslim history. *See* also AFGHANISTAN; INDIA: *History.*

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MAHMUD NEDIM PASHA (*c.* 1818–1883), Ottoman grand vizier of Turkey, was the son of Nejib Pasha, formerly governor general of Baghdad. He was successively undersecretary of state for foreign affairs; governor general of Syria and Smyrna (Izmir); minister of commerce; governor general of Tripoli; minister successively of justice and marine (1869); grand vizier during 1871–72 and 1875–76; minister of the interior during 1879–83.

His policy and administration were reactionary. He allowed Sultan Abdul-Aziz to become an absolute monarch, thus destroying the liberal influence that previous ministers had taken over 30 years to introduce from Europe. As grand vizier, Mahmud Nedim tried to keep his office by flattering the sultan and by providing him with money for his extravagance. In foreign policy, owing to his enmity toward liberal ideas, he opposed Britain and France and won the friendship of Russia. By 1875 he was basing all his decisions on the advice of Count Nicholas Ignatiev, the Russian

ambassador in Constantinople, a fact which earned him the nickname of "Mahmudov." In 1876, after the rising in Bulgaria occasioned by Ignatiev's intrigues, Mahmud Nedim became so unpopular that threats were made to assassinate him. To calm public feeling Abdul-Aziz dismissed him. Mahmud died in Istanbul on May 14, 1883. (E. Z. K.)

MAHOGANY is among the foremost cabinetwoods of the world and one of the most valuable timbers in tropical America. It is the product of the genus *Swietenia,* family Meliaceae. Other hardwoods are called mahogany because of a resemblance in colour or texture to the wood of *Swietenia.*

True Mahogany.—The species first discovered was the West Indies mahogany (*Swietenia mahagoni*), native in the Bahamas, Cuba, Jamaica, Hispaniola and southern Florida. More important commercially is Honduras mahogany (*Swietenia macrophylla*) of southern Mexico, Central America and South America, found in Colombia, Venezuela and the upper Amazonian region of Peru, Bolivia and western Brazil.

Mahogany trees are scattered through wet tropical forests and are grown in plantations and for shade and ornament around the world. The alternate pinnate leaves have 4 to 12 paired, shiny, pointed leaflets with the two sides unequal. Many small greenish-yellow five-petaled flowers are borne in clusters. The distinctive hard, pear-shaped seed capsules split into five parts from the base upward, releasing many winged seeds. The wood characteristically is rich reddish brown, especially after exposure, though when freshly cut it ranges from light pink to golden brown. It is fine-textured with scattered pores and often with a highly attractive figure, such as a stripe, mottle, fiddleback or swirl. Of uniformly high grade, it is easily worked, takes a beautiful polish, stains and glues readily and is strong and durable.

The oldest surviving use of carved mahogany is in the cathedral at Santo Domingo, built 1514–40. Hernán Cortés in 1521 adapted it for shipbuilding. One of the first recorded uses in England was at Nottingham castle in 1680. For fine furniture, mahogany became popular in the early part of the 18th century, when cabinetmakers began to carve decorations on this strong wood. Other uses include cabinetwork, television cabinets, paneling, veneers, plywood, molded plywood boat hulls, yacht interiors, working models and foundry patterns. In World War II mahogany served for PT boats and aircraft.

Other Mahoganies.—The word mahogany, usually with a descriptive or geographic qualification, has been applied to nearly 200 other species. Khaya, or African mahogany, is obtained from the genus *Khaya* (mostly *Khaya ivorensis;* family Meliaceae) in West Africa, mainly Ivory Coast, Ghana and Nigeria. Wood of related genera, for example sapele (*Entandrophragma cylindricum*), also has been marketed as African mahogany. The trade name Philippine mahogany has been applied to red lauans (*Shorea negrosensis, S. polysperma*—also called tangile—and related species) from the Philippine Islands; they belong to the dipterocarp family (Dipterocarpaceae). The U.S. Federal Trade commission has approved the names African and Philippine mahogany but otherwise restricts mahogany to woods of *Swietenia.*

In western North America several species of shrubs and small trees of the genus *Cercocarpus,* of the rose family, with hard, fine-grained, reddish wood, are known as mountain-mahogany. Lemonade sumac (*Rhus integrifolia*), a handsome evergreen shrub or small tree of southern California and Mexico, has been called mahogany sumac or mahogany. (E. L. L.)

MAHÓN (Port Mahón), a town of Spain, capital of Minorca, in the Balearic Islands. Pop. (1960) 16,619. Located on the southeast side of the island, Mahón has a natural harbour, one of the finest in the Mediterranean, extending inland 3½ mi. Because of its harbour Mahón replaced Ciudadela as capital of Minorca during the period of British occupation, and its characteristic white stone houses with green shutters, brass knockers and latches—many of them built for British officers—are reminiscent of Georgian England. Southeast of Mahón is the village of Villa Carlos (George Town), a typical British colonial garrison town laid out in 1771 by a British engineer. At the mouth of the port are the ruins of Forts San Felipe and Marlborough; it was for his refusal to defend the town that Adm. John Byng (*q.v.*) was shot. Mahón's most important industries are shoe manufacturing, manufacture of imitation jewelry and pearls, and the distilling of gin, and there are handcrafts. The surrounding district is concerned with farming and cattle raising, and Mahón cheese is well known. Mahón is connected by road with Ciudadela, on the west side of the island, and by air and sea with Barcelona and the other islands.

Mahón (ancient Portus Magonis) bore the name of the Carthaginian general Mago. Under the Romans it was a *municipium.* Barbarossa besieged and captured the city in 1535, and in 1558 it was sacked by a corsair. The British, after their seizure of Mahón in 1708, declared it a free port in 1718. In 1756 it fell into the hands of the French, was restored to the British in 1763, recovered by the Spanish in 1782 and in 1802 finally ceded to Spain.

See also Balearic Islands; Minorca. (R. H. Gi.)

MAHONE, WILLIAM (1826–1895), U.S. railroad president, Confederate general in the Civil War and U.S. senator, was born in Southampton county, Va., on Dec. 1, 1826. In 1847 he graduated from the Virginia Military institute, took up engineering as a career and by 1860 had become president of the Norfolk and Petersburg railroad. At the outbreak of war in 1861 he entered the Confederate service and participated in almost all the major campaigns of General Lee's army. He was promoted to the rank of brigadier general in March 1864 and major general in August after brilliant fighting around Petersburg.

After the war, Mahone became president of the Virginia and Tennessee railroad and was largely responsible for the development of the Norfolk and Western. Because of opposition from conservative Democrats to his fiscal plans, he formed in 1878 the Readjuster party. While in office, this organization was partly successful in readjusting or scaling down the debt of the impoverished state of Virginia to what it deemed practical limits, and it also promoted education and economic development. In 1880 Mahone was elected to the U.S. senate as a Readjuster but voted with the Republicans. His action led to an even balance of power in the senate and angered the Democrats, who lost their anticipated majority. Mahone was not re-elected to the senate in 1886 and never again had much influence politically. He died at Washington, D.C., on Oct. 8, 1895.

See N. M. Blake, *William Mahone of Virginia: Soldier and Political Insurgent* (1935). (R. D. Me.)

MAHONIA, a genus of evergreen shrubs of the barberry (*q.v.*) family (Berberidaceae) and considered by some as a section of *Berberis.* The mahonias differ from the true barberries mainly in being thornless and in having compound leaves and a calyx of nine sepals. There are about 50 species, found chiefly in Asia, western North America and Central America. Several are cultivated for their ornamental foliage, flowers and fruit, including the Oregon grape (*q.v.*); the Japanese mahonia (*M. japonica*), native to China; and *M. fortunei,* also native to China and named after the English traveler Robert Fortune.

MAIA, in Greek mythology, the eldest of Atlas' seven daughters, the Pleiades (*q.v.*), by Pleione, one of the 3,000 daughters of Oceanus. Maia was mother by Zeus of Hermes. She was commonly confused by the Romans with their own Maia or Maiesta, who was the cult partner of Vulcan.

MAIDA, BATTLE OF, a victory won by the British under Maj. Gen. Sir John Stuart over the French under Gen. J. L. Reynier at Maida in southern Italy on July 4, 1806, during the Napoleonic Wars. After Napoleon had crushed the Austrians and Russians at Austerlitz in Dec. 1805, a French army overran the Bourbon kingdom of Naples. A small British force withdrew from the mainland to Sicily, which was soon threatened with invasion. The British commander, Stuart, soon saw an opportunity to strike back at the French, who were overextended and embroiled with insurgent Calabrians. In conjunction with Adm. Sir Sidney Smith he landed 4,500 men near Maida, in the neck of the Calabrian peninsula, cutting off the southernmost French division commanded by Reynier. Reynier concentrated rapidly and on July 4 had 6,500 men very strongly posted near Maida. Stuart had no

option but to attack him or to re-embark, and was advancing to attack when the French themselves took the offensive.

Reynier and Stuart had already faced each other at the battle of Alexandria, and Maida produced some remarkable parallels. On both occasions the French left a strong position to attack an embarrassed British force and were defeated by the good conduct of the British infantry firing volleys in line. Though Reynier's superiority in cavalry and artillery prevented a pursuit, he sustained 2,200 casualties and had to abandon Calabria. The British losses were 327 killed and wounded. Though they subsequently withdrew, the British had achieved a decisive spoiling attack against the French preparations to invade Sicily—a success rendered permanent by the later reinforcement of the island. The campaign is a classic example of the use of sea power to achieve local superiority through mobility and surprise. (P. G. M.)

MAIDENHAIR FERN, the common name for plants of the large genus *Adiantum*, comprising about 200 species of dainty, shade-loving forms with shiny black or purplish stipes and thin delicate fronds or leaf blades, either simple or divided into fan-shaped segments or pinnules. The brownish fruit dots are marginal, and are borne on the underside of the pinnule. The genus is largely of tropical America, with a few species in temperate North America.

A. capillus-veneris, Southern maidenhair or Venus'-hair, occurs in temperate and tropical America, in the warmer parts of the old world and is a popular plant in greenhouses. *A. pedatum*, a larger and beautiful fern, grows in woods from Nova Scotia to Alaska and southward from Florida to Texas. Adiantum is an

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SOUTHERN MAIDENHAIR FERN (ADIANTUM CAPILLUS-VENERIS)

ancient name, meaning unwetted, the foilage shedding raindrops. *See* also FERN. (J. M. BL.)

MAIDENHAIR TREE: *see* GINKGO.

MAIDENHEAD, a municipal borough of Berkshire, Eng., lies on the Thames, 12 mi. N.E. of Reading by road. Pop. (1961) 35,411. The centre of the town and principal shopping area comprises High street, King street and Queen street; the Henry Reitlinger Fine Art museum, containing prints and drawings, ceramics, carvings, etc., is located by the river near Maidenhead bridge. The first charter was granted by Elizabeth I in 1582. Almshouses were built in 1659, and the Guildhall, founded in 1777, was enlarged in 1878. The stone bridge (1772–77) carries the London to Bath trunk road over the river, and the railway bridge, constructed in 1837–38 to the design of Isambard Kingdom Brunel, has two of the widest brick spans in the world. Maidenhead Thicket and Pinkney's Green, covering 535 ac. of open National trust land, and the summer boating facilities afforded by the Thames, have made the town a popular residential area and "up river" summer resort. In the Thicket is a Roman camp and traces of prehistoric settlement have also been found there. White Waltham airfield is about 3 mi. S.W. A wide range of light industries includes launch- and boatbuilding.

MAIDENKIRK: *see* KIRKMAIDEN; JOHN O'GROATS.

MAID MARIAN: *see* ROBIN HOOD.

MAIDSTONE, a market town and municipal borough and the county town of Kent, Eng., lies on both banks of the Medway 36 mi. E.S.E. of London by road. Pop. (1961) 59,790. There is much evidence of Roman settlement along the Medway valley, and the site of a Roman road runs through the present town. The name Maidstone is derived from the Saxon Maeidesstana, given as Meddestane in the Domesday Book, and is taken to mean "the maidens' stone" (Ekwall). At the time of the Domesday survey Maidstone, as a manor, belonged to the archbishop of Canterbury, and from the reign of John to the Reformation the archbishops had a residence there. The shire moot was held on Penenden heath in the middle ages, and the heath was the scene of executions and great county meetings until the 19th century. Maidstone was an assize town in the reign of Edward I. In 1537 Thomas Cranmer exchanged the manor of Maidstone with the king, and it was granted by Edward VI to Sir Thomas Wyat. Edward incorporated the town in 1549, but this charter was revoked as a punishment for Wyat's rebellion. A second charter was granted by Elizabeth I (1559), a third and fourth by James I (1603 and 1619). Charles II in 1682 called in the old charters and issued a new one. In 1740 this charter was forfeited, and after many petitions a new one (the last) was granted by George II in 1747. Four fairs were granted by the charter of 1549 and a Thursday market, first granted by Henry III to Archbishop Boniface in 1261, was confirmed. A market every second Tuesday in the month was granted in 1751.

The manufacture of linen and woolen goods was increased by Walloons, who settled there in 1567. This was succeeded by papermaking, later the chief industry of the district. Maidstone is also the county centre for the distribution of fruit, grain and hops. The cultivation of hops in the area has been carried on since the 16th century, and there are large breweries and maltings. At East Malling, 4 mi. N.W., is a horticultural research station specializing in experiments in fruitgrowing; Bradbourne house is its headquarters. Other industries include confectionery making, quarrying for Kentish ragstone, agricultural implement manufacturing and printing. Ragstone from the Maidstone district was used in Roman London and medieval times and was utilized in the building of Hampton court, Eton college and the Tower of London. Maidstone is the administrative centre of the Kent County council and of the Kent River board. It is also a commercial centre.

In about 1260 Archbishop Boniface established Newark hospital there for poor travelers; the main building is gone, but the chapel, with modern additions, is St. Peter's church. The rebuilding of the Norman parish church of St. Mary was begun in 1395 by Archbishop William Courtenay, who erected on the same site the present great perpendicular Church of All Saints in Kentish ragstone. Round the church are grouped the medieval Archbishop's palace, now used for public functions; the College of All Saints, founded *c.* 1395 by Archbishop Courtenay for secular canons; and the Archbishop's stables, now used as a municipal museum of carriages (opened 1946). The grammar school was founded in 1549 and endowed with the estates of the local Corpus Christi fraternity, then dissolved. The medieval hall remains, but in 1871 the school was moved to buildings on a new site. Famous scholars include Christopher Smart, the poet; John Pond, the astronomer; and Adm. Sir Robert Calder. Lawrence Washington, collateral ancestor of George Washington, lived and died (1619) in the town, and there is a memorial tablet to him in All Saints' church. William Hazlitt, the essayist, was born in Maidstone in 1778. A municipal museum and art gallery, with a public library, was opened in 1858 in Chillington Manor house, a Tudor building that is also the headquarters of the Kent Archaeological society. The town hall was built *c.* 1762–63. There are a girls' grammar school, a technical college and a college of art. Penenden heath was enclosed in 1882 as a public recreation ground. In 1929 the corporation bought the Mote estate of 558 ac. and converted it into a public park. The borough has its own courts of quarter sessions and summary jurisdiction. A new courthouse was opened in 1937.

Cobtree manor, just north of Maidstone on the Chatham road, is generally thought to be the scene of the Dingley Dell cricketing party in Charles Dickens' *Pickwick Papers*. At West Malling, 6 mi. N.W., is Malling abbey, founded in 1090 by Gundulph, bishop of Rochester, and now restored to use as an Anglican Benedictine nunnery. St. Leonard's tower is all that remains of a Norman chapel. The village has a long cricketing tradition.

MAIDU, once one of the largest Californian Indian tribes, living in the eastern Sacramento valley and Sierra Nevada mountains, they spoke a Penutian (*q.v.*) language. Their population in A.D. 1770 was computed at 9,500 for the three main dialectal divisions (northeastern, northwestern, southern or Nisenan). Their number in the 1960s, including persons of mixed blood, was less than 300. Language divisions correspond only in part with physiography and cultural cleavages, and ethnologists recognize valley, foothill and mountain cultural types. Political organization was based upon the tribelet, comprising a series of villages with an average total of about 250 persons and holding exclusive rights to 100 to 200 sq.mi. of territory. A chief, usually a wealthy man from the largest village, was political head of the tribelet. The Maidu, together with the Wintun of the western Sacramento valley and the Pomo (*q.v.*) in the southern Coast range, best exhibited central Californian culture as judged by complexity of the spirit-impersonating Kuksu religion, basketry manufacture, and numbers of large, stable villages. This cultural peak was supported by an unusual abundance of such food as salmon, deer, elk, acorns and grass seeds.

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MAIDUGURI: *see* YERWA-MAIDUGURI.

MAIKOP (MAYKOP), a town and administrative centre (since 1936) of the Adygei autonomous oblast of Krasnodar krai, U.S.S.R., stands on the right bank of the Belaya river, where it issues from the Caucasian foothills. Pop. (1959) 82,118. Industries include metalworking and machine building (especially for the timber and petroleum industries), a wide range of timberworking (particularly furniture and parquet making), tannin extracting and food processing. Maikop oil fields are to the southwest with the main centres at Apsheronsk, Neftegorsk and Khadyzhensk. In 1930 a hydroelectric plant was completed on the Belaya. The many mineral springs in the neighbourhood have given Maikop some importance as a spa. The town has a pedagogic institute and an Adygei language, history and literature institute. It was founded in 1857–58 as a Russian fortress and was captured by the Germans during World War II. (R. A. F.)

MAIL; *see* POSTAL SERVICES.

MAILÁTH, JÁNOS, COUNT (1786–1855), Hungarian man of letters, the interpreter of Magyar culture to the Germans and the sympathetic historian of the Habsburg monarchy, was born in Pest on Oct. 5, 1786, the son of Count József Mailáth, an imperial minister of state and a member of a well-established family. Having studied philosophy at Eger and law at Győr, he obtained a post in the government service but soon had to resign because of an injury to his eyesight. Devoting himself to literary work, he edited two important collections of medieval German poetry (1813, 1816) and published some German verse of his own (1814) before producing his German translations of Hungarian poems (1817, 1829), his presentation of Hungarian folklore (*Magyarische Sagen, Märchen und Erzählungen*, 1837) and his five-volume history of the Magyars (also in German, 1828–31). These followed other works on special aspects of Hungarian history and also the five-volume *Geschichte der österreichischen Kaiserstaat* (1834–50), more perceptive than any preceding study of the Habsburg empire. Mailáth also wrote on mesmerism (1843) and on the healing power of animal magnetism (1852).

Mailáth stood apart from both the revolutionary and the conservative schools of thought. In 1848 he left Vienna for Munich. At last, finding himself destitute, he became despondent and made a suicide pact with his daughter Henrika, who had long been his amanuensis; on Jan. 3, 1855, they tied themselves together by the wrists, weighted their clothes with stones and threw themselves into the Starnberg lake.

MAILLART, ROBERT (1872–1940), Swiss engineer, renowned for his pioneering work in reinforced-concrete flat-slab construction and the unsurpassed beauty and elegance of his bridges, was born in Bern, Switz. June 6, 1872. He was educated at the Federal Institute of Technology, Zürich (1890–94). Then worked in France with François Hennebique, who had the first reinforced-concrete construction firm. In 1901 Maillart founded his own engineering firm in Zürich. He went to Russia in 1912, where he constructed factories and warehouses in Kharkov, Riga and St. Petersburg (Leningrad) for Swiss companies. After the Russian Revolution he returned to Switzerland financially ruined. In 1919 he again founded an engineering firm and continued construction until his death in Zürich on May 4, 1940.

Among Maillart's works are bridges, spare airily over space, belonging to the purest expression that the modern era has been able to achieve. They include the Tavanasa bridge (1905), span 170 ft.; Salginatobel bridge (1929–30), span 295 ft.; Thur bridge (1933), span 220 ft.; a bridge over the Arve river near Geneva (1936–37), span 183 ft.; and bridges at Lachen (1940) and over the Sionne river (1940). He was the first mushroom column, flat-slab construction, for a warehouse in Zürich (1910).

See E. B. Mock, *The Architecture of Bridges* (1949); S. Giedion, *Space, Time and Architecture* (1954). (S. Ge.)

MAILLOL, ARISTIDE (1861–1944), French sculptor, whose primary importance rests on his monumental studies of the nude, was born at Banyuls-sur-Mer, Pyrénées-Orientales, on Dec. 8, 1861. At first a painter, he studied at Perpignan and, from 1881 to 1886, in Paris. Like many young artists at this time, he then abandoned easel painting, taking up tapestry and wood carving and, about the turn of the century, began to work on a grand scale in clay, marble and bronze. At that time Maillol began to be influenced by the "synthesist" movement of Paul Gauguin (*q.v.*) and by Maurice Denis and his concern with statuesque calm, order and unity at the expense of detail.

This engagement was strengthened in the first decade of the 20th century by a reappreciation of the archaic art of Greece (which Maillol visited in 1905); and it gave his work qualities which at once distinguished it from the intensely emotional and disrupted forms of Auguste Rodin, then powerfully influential.

Closely based on the living model, Maillol's work is nonetheless formal and he is preoccupied with over-all unity and balance. The emotional force of his work depends on disciplined relationships of mass and direction, and this control distinguishes it again from Rodin's frequent dependence on accidental effects of surface. Among Maillol's large works are the reclining figure of "Pomona" in the Tuileries gardens, Paris (a monument to Paul Cézanne); the war memorials at Elne, Céret and Port Vendres; the standing figure of "Flora" (1911); and the "Crouching Woman" made for his friend Count Kessler. There is a portrait head of Auguste Renoir (1907), between whose sculpture and Maillol's there is an affinity. He also worked in high relief in stone and made fine terra-cotta statuettes, and his drawings and the book illustrations of his late years are of high quality. He died after a road accident near his birthplace in Oct. 1944. (D. C. T. T.)

MAILLY, LOUISE JULIE DE MAILLY-NESLÉ, COMTESSE DE (1710–1751), the eldest of three sisters who became mistresses of Louis XV of France, was born on March 16, 1710, the daughter of Louis de Mailly, marquis de Nesle. In 1726 she married her cousin Louis, comte de Mailly. Though her liaison with the king began in 1733, she behaved unobtrusively and was not acknowledged as his mistress until 1738. In the following year the king extended his favours to her more ambitious sister Pauline Félicité, marquise de Vintimille, who used her position to advance the interests of the future marshal de Belle-Isle but died on Sept. 9, 1741. Madame de Mailly then regained some influence with the king and continued her sister's policy of supporting Belle-Isle. She was soon supplanted by another sister, Marie Anne, marquise de la Tournelle and later duchesse de Châteauroux, who procured her dismissal from court at the end of 1742. She died in Paris on March 30, 1751.

See N. Dietrich, *Les Maîtresses de Louis XV* (1961), and works cited under CHÂTEAUROUX, M. A. DE MAILLY-NESLE, DUCHESSE DE.

MAIL-ORDER BUSINESS, a method of merchandising in which the seller's offer of merchandise is made through a circular, catalogue or advertisement placed in a newspaper or magazine and the buyer places his order by mail. Delivery of goods has traditionally been made through freight, express or parcel post on a cash-on-delivery basis. While mail-order merchandising in the United States has developed mainly as a method of retailing, there also are a few wholesale distributors who do a large volume of business on a mail-order basis.

Retail mail-order selling developed primarily as a method of selling to rural customers, but it now also includes millions of urban customers. For the convenience of city residents the leading companies have supplemented their traditional direct-by-mail facilities with catalogue-order offices in strategic locations and, in some cases, with round-the-clock telephone ordering services and the promise of delivery by truck within 48 hours. In some areas merchandise delivery is made within 24 hours after the order is placed.

Most mail-order businesses are mail specialty sales firms selling by the traditional method. Department stores also do a significant volume of business through their mail-order divisions. The vast bulk of mail-order business, however, is accounted for by a few firms selling general merchandise lines. The multibillion-dollar volume of Sears, Roebuck and Company and Montgomery Ward and Company accounts for most of the retail mail-order sales business in the United States. Though dwarfed by these two giants, Spiegel and Aldens, Inc. are also very large establishments.

Responding to major population shifts, the two largest mail-order companies established hundreds of retail stores across the country in the years after 1925. By mid-century the retail store sales volume of the largest firms exceeded that of their mail-order divisions. In addition to conventional over-the-counter selling, these retail stores included facilities for customers wishing to order goods through catalogues. Credit sales also became important in the mail-order business.

Mail-order operations have been known in the U.S. in one form or another since colonial days, but not until the latter part of the 19th century did this form of distribution assume a significant role in domestic trade. The agricultural expansion in the U.S. together with the completion of the continental railroad network combined to provide a basic opportunity for a new form of distribution. The original merchandise mail-order houses developed to serve the market that was not being adequately served by conventional retailing outlets in rural areas. One of the impelling forces leading to the original success of the mail-order companies in rural markets was the bringing of a variety of merchandise to the isolated farm buyer at comparatively low prices. This great growth was stimulated by a postal-rate structure which encouraged the wide dissemination of the early mail-order papers and also the distribution of catalogues. The establishment of the parcel-post system in 1913 added another important auxiliary to the continued expansion of mail-order operations.

Of significant importance in encouraging the growth of the early mail-order companies was the general antagonism U.S. farmers felt toward middlemen. The American Grange was especially vocal in expressing the resentment of the agricultural population toward what farmers considered the excessive size of distributors' trading margins. The early advertising copy of the mail-order companies capitalized effectively upon this attitude of many farmers toward the merchant class, and the earliest years of Montgomery Ward and Company saw a close association between the company and the Grange. Members of the Grange were given special inducements to trade with Montgomery Ward when the company was founded in 1872.

The established mail-order houses came to be universally respected by both their customers and their competitors for adopting policies of full guarantees on merchandise and of liberality in making adjustments. Although the companies were leaders in the movement for accurate and informative advertising of essentially reputable merchandise, there had always been some exceptions. Indeed, the early years of the business saw extensive advertising campaigns which attempted to exploit every possible opportunity to glorify the merchandise and to impel the incautious customer to buy. Modern mail-order catalogues, however, are generally models of propriety and truthfulness in advertising.

The most successful mail-order companies have enjoyed certain sources of economy common to large-scale merchandising. They buy in large quantities; they frequently order merchandise manufactured to their own specifications; and in many cases they arrange for the production of their orders on a schedule which permits the supplier to sell at lower margins than he would otherwise demand. In some cases the large firms contract for the entire output of particular manufacturers, and occasionally the mail-order company is completely integrated in terms of ownership of factory outlets, although this is not common.

Apart from the economies of large-scale buying and selling, the mail-order operation offers certain other opportunities for operating economies since the mail-order plants themselves are essentially warehouses and may be located in low-rent areas. Further economies are achieved in the handling and shipping of merchandise. Machines and mechanical aids of many types are employed. Manpower is eliminated wherever a machine will be more efficient. Pneumatic tubes, endless-belt conveyers, chutes and electric trucks are used in the distribution of orders to the numerous merchandise departments into which the mail-order house is organized. Paralleling these mechanical facilities, personal effort is organized along highly specialized lines. Throughout the entire system of buying, handling and shipping, substantial savings of time and money are achieved and are reflected in the retail prices found in the mail-order catalogue, the primary selling instrument of the important mail-order firms.

The mail-order houses contributed substantially to improving the efficiency of retail distribution in the United States. Perhaps more important than any other single service was their effect in breaking the local monopolies of retail stores in once isolated areas by providing rural buyers with a feasible means for purchasing a wide variety of merchandise at relatively low prices.

While company sales volume of the largest mail order firms is enormous, the relative importance of mail-order sales to retail trade in general is not great. Mail-order sales constituted less than 1% of the total retail sales volume in the United States in the early 1960s.

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(J. E. J.)

MAIMANA, a town and capital of Maimana province in northwest Afghanistan, lies 2,450 ft. above sea level in a green valley encircled by the northern foothills of the Band-i-Turkistan range, 140 mi. W.S.W. of Mazar-i-Sharif. Pop. (1962 est.) 30,062. It was formerly the capital of a small khanate, long in dispute between Bukhara and Kabul until its subjugation by Abdurrahman Khan in 1868. The khanate was allotted to Afghanistan by the Russo-Afghan boundary commission of 1885. The town's former fortified character has disappeared. On a mound from where, before its destruction in the late 1870s, the old castle dominated the town, stands a modern cinema in a park. Maimana has a small airport with services to Herat, Mazar-i-Sharif and Kabul. Roads to Herat (about 180 mi.) and Mazar-i-Sharif (about 220 mi.) are difficult and impassable during spring floods, and their eastern stretches have patches of soft sand. There is no road to the Soviet border 30 mi. away. Maimana is a small commercial centre.

MAIMANA PROVINCE is a minor province bounded west by the Turkmen Soviet Socialist Republic, east by Shibarghan, south by Ghor and southwest by Herat. It consists of mountains with fertile valleys to the south, where are the towns of Maimana and Qaisar, and desert plains to the north, with the towns of Daulatabad, Shirzen, Tagao and Andkhui, another former khanate, which has preserved its picturesque character. The people are mostly Uzbeks with some Pushtuns and Turkmens in the south. The main occupations are carpet weaving, sheep grazing and the preparation of karakul (qq.v.). Pop. (1962 est.) 423,323. (X.)

MAIMBOURG, LOUIS (1610–1686), French Jesuit and

historian, an energetic defender of Gallican liberties in his *Traité historique de l'établissement et des prérogatives de l'Église de Rome et de ses évêques* (1685; new ed., 1831). Born at Nancy on Jan. 10, 1610, he entered the Society of Jesus at the age of 16. His works include *Histoire du lutheranisme* (1680) and *Histoire du calvinisme* (1682), the latter being useful to the French government as propaganda for the revocation of the Edict of Nantes. His defense of French liberties in his *Traité* was bitterly resented by Pope Innocent XI, who ordered the Jesuits to expel him. Louis XIV granted him a pension and a retreat at the abbey of St. Victor, Paris. He died on Aug. 13, 1686.

His works were published in 14 volumes (1686–87).

MAIMING, mutilation, a physical injury which involves the loss of, or incapacity to use, a bodily member. Maiming or mutilation is and has been practised by many peoples with various ethnical and religious significances, and was a customary form of punishment on the principle of an "eye for an eye." (*See* MUTILATIONS AND DEFORMATIONS.)

In law "maiming" was made a criminal offense; the old law term employed for a special case of maiming of persons was mayhem (*q.v.*), an Anglo-French variant form of the word. The punishment incurred for maiming of cattle in Great Britain was set at 13 to 14 years of penal servitude. Malicious injury to other animals was made a misdemeanour punishable on summary conviction. For a second offense the penalty was set at imprisonment with hard labour for more than 12 months under the Malicious Damage act of 1861. In both British and U.S. law maiming means the permanent injury of the animal; wounding or otherwise mistreating an animal is a separate offense.

MAIMON, SALOMON (*c.* 1754–1800), Jewish philosopher who was acknowledged by Kant to be the most acute of his critics, was born about 1754 at Nieswiez in Polish Lithuania and was married off by his father at the age of 11. He gained a remarkable proficiency in Hebrew, studying outside the conventional limits of the Talmud, and acquired a particular reverence for Maimonides (*q.v.*), in whose honour he took the surname Maimon instead of the original patronymic Ben Joshua. In 1770 he estranged himself from his orthodox coreligionists by a commentary on Maimonides' *Guide of the Perplexed.* Eight years later he left Poland for Königsberg to begin a life of material insecurity and wandering over northern Europe only terminated in 1790 when he was offered the retreat on the estate of Count Adolf Kalkreuth at Nieder-Siegersdorf (Silesia), where he died on Nov. 22, 1800.

Nearly all Maimon's philosophical works were published during the years 1790–1800, including the two by which he is best remembered: the autobiography edited for him as *Salomon Maimons Lebensgeschichte* by Karl Philipp Moritz (1792); and *Versuch über die Transcendentalphilosophie* (1790), formulating his objections to Kantian philosophy. In this work Maimon seizes upon the fundamental incompatibility of a consciousness which can apprehend, yet is separated from, the thing-in-itself. That which is object of thought cannot be outside consciousness; just as in mathematics $\sqrt{-1}$ is an unreal quantity, so things-in-themselves are *ex hypothesi* outside consciousness, that is to say, unthinkable. The Kantian paradox he explains as the result of an attempt to explain the origin of the "given" in consciousness. The form of things is admittedly subjective; the mind endeavours to explain the material of the given in the same terms, an attempt which is not only impossible but involves a denial of the elementary laws of thought. Knowledge of the given is, therefore, essentially incomplete. Complete or perfect knowledge is confined to the domain of pure thought, to logic or mathematics. Thus the problem of the thing-in-itself is dismissed from the inquiry, and philosophy is limited to the sphere of pure thought. The Kantian categories are, indeed, demonstrable and true, but their application to the given is meaningless and unthinkable.

By this critical skepticism Maimon takes up a position intermediate between Kant and Hume. Hume's attitude to the empirical is entirely supported by Maimon. The causal concept, as given by experience, expresses not a necessary objective order of things, but an ordered scheme of perception; it is subjective and cannot be postulated as a concrete law apart from consciousness.

Maimon's other published works include *Philosophisches Wörterbuch* (1791); *Über die Progressen der Philosophie* (1793); *Versuch einer neuen Logik* (1794); and *Kritische Untersuchungen über den menschlichen Geist* (1797).

See Hugo Bergman (ed.), *The Autobiography of Solomon Maimon,* with useful commentary (1954).

MAIMONIDES (MOSES BEN MAIMON) (1135–1204), also known from his initials, with his title rabbi, as RAMBAM, Jewish philosopher, physician and master of rabbinic literature, was born in Córdoba, Spain, of an illustrious Jewish family and educated by his learned father. When Córdoba fell to the Almohads in 1148 and the position of the Jews became intolerable, the family emigrated first to Morocco, then for a short while to Palestine and finally to Egypt. Maimonides eventually settled in Fostat, a suburb of Cairo, where he attained the position of *nagid* or accredited leader of Egyptian Jewry. He was appointed court physician to Saladin and was invited by King Richard I to come to England but refused the invitation.

Maimonides' greatest work in the rabbinic field is his *Mishneh Torah,* a kind of *summa theologiae* of Judaism, composed in an elegant and concise Hebrew, arranged in 14 books and offering a systematic presentation of the entire content of the rabbinic tradition. It was preceded by his *Commentary on the Mishna* and by the *Book of Commandments,* both written in Arabic. The *Mishneh Torah* secured for Maimonides a commanding position in the development of rabbinic law and represents the first of a series of authoritative codes. From his early youth, Maimonides was attracted to Aristotelian philosophy as taught by al-Farabi and by Avicenna. At the age of 16 he composed a *Treatise on the Terminology of Logic;* and his *Commentary on the Mishna* embodies a fair amount of philosophy, especially in the *Eight Chapters* prefacing his comments on the tractate *Avoth.* The same applies to his code, which opens with an outline of his metaphysics and ethics. His celebrated *Guide of the Perplexed* contains the ripe fruit of his philosophical thinking and exercised considerable influence on both Jewish and Christian scholasticism. Written in Arabic, it seeks to interpret the biblical and rabbinic theology in terms of Neoplatonic Aristotelianism.

The first book of the *Guide* discusses the figurative meaning of anthropomorphic expressions applied to God in the Scriptures and examines the propriety of the various types of attributes or predications of God. The essence of God can be neither defined nor described. Existence is not something added to, but implied in, the essence of God. The *via negativa* is the only admissible way of speaking about God's essence; that is to say, we can deny all positive statements about God which imply a deficiency. But we may also admit "attributes of action" such as justice, love, etc., seeing that they do not touch upon the mystery of his hidden essence and describe only God's relation to the world in terms of cause and effect. The first book concludes with a comprehensive statement of the principles of the Muslim mutakallim and their refutation. The second book proves the existence of God by the argument of the unmoved mover and by the distinction between the necessary and the possible and between the necessary and the contingent. Aristotle's cosmology is accepted in outline, and the separate intelligencies of Neoplatonic Aristotelianism moving the celestial spheres are identified with the angels of Scripture. Aristotle's doctrine of the eternity of the world Maimonides finds less acceptable, not because it contradicts the plain meaning of Scripture (this could, if necessary, be interpreted allegorically) but because it runs counter to the fundamental biblical notion of a God not bound by necessity and creating the world freely. Maimonides makes the point that unless we allow for the free operation of God's will the irregularities in the planetary motions cannot be explained. The second book also discusses the nature of prophecy: the prophets of the Bible are described as combining intellectual insight with the strongest imagination; their visions represent intuitive intellections concerning the spiritual world and their dreams future events. Following al-Farabi's *The Model State* and Avicenna's discussion of prophecy, Maimonides sees in the type of the prophet a kind of Platonic philosopher-king, the lawgiver of the ideal state. The

third book treats of the nature of evil, of providence, of design in nature, of the historical background of the biblical ritual (this section is important as an early essay in comparative religion) and of moral virtues as steppingstones to the contemplative life. (*See* also JEWISH PHILOSOPHY.)

Editions of the *Guide* are: by S. Munk, Arabic text with French translation and valuable notes, 3 vol. (1856–66), English translation by M. Friedlander, 3 vol. (1881–85), and reissue, 1 vol. (1925), and German translation by A. Weiss, 3 vol. (1923). There is also an English translation of selected passages by C. Rabin, with introduction and commentary by J. Guttmann (1952).

Other texts include the *Treatise on the Terminology of Logic*, edited with English translation by I. Efros (1937–38); *Eight Chapters*, English translation by J. I. Gorfinkle (1912); and sections from the *Mishneh Torah* in English translation by M. Hyamson (1949 *et seq.*).

See bibliographies compiled by J. L. Gorfinkle in I. Epstein (ed.), *Moses Maimonides, 1135–1204*, pp. 229–248 (1935); and by G. Vajda in *Jüdische Philosophie*, pp. 20–24 (1950). (A. AN.)

MAIN, a river of Germany, 325 mi. long and the most important right-bank tributary of the Rhine. It has two sources, the Weisser Main (White Main) which rises in the Fichtelgebirge, and the Roter Main (Red Main) which, rising on the eastern slope of the Frankish Jura, flows past Bayreuth. They unite near Kulmbach and the Main then flows northwest round the north end of the Frankish Jura to Bamberg. There it receives its chief tributary, the Regnitz (left), flows amid vine-clad hills to Würzburg and thence between the forest-covered Spessart and Odenwald ranges to Gemünden. There it is joined by the Fränkische Saale (right) and, turning abruptly south, receives the Tauber (left) at Wertheim. It flows due north to Aschaffenburg, then west passing Frankfurt to join the Rhine above Mainz. The river is navigable upstream as far as Würzburg by 1,000-ton barges and to Bamberg by 600-ton barges. The old Ludwig canal links the Regnitz and the Danube. A new canal alongside to take 1,500-ton barges is planned from Bamberg to Kelheim on the Danube.

(R. E. DI.)

MAINA (MANI) denotes that part of the Peloponnese occupied by the mountain range of Taygetus from Sparta to Cape Matapan (Tainaron), the modern eparchies of Oetylos (Oitylon) and Gythium (Yithion), Greece. The inhabitants of this natural fortress were less affected than those in more accessible regions by movements of population and political changes. They did not become Christians until the 9th century; and they resisted in turn the Byzantine administration, the barbarian invaders, the Latin princes of Achaea and the Turks. Nevertheless, the feudal keeps on the western side erected by the Latin princes in the 13th century show that the Mainotes did not entirely escape control; and during the 15th to the 17th centuries they accepted the overlordship of a family claiming to belong to the Comneni of Trebizond. Later they were brought into some measure of submission to the Turks. The real power, however, was vested in the turbulent chieftains of the hundred villages in which the Mainotes lived. As the soil was poor, many took to piracy and others migrated to Corsica.

During the 18th century the family of Mavromikhalis (Black Michael) established a supremacy and led the chieftains to join the rising of 1770 in the Peloponnese instigated by the Russians. Though defeated, the Mainotes yet managed to secure in 1777 an even greater degree of independence than they formerly enjoyed. In 1819 Petros Mavromikhalis (Petro Bey) and other chieftains joined the Philiki Etaireia. They were among the first to rise in 1821 at the outbreak of the War of Greek Independence (*q.v.*) and their military contribution to the cause was important. But like other Greek chieftains, Petro Bey and his captains were antagonistic to central institutions. They opposed the government in the civil war of 1823 and in May 1830 defied Kapodistrias, who was assassinated by Georgios and Konstantinos Mavromikhalis at Nauplia on Oct. 9, 1831. Maina remains one of the wildest and lesser known parts of Greece.

See P. L. Fermor, *Mani: Travels in the Southern Peloponnese* (1958). (D. DN.)

MAINE, SIR HENRY JAMES SUMNER (1822–1888), English jurist and historian, a pioneer in the study of comparative law, was born on Aug. 15, 1822. He was educated at Christ's hospital and Pembroke college, Cambridge, where he excelled in classical studies. From 1847 to 1854 he was professor of civil law at Cambridge university and also began lecturing on Roman law at the Inns of Court, the legal centre in London. These lectures formed the groundwork for his first book, *Ancient Law* (1861; new ed., 1930), which made his reputation at one stroke. Its object was "to indicate some of the earliest ideas of mankind, as they are reflected in ancient law, and to point out the relation of those ideas to modern thought." Historical in approach and objective in method, the work drew upon Roman law, systems of both western and eastern Europe, laws of India and primitive law in order to trace and define basic concepts. Although some of his statements necessarily were modified or invalidated by later research, Maine helped put the study of comparative jurisprudence on a sound historical footing. *Ancient Law* also was influential in political theory and, because of its controversial theories on primitive law, in anthropology.

From 1863 to 1869 Maine was a legal member of the council of the governor-general in India, where he was largely responsible for plans for the codification of Indian law. He also served as vice-chancellor of Calcutta university. Upon his return to England he became, in 1869, the first professor of historical and comparative jurisprudence at Oxford and, in 1887, professor of international law (a subject that occupied his later years) at Cambridge. The recipient of many honours during his lifetime, he died on Feb. 3, 1888, at Cannes, France.

Maine's other books include *Village Communities in the East and West* (1871); *Early History of Institutions* (1875); *Dissertations on Early Law and Custom* (1883); *Popular Government* (1885). *See* also JURISPRUDENCE.

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MAINE, LOUIS AUGUSTE DE BOURBON, DUC DU (1670–1736), French prince, was born on March 31, 1670, probably at St. Germain, the eldest to survive of Louis XIV's children by the marquise de Montespan. In Dec. 1673 he was legitimated and given the title duc du Maine. He received a good education and had his first taste of military service in 1688, when he took part in the siege of Philippsburg. He served with honour and some distinction in succeeding campaigns in the Low Countries until 1702.

Maine received a great flow of honours from Louis XIV, who loved him dearly. On May 5, 1695, Louis accorded him a rank intermediate between the legitimate princes of the blood and the other peers, who bitterly resented this promotion; and on July 29, 1714, another royal decree gave him the same rank as the legitimate princes, with the right of eventual succession to the throne. The king tried to reinforce this ruling by the provisions of his will: not only was Maine given a place in the projected regency council, but he was also to have the guardianship of Louis XV and the command of the royal guards. When Louis XIV died, however, his nephew Philippe, duc d'Orléans, had himself made sole regent and withheld the command of the guards from Maine, who was left only with control over the new king's education, not the guardianship. Next, in July 1717, Maine was deprived of his status as a prince of the blood and of his right of succession; and in Aug. 1718 he lost his control over the king's education.

Maine had been married on March 19, 1692, to Anne Louise Bénédicte de Bourbon-Condé (1676–1753; *see* CONDÉ, PRINCES DE). At first preoccupied with brilliant social and literary festivities at Sceaux, she had turned her ambitions to politics in the last years of Louis XIV's reign. Angered by the regent's treatment of her husband, she became the moving spirit in a conspiracy between the Maines and the Spanish ambassador Antonio Giudice, príncipe de Cellamare, whose instructions were to try to secure the French regency for Louis XV's uncle, Philip V of Spain. Guillaume Dubois, the regent's minister, soon discovered what was afoot, and Maine, the duchesse and Cellamare were all arrested (Dec. 1718).

Maine and his wife were imprisoned for just over a year. He

then retired from public life and even became reconciled with Orléans. For a time he was separated from the duchesse, who retired to the château at Sceaux to revive its former splendours to some extent. Maine died there on May 14, 1736. The duchesse died in Paris on Jan. 23, 1753.

See W. H. Lewis, *The Sunset of the Splendid Century* (1955).

(B. J. R.)

MAINE (LE MAINE), an old province of France, bounded north by Normandy, east by Orléanais, southeast by Touraine, south by Anjou and west by Brittany and corresponding approximately to the modern *départements* of Mayenne and Sarthe (*qq.v.*), though the province included Domfront (now in Orne) and Montoire (now in Loir-et-Cher) and did not include Le Lude, La Flèche, Château-Gontier or Craon (from Anjou).

The two Gallo-Roman *civitates* of the Cenomani and of the Diablintes, with their capitals respectively in the towns later called Le Mans (*q.v.*) and Jublains (between Mayenne and Evron), were merged in the middle of the 5th century into a single *pagus* or district of Le Mans. From the same time bishops of Le Mans are recorded. The 9th century was marked by Breton and Viking incursions. Hereditary counts, beginning with a warlord called Roger in the 890s, usurped much of the bishops' temporal authority; but in the 11th century their countship was compressed between Normandy and Anjou. Maine fell to Anjou early in the 12th century and then, with Anjou and Normandy, to the French king Philip II Augustus at the beginning of the 13th. Louis IX of France granted it to his brother, the future Charles I of Naples, in 1232, but Charles II of Naples transferred it in 1290 to Charles of Valois, whose grandson John II of France granted it in 1356 to his son Louis (later Louis I of Naples). When the latter's great-grandson Charles died childless in 1481, Maine reverted to the French crown. Economically the great achievement of the middle ages in Maine was the clearing of wide tracts of woodland and scrub for agriculture and settlement in the 11th–13th centuries. In the Hundred Years' War the country was several times overrun by the English and occupied by them from 1425 to 1448.

In the last centuries of the *ancien régime* Maine was a province under a military governor with his seat at Le Mans, but was administered, with Anjou and Touraine, by the intendant of the *généralité* of Tours.

MAINE, popularly called the "Pine Tree" state, is the most northeasterly state of the United States and the largest state in New England; it was admitted to the union in 1820 as the 23rd state. It is bounded on the northwest by the Canadian province of Quebec; north and east by New Brunswick; south-southeast by the Atlantic ocean; and west by New Hampshire. It has an area of 33,215 sq.mi., 2,203 sq.mi. being inland water surface; in size it ranks 39th among the states.

The state capital is Augusta (*q.v.*). The white pine is the state's official tree, the white-pine cone and tassel the state flower and the chickadee the state bird. The flag is a blue field upon which is embroidered the state's coat of arms.

PHYSICAL GEOGRAPHY

Physical Features.—Maine lies between the extremes of approximately 43° 4′ and 47° 28′ N. lat. and 66° 57′ and 71° 7′ W. long. Considering the area as a whole, the surface of Maine is a gently rolling upland, above which rise mountain peaks, isolated and in clusters, and below which are numerous river valleys. The highest peak is Mt. Katahdin (5,268 ft.), other high mountains being Saddleback mountain (4,116 ft.), Mt. Abraham (4,049 ft.), Mt. Bigelow (4,150 ft.) and Mt. Blue (3,187 ft.). A little north of this line of mountain peaks is the water parting which divides the state into a north slope and a south slope. The north slope, though hilly in the middle and west, is so poorly drained that swamps abound in all sections. The south slope, which contains nearly all the mountains and is generally more hilly, has a mean descent toward the sea of about seven feet to the mile.

During the period of the great continental glaciation, Maine was overrun by the glacial icecap, which left more than 1,600 lakes scattered throughout the state. Few other states have so many large lakes of such beauty, and they contribute largely to a constant supply of water power, for which the rivers of southwest Maine are exceptionally well adapted. Moosehead lake (about 117 sq.mi.) is the largest lake in Maine and the largest inland body of water wholly in New England; the Kennebec river is its principal outlet. Other lakes, such as the Rangeleys, the Chesuncook and Twin lakes, on the Penobscot, and the Grand lake, at the headwaters of the St. Croix river, equal Moosehead's picturesque setting.

Another important feature of Maine's physiography is the irregular coast line with its numerous islands and bays and many good harbours. The shortest distance between extremities of the coast is only 225 mi., but because of projections and indentations the coast line measures about 2,500 mi. West of the mouth of the Kennebec river are marshes and low grassy islands, but east of the river the shore becomes much bolder and rises in precipitous cliffs. Casco, Penobscot and Passamaquoddy bays are representative of the capacious and well-protected harbours.

The principal river systems of Maine are the St. John on the north slope and the Penobscot, Kennebec, Androscoggin and Saco, with numerous falls and rapids, on the south slope.

Climate.—The climate of the state is moist and rather cold. The precipitation is about 42.5 in. annually and is distributed very evenly throughout the year, 10 to 11 in. of rain or its equivalent in snow falling each season. The snowfall varies from about 60 in. on the coast to more than 100 in. on the north slope, the average for the state being about 83 in. The summers are short, with a growing season of only about 4½ months. The mean summer temperature is about 62° F. (16° C.), the mean winter temperature approximately 20° F. (−7° C.). The mean annual temperature for the entire state is 42° F.

Soil.—The soil types, though exceedingly varied, are in general poor, as a result of glaciation. The most productive area of the state is the potato-growing region in Aroostook county.

Vegetation.—Maine once was famous for its virgin stands of white-pine trees, and there still exist great numbers of white pine, fir and spruce. Among the other kinds of trees are hemlock, balsam fir, red and bur oak, white and yellow birch, sugar and mountain maple, box elder, tamarack, red spruce, white cedar, black willow, aspen, beech, white or American elm (especially typical of New England), mountain ash and wild fruit trees. The flowers and blossoming shrubs are those that are common to the north temperate zone. Among the more widely distributed ones are the anemone, all kinds of asters, wild bergamot, bittersweet, black-eyed Susan, clover, daisy, blue flag, goldenrod, many varieties of lilies and the trailing arbutus. Devil's-paintbrush, pinks, rhodoras, wild roses and violets also grow in profusion.

Animal Life.—Perhaps the most numerous of the wild animals common to Maine are deer, more than 40,000 of which are killed annually by hunters. Others are black bear, beaver, red fox, otter, mink, weasel, squirrel, rabbit, porcupine, muskrat, woodchuck and wildcat. Game birds native to the state include the Canada goose, wood duck, ruffed grouse, pheasant and many others. Other birds are the American eagle and varieties of owls and loons, and, among songbirds, robins, orioles, bobolinks, kingbirds, swallows and chickadees. Trout, pickerel and salmon are plentiful in the lakes; coastal fish include tuna, cod and flounder.

Parks, Memorial Sites and Recreation.—Established in 1919 as Lafayette National park, with headquarters at Bar Harbor, Acadia National park is the only national park in New England and the oldest east of the Mississippi river. Baxter State park, in the northern Maine wilderness, has Mt. Katahdin as its chief attraction; Mt. Katahdin marks the beginning of the Appalachian trail (*see* APPALACHIAN MOUNTAINS). Other state parks of interest include Aroostook State park, near Presque Isle, and Fort Knox State park, at Prospect, on the site of a fortification built after the Aroostook War. Among the memorial sites are Fort Edgecomb memorial, on Davis Island, built in 1808 to defend Wiscasset harbour; Fort Machias memorial, off which the British schooner "Margaretta" was captured early in the Revolutionary War; Fort McClary memorial, the first recorded fortification of the Massachusetts bay colony on the Maine side of the Piscataqua river; Fort George memorial, at Castine, which has earthworks and

fortifications built by the British in 1779; Fort William Henry memorial, at Bristol; and Fort Popham memorial, at Phippsburg, on a site fortified during the Revolutionary War and the War of 1812 and meant to guard the entrance to the Kennebec river.

Maine's position as a favourite resort for summer vacationists dates from about 1870, when camps, summer hotels and boarding-houses began to multiply throughout the state. Maine is now one of the nation's leading vacation spots.

HISTORY

Discovery and Settlement.—Most historical scholars believe that Maine was sighted by Norsemen about A.D. 1000, but for lack of definite evidence the credit of discovering Maine passes to others. John Cabot probably saw Maine on his second voyage to the new world in 1498. Among the explorers of the 16th and early 17th centuries who reached Maine were Giovanni da Verrazano (1524), Pierre du Guast, sieur de Monts (1604), George Weymouth (1605) and John Smith (1614). Smith explored and mapped the coast and gave to the country the name New England.

At the time of these early explorations there were probably at least 25,000 Indians of the Algonkian group living in Maine, separated from the main body of Algonkians by their bitter enemies the Iroquois. They lived in semipermanent villages along the main rivers and subsisted on fish, game and a primitive agriculture, which featured corn and other garden vegetables. Property was owned in common. The manner of government varied from tribe to tribe.

In 1603 De Monts received from the king of France a grant of all the land between the site of Philadelphia and Newfoundland, and in 1604 he established a colony on St. Croix Island, at the mouth of the St. Croix river. Samuel de Champlain, the geographer of the expedition, explored the Maine coast, ascended the Penobscot and Kennebec rivers and discovered and named Mount Desert Island, on which Bar Harbor is now located. Bitter cold and scurvy reduced the St. Croix colony to less than one-half its original size by spring, when it was decided to relocate at Port Royal (now Annapolis Royal, Nova Scotia). In 1605 George Weymouth explored the St. George river area, captured five Indians and carried them to England, where three of them lived for a time in the family of Sir Ferdinando Gorges, who was to become the leader in founding Maine. In 1607 the Plymouth company, of which Gorges was a member, sent out a colony, numbering 120 persons, under the direction of George Popham and Raleigh Gilbert. The colony was established at the mouth of the Kennebec river in August, but because of insufficient supplies about three-fifths of the company returned to England in December. Popham died during the winter and Gilbert assumed command. The next spring the news of the death of one of the colony's chief sponsors and a rich inheritance for Gilbert, together with the hardships of the winter, caused the colonists to abandon the settlement and return to England. In 1613 the French Jesuits Pierre Biard and Edmond Masse began the construction of a mission station on Mount Desert Island, but the station was destroyed by Sir Samuel Argall, acting under the instructions of the English at Jamestown, Va.

Proprietary Period and Massachusetts Ownership.—In 1620 the Council for New England, successor to the Plymouth company, obtained a grant of the country between 40° and 48° N., extending from sea to sea; and two years later Gorges and John Mason received the land between the Merrimack and Kennebec rivers under the name Province of Maine. In 1629 the territory was divided, with Gorges taking the portion between the Piscataqua and Kennebec rivers. In the early 1630s numerous land grants were made in the vicinity of Kittery, Wells, York, Saco, Scarboro and Falmouth (Portland), and permanent settlements were established. In 1635 the Council for New England surrendered its charter, but Gorges kept the land which had been granted to him, calling it New Somersetshire. In 1639 he procured a royal charter investing him with feudal powers. His charter, however, conflicted with other grants by the Council for New England; his authority was contested especially by George Cleeve, whose Lygonia patent issued by the council extended along the coast from the Kennebunk to the Kennebec.

Simultaneously, Massachusetts, fearing the royal authority in Maine, reinterpreted its charter so as to make its northern boundary an east-west line 3 mi. N. of the source of the Merrimack river. This meant that Massachusetts laid claim to land as far east as Casco bay, or almost the whole of settled Maine. Massachusetts received the allegiance of Maine towns between 1652 and 1658. In 1677 Massachusetts purchased the claims of the Gorges family for £1,250 and held the province as a proprietor until 1691, when, by the new Massachusetts charter, Maine was extended to the St. Croix river and made an integral part of Massachusetts.

Maine was subjected to the rigours of six wars (known collectively as the Indian Wars) between 1675 and 1763. In four of these the French were active allies of the Maine Indians against the English. During the first three wars the English were virtually driven from Maine, but the tide turned permanently in their favour after the treaty of Utrecht in 1713.

During the American Revolutionary War, in 1775, the town of Falmouth (Portland) was burned as a reprisal for its defiance of British law. Benedict Arnold marched through Maine on his expedition to Quebec (1775), and the first naval engagement (the battle of the "Margaretta") of the Revolutionary War occurred off Machias. An attempt by the Americans to recapture Castine, which the British had occupied in 1779, was a dismal failure. From 1807 to 1812 the embargo and nonintercourse laws were a severe blow to Maine's shipping industry, and Eastport, Belfast and Bangor were captured and eastern Maine was occupied by the British with only token resistance in the War of 1812.

Statehood.—Maine was generally well governed by Massachusetts, but geographical separation, a heavy debt, unequal representation in the legislature and different economic and political policies (Maine was largely Democratic and Massachusetts Federalist) created a desire for independence even before the close of the Revolutionary War. After the War of 1812 the independence movement gained momentum, and in 1816 Massachusetts authorized separation if a popular vote gave a majority of five to four for separation. As the vote was only 11,969 yeas to 10,347 nays, the advocates of separation were unsuccessful. A source of strong opposition to separation was removed in 1819 when congress rearranged the customs districts so that coasting vessels from Maine, as a separate state, would not have to enter and clear on every trip to or from Boston. Consequently, separation measures were carried by large majorities that year, and a constitution was framed by a convention that met in Portland in October. The constitution was ratified by town meetings in December and Maine applied for admission into the union. Because of the controversy then current in congress concerning the admission of Missouri as a slave state, Maine's admission became an important national issue. Finally by an act of March 15, 1820, Maine was admitted, its admission being a part of the Missouri Compromise (*q.v.*).

Boundary Dispute.—The northeast boundary of the state, which forms the northeast boundary of the United States, was long a matter of serious controversy between the United States and Great Britain. The treaty of 1783 ending the Revolutionary War identified the boundary in part as extending along the middle of the St. Croix river to its source, from there due north to certain highlands and along the highlands "to the north-westernmost head of Connecticut river." The dispute concerned just what the St. Croix river was and the location of its source and which highlands were to mark the boundary. The exact location of the St. Croix and its source was established by a commission provided for by the Jay treaty of 1794, but identifying the highlands proved to be a more difficult problem. Maine claimed that the highlands referred to overlooked the St. Lawrence river, but Great Britain contended that they were in the vicinity of Mars hill. The king of the Netherlands was chosen as arbitrator, and in 1831 he returned a decision unfavourable to Maine, causing the federal senate to withhold its assent. The disputed area thus became the scene of a disturbance known as the Aroostook War in 1838–39. Maine erected forts along the line it claimed, and the federal government prepared to resist British efforts to exercise exclusive jurisdiction. War seemed inevitable until Gen. Winfield Scott,

who had been sent to take command on the Maine frontier, was able to arrange a truce whereby both sides withdrew their armed forces in favour of a civilian posse. Three years later the Webster-Ashburton treaty was effected, whereby Maine and Great Britain divided the disputed territory virtually in half.

19th-Century Politics.—From 1820 until 1854 Maine was classed as a Democratic state, although Whig governors were elected in 1837, 1840, 1852 and 1853. With its prohibitory laws of 1846 and 1851, Maine pioneered in regulating the liquor business. As a result of the prohibition and slavery questions there was a party disintegration between 1850 and 1855, followed by the supremacy of the Republican party from 1856 to 1878. In the latter year no gubernatorial candidate received a majority of the votes as required by the constitution and consequently a Democratic-Greenback fusion in the legislature declared the Democratic candidate, Alonzo Garcelon (1813–1906), governor. The electorate again failing to select a governor the following year (state elections were annual until 1897 when they were made biennial), Governor Garcelon and his council counted out Republicans and replaced them with fusion candidates in the legislature. On Jan. 3, 1880, the supreme court declared the governor and council in error in counting in a fusion majority, but on Jan. 7 the governor swore in a legislature with 78 fusion and only two Republican members; the governor's term having expired, the president of the senate, James D. Lamson, became governor ex-officio. On Jan. 12 the Republicans, whose organized legislature was declared legal by the supreme court, seized the legislative chambers and chose as governor Daniel F. Davis. Former Governor Joshua L. Chamberlain was largely responsible for the peaceful solution of the difficulty which had had the state on the edge of civil war for a number of weeks, and ultimately Republican legislators and a Republican governor took office. In 1880 the Democrats and Greenbackers united and elected their candidate, but after 1882 Maine was strongly Republican until 1910.

Modern Times.—In 1910 the Democrats elected a governor and also in 1914, but Republicans again dominated politics otherwise until the 1930s. Louis Brann, Democrat, was elected in 1932 and re-elected in 1934, but Franklin D. Roosevelt failed to carry the state. In 1933 Maine voted for the repeal of the 18th amendment (prohibition) and in 1934 repealed its own prohibition statute. The high hopes held for the Passamaquoddy bay hydroelectric project were dashed in 1936 when congress discontinued funds for it though President Roosevelt favoured it. In 1950 a Canadian-U.S. commission indicated that detailed study must be made before the project's revival as a joint undertaking would be possible. After World War II several army and navy airfields in Maine were closed, but construction of the huge Loring air base at Limestone was undertaken. The Presque Isle, Bangor and Brunswick air bases were reactivated in 1951 and became increasingly important in the national defense system. The principal ground station for the communications satellite Telstar I was completed near Andover in 1962 and took part in the exchange of telephone messages and television programs between the U.S. and Europe. The Andover station used a 177-ft.-long horn antenna, traveling wave tubes, lasers and a special feedback circuit to receive and amplify signals received from the satellite.

Maine's traditional Republicanism was shaken in 1954 when Democrat Edmund S. Muskie won the governorship; he easily won re-election in 1956, and in 1958 he became the state's first popularly elected Democratic U.S. senator. Adding to the Democratic trend was the election in 1956 of a Democratic congressman, Frank M. Coffin, who was re-elected in 1958 and joined by another Democratic congressman, James C. Oliver, to give the Democrats two of Maine's three seats in the house. Clinton A. Clauson, Democrat, won election that year as Maine's first four-year-term governor; on his death on Dec. 30, 1959, however, he was succeeded by the Republican president of the state senate, John H. Reed. In 1960 Reed defeated Coffin for the governorship (and was elected by a narrow margin to a full term in 1962) and Republicans won Maine's three house seats (reduced to two by reapportionment after the 1960 census). In presidential elections Maine voted Democratic in 1964 for the first time since 1921.

GOVERNMENT

Maine was long noted as the only state to hold elections in September, but a constitutional amendment approved by the voters in 1957 moved its election day to the November date of other states, effective in 1960. The state has had only one constitution, ratified in Dec. 1819. It admits of amendment by a two-thirds vote of both houses of the legislature, followed by a majority vote of the electorate at the next election; or, as provided by an amendment adopted in 1875, the legislature may by a two-thirds vote of each house summon a constitutional convention. Among the more important amendments adopted have been those which granted the franchise to the Indians, authorized a $20,000,000 bond issue for a state industrial mortgage program, changed the election date from September to November and established the four-year term for governor.

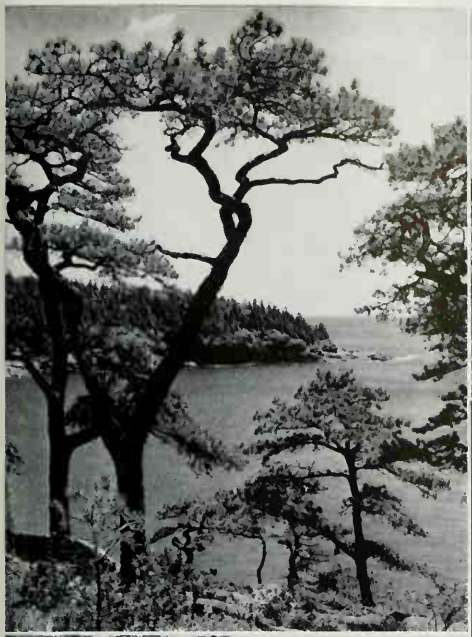
Executive.—The governor is the only executive officer of the state elected by popular vote. There is no lieutenant governor, the president of the senate succeeding to the office of governor in case of a vacancy. There is also a council of seven members elected by the legislature (not more than one from any one senatorial district), whose sole function is to advise the governor. His power of appointment is unusually extensive, but the advice and consent of the council (instead of that of the senate as in other states) are required for his appointments. He appoints judges, medical examiners and notaries public, besides all other civil and military officers for whose appointment neither the constitution nor the laws provide otherwise. His removal power extends even to the locally elected sheriffs and county attorneys. Besides the seven members of the council, the secretary of state, the treasurer, the attorney general, the commissioner of agriculture and the auditor are elected by the legislature.

Legislative.—The legislature meets on the first Wednesday in January in odd-numbered years. It is composed of a senate of 34 members and a house of representatives of 151 members. Members of each house are elected for terms of two years, senators by counties roughly on the basis of one for each 30,000 inhabitants, and representatives approximately according to the population of towns and cities, with a maximum of seven for any one municipality. In 1908 a constitutional amendment provided for referendum and initiative by the people.

Judiciary.—At the head of the judicial branch is the supreme judicial court, which consists of a chief justice and five associate justices appointed by the governor and council for terms of seven years. The court's chief function is to hear appeals on points of law, but it renders advisory opinions when requested by the governor, council or either branch of the legislature. Below the supreme court is a seven-member superior court, whose members are also appointed for seven-year terms. Each judge goes on circuit in various counties as assigned by the chief justice of the supreme court.

The superior courts are the only jury courts in Maine. They hear appeals from the local courts and hear the more important civil and criminal cases as courts of first instance. In 1961 legislation was adopted to replace part-time municipal and trial justice courts with full-time district courts.

Local Government.—The principal units of local government are the town (or township), the plantation, the county and the city. As in other parts of New England, the town or city is the most important of these. At the regular town meeting, ordinarily held in March, the electorate of the town assembles, decides what shall be done for the town during the ensuing year, elects officers to execute its decisions with limited discretion and votes money to meet the expenses. The principal officers are the selectmen (usually three), town clerk, assessors, collector, treasurer, school committee and road commissioner. Maine is the only state in the union that retains what is known as the organized plantation. This is a governmental unit organized from an unincorporated township having at least 200 inhabitants, and its principal officers are the moderator, clerk, three assessors, treasurer, collector, constable and school committee. The city-manager form of government was introduced in Maine in 1917 in the city of Auburn. The county is an intermediate organization between the state and the towns, to



BY COURTESY OF (BOTTOM RIGHT) DESERT OF MAINE, PHOTO BY COAST O'MAINE STUDIO; PHOTOGRAPHS (TOP LEFT) A. DEVANEY, (TOP RIGHT) SAMUEL CHAMBERLAIN, (CENTRE RIGHT) EWING GALLOWAY, (BOTTOM LEFT) H. ARMSTRONG ROBERTS

VIEWS OF MAINE

Top left: Pines along the ocean near Bar Harbor, on Mount Desert Island, site of Acadia National park

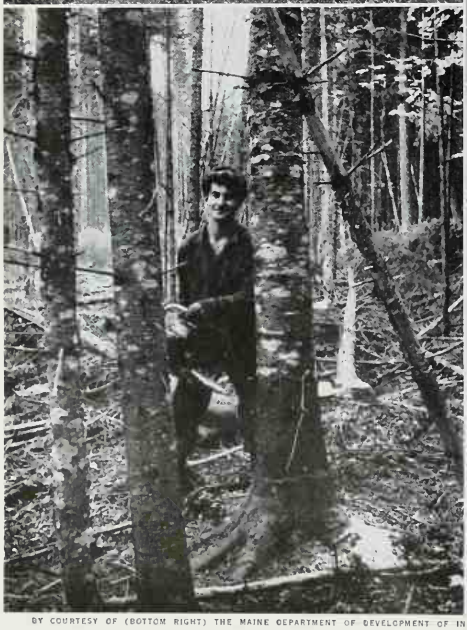
Top right: Portland Head light, 1791, oldest lighthouse on the Maine coast, rises 101 ft. above high water. From the hurricane deck can be seen most of the more than 200 Casco bay islands and Cape Elizabeth shore

Centre right: The public square at Kennebunk, with Civil War monument and cannon from the Revolution. Settled about 1650, Kennebunk is one of the oldest towns in Maine

Bottom left: Lobster boats at New Harbor

Bottom right: Old barn on the edge of the Desert of Maine

MAINE



BY COURTESY OF (BOTTOM RIGHT) THE MAINE DEPARTMENT OF DEVELOPMENT OF INDUSTRY AND COMMERCE; PHOTOGRAPHS, (TOP LEFT) RUOHOMAA FROM BLACK STAR, (TOP RIGHT) A. DEVANEY, (CENTRE RIGHT AND BOTTOM LEFT) ERICH HARTMANN FROM MAGNUM

AGRICULTURE, FISHING AND INDUSTRY

Top left: Blueberry-pickers at work on a farm overlooking Penobscot bay. The fruit has considerable commercial importance in the state

Top right: Lobster fisherman at work on equipment. Maine is noted for the quality of its lobsters

Centre right: Spool-loader in a factory at Biddeford, which has one of the largest textile machine plants in the U.S.

Bottom left: Lumberjack at work near Rangeley. Lumbering and forestry products comprise Maine's leading industry

Bottom right: Potato harvesting. Maine has the largest potato crop in the U.S.

assist chiefly in the administration of justice, especially in the custody of offenders. Its officers are three commissioners, a treasurer, a register of deeds, a judge of probate, a register of probate, a clerk of courts, a county attorney and a sheriff.

Finance.—Before 1912 the state constitution forbade the borrowing of money in excess of $300,000, except for the suppression of a rebellion, for war purposes or for repelling an invasion. In that year an amendment to the constitution was adopted allowing the state to incur a debt not exceeding $2,000,000 for state highway purposes. Between 1912 and 1935, 12 amendments dealt with state debt and bond issues, gradually increasing the debt limit. An amendment adopted in 1950 removed all debt limitations and permitted bonds to be issued at the discretion of the legislature, by a two-thirds vote of each house, subject to popular referendum.

In order of importance, the chief sources of state funds in the second half of the 20th century were federal grants, gasoline tax, liquor, registrations and drivers' licences, general property tax, cigarette and tobacco taxes and public utility and insurance company taxes. These accounted for about three-fourths of the operating funds. Revenue was more than $100,000,000 annually, about 20% of which was from federal grants. Lacking an income tax or general sales tax, the state had a narrow tax base until 1951, when the legislature enacted a general 2% sales tax (exempting, however, food). In 1957 the rate was increased to 3%. With the additional revenue thus provided, the state was able to increase substantially its services, particularly in the fields of education and health and welfare. At that time, expenditures were about $110,000,000 annually. The bonded debt was about $40,000,000. The major expenditures were for highways, health and hospitals, education, and public welfare. Total expenditures nearly doubled between 1950 and 1960, but revenues maintained a similar pace. Per capita income rose from $1,188 in 1950, nearly $300 below the national average, to $1,843 in 1961.

POPULATION

The census of 1820, the year Maine entered the union, revealed that the state had a population of 298,335. This placed it 11th among the 27 states and territories that then composed the union. The population was classified as a little more than 97% rural. The decade between the censuses of 1790 and 1800 was the period of most rapid growth—the population showed an increase of 57.2% in 1800 over that of 1790. At mid-19th century the state had a population of 583,169 (86% rural) and was 16th in population among the 37 states and territories. During the decade between 1860 and 1870 Maine's population declined by about 0.2%. In 1900 the population was 649,466 (66% rural) and ranked the state 31st in the union. The 1950 population figure was 913,774 (35th among the states), 51.7% of which was urban. In 1960 Maine had a population of 969,265, an increase of 55,491 or 6.1% over 1950. The total urban population for 1960 was 497,114 or 51.3% of the total. The standard metropolitan statistical area of Portland had a population of 120,655 in 1960, an increase of 713 over 1950. The population per square mile in 1960 was 29.2, as compared with 49.6 for the United States as a whole.

Distribution by colour and nativity in 1960 was as follows: 93.2% native white; 6.1% foreign-born white; and 0.6% non-white. Of the foreign-born white population, 72.1% were Canadians, 6.7% were born in Great Britain and 3.6% in Ireland. Of the total population, 10.8% was 65 years old or over. Of the population 14 years old and over, 50.9% was in the labour force.

*Maine: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	969,265	913,774	847,226	768,014	694,466
Auburn	24,449	23,134	19,817	16,985	12,951
Augusta	21,680	20,913	19,360	14,114	11,683
Bangor	38,912	31,558	29,822	25,978	21,850
Bath	10,717	10,644	10,238	14,731	10,477
Belfast	6,140	5,960	5,540	5,083	4,615
Biddeford	19,255	20,836	19,790	18,008	16,145
Brewer	9,009	6,862	6,310	6,064	4,835
Brunswick†	15,797	10,996	8,658	7,261	6,806
Brunswick	9,444	7,342	7,003	—	—
Caribou	8,305	4,500	8,218†	6,018†	4,758†
Gardiner	6,897	6,649	6,044	5,475	5,501
Houlton†	8,202	8,377	7,771	6,191	4,686
Houlton	5,976	6,029	—	—	—
Kittery	8,051	6,692	5,374†	4,763†	2,872†
Lewiston	40,804	40,974	38,598	31,791	23,761
Millinocket	7,318	5,755	6,223†	4,528†	—
Old Town	8,626	8,261	7,688	6,956	5,763
Portland	72,566	77,634	73,643	69,272	50,145
Presque Isle	12,886	9,954	7,939	5,581	3,804
Rockland	8,769	9,234	8,899	8,109	8,150
Rumford	7,233	7,888	8,447	8,576†	3,770†
Saco	10,515	10,324	8,631	6,817	6,122
Sanford	10,936	11,094	14,886†	10,691†	6,078†
Skowhegan	6,667	6,183	7,159†	5,981†	5,180†
South Portland	22,788	21,866	15,781	9,254	6,287
Waterville	18,695	18,287	16,688	13,351	9,477
Westbrook	13,820	12,284	11,087	9,453	7,283

*Populations are reported as constituted at date of each census.
†Township.
Note: Dash indicates place did not exist during reported census, or data not available.

EDUCATION

Public Schools.—The first school in Maine was a mission established in 1696 by Father Sebastian Rasle on the Kennebec river. Other Jesuit missions were shortly afterward established at Passamaquoddy and at Indian Island. The first town school was established at York in 1701. Characteristic of the early days of education in Maine were the "moving schools," which traveled from place to place, remaining only a few weeks in one location. Greater organization was introduced in 1789 when Massachusetts, of which Maine was then a part, adopted a law requiring liberal instruction for all children and college training for all teachers. When Maine became a separate state in 1820, its educational system was patterned after that of Massachusetts. In 1828 the income from certain state lands was designated a public-school fund. Legislation passed in 1873 provided for the creation of free public high schools; education was made mandatory in 1875.

The state department of education is administered by a commissioner selected by an unpaid state board of education, consisting of ten members serving five-year overlapping terms. The department supervises the distribution of state subsidies to local areas on the basis of complex legislative formulas, designed to secure uniform minimum standards and to aid the less wealthy communities. The department exerts considerable control over school-building design, curriculums, teaching methods and teacher training, certification and placement. It is also responsible for education in the unorganized townships where there is no local government. Still further, it groups towns and small cities into unions which are administered by locally chosen superintendents of schools. Towns and cities retain considerable local autonomy in school affairs. A sizable quantity of school-building districts were created by special legislative acts to allow municipalities to circumvent the constitutional debt limit (usually 5% of the assessed valuation).

In 1957 the legislature passed the Sinclair bill, designed to encourage the formation of school districts and the consolidation of small high schools. At that time Maine had more than 125 high schools with fewer than 100 pupils.

Children between the ages of 7 and 15 are required to attend school. The free public elementary and secondary schools are supplemented by numerous parochial schools and more than 50 private schools and academies. At mid-20th century Maine was spending about $222 annually per pupil, or about $70 less than the national average.

Higher Education.—The state department of education (*see* above) administers the state teachers' colleges, at Gorham, Farmington, Fort Kent, Machias (Washington State) and Presque Isle (Aroostook State); and a trade school, the Vocational Technical institute, at South Portland. The state also operates a maritime academy at Castine.

Chief among the state-controlled institutions of higher learning is the University of Maine, at Orono, established in 1865 as the State College of Agriculture and the Mechanic Arts; the name was changed to University of Maine in 1897. The university is composed of schools and colleges of arts and sciences, agriculture, home economics, technology and education, forestry, nursing, and physical education and athletics. The school of law is in Portland. The university also has a division of graduate study; co-operative

extension service; agricultural experiment station; technology experiment station; and department of industrial co-operation. In 1957 the university absorbed the Portland junior college, after which the latter was operated as a branch under the name of the University of Maine in Portland.

Among the private institutions of higher learning is Bowdoin college, founded in 1794 at Brunswick (*q.v.*). Other colleges are Bates college (Lewiston, nonsectarian, 1864) and Colby college (Waterville, nonsectarian, 1813).

HEALTH AND WELFARE

The state's welfare activities were co-ordinated in 1931 by an act establishing the department of health and welfare. The department was composed of three bureaus, health, welfare and institutional service, having authority over the state's welfare program. In 1939 the legislature removed control of state institutions from health and welfare to a new department of institutional service.

The penal and reformatory institutions consist of the state prison, at Thomaston; the reformatory for men, at South Windham; the reformatory for women, at Skowhegan; the state (reform) school for boys, at South Portland; and the state (reform) school for girls, at Hallowell; the state schools are not places of punishment, but reformatories for delinquent boys from 8 to 16 years of age and girls from 6 to 16 years of age who have been committed by the courts for violations of law, or, in the case of girls, who, by force of circumstances or association, are "in manifest danger of becoming outcasts of society." The inmates in these schools get instruction in various trades and occupations so as to be able to earn a living when discharged.

Paupers formerly were cared for chiefly by towns and cities, those wholly dependent being placed in almshouses and those only partially dependent receiving aid in their homes. Federal-state funds for old-age assistance, aid to dependent children, aid to the blind and aid to the permanently and totally disabled are administered by the department of health and welfare. Unemployment compensation is administered by an employment security commission of three members.

The mental and charitable institutions maintained by the state are: the Augusta State hospital, at Augusta; Bangor State hospital, at Bangor; Central Maine sanatorium, at Fairfield; Pineland Hospital and Training School for the Feeble-minded, at West Pownal; Military and Naval Children's home, at Bath; and the Maine School for the Deaf, at Portland.

THE ECONOMY

Agriculture.—Agriculture is less important than it once was in Maine, the number of farms having declined from around 50,000 at the time of World War I to about 18,000 in the second half of the 20th century. Maine ranks first among the states in potato production, with Aroostook county as the leading producing centre. Production usually amounts to more than 60,000,000 bu. annually. To avoid a one-crop economy Aroostook county has begun raising peas, oats and beef cattle. Other important state crops are corn, barley, hay, beans, McIntosh apples and blueberries. Market gardening is important in the area around Portland. Dairying has long rivaled potatoes in importance. The most significant agricultural development after World War II was the raising of poultry, especially broilers. In ten years the number of broilers raised multiplied more than five times, to more than 50,000,000. Belfast is the centre of the industry.

Industry.—The construction of wooden ships was a principal industry in Maine until the middle of the 19th century, with some building of wooden (principally "downeasters" and schooners) and steel ships continuing, especially during World Wars I and II. Bath remains the chief centre of this activity. Cotton, woolen and paper mills, built in large numbers in the 19th century, were located on rivers to take advantage of the abundant water power. Sawmills were numerous from early colonial days. Later a variety of woodworking industries was established. After World War I there began a decline in textile manufacturing, which continued after World War II. Paper mills, shoe factories and food processing plants replaced the textile factories. The paper and textile industries were the leaders in the value of their products, but the leather products industry, especially shoes, employed the largest number of persons.

Minerals.—Maine formerly produced bricks, lime, granite and slate in sizable quantities, but output of these materials has dwindled. The state's principal mineral products in order of value are cement (New England's only cement plant is located at Thomaston), sand and gravel, stone, sheet mica, feldspar (about 25% of all the feldspar produced in the U.S.) and beryllium ore concentrates, with an average annual value in excess of $12,000,000. Maine, however, produces less than 1% of the total mineral output of the U.S.

Fisheries.—Fishing is an important coastal industry, affording employment to about 10% of the state's population. The catching and packing of young herring under the trade name of sardines represents the largest annual catch but is greatly exceeded in value by the lobster catch. Other fish of commercial importance include cod, haddock, hake, pollack, mackerel, ocean perch, alewives and flounders. Clams, sea scallops and crabs are also abundant in Maine waters. A rapidly growing activity is the collection of bloodworms and sandworms for bait. Average annual landings at Maine ports in the second half of the 20th century totaled about 300,000,000 lb. valued at approximately $20,000,000. Lobsters alone accounted for about 55% of these revenues.

Forestry.—More than four-fifths of the land area of Maine is forested (after Alaska the largest per capita acreage in the nation), and more than one-half of the land area is unorganized territory, with no local government and few permanent inhabitants. A forest district tax on timberlands finances fire protection and other services performed by the Maine forest service.

Lumbering has always been Maine's chief industry. In colonial days Maine pine trees were the chief source of masts for the British navy. In the 19th century the forests sustained the many shipyards, and Maine was long the leading producer of wooden ships in the United States. In the 20th century the same forests supplied pulpwood for the paper mills and lumber for the building trades. The annual production of pulpwood in the second half of the 20th century was more than 1,900,000 cords and that of lumber exceeded 500,000,000 bd.ft. Hardwoods, such as maple, beech and birch, were also widely used to make plywood, spools, dowels, toothpicks, skis, furniture, toys and novelties. Wood-using industries employed more than one-third of the wage earners of the state.

The Allagash region of northern Maine has been the major source of pulpwood. In the 1960s the establishment of an Allagash national recreation area was proposed to preserve about 300,000 ac. of wilderness including more than 60 lakes and 360 mi. of rivers and streams.

Transportation and Communications.—The southwestern part of the state, where the manufacturing, quarrying and much of the older agricultural district are located, always has had satisfactory means of transportation either by water or rail. The first international railroad in North America, the Atlantic and St. Lawrence (now a part of the Canadian National system), connected Portland and Montreal in 1853. During the American Civil War the chief railroad system in Maine was begun when the Maine Central was formed out of two short-line railroads connecting Lewiston and Bangor. It was not until the last decade of the 19th century that the forests, farmlands and summer resorts of Aroostook county were reached by rail. In the second half of the 20th century, following considerable contraction, particularly in the less populous areas, the total railway mileage was slightly less than 2,000. Formerly there were five narrow gauge lines (two feet between the rails) and numerous electric lines operating in the state, but they have all become defunct. Many branch rail lines have been abandoned and passenger service on the Maine Central ceased in 1960.

Maine's coast line has many excellent harbours. The Kennebec river is navigable for coast vessels to Augusta, and the Penobscot to Bangor. For decades steamboats regularly plied between Maine ports and Boston, New York and several Canadian ports,

but none have operated since just before World War II. In 1956 the Canadian National railways instituted a daily ferry service between Bar Harbor, on Mount Desert Island, and Yarmouth, Nova Scotia. This service proved attractive to the tourists who annually visit Mount Desert Island and Acadia National park.

Maine is connected with the other states by commercial airlines. Plane, auto and truck transportation have all but eliminated rail passenger service and drastically reduced rail freight traffic. Modern highways have been built in many parts of the state, including a turnpike running from the state capital, Augusta, to the New Hampshire line. Highways totaled more than 20,500 mi.

See also references under "Maine" in the Index.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year,* American edition. (R. M. Y.)

MAINE DE BIRAN, MARIE FRANÇOIS PIERRE GONTHIER (1766–1824), French philosopher, was born at Bergerac on Nov. 29, 1766. The name Maine he assumed from an estate called Le Maine which belonged to his father. Maine de Biran entered the king's lifeguards and defended Louis XVI at Versailles on Oct. 5 and 6, 1789. He then retired to his estate at Grateloup, near Bergerac, and pursued his studies in mathematics and philosophy until, after the fall of Robespierre, he entered public life as an administrator in the *département* of the Dordogne. He became a member of the Corps Législatif in 1809 and was among those who expressed public opposition to Napoleon in 1813. After the Restoration he became treasurer to the chamber of deputies. He died in Paris on July 16, 1824.

Maine de Biran first became known in the intellectual world as one of the Idéologues. These philosophers developed the antimetaphysical and empiricist aspects of Locke's philosophy in the manner of Condillac; and Maine de Biran's philosophical importance consists in his gradual and detailed discovery of the inadequacies of this point of view. His diary, in which he commented on his administrative and political activities as well as on his philosophical reading, throws valuable light on the thoughts and struggles of a diffident philosopher forced to play a decisive part in politics. Both as philosopher and as diarist his interest is in the inner life of man.

His first important philosophical writing and one of the few published during his lifetime was *Influence de l'habitude sur la faculté de penser* (1802; Eng. trans. by M. D. Boehm, *The Influence of Habit on the Faculty of Thinking,* 1929). In it, developing an idea of Destutt de Tracy's, he stresses the role of the will in our perception of the physical world and argues that the result of becoming habituated on a being that possessed only sense-experience would be that it would lose consciousness altogether. These themes of the importance of the will and of the impossibility of analyzing the self entirely in terms of sensation and feeling were developed in later works. In his *Mémoire sur la décomposition de la pensée* (1804), Maine de Biran criticizes Descartes for confusing the self considered as subject with the self considered as a substance in the natural world and is thus led to suppose that the methods appropriate to the study of nature are incapable of revealing the essence of selves or subjects. In his *Essai sur les fondements de la psychologie* (1812), Maine de Biran concluded that there is a "hyperorganic" element in the self, even though "my body and myself form a single being." In his *Nouveaux essais d'anthropologie* (1823–24) he describes the self as developing through an animal, purely sensitive phase (*vie animale*) to a human phase of will and freedom (*vie humaine*) and culminating in experiences which transcend humanity (*vie de l'esprit*).

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(H. B. A.)

MAINE-ET-LOIRE, an inland *département* of western France, formed in 1790 for the most part from the southern portion of the ancient province of Anjou (*q.v.*), and bounded north by the *départements* of Mayenne and Sarthe, east by Indre-et-Loire, southeast by Vienne, south by Deux-Sèvres, southwest by Vendée and west by Loire-Atlantique. Area 2,787 sq.mi. Pop. (1962) 556,272. The *département* is traversed from east to west by the broad valley of the Loire river, which in the centre receives an important right-bank tributary, the Maine, formed from the confluence above Angers of the Mayenne, Sarthe and Loir. The western part of the *département,* on the old schist rocks of the Armorican massif, is rather hilly, pastoral country, concerned mainly with livestock farming. This *bocage* of fragmentary woodlands and farmland that consists of a patchwork of small fields enclosed by quickset hedges contrasts strikingly with the open grain lands (*plaines*) of the east, on platforms of younger calcareous rocks trenched by the alluvial valleys of the Loire, Loir and Sarthe. The Loire valley, known there as the Val d'Anjou, is a strip of rich meadows, market gardens, orchards and vineyards. Hemp was formerly widely grown, but has given way to other, more profitable crops. The rainfall is moderate and the climate notably mild in winter, when mists are a feature of the weather. Delicate plants flourish out of doors and vegetables can be produced very early. The north of the *département* lies on the northern limit of viticulture, however, and vineyards are found chiefly in the Loire valley and in the south of the *département* astride its left-bank tributary, the Layon, where the schist soils give the wine a distinctive character. The warm weather that persists into late autumn is responsible for the special degree of maturation of Angevin wines. Saumur is famous for its sparkling white wine. In the western and northern parts of the *département* large quantities of cider apples are produced. The slates of the Armorican massif are quarried in places, especially at Trélazé, and deposits of high-grade iron ore that occur in a belt across the north of the *département* are worked in the vicinity of Segré. Electrical engineering developed after World War II at Angers, but there is generally little manufacturing and the *département* is almost entirely agricultural, the towns being essentially markets and rural service centres. Such are Angers, Saumur, Segré and Cholet, the centres of the four *arrondissements* into which the *département* is divided.

Angers (pop. [1962] 109,614), the largest town and *préfecture* and the ancient capital of Anjou, situated at an important junction of routes on the Maine river 5 mi. above its confluence with the Loire, is also the seat of a bishopric that is coextensive with the *département.* It has a court of appeal, but for educational administration the *département* comes under Rennes. The great 13th-century castle and the cathedral, dominating the town, together with other old buildings and museums that house fine collections of tapestries, paintings and other art objects, make Angers one of the most attractive old towns of France. The castle at Saumur and the abbey at Fontevrault-l'Abbaye, with a fine Romanesque

church where the first Plantagenets were buried, are also especially noteworthy. The interesting old town of Les Ponts-de-Cé, built partly on islands in the Loire, with seven bridges, provided the only bridge crossing of the river between Nantes and Saumur until after the French Revolution. Although the Loire and Mayenne, and to a lesser degree the Sarthe, are navigable, they no longer carry much traffic. (Ar. E. S.)

MAINE RIVER, France, is a right-bank tributary of the Loire (*q.v.*) which it enters at La Pointe below Angers. The Maine itself (7 mi. long), located in Maine-et-Loire *département*, is formed from the confluence of the Mayenne, Sarthe and Loir rivers. The Mayenne, rising in the hills of Normandy, flows south past Laval through the hilly pastoral country of the easternmost part of the crystalline Armorican massif. The Sarthe and its tributary the Huisne, which joins it at Le Mans, rise in the hills of the Perche. Before joining the Mayenne, the Sarthe receives the Loir, flowing westward from the margins of the limestone platform of Beauce. The dry, sandy platforms of Maine, which the Sarthe and Loir traverse, are far from fertile and carry much woodland, but the broad river valleys, with their alluvial floors, are exceptions, with strips of rich cultivation, including orchards and vineyards at their northern limit. Below Angers, the Maine valley enters the wide alluvial trench of the Loire, there known as the Val d'Anjou. The navigable waterway of the lower Loire is continued by the Maine, and the Mayenne is navigable by small craft as far as Brives and the Sarthe less satisfactorily to Le Mans. (Ar. E. S.)

MAINPURI, a town and district in the Agra division of Uttar Pradesh, India. The town lies 68 mi. E. of Agra city and consists of two distinct parts: Mainpuri proper and Ganj or Mukhamganj. Pop. (1961) 33,610. The main places of interest are the raja's palace or *Garhi*, the mission buildings including a high school, and the Lanegunj market. The town is well known for its carved wooden articles inlaid with brass wire and for chewing-tobacco. Its industries include cotton ginning and electric-lamp and glass works. The Agra branch of the Grand Trunk road passes through the town, which is also served by the Northern railway.

Mainpuri District lies in the Ganges-Jumna doab. Pop. (1961) 1,180,894; area 1,680 sq.mi. It consists of an almost unbroken plain wooded throughout with mango groves; isolated clumps of babul trees occasionally relieve the bareness of its usar (saline) plains. On the southwestern boundary the Jumna flows in a deep alluvial bed, in some places sweeping under high banks and elsewhere leaving a strip of fertile soil between the river and the upland plain. The district is watered by the Upper and Lower Ganges canal. Its main crops are wheat, gram, barley and rice.

Mainpuri formed part of the great kingdom of Kannauj (*q.v.*), and after the fall of that state was divided into a number of petty principalities. It fell to the Moguls on Babur's invasion in 1526, passed in the late 18th century to the Marathas, and later became a part of Oudh province. When this part of the country was ceded to the British in 1801, Mainpuri town became the headquarters of the extensive district of Etawah, which was in 1856 reduced by the formation of Etah and Mainpuri into separate collectorates. (B. Si.)

MAINTAINED PRICE: *see* Fair Trade Laws.

MAINTENON, FRANÇOISE D'AUBIGNÉ, Marquise de (1635–1719), the second and secret wife of Louis XIV of France, was born at Niort in Poitou, where her father, Constant d'Aubigné, the disreputable son of the great Huguenot soldier and poet Théodore Agrippa d'Aubigné, was a prisoner of state under relaxed surveillance; her mother, Jeanne de Cardilhac, whom Constant had married in Dec. 1627 (during the first months of his detention) had already had three other children by him. Baptized as a Catholic on Nov. 28, 1635, Françoise was brought up as a Huguenot by her aunt, Mme de Villette (Louise Artémise d'Aubigné), till Constant's release (1642). Constant was in 1645 appointed governor of the West Indian island of Marie Galante, but found nothing to do there and installed his family on Martinique before returning to France; he died at Orange on June 17, 1647. When Françoise was brought back to France, Mme de Villette took charge of her again; but soon the comtesse de Neuillant (Louise Tiraqueau) obtained the custody of the child and proceeded to reconvert her to Catholicism. In April or May 1652 Françoise, by this time probably an orphan, was married to the deformed and invalid writer Paul Scarron (*q.v.*).

How Mme Scarron lived with her husband's mixed entourage in Paris is a matter of some uncertainty. Later her enemies alleged that she found lovers among the gentlemen who visited the impecunious household—in particular the marquis de Villarceaux (Louis de Mornay). Yet on Scarron's death (Oct. 1660) she would have been almost destitute if certain ladies had not induced the queen mother, Anne of Austria, to allow her an annual pension of 2,000 livres, which enabled her to live decently.

Through her connection with noble ladies the widow Scarron was introduced to the marquise de Montespan (*q.v.*); and when the latter began to have children by Louis XIV she chose the widow as their governess (1669). At first these births were kept secret, and Mme Scarron conceived a deep affection for her clandestine charges, especially for the eldest son, later duc du Maine (*q.v.*). At the end of 1673, however, the children were legitimated, and in 1674 Mme Scarron appeared publicly with them at Versailles. In the spring of 1675 she bought the lordship of Maintenon, near Chartres.

The interest that Louis XIV began to take in the beautiful and intelligent widow (nearly three years his senior) soon excited Mme de Montespan's jealousy, and relations between the two women became strained. Maintenon was raised to a marquisate in 1678, and Mme de Maintenon was appointed lady-in-waiting to the dauphine (Marie Anne Christine of Bavaria) in 1680. When Mme de Montespan fell definitively from favour after the Affair of the Poisons (*q.v.*), Mme de Maintenon was left in undisputed command of the king's affections; but she was devoutly anxious to avoid the scandals that his previous liaisons had provoked. The queen, Marie Thérèse, was delighted at the consideration with which she was now treated.

The queen died in Mme de Maintenon's arms on July 30, 1683. At a date that is still controversial, Louis XIV secretly married Mme de Maintenon. For the date, modern conjectures are divided between Oct. 1683 and April–May 1697.

The influence of Mme de Maintenon from the 1680s to Louis XIV's death was considerable in so far as she was habitually consulted by the king and also by his ministers, who always preferred to have her on their side; but while her views counted for much in matters of detail and, especially, in matters concerned with the domestic life of the royal household, they were not supreme in public affairs. A pious Catholic, she was largely responsible for the graver atmosphere at court after the licence of earlier years; and she was an assiduous converter of Huguenots, though she cannot be blamed for the savageries accompanying the revocation of the edict of Nantes (1685). The duc de Saint-Simon, whose portrait of "the hag" in his *Mémoires* has done much to blacken her reputation, regarded her as an upstart hypocrite in league with the Jesuits for the ruin of the Jansenists, the Quietists and Fénelon; but he hated her chiefly for promoting the elevation of her former pupils, the royal bastards. During the War of the Spanish Succession she maintained an intimate political correspondence with the princesse des Ursins (*q.v.*).

Deeply interested in Catholic education and mindful of her own past, Mme de Maintenon already in 1681 sponsored a home for poor girls at Rueil, which the king transferred to Noisy in 1684; her great achievement was the founding of an institution for poor girls of the nobility at St. Cyr, endowed by the king in 1686.

Louis XIV died on Sept. 1, 1715. Mme de Maintenon then retired to seclusion at St. Cyr. The regent Orléans continued her pension of 48,000 livres. She died at St. Cyr on April 15, 1719. There are editions of her letters by T. Lavallée (1856 and 1865–66) and by M. Langlois (1935–39).

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Louis XIV et Madame de Maintenon (1958).

MAINZ (French MAYENCE), one of the oldest cities of Germany and a port on the Rhine river, which after partition of the nation following World War II became (1950) the capital of the *Land* (state) of Rhineland-Palatinate, Federal Republic of Germany. It lies on the left bank of the Rhine, opposite the junction of that river and the Main in the Rhenish wine-growing area. At the intersection of two federal highways (*Bundesstrassen*), Mainz is also a railway junction and is about 30 km. (18½ mi.) S.W. of the Rhine-Main international airport (near Frankfurt am Main). Including suburbs on the right bank of the Rhine, the city had a population of 158,533 in 1939; excluding the right-bank communities, which were later separated from Mainz, the population was 75,020 in 1946. Pop. (1961) 134,375.

Mainz was a pre-Roman settlement. Its strategic importance was early recognized by the Romans, who in the 1st century B.C. established a military camp that became known as Maguntiacum or Mogontiacum. A town gradually arose round the camp, which became the capital of Germania Superior. In about 451 the Romans abandoned the Rhine area. Mainz, already destroyed by Alamanni in 368 and by Vandals and Slavs in 406, was left unprotected against the mass migrations, and first found peace again under Frankish rule. In the 6th century, under Bishop Sidonius, a new Mainz arose, which in 747, under St. Boniface, became the ecclesiastical centre of Germany, and later (*c.* 780) an archbishopric. Charlemagne, who had a palace in the neighbourhood, gave privileges to Mainz, which grew rapidly in wealth and importance. In 1118 it attained certain rights of self-government and in 1244 it became a free city. In 1254, known as "Golden Mainz," it became the centre of a powerful league of Rhenish towns. But a decline in its commercial prosperity soon followed.

Mainz is noted for its association in the 15th century with Johann Gutenberg (*q.v.*) and the development of printing. In 1462 there was warfare between two rival archbishops. The citizens espoused the losing cause and were deprived of their privileges; many of them were driven into exile and thus carried into other places knowledge of the art of printing.

During the Thirty Years' War (1618–48), Mainz was occupied by Swedish and French troops. The French again occupied the fortress in 1792, when a small group of citizens, members of a Jacobin club who welcomed the ideas of the French Revolution, collaborated with them. After a long siege and much damage, Mainz was handed over to Prussian and Austrian forces in 1793. It was ceded to France by the treaty of Campo Formio in 1797 and again by the treaty of Lunéville in 1801. In 1814 Mainz was restored to Germany, and in 1816 it was given to the grand duke of Hesse. It was a fortress of the German confederation and later of the *Reich*. After World Wars I and II, Mainz was occupied by French troops. About 80% of the city was destroyed during World War II; however, reconstruction was rapid and extensive.

Roman remains include the rests of pillars of an aqueduct (the so-called Roman stones) and the Eichelstein (the socle of a monument believed to have been erected by the Roman legions in honour of the general Nero Claudius Drusus). Relics are housed in the Central Roman-Germanic museum.

St. Martin's cathedral towers over the city. Originally erected under Archbishop Willigis (975–1009), it is a Romanesque edifice that in the course of the centuries acquired additions of nearly every existing style. It was burned repeatedly and was continually rebuilt. Henry II, Conrad II and Frederick II were anointed and crowned emperor in the cathedral. Other noteworthy churches include St. Ignatius (18th century), St. Stephen, built 1257–1328 and restored in 1857, and St. Peter (18th century), all renovated after World War II. The University of Mainz (chartered in Nov. 1476) declined during the period of French dominance and was closed in 1816.

Mainz was revived as a university city in 1946 on the establishment of Johannes Gutenberg university, with which various faculties and special institutes are associated. The Max Planck Institute of Chemistry and the Academy of Sciences and Literature are there, and the Institute of European History was established in the building of the old university.

The Gutenberg monument, by Bertel Thorvaldsen and Charles Crozatier, was erected in 1837. The Gutenberg museum houses various exhibitions concerning printing and paper.

The archbishopric was one of the seven electorates of the Holy Roman empire, and became a powerful state during the middle ages, retaining some of its importance until its secularization in 1803. Its archbishop was president of the electoral college, archchancellor of the empire and primate of Germany. The lands of the electorate were on both banks of the Rhine; their area at the time of the French Revolution was about 3,200 sq.mi. The lands on the left bank were seized by France in 1801; at the secularization some of those on the right bank were given to Prussia and to Hesse, while others were formed into a grand duchy for Karl von Dalberg. The archbishopric itself was transferred to Regensburg, and Mainz became a bishopric only.

Trade and Industry.—Favoured by its site but hampered by its military importance and, until 1462, by the illiberal rule of its archbishops, the city developed its commerce in strong competition with Frankfurt am Main. Under Napoleon, Mainz suffered a sharp decline. Later it became the centre of the Rhenish wine traffic. Industries produce and export chemical and cosmetic products, sparkling wine, brandy, foods, luxury items, optical products and measuring instruments, glassware, paper, musical instruments, machinery and cement. Chief imports include pit coal, coke, grain and pig iron.

See also references under "Mainz" in the Index. (A. F. PR.)

MAIORESCU, TITU (1840–1917), Rumanian philosopher, critic and statesman, who represents a western critical influence in modern Rumanian culture, was born at Craiova on Feb. 15, 1840. He studied at Vienna, Berlin and Paris, and taught for many years at Iaşi before becoming professor of philosophy at Bucharest university in 1884. He tried to reconcile the philosophical systems of Kant, Hegel and Schopenhauer, and translated Herbert Spencer's *A Plea for Liberty* in 1893. His sober, critical essays on culture and literature and his lifelong struggle against the absurdities of the Latinist school and against the new state's empty and false forms of civilization inaugurated a new era.

A leader and reformer of public opinion in the 1890s and after the turn of the century, he exercised a deep literary influence through the periodical *Convorbiri Literare* (1867) and through his teaching in the University of Bucharest. The literary society *Junimea*, created by him in Iaşi in 1863, developed into a conservative party to counteract the liberal party. He was prime minister and presided at the peace conference of Bucharest after the Balkan Wars (1913). He died at Bucharest on July 7, 1917.

See E. Lovinescu, *T. Maiorescu*, 2 vol. (1940). (G. NS.)

MAIRET, JEAN (1604–1686), French dramatist, the forerunner and rival of Corneille, was born in Besançon on May 10, 1604, and seems to have worked chiefly in Paris, where he secured important patrons, notably the duc de Montmorency and the comte de Belin. This enabled him to launch a series of plays which showed the growing taste of the public for regular drama. He started with pastorals, imitating the *Astrée* of Honoré d'Urfé (*q.v.*) in *Chryséide et Arimant* (1625; ed. H. C. Lancaster, 1925) and more freely still in *Sylvie* (1626; ed. J. Marsan, 1905) and in *La Sylvanire ou la morte vive* (1630, ed. R. Otto, 1890). These, with a comedy, *Les Galanteries du duc d'Ossone* (1632), renewed conventional themes by dramatic skill and witty writing: it is known that Mairet and Paul Scarron used to practise *pointes* (witticisms) together. The preface to *Sylvanire* shows Mairet concerned to satisfy the public with the new "regular" Italian style of drama, observing rules of place and time and a new standard of verisimilitude and decency. He had even greater success in exploiting this regularity in tragedy: *Virginie* (1633), *Sophonisbe* (1634, ed. K. Vollmöller, 1888), *Le Marc-Antoine, ou la Cléopâtre* (1635), *Le grand et dernier Solyman* (1637). Finally he tried tragicomedy: *L'Illustre Corsaire, Roland furieux, Athénaïs* and *Sidonie*, all acted between 1636 and 1641. After this he seems to have abandoned the theatre, for unknown reasons. In the quarrel over *Le Cid* he had bitterly opposed Corneille (*q.v.*), but there is no evidence that his pique continued. There are signs of political activity, culminating in the Fronde (*q.v.*), but nothing is known of

his last years. He died at Besançon on Jan. 31, 1686. His importance as an artisan of French classical drama is fully appreciated by modern critics. His characters, his verse, his situations were all used by contemporaries. Before Corneille, he brought to the stage the famous Cornelian figures Sophonisbe and Pulchérie, and he anticipated Racine's Roxane.

See H. C. Lancaster, *A History of French Dramatic Literature in the Seventeenth Century,* part 1, vol. 1 (1929); A. Adam, *Histoire de la littérature française au XVII siècle,* vol. 1 (1948). Dating of the plays has caused confusion because dates of publication and of acting vary; in this article dates of acting are given, and follow Adam.

(W. G. Me.)

MAIRONIS, the pen name of the Lithuanian writer Jonas Mačiulis-Maciulevičius (1862–1932), the most important poet at the time of the national awakening in Lithuania, who was born on Nov. 2, 1862, at Passandravys, Siluva. From 1883 to 1884 he studied literature at Kiev university, then theology at the seminary in Kaunas and at the Catholic academy, St. Petersburg. He became professor of moral theology at the seminary in Kaunas, and then at the Theological academy, St. Petersburg. In 1909 he was appointed rector of Kaunas seminary and, in 1922, became professor at Kaunas university. He died in Kaunas on June 28, 1932. In his lyrics, contained in *Pavasario balsai* (1895), satirical poetry, in *Raseinių Magdė* (1909) and *Musų vargai* (1920), and poems, in *Jaunoji Lietuva* (1908), first published in 1895 as *Terp skausmų į garbę,* Maironis tries to awaken national feeling suppressed by foreign rulers. Importance of national consciousness is still more stressed in his dramatic trilogy idealizing ancient kings of Lithuania: *Kęstučio mirtis, Vytautas pas kryžiuočius* and *Vytautas Karalius* (1922–30). These won him great popularity in his country.

In the 20th century, Lithuanian literature tended toward both realism and neo-romanticism; Maironis turned to the latter, combining it with patriotic idealism. His verse is clear, direct, has harmonious form and is rhythmically versatile, and it was he who introduced syllabic metre into Lithuanian poetry.

See J. Tumas, *Jonas Mačiulis-Maironis* (1926). (J. A. A.)

MAISTRE, JOSEPH DE (1753–1821), French polemical writer and diplomat who, uprooted by the French Revolution and profoundly disturbed by its implications, became the first, as he remains the greatest, of the uncompromising exponents of the conservative tradition. He was born at Chambéry on April 1, 1753, the son of François Xavier de Maistre, president of the senate of Savoy. He studied with the Jesuits at Turin, entered the civil service of Savoy and became a member of the senate in 1787; he married Françoise de Morand in 1786. His intellectual formation was influenced by liberalism, freemasonry and illuminism, which seem at odds with his later opinions. His earliest writing was a *Mémoire au duc de Brunswick sur la Franc-Maçonnerie* (1781). On Sept. 22, 1792, Savoy was invaded by republican troops, resistance collapsed and the duchy was annexed. De Maistre left Chambéry for Geneva and lifelong exile; the shock impelled him to his vocation as a writer. He frequented Mme de Staël's salon at Coppet, and his *Considérations sur la France* (1796) was the outcome of controversy with Benjamin Constant, the French writer and politician. In 1793 he was established at Lausanne as official correspondent to Charles Emmanuel IV, king of Sardinia, who summoned him to Turin in 1797, made him chief magistrate of the Sardinian kingdom in 1799 and in 1802 appointed him envoy extraordinary and minister plenipotentiary at St. Petersburg, where he arrived on May 13, 1803. There he wrote all the works of his maturity, only one of which was published during this period: the *Essai sur le principe générateur des constitutions politiques* (1810). There he remained, separated from his wife and children, until June 1817, when he was recalled. In 1819 he was reappointed chief magistrate and made minister of state; he published *Du Pape* in that year. He died at Turin on Feb. 26, 1821.

Baudelaire asserted that De Maistre had taught him to think, and if the art of thinking is the relentless pursuit of logical consequences from an accepted premise, Joseph de Maistre is supremely a thinker. His personal experience of revolution compelled him to posit a spiritual absolutism, the sole principle of stability and continuity, from which all temporal order, including monarchy, must be derived. He placed this absolutism in a sovereign pontiff, the pope, and his treatise *Du Pape,* with its pendant *De L'église gallicane,* examines all the corollaries of this conviction. But De Maistre's unflinching determination to follow his thought through to the end is displayed in his greatest, though unfinished, work, *Les Soirées de St. Petersbourg* (1821), with its acclaim of the public executioner as the guardian of social order, and in the *Lettres sur l'Inquisition espagnole,* with its apologia for the necessity of the Inquisition's punitive role. It is scarcely surprising to discover the animated virulence of his pages on Bacon, John Locke, Jean Jacques Rousseau and Voltaire—the rigorous prose rising to the apocalyptic visions of exile.

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(H. G. Wh.)

MAISTRE, (FRANÇOIS) XAVIER (JOSEPH MARIE) DE (1763–1852), French novelist and essay writer, younger brother of Joseph de Maistre, whose best-known work, *Voyage autour de ma chambre,* charmingly expresses the idea that happiness is found within oneself, was born at Chambéry on Nov. 8, 1763. He intended to be a painter but joined the Sardinian army and became an officer. When the French revolutionary armies overran Sardinia he left the country and in 1799 joined the Russian army in Switzerland, subsequently becoming one of Marshal Aleksandr Suvorov's aides. He lived in Moscow as a painter from 1800 until 1805 when, through his brother's influence, he became director of the naval library and museum. Returning to active service in 1810, he served in Persia and the Caucasus (where he was wounded), and became a major general in 1813, the year of his marriage. He left the army in 1816. He regarded painting and writing as mere pastimes, but his books are still remembered, especially *Voyage autour de ma chambre* (1795), written when he was temporarily confined to quarters as a young soldier. Still a model of fantasy and wit, it passed through many editions and translations and was much imitated. Other works include *Le Lépreux de la cité d'Aoste* (1811), a moving book which reflects his brother's political ideas; *La Jeune Sibérienne* (1823); and *Les Prisonniers du Caucase* (1825). He was also interested in science and published a *Mémoire sur l'oxydation de l'or* (1811). He died in St. Petersburg on June 13, 1852. (R. Dl.)

MAITLAND, EDWARD (1824–1897), English eccentric mystic and humanitarian, was born the son of a Brighton clergyman, at Ipswich, Oct. 27, 1824, graduated from Caius college, Cambridge, in 1847 and began his career by participating in the Californian and Australian gold rushes. Returning to England in 1857, he became best known for his association with the even more eccentric Anna Kingsford, variously vegetarian, antivivisectionist and theosophist, with whom he published *The Keys of the Creeds* (1875) and *The Perfect Way: or the Finding of Christ* (1882), and founded the Hermetic society in 1884 "to promote the comparative study of the philosophical and religious systems of the East and of the West." After her death he founded the Esoteric Christian union and wrote her *Life and Letters,* incorporating much autobiographical material (1896). He died at Tonbridge on Oct. 2, 1897. (G. F. A. B.)

MAITLAND, FREDERIC WILLIAM (1850–1906), English jurist and historian of law, whose special contribution was in bringing the historical and comparative methods to bear upon the development of English law and institutions, was born on May 28, 1850, in London. Educated at Eton and at Trinity college, Cambridge, he was called to the bar in 1876. Trained as a conveyancer, he later turned to legal history and comparative jurisprudence and was appointed reader in English law (1884) and then Downing professor (1888) at Cambridge. As a historian he has been ranked with Gibbon and Macaulay. Despite delicate health, his publications were numerous. Among the most important are *Justice and Police* (1885), *Bracton's Note-Book* (1887), *Memoranda de Parliamento* (1893), *History of English Law* (with Sir F. Pollock, 1895; 2nd ed. 1898), *Domesday Book and Beyond*

(1897), *Township and Borough* (1898), *Canon Law in England* (1898) and *English Law and the Renaissance* (1901). His papers were published in *Collected Papers* (1911) and *Selected Historical Essays* (1957). He edited several important volumes for the Selden society, founded by him and others for the study of English law. His works are characterized by vigour, clarity and grace of style; they reflect immensity of intellectual grasp, vast knowledge, mastery of original sources, and the most exacting standards of scholarship. He died at Las Palmas, Canary Islands, on Dec. 19, 1906.

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MAITLAND, JOHN (MAITLAND OF THIRLESTANE) (1543–1595), chancellor of Scotland (1587–95) and prominent adviser to James VI, was the second son of Sir Richard Maitland of Lethington and the younger brother of William Maitland of Lethington. He was born in 1543 and after completing his education in France succeeded his father as keeper of the privy seal in April 1567 and became a lord of session in June 1568. He was forfeited in May 1571 for supporting Mary Stuart and was imprisoned for a time in Tantallon castle by the regent Morton. After Morton's fall Maitland was restored to the bench in 1581, became a member of the privy council in 1583 and was knighted and appointed secretary in 1584. On the fall of the powerful favourites, James Stewart, earl of Arran, and Patrick, master of Gray, at which he connived, Maitland became the principal adviser of James VI in 1586, pursuing a policy of an alliance with England, compromise with the kirk and the creation of an official class independent of the aristocracy. He was appointed chancellor on July 29, 1587, and was created Baron Thirlestane on May 17, 1590. His great influence aroused the jealousy of the nobles, of the queen and particularly of Francis Stewart, earl of Bothwell. After the murder of the earl of Moray by the earl of Huntly in Feb. 1592, which was popularly attributed to the chancellor, his enemies combined to bring about his fall. Maitland had to leave the court for a time, and although he sponsored the so-called golden act (1592) recognizing the presbyterian structure of the kirk and was subsequently reconciled with the queen and others, he never recovered his earlier power. Nevertheless, he retained the chancellorship until his death on Oct. 3, 1595.

See M. Lee, *John Maitland of Thirlestane and the Foundation of the Stewart Despotism in Scotland* (1959). (J. IM.)

MAITLAND, SIR RICHARD (LORD LETHINGTON) (1496–1586), Scottish poet, lawyer, statesman and compiler of an important collection of Scottish verse. "Manly Maitland," as he was called in an epitaph, was the son of Sir William Maitland of Lethington, who was killed at Flodden. He studied law at St. Andrews and Paris, served James V and was keeper of the Great Seal (1562–67) under Queen Mary. Although he went blind about 1561, he remained active as a judge until 1584 and busied himself with writing and collecting Scottish poetry. He died on March 20, 1586. Maitland's poems reflect the troubled condition of Scotland in his time. Many have social and political themes, which they treat sometimes satirically, sometimes with the meditative seriousness of an old and blind man who loves his country and who asks his more fanatical and intolerant contemporaries, "How suld our commonweill endure?" They have frequently a nice and laconic strength and a metrical expressiveness, both reminiscent of his English contemporary, Sir Thomas Wyat. Maitland included his own poems in his valuable collection of Scottish poetry known as the *Maitland Folio Manuscript* (begun about 1570), and his daughter added others while she compiled the smaller anthology called the *Maitland Quarto Manuscript* (1586). The 183 leaves of the folio and the 138 leaves of the quarto also contain a selection of works by Robert Henryson, William Dunbar, Gavin Douglas and other poets of the period. Maitland's services to Scottish history and literature were commemorated by the foundation of the Maitland club in 1828 to continue their study.

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MAITLAND, WILLIAM (MAITLAND OF LETHINGTON) (*c.* 1528–1573), Scottish statesman and stanch supporter of Mary Stuart, was the eldest son of Sir Richard Maitland and was born, probably at Lethington, *c.* 1528. Educated at St. Andrews university and on the continent, he became secretary to the regent, Mary of Lorraine, in 1558. Joining the lords of the congregation in 1559, he helped to expel the French from Scotland by the treaties of Berwick (Feb. 1560) and Edinburgh (July 1560). He became secretary to Mary Stuart and a lord of session in 1561, and thereafter his overriding aim was to secure her recognition as successor to the English crown. He believed that this would pacify religious issues in Scotland by abating the political influence of Mary's Roman Catholicism. He also tried to restrain the Protestant extremists by holding a public debate with John Knox in 1564 on resistance to an idolatrous prince. Maitland favoured Mary's marriage to Henry Stewart, Lord Darnley, in July 1565, but after the murder of David Rizzio, the queen's favourite, the ascendancy of James Hepburn, earl of Bothwell, forced him to flee the court in fear of his life. He was reconciled to Bothwell in Sept. 1566, but after Darnley's murder (in which Maitland was implicated) in Feb. 1567, he opposed Mary's marriage to Bothwell and joined the opposition.

On Bothwell's flight, Maitland worked persistently for reconciliation and the restoration of Mary. At the York and Westminster conferences in 1568–69, he tried to exculpate the queen from the Darnley murder and to promote her marriage to the duke of Norfolk. Maitland broke with the regent Moray's party over this and was arrested in Sept. 1569 for complicity in Darnley's death, but he was later rescued and led the queen's supporters in the civil war following Moray's murder (1570). Maitland held Edinburgh castle until forced to capitulate in May 1573 and subsequently died in prison at Leith on or about June 9, 1573.

Accused by contemporaries of faithlessness, he tried to promote the best interests of Mary Stuart, often in defiance of her own actions, but he allowed his own policy to become obsessive and underestimated the force of contemporary religious feeling.

See E. Russell, *Maitland of Lethington* (1912). (J. IM.)

MAITLAND, a city of New South Wales, Austr., situated in the lower valley of the Hunter river, 20 mi. N.W. of Newcastle. Pop. (1961) 27,353. Maitland is subject to flooding, but its suburbs, East Maitland, Morpeth, Tenambit, Lorn, Telarah and Rutherford, are on high ground to the east and west. In the adjacent farming area, mixed farming is extensively practised, as well as dairying and beekeeping. Lucerne, corn (maize), millet, potatoes and vegetables are grown. Maitland is the market centre for stock and processes meat for local, metropolitan and export markets. Industries include the manufacture of rayon and textiles, clothing, bricks, tiles and pipes, and light engineering. There are bus services to all centres within 30 mi. and the city is served by the Newcastle suburban railway, while express train services link the district with Sydney and the northern half of New South Wales.

Cessnock (pop. [1961] 35,281) lies 18 mi. S.W. of Maitland and is the market town of the south Maitland coal fields, which cover an area of about 100 sq.mi. and contain more than 1,500,000,000 tons of reserves. Average annual production is about 9,000,000 tons of excellent quality coal. Cessnock is also the centre of a good agricultural district.

MAITRAKA, the name of an Indian dynasty that ruled in Gujarat and Saurashtra (Kathiawar) from the end of the 5th to the 8th century A.D. The capital of the Maitrakas was Valabhi, the modern Wala (Vala), near the eastern coast of the Saurashtra peninsula. The founder of the line, Bhatarka, was a general who apparently profited by the decay of the Gupta empire and established himself as the ruler of the region. Although the early Maitraka kings were loosely feudatory to the Guptas, they were in fact independent. Under the powerful Siladitya I (end of 6th century) the kingdom became very influential, and its rule extended

into Malwa and Rajasthan. Later, however, the Maitrakas suffered at the hands of the Chalukyas of the Deccan and of Harsha (*q.v.*) of Kannauj.

The Maitrakas revived after the death of Harsha and became fully independent, but in the 8th century new enemies appeared. These were the Arabs, who established themselves in Sind in 712. Thenceforward the Maitrakas were continually attacked by them, and the last Maitraka king, Siladitya VI, apparently perished when Valabhi was razed to the ground (*c.* A.D. 780). The invaders did not hold the territory, however, and the region came under the influence of the rising Rashtrakuta dynasty of the Deccan.

The Maitraka kings were great pātrons of religious foundations. Their kingdom was an important centre of Buddhism and, according to tradition, it was in Valabhi that the Svetambara Jain canon was codified.

See Niharranjan Ray, "The Maitrakas of Valabhi," *Indian Historical Quarterly*, vol. iv, pp. 453–474 (1928); Krishnakumari J. Virji, *Ancient History of Saurashtra* (1955). (A. L. Ba.)

MAITREYA (literally, "benevolent"), the name of the Bodhisattva who is to be the next future Buddha. Buddhism holds that its truths have been and will be taught by numerous Buddhas, who arise in succession. Maitreya (Pali, Metteyya) is believed to be the next after Sakyamuni (*see* GAUTAMA BUDDHA), or the fifth among 1,000 Buddhas. The theory of recurrent Buddhas may not be primitive but it certainly arose before the close of the Pali canon, as Metteyya is mentioned there (Digha Nikaya, no. 26; Buddhavamsa, ch. 27, etc.). According to the later belief he is the lord of the Tushita heaven, due to be born in this world after the lapse of 5,670,000,000 years and to save living beings.

Maitreya or Maitreyanatha is also the name of a Buddhist master (*c.* A.D. 270–350), the founder of the Yogacara school, who was later identified with Maitreya Bodhisattva. He was the teacher of Asanga, a great Buddhist philosopher, and composed some philosophical works.

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MAIZE (CORN or INDIAN CORN), the principal food plant of America. The word maize, derived from the Arawak Indian word *má-hiz*, was formerly preferred in international usage since corn, the term by which the plant is known in the United States and Canada, was in many countries synonymous with grain and was applied to any cereal. The botanical name is *Zea mays*. The Spanish equivalent, *maíz*, is still used in the Spanish-speaking countries of America, but elsewhere in the world wherever English is commonly spoken the word maize is giving way to corn. In southwestern United States maize means specifically a variety of sorghum, milo maize. *See* CORN; *see* also references under "Maize" in the Index.

MAJANO (MAIANO), **BENEDETTO DA** (1442–1497), Italian sculptor, was born at Majano, near Florence. His earliest surviving work is the shrine of S. Savino (1468–70) in Faenza cathedral. Between 1470 and 1475 he was engaged on the altar of Sta. Fina in the Collegiata at S. Gimignano, in a chapel designed by his elder brother Giuliano (1468) and decorated with frescoes by Ghirlandajo. The connection between Benedetto da Majano and Ghirlandajo is reflected in the five narrative reliefs in Benedetto's masterpiece, the pulpit in Sta. Croce in Florence (probably 1472). A bust of Pietro Mellini (Museo Nazionale, Florence), by whom the pulpit was commissioned, is dated 1474 and reveals the same accumulation of naturalistic detail as is found in the male portraits of Ghirlandajo. The ornate decorative parts of the Sta. Croce pulpit are of great distinction and have a counterpart in the marble doorway of the Sala dei Gigli in the Palazzo Vecchio, Florence.

After this time Benedetto was employed on two major works for the church of Monte Oliveto in Naples, the tomb of Mary of Aragon (d. 1470), begun by Rossellino, and an altarpiece of the Annunciation (1489). Concurrently, he was employed by Filippo Strozzi, of whom he made a portrait bust (marble in the Louvre, Paris; terra cotta in the Kaiser Friedrich museum, Berlin) and whose tomb in Sta. Maria Novella, Florence, he completed after 1491. His last major works, the altar of S. Bartolo in S. Agostino at S. Gimignano (1493–95) and an unfinished group representing the "Coronation of Ferdinand of Aragon" (Museo Nazionale) show some decline in quality.

As a sculptor Majano occupies a place above Mino da Fiesole and below Andrea del Verrocchio, and his work depends for its effect less on invention and originality than on unfailing taste and an exceptionally high level of technical skill. He was also an architect. Majano died on May 24, 1497.

See L. Dussler, *Benedetto da Majano* (1924). (J. W. P.-H.)

MAJESTY awe-inspiring greatness, in particular the attribute of divine or sovereign power. The ancient Romans spoke of the majesty (*maiestas*) of the republic or of the Roman people, violation of which entailed a charge "of injured majesty," *crimen laesae maiestatis; i.e.*, of *lèse-majesté* or treason (*q.v.*). Under the principate the majesty of the state was transferred to the emperor's person, whose *maiestas augustalis* was protected from disrespect by extension of the law of treason. An early example of the modern usage of the term as an honorific form of address occurs in a letter of Q. Aurelius Symmachus to Theodosius I, whom he calls "Your Majesty," after which it becomes frequent in addresses to the western emperors (*cf.* the *megaleiotes* of the Byzantines).

In the middle ages the Holy Roman emperors had "majesty" from the time of Louis the Pious but kings (*e.g.*, Henry II of England), popes, cardinals and archbishops also enjoyed it occasionally; Hugh, count of Champagne, even referred to his own in a letter to the monks of St. Remy (1114) and the citizens of Ghent ascribed it to Philip the Good, duke of Burgundy (1453). In these instances, however, one of the parties to the communication recognized the other as his superior: no precedent was therefore established for solving the problems that obstructed diplomacy when the emperor proved unwilling to accord "majesty" to other sovereigns who claimed it. Having withheld it from Francis I of France at the signing of the treaty of Cambrai (1529), Charles V eventually allowed it to him at the peace of Crépy-en-Laonnois (1544), with the distinction however that Charles's "majesty" was there specified as "Caesarean" while Francis' was only "Royal." The kings of Spain, on the other hand, managed to retain the "majesty" acquired when Charles was both king of Spain and emperor.

Embarrassments recurred (notably in the preliminaries of the peace of Westphalia) until the solution adumbrated in 1544 was generally adopted in the 18th century, when the "majesty" of the several kings was determined by qualification with the special epithets that the papacy had given them as kings: the king of France, then, as "Most Christian king," became "His Most Christian Majesty"; the king of Spain, "His Catholic"; and the king of Portugal, "His Most Faithful." Maria Theresa, during the War of the Austrian Succession, had "Apostolic Majesty" as undisputed successor of the "Apostolic kings" of Hungary; later, their right to the empire established, she and her successors had "Imperial and Apostolic."

The sovereign of the United Kingdom is "His" or "Her Britannic Majesty" for international purposes. "His Majesty" is usually enough for any ruler within his own realm but may be amplified: "His Sacred" (16th–17th century), "His Most Gracious" and "His Most Excellent Majesty" are English forms.

MAJOLICA, a name properly applied to a species of Italian ware in which the body is coated with a tin enamel, on which a painted decoration is laid and fired. It is also applied to similar wares made in imitation of the Italian ware in other countries. The word in Italian is *maiolica*. *See* POTTERY AND PORCELAIN.

MAJOR, a military rank standing above captain. Originally, the term was used adjectivally in the title sergeant major, the "third principal officer in a regiment" (Ward, 1639), now the major. In the 16th and 17th centuries there was a similarity between the duties of the sergeant, sergeant major and sergeant major general, in that they attended to the drill and administration of a com-

pany, a regiment and an army, respectively. In conversation, sergeant major was abbreviated to major and sergeant major general to major general, whence the modern titles of major and major general derive. In the case of sergeant major the sergeant was dropped about 1660.

In the 17th century the duties of a major were a combination of those now performed by the major (second in command) and sergeant major, but on the introduction of adjutants he was relieved of much of the routine work. The brigade major corresponds in a higher sphere to the adjutant of a battalion. Such expressions as town major and fort major indicate the purpose of the appointment.

The rank of major has always been below that of lieutenant colonel. In a regiment commanded by a colonel, he was the third in command; in a battalion commanded by a lieutenant colonel, he was second in command. In the larger organizations of the 20th century a regiment might have three or more majors, each commanding a battalion.

Drum major was an ancient title in the British service and was adopted by the U.S. army early in its history. The drum major was responsible for training the regimental drummers and often had the additional functions of regimental postman and banker. The title sergeant major was introduced as a noncommissioned rank in the British service early in the 18th century and was elevated to warrant rank in 1881. In the U.S. army it has usually indicated the principal administrative noncommissioned officer of a unit, the chief assistant to its adjutant.

See also INSIGNIA, MILITARY; OFFICERS, MILITARY. For the musical meaning of the term major *see* HARMONY. (F. P. T.)

MAJORCA (Sp. MALLORCA), a Spanish island, the largest of the Balearic Islands, located in the western Mediterranean sea. Area 1,405 sq.mi. Pop. (1960) 363,701. Palma (*q.v.*) is the capital of Majorca and of Baleares province.

Two mountainous regions, trending southwest–northeast and each about 50 mi. in length, occupy the western and eastern thirds of the island, being separated by a depression which terminates in Palma bay on the south and Alcudia and Pollensa bays on the north. The northwestern mountains are the higher range, Puig Mayor attaining 4,741 ft. Precipitous cliffs, often over 1,000 ft. high, compose much of the north coast. The varied landscape includes pine forests, olive groves, torrent gullies, intensively terraced slopes and fertile valleys such as those of Valldemosa and Sóller. The much less rugged southeastern hills are especially famous for their extensive limestone caves and subterranean lakes. The central lowland, benefiting from the shelter provided by the northwestern mountains, is a rich agricultural zone with the typical two-tier cultivation of olives, figs, apricots, oranges, almonds and vines with crops of cereals, lucerne and legumes among the trees, and stock raising.

The island's economy is based principally on these agricultural products and on the tourist industry, although marble and building-stone quarries, superphosphate works and light industries manufacturing pottery, glassware, shoes, rugs and souvenirs provide some employment. The wines produced are light but of good quality, those of Felanitx and Binisalem being especially notable.

The road system fans out from Palma to all parts of the island. Four railway lines link Palma with Inca (pop. 13,816 [mun.]) and La Puebla (9,931 [mun.]), Manacor (19,224 [mun.]) and Artá (6,500), Felanitx (11,797 [mun.]) and Lluchmayor (10,664 [mun.]), and Santañy (5,082 [mun.]). The other principal municipalities are Pollensa (8,552) and Sóller (9,473 [mun.]) in the northern mountains. Maritime services connect the island with the mainland and the other Balearic islands. There are regular air services to Barcelona and Paris.

The fairs and colourful ceremonies, such as those of Pollensa during Holy Week, the mountain scenery, benign climate and the island's rich historical heritage attract thousands of visitors each year. At Valldemosa is the abandoned monastery where Chopin and George Sand stayed in Majorca and where Chopin wrote some of his finest mazurkas and preludes.

For history and archaeology *see* BALEARIC ISLANDS.

(G. J. B.)

MAJORIAN (JULIUS MAJORIANUS), Western Roman emperor from A.D. 457 to 461, was born of a distinguished military family and had himself served under Aëtius (*q.v.*). An old friend of Ricimer (*q.v.*), Majorian helped to overthrow the emperor Avitus (*q.v.*) in 455. Appointed master of the soldiers in 457, he inflicted a defeat on Alamannic invaders at Bellinzona, and on April 1, supported by Ricimer, was proclaimed emperor at Ravenna. In the summer he repulsed a landing in Campania of the Vandals of Gaiseric (*q.v.*). He was interested in the administration of his realm and tried to remove abuses in the collection of taxes and to protect the provincials from other forms of oppression. Most of his legislation dates from the year 458. In that same year he began to build a fleet with a view to recovering Africa from the Vandals. But he had not yet secured recognition in Gaul, where there was a movement to appoint Marcellinus as emperor. Majorian accordingly went to Gaul in 460, was praised in an extant panegyric by Sidonius Apollinaris (*q.v.*), formed an alliance with the Visigothic king Theodoric II, and on March 28 was in Arles, assured of the support of the Gallo-Romans. His preparations for a war against the Vandals were now complete and in May 460 he crossed the Pyrenees into Spain. He marched to Cartagena, where the 300 ships of his fleet were assembled. But Gaiseric's fleet made a sudden descent on the Spanish coast and, aided by treachery, captured the larger part of the imperial navy in the bay of Alicante. Majorian was obliged to make a humiliating peace with the enemy and returned to Gaul. He then crossed the Alps, but having disbanded his army he fell into Ricimer's hands on Aug. 2, 461 and was compelled to abdicate. Five days later he was put to death at Tortona and several months afterward was succeeded as emperor by Libius Severus. His legislation and character make Majorian the only Western emperor of the 5th century to have some claim to greatness.

See J. B. Bury, *History of the Later Roman Empire*, vol. i, ch. 10 (1923); E. Stein, *Histoire du Bas-empire*, vol. i (1959). (E. A. T.)

MAJUNGA, the second largest town of the Malagasy Republic (Madagascar), lies on the northwest coast at the mouth of the Betsiboka river, whose estuary widens there into Bombetoka bay. Pop. (1959) 34,119, of whom about 4,500 were foreigners; but immigrants from the Comoro Islands are almost as numerous as the Malagasy. Situated on the northeast corner of the bay, the town fronts both the estuary and the sea. It surrounds a low eminence and includes some fine streets, notably a water-front boulevard lined with coconut palms. Old buildings are confined to the harbour quarter which has some 19th-century Arabian houses; modern buildings include the Roman Catholic cathedral.

As a port, Majunga is of significance chiefly for transshipment, and about 300,000 tons of shipping are handled annually. It is linked by road with Diégo-Suarez and with Antananarivo (Tananarive), the capital (about 225 mi. S.S.E.). Air services to other centres in the republic use Fleuret Davioud airport, 4 mi. from Majunga. Industries include the processing of agricultural products (raffia, sisal, rice, edible oils), meat canning and the manufacture of soap, sugar and cement.

Majunga served as the base for the French expeditionary force that in 1895 advanced on Antananarivo and established a protectorate over the country.

MAJUNGA PROVINCE (pop. [1960 est.] 652,829; area 59,019 sq.mi.) rises eastward to the Tsaratanana massif in the central highlands. Coffee, rice, sugar, cassava and fibres are cultivated, hardwood timbers are exploited and beef cattle are raised. The offshore island of Nosy Be (*q.v.*) in the Mozambique channel is part of the province. (J. AR.)

MAKARIOS III (MIKHAIL KHRISTODOULOU MOUSKOS) (1913–), archbishop and primate of the Orthodox Church of Cyprus and national leader of the island's Greek population, was born at Ano Panaya, near Paphos, on Aug. 13, 1913. Educated at the Pan-Cyprian gymnasium in Nicosia and at the University of Athens, he was ordained priest in 1946 with the name of Makarios. He went to the United States to continue his studies at Boston university, but returned to Cyprus in 1948, when he was elected bishop of Citium. He at once began to engage in politics and organized a national movement for *enosis* (union) with Greece.

In 1950 he was unanimously elected archbishop and ethnarch (national leader) of Cyprus. In 1955 he proposed that the British government should recognize the Cypriot people's right to self-determination. In March 1956 he was deported to the Seychelles Islands. Released from exile on March 28, 1957, he did not return to Cyprus until March 1959, after the signing of the London agreement on the future of Cyprus. On Dec. 14, 1959, he was elected president of the Republic of Cyprus, taking office on Aug. 16, 1960, when Cyprus attained full independence. In Oct. 1963, convinced that the 1959 constitution was unworkable, he suggested its revision to the Turkish Cypriot minority. The rejection of his proposal by the Ankara Turks (Dec. 1963) precipitated a new and serious crisis. *See* also CYPRUS: *History*.

MAKART, HANS (1840–1884), Austrian painter, who became the most celebrated painter of the great bourgeois epoch in Vienna, was born in Salzburg on May 29, 1840. He got his decisive training in Munich under Karl von Piloty, the leading historical painter at that time. He gave himself over entirely to a superficial, idealized historicalism, even in his portraiture, taking the 16th-century Venetians and Van Dyck and Rubens as his models in composition and colour. Makart lived in Vienna from 1869 and died there, Oct. 3, 1884. In 1879, when he was at the peak of his fame, he undertook to design the festal procession which was to celebrate the silver wedding of the emperor Francis Joseph I and the empress Elizabeth.

Makart's art, with its riotous, decorative grandiloquence, was in general the kind which is destined to fade quickly. But it is not difficult to recognize in many details and in individual works no small talent as a painter and an unusual gift for colour.

Important works are in the galleries of Vienna, Berlin, Hamburg and Stuttgart. He also executed a series of decorative lunettes for the Kunsthistorisches museum in Vienna. His historical pictures include "Caterina Cornaro" (1873), "The Entry of Charles V Into Antwerp" (1878) and "The Plague in Florence" (1867–68); other works are "The Burg Theatre Actress Charlotte Wolter as Messalina" (1876) and "The Triumph of Ariadne" (1873).

See Emil Pirchan, *Hans Makart* (1954). (F. Ny.)

MAKASAR (MACASSAR), the chief port and largest city in the island of Celebes (Sulawesi), Indonesia, and capital of the province of Sulawesi Selatan/Tenggara (South-Southeast Sulawesi). Pop. (1961) 384,159 (municipality), including a large number of foreign nationals, particularly Chinese. The city is picturesque when seen from the sea. Parallel roads run from the harbour through the old city with its rows of 17th-century houses built close together and its open squares to the old Fort Rotterdam, originally built by the Portuguese. Facing the fort is a large green square, surrounded by official buildings and business premises. Gaily coloured, plaited basketry is an outstanding feature of Makasarese markets. The city lies on the western side of the most southerly peninsula of Celebes. Its situation is low and the immediately surrounding country swampy. The forest-clad hills of Maros, however, and the beautiful waterfall of Bantimurung are nearby attractions. Near the city is the grave of Dipa Negara (Diponegro), leader of the Java rebellion in 1825 against the Dutch, who was exiled and died at Makasar.

The people, the Mangkasaras or Makasars, are a branch of the Malay people, similar to but not completely identical with the Bugis (*q.v.*), who inhabit the same region. (*See* CELEBES: *People*.)

The development of the port of Makasar was retarded by lack of harbour and wharf facilities until 1925, when new wharves, breakwaters and storage facilities were built. These were later modernized and extended. The main commodities exported from Makasar are copra, gums and resins, rubber, coffee and rattan; minor exports include kapok, ebony, maize, spices, hides and skins. The port is also a great centre for the distribution and transshipment of imports destined for other parts of Celebes, the Moluccas and the Lesser Sunda Islands. Makasar is connected by sea with the other ports of Indonesia and neighbouring countries, and by air with the major towns of Indonesia. A steam tramway runs from Makasar to Takalar, and good roads link Makasar with the hinterland.

Already a flourishing port when the Portuguese came to Indonesia in the 16th century, Makasar came under the control of the Dutch, who built a trading station there in 1607 (under the name of Vlaardingen) and who finally shattered the power of the sultan of Makasar in 1667. From that time it was in Dutch hands and was a useful base for their operations against the sultans of Celebes. The city was occupied by the Japanese from Feb. 1942 until 1945. In 1946 it was made the capital of the Dutch-sponsored state of East Indonesia (Indonesia Timur), and in 1949 it became part of the Indonesian republic.

MAKEMIE, FRANCIS (*c.* 1658–1707/08), American colonial Presbyterian clergyman and leader in forming the first American presbytery, was born in County Donegal, Ire., about 1658 and was educated at the University of Glasgow. In 1682 he was ordained by the Presbytery of Laggan, Ire., to go to America in response to a plea from a Colonel Stevens in Maryland. Makemie preached in Somerset county, Md., and in the Barbados for a number of years, supplementing his meagre income by trading. About 1690 he married the daughter of a wealthy merchant of Accomack, Va., and took up residence there. A year later he was in London, where he was associated with Increase Mather of Boston, with whom he had corresponded for several years, and with other Presbyterian and Congregationalist leaders.

For ten years he preached and traded between Accomack and the Barbados, and sought also to unite the various struggling Protestant churches of these areas in a common cause. However, Anglican attempts to silence him by arrest, and a severe controversy with George Keith, first a Quaker and then an Anglican zealot, awakened Makemie to the peril of the Dissenting churches in the colonies. His ties with the Boston ministers were continued, and in 1706 Makemie seems to have been the leading spirit in uniting several scattered churches and pastors in Virginia, Maryland, Pennsylvania and New Jersey into a presbytery. The following year Lord Cornbury of New York imprisoned Makemie and a colleague, John Hampton, for preaching on Long Island without licences. After several months of imprisonment, and a long and costly trial, Makemie was acquitted. Cornbury was soon recalled to London. Thereafter the provisions of the Toleration act in England were claimed by all Dissenters in the American colonies. In his trial Makemie had been aided by the Boston Congregationalist ministers, leading Dissenting ministers in London and prominent New York citizens.

Makemie's death occurred in late 1707 or early 1708. Six of his several controversial and sermonic publications are extant.

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MAKE-UP (STAGE, MOTION PICTURE AND TELEVISION). As long as dramatic exposition has existed it has presumably been accompanied by some form of masquerade for the purpose of transforming the actor into the part he portrays. The use of make-up for cosmetic purposes dates from earliest historical times (*see* COSMETICS AND COSMETOLOGY; COSTUME DESIGN, THEATRICAL).

A suggestion of the simplicity and crudeness of the earliest make-up may be found in the religious rites of primitive races in modern times. The Patagonians, whose only form of dramatic movement was the swaying of their bodies and a monotonous mumbling of incantations, made up for the occasion by smearing their faces with chalk. Among the Australian aborigines, who rank somewhat higher in the ethnological scale, ritual ceremonies are enhanced by bodily adornments of wreaths, flowers and feathers worn over greased bodies and faces daubed with white clay.

The Aleuts use painted wooden masks representing demons and sea animals for their mystic rites, while the natives of the South Sea islands dress their heads with helmetlike structures, into which are built masks of wood, reeds, tortoise shell and human skulls, sometimes decorated with vegetable substances to represent hair. Some of these islanders, *e.g.*, the members of the Areoi societies, discarded the mask and painted their faces red and their bodies black. The Indians of North America decorated their

bodies and faces with variously hued war paints; and their medicine man dressed for rituals in the skin and head of elk, bear, wolf or panther. *See* also MASK.

STAGE

Early.—The Chinese and Siamese theatre not only handed down an old tradition of masks but also made use of grotesquely painted faces of blue, green, ochre, vermilion and ghastly white for demons and spirits. Ancient Egyptian kings and priests wore wigs during official ceremonies; excavations dating back to 5000 B.C. reveal that eye and face paints were widely used. Persian warriors wove strands of jute into their marcelled beards.

In the procession of Dionysus (out of which grew the Greek drama) the god was represented with long hair and a long beard, two small horns projecting from his forehead, while the reeling Bacchantes appeared with faces smeared with wine dregs or mulberry juice. Some of the followers in the train portrayed dead souls clad in shrouds with their faces covered in white lead.

Medieval.—For miracle plays of the 14th century and onward, actors made up with startling realism as animals, devils, saints and angels. Much ingenuity in facial disguise was used in a medieval play called *The Acts of the Apostles*, wherein the spectators saw the eyes of St. Matthew drawn out of his head and watched Simon Magus change his face several times. In an early English Passion play, Christ and the apostles wore gilt wigs; the evil spirits appeared with bodies painted a reptilelike green and with huge ox and ram horns ornamenting their heads.

Renaissance.—A favourite farce actor in Paris during the reign of Henry IV was known as Gros Guillaume. His face make-up consisted of a thick coating of flour, which at comic moments, he sent flying into the eyes of his fellow actors by puffing out his fat cheeks; on his chin he wore a piece of white lamb's skin to represent a beard. The popular *commedia dell'arte* (*q.v.*) of the Italian theatre of the 16th and 17th centuries was performed by actors masked always in the typical grotesquerie of Harlequin, Pantaloon, Scaramouch, Capitano, etc. The white face of the modern circus clown is a direct inheritance from the French Pierrot, who in the 19th century discarded the mask of the *commedia dell'arte* clown, Pedrolino, and powdered his face with flour.

The English stage of Elizabeth I did away with the mask as a means of facial make-up. Instead of wearing the set expressions of the disguised Harlequins and Pantaloons, actors appeared in their own faces or were painted, bearded and wigged as the character required. Cosmetics were applied simply and obviously as there was no artificial lighting to soften disguise deficiencies. The theatre of Molière encountered few make-up difficulties. The customary long ringlets of the court were worn whatever the period of the play, whether Roman or contemporary, and the only beard necessary was the partly shaved mustache of the prevailing mode.

The 19th Century.—The ignoring of archaeological verity in make-up was characteristic of the English stage until after the time of David Garrick, who, for nearly every character, wore the white court wig of George III and as Romeo appeared as a British gentleman of his day. The art of make-up was studied but little before the beginning of the 19th century. Costume was clumsy and wigs and beards for character parts were of crude material. The early method of acting Shylock was as a comedy part that roused audiences to laughter. Thomas Doggett, a celebrated Shylock, wore a ridiculous red wig and beard for the part. The first actor to redeem the character from buffoonery was Charles Macklin, who presented him as sinister and black-bearded. Since Macklin, actors have varied the aspect of Shylock according to their fancy. Sir Henry Irving, for example, portrayed him as an elderly aristocrat.

The stage lighting of the period, provided first by candles and later by oil lamps, was dim and ineffectual; consequently, crudity in make-up passed unnoticed. When illuminating gas and calcium (lime) lights were introduced the necessity arose for greater circumspection in appearance. Make-up material, however, was still somewhat elemental and natural-appearing heads and complexions were a rarity. (*See* also STAGE DESIGN: *Development of Stage Lighting Equipment.*) (O. SK.; M. F.)

Modern.—With the introduction of electric lights into the theatre came the need for new make-up materials and more skilful techniques of application. Crude, inartistic effects could not be hidden under the revealing light of electricity. A new era of realism was dawning. Stick grease paint, a revolutionary invention, soon made its first appearance, and by 1890 the demand for stage make-up had warranted its manufacture on a commercial scale.

The importance of modern stage make-up cannot be overemphasized. If it were not used, the performer would discover quickly that the stage lighting system had removed all the colour from his complexion. Therefore, make-up is necessary to restore this colour and define the features of the face to ensure a natural appearance. It also helps the player to look and feel the part, and for most character interpretations it is absolutely essential. Standardized charts show the correct shades of make-up for various types of men, women and children.

MOTION PICTURES

During the early days of motion pictures, specially created make-up for the new medium was not available. The few players who wore make-up borrowed both materials and techniques from the stage. Characters invariably were standard types: hero, heroine and villain. The hero and heroine were heavily made up with painted lips, chalk-white faces and dark eyes. The villain depended only upon long "moustachios" and heavily painted black eyebrows. Stick grease paint of the theatre, however, was not satisfactory. Necessarily heavy applications made it impossible for the actor to appear natural looking in close-ups and the limited range of colours failed to meet requirements of motion-picture lighting and photography.

The first make-up designed expressly for motion pictures was created by Max Factor and was introduced by him in 1910. It was a light, semiliquid grease paint that was made available in jars in a precisely graduated range of tan-tone shades suitable for the lighting and orthochromatic film emulsion of that period. A short time later, this new grease paint became the first make-up to be made available in tubes.

Prior to 1928, there were no established standards for motion-picture lighting or the selection of make-up colours. But with the advent of panchromatic film and incandescent lights on the sets, a complete gradation of make-up shades was created that allowed every player, from those with the lightest to those with the darkest complexions, to appear true to type on the screen. In Feb. 1928, the Society of Motion Picture Engineers conducted a special series of tests to standardize the film, lighting and colours of make-up that were most effective for motion pictures. Obviously, the principal consideration was the appearance of the players and it was quickly determined that the make-up colours that had been used with orthochromatic film and arc lighting would have to be

(RIGHT) CULVER PICTURES, INC.

LON CHANEY (LEFT) IN MAKE-UP FOR QUASIMODO IN "THE HUNCHBACK OF NOTRE DAME" AND (RIGHT) WITHOUT MAKE-UP

BY COURTESY OF TWENTIETH CENTURY FOX FILM CORPORATION

(LEFT) EARLY FILM MAKE-UP TECHNIQUES FOR THE ROLE OF CLEOPATRA AS PLAYED BY THEDA BARA, ABOUT 1915, AND (RIGHT) MODERN MAKE-UP APPLIED TO ELIZABETH TAYLOR FOR THE 1963 FILM "CLEOPATRA"

changed. As a result of these experiments, Max Factor created a completely new range of make-up colours called panchromatic make-up. For this achievement, he won a special Academy of Motion Picture Arts and Sciences award.

The main requisite in making-up a film player is the foundation colour, which is supplied in many distinctive tones ranging from a faint tan to a warm brown. Lipstick shades from light red to deep red are used, depending on the effect desired photographically. Eyeshadow and lining colours are selected in shades that are best suited to the individual. These may include blue and green as well as the panchromatic colours.

Motion-picture make-up is both corrective and creative. Make-up always must be applied skilfully, delicately and subtly so that facial expression will have natural freedom. The inexperienced person should remember that on the screen, particularly in close-ups, the face may be magnified many times larger than life-size. Consequently, every complexion flaw or crudely applied make-up artifice is clearly discernible. As a corrective art, make-up serves to (1) cover blemishes; (2) provide the face with a smooth and even colour tone for the most effective photography; (3) clearly define the facial features for more visibly expressive action; (4) make the player appear more attractive; and (5) ensure a uniform appearance before the camera. As a creative art, make-up enables the player to take on the appearance of almost any type of character. It can be his means of achieving a distinctive "screen personality." It can make the young appear to age believably and the old appear to look young again. Countless special make-up devices, effects and tricks are available. Tears can be produced by blowing fumes from a menthol tube into the eyes; the opening of the tube must be covered with gauze, however, to avoid blowing crystals into the eyes. Weird or comedy effects may be created by blocking out teeth with black tooth enamel. Realistic scars are made by applying nonflexible collodion with a brush.

Wigs, hairpieces and mustaches also are an integral part of the motion-picture make-up art and the ancient art of wigmaking has kept pace with the general advancement and perfection of make-up. Modern wigs and hairpieces are made of human hair. Each individual strand of hair is tied with a special needle into a lace-like foundation, which is stretched over a wooden wig block sculptured in the size and shape of the head contours. The most artistic beards and mustaches usually are made with crepe hair, which comes in various shades and is applied with spirit gum. Prepared beards and mustaches also are available. These are made on lace and can be used indefinitely. The bald or balding actor necessarily relies upon a hairpiece as a means of regaining a youthful appearance, but players of all ages and types depend upon hair goods to achieve realistic characterizations. The film *Marie Antoinette* (1938) called for 903 ornately fashioned white wigs and 1,200 less elaborate wigs for peasant extras. Another period movie, *Forever Amber*, required 4,402 wigs. In Cecil B. DeMille's *The Ten Commandments* approximately 7,500 hairpieces, including beards and mustaches, were used. (*See* also WIG.)

Make-Up for Colour Films.—The introduction of colour to motion pictures brought make-up problems of the most serious nature. Existing grease paint made some players appear to have jaundice. Other faces became bright red, blue or green on the screen. As colour film processes were improved, the need for a new type of make-up became mandatory. The problem was not one of merely developing new colours. Entirely new materials had to be created. After initial tests were conducted with a liquid make-up, which did not prove satisfactory, experiments were started in a completely new field of make-up principles. This resulted in the introduction of a spectacularly successful solid (Pan-Cake) make-up that was applied with a moist sponge. Instead of covering and concealing skin surfaces, the new material provided a light, transparent film of colour. It was first used in *Walter Wanger's Vogues of 1938* and later in *The Goldwyn Follies*. For the first time in history players appeared realistic and lifelike enough to convey the impression that they might at any time step down from the screen into the theatre. Soon Pan-Cake Make-up started replacing grease paint to a large extent, even for black-and-white films. Another highly successful material introduced for colour motion-picture use was a creamy foundation in semi-solid stick form. Make-up charts show the correct colours to use for each type of colour film.

The basic techniques of applying make-up for colour photography are virtually the same as those for black-and-white photography, except that colour photography demands even greater skill and perfection in application methods.

TELEVISION

Special make-up for television was created in 1932 as the result of tests conducted in collaboration with the pioneer Don Lee experimental television station, W6XAO, in Los Angeles. Four major phases of technical development have occurred in the evolution of television make-up. The first creation was a light-coloured monotone. Next came the "painted Indian" effect that employed the multiple colours that televised most naturally during the intermediate period of television. This was followed by the development of the modern series of colours in solid and semisolid foundations for black-and-white television. The fourth step was the creation of special materials and shades for colour television.

Although 11 shades of make-up eventually became available for black-and-white television, the average foundation make-up needs for the medium could be fulfilled with 6 colours from the middle range (4 to 9) of numbers. Colours in the lower numbers are light pastel pinks and beiges. In the higher numbers, they are tan, brown and dark brown. Without make-up, performers cannot expect to have attractive complexions on television. Light complexions become ghostly white. Dark complexions look dirty. Men who may be closely shaved appear to need a shave. Everyday make-up shades used by women televise too light or too dark and ordinary lipstick colours usually wash out. Screen make-up shades are equally unsatisfactory.

For colour television, various new materials and countless variations of colours were tested. The success of colour television depends largely on presenting natural-appearing human skin tones. It might be relatively unimportant if a green dress appeared blue on a colour-receiving set, but a performer with a green face would be ludicrous. The problem is complicated by the requirement that faces must appear lifelike on colour television and at the same time appear natural in the simultaneous black-and-white telecast. The make-up for colour television is available in about 12 shades in both solid and semisolid forms.

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(M. F.)

MAKEYEVKA, a town of Donetsk (formerly Stalino) *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., stands on the headwaters of the small Grusekaya river, 11 km. (7 mi.) E. of Donetsk city. Pop. (1959) 357,575. The town was founded in 1899, with the establishment of a metallurgical works, and has grown into a major industrial centre. Modern industries include large integrated iron and steelworks and a steel tubes plant. Makeyevka has become one of the largest coal mining centres of the Donets basin or Donbass and second in population in the *oblast* only to Donetsk. There are also other metalworking and coke-chemical plants and factories for pneumatic machinery, shoemaking and food processing. In the 1920s it was known as Dmitrievsk.
(R. A. F.)

MAKHACHKALA, a port and administrative centre of the Dagestan Autonomous Soviet Socialist Republic, U.S.S.R., stands on the eastern shore of the Caspian sea, at the northern end of a narrow coastal plain. Pop. (1959) 119,334. It was founded as the Petrovskoye fortress in 1844, became Port Petrovski in 1857 and was renamed in 1921 after Mohammed Ali DaKhadaev Makhach, a Dagestani national hero. Deposits of petroleum occur nearby and a pipeline runs from the Grozny field 90 miles distant. There is a refinery and much oil is shipped. A fishing fleet is based there, and industries include textile and footwear manufacturing, brewing, fish canning and cement making. Makhachkala has a branch of the Soviet Academy of Sciences, medical, agricultural and pedagogic institutes, and it has a Kumyk national theatre.
(R. A. F.)

MAKÓ, a town in the steppelands of the southeastern extremity of Hungary, 217 km. (135 mi.) from Budapest by rail. Pop. (1960) 29,935 (mun.). It is the administrative centre of Csanád *megye* (county) and lies near the north bank of the Maros river, a few miles upstream from its junction with the Danube. Makó is in tradition and appearance a "village town," surrounded by a fertile countryside. The municipality was for long in possession of much farming land; this produced abundant grain and onion crops. The herds of large-horned cattle were also much prized. Makó has long-established milling industries and more recent textile factories. It is a market centre and a crossing point of secondary and minor roads. The journalist Joseph Pulitzer was born in Makó.
(H. G. S.)

MAKONDE, a Bantu-speaking people of southeastern Tanganyika, numbering about 285,000 in the 1960s. They are closely related to the neighbouring Mwera (120,000) and Makua (95,000). Both Makonde and Makua spread into Portuguese East Africa (the population figures are for Tanganyika only). All these peoples reckon matrilineal descent; they lack centralized chieftainship and are cultivators of grain crops. Many of them now emigrate to other parts of the east African coast, and there are several thousands in Zanzibar. They are renowned for their woodcarving, which is in a style found nowhere else in east Africa but shows affinities with the carving of the southern Congo and northern Angola. *See* also TANGANYIKA: *The People;* AFRICA: *Ethnography* (*Anthropology*): *East Africa.*

See J. Dias, *Portuguese Contribution to Cultural Anthropology* (1962).
(J. F. M. M.)

MAKRAN (MEKRAN; Persian MOKRAN), the coastal region of southeastern Iran and southwestern Pakistan, extending along the Gulf of Oman for about 600 mi. from Ra's (cape) al Kuh to Las Bela (southeast Baluchistan). The Makran of Pakistan is sometimes known as Kech-Makran, to distinguish it from the Iranian region. The two together constitute Makranat, a term used by several historians. The long lateral valley of the Kech (Kej) river and the name Makran are associated in early geographies: thus the area was called Kej-Macoran by Marco Polo, who visited it in 1294. The name is applied in particular to a former province of Iran, now included in Iranian Baluchistan (*q.v.*), and to one of the former Baluchistan states, which became a district of the Kalat division on the integration of the state into the new province of West Pakistan in Oct. 1955.

The region consists mostly of mountains, the parallel ranges of which have a general structure east to west, including narrow valleys. Makran's 200-mi.-long sandy coast line in Pakistan is broken by the magnificent cliffs of Malan, the headlands of Ormara and Gwadar, the precipitous coast of Jabal Zarain (near Pasni), the bays of Charbar (Chah Bahar) and Gwatar (Gavater) and the inlet near Ra's-e Meydani. The volcanic action that preceded the upheaval of recent strata and the folding of the edges of the interior highlands is evidenced by occasional volcanoes of boiling mud. The coast is indented with several harbours: Ormara East and West bays (Dimi Zarr and Padi Zarr), Khor Kalmat, Pasni, Gwadar and Charbar, all of which are rather difficult of approach because of the sand bar apparently extending all along the coast, probably the remains of a submerged ridge. They are all subject to lively surf under certain wind conditions. Gwadar, which, with about 300 sq.mi. of hinterland, belonged to the sultanate of Muscat and Oman till 1958, is the most important harbour. Except in the Kech (upper Dasht) valley and that of the Bolida, an affluent of the Kech, there is not much cultivation. These two picturesque valleys have thick date palm groves, croplands and orchards. The principal spring crops (*jopag*) are wheat and barley, and the autumn crop (*eraht*) is jowar. Dates are, however, the crop par excellence of Makran. *Laghati* (compressed dates) constitutes the staple food of the poor. Subterranean channels (*karez*), pools in river beds (*kaurjo*) and springs are, besides floods, the sources of irrigation. Hills are generally barren with sun-cracked crags and ridges, with parched valleys between. The Rakhshan and Mashkel rivers, sweeping down from the Kalat highlands in Pakistan and the Kuh-e Bam Posht uplands of Iran, unite to break through the hills northward and form the lake and swamps of the Hamun-i-Mashkel and define the northern limits of Makran. In their valleys are narrow strips of very advanced cultivation, especially of dates. The Makran coastal waters are famous for the quality of their fish.

The etymology of the name is uncertain. Some scholars regard Makran as a corruption of Mahi-Khoran ("fish eaters"), identified with the Ichthyophagi (now represented by the Meds) who were mentioned in the *Indica* of the Greek historian Arrian. According to Lord Curzon, who was governor general of India (1899–1905), the name is Dravidian, which appears as Makara in the *Brihat Sanhita* of Varaha-mihira in a list of tribes contiguous to India on the west. The country was the ancient Gedrosia of the Persian and Macedonian empires and was the scene of the famous retreat of Alexander from India in 325 B.C. Lying on the route from west to east, it has been significant in the history not only of Baluchistan but also of Iran and India. The suzerainty over Makran gravitated sometimes to the west and sometimes to the east. Local tradition relates that, of the indigenous races, the Rinds, Hot and Maliks, who held sway after the Arabs, were followed by Buledais, who in their turn were ousted by the Gichkis from India. These fell under the suzerainty of Kalat in the mid-18th century.

There is a prominent Arab element, for the Arabs held Makran before they conquered Sind. More than half are Balochi, who are middle-class cultivators. Darzadis, regarded as of aboriginal descent, form the second largest group. They have a fine physique and are mainly artisans. The fishermen are chiefly Meds and Koras. The coastal Negroes are descended from imported slaves.

MAKRAN DISTRICT of Pakistan had a population (1961) of 146,990. Turbat (4,578), formerly the capital of the state, is now the district headquarters. Panjgur (2,032) in the Rakhshan valley is the chief town in the interior, and Pasni the largest town on the coast. Its port is being developed on modern lines. (K. S. AD.)

MALABAR CHRISTIANS, the name usually given to the autocephalous Eastern Church of the southwest coast of India acknowledging the Syrian Orthodox patriarch of Antioch as its spiritual head. The existence of an ancient church on the Malabar coast was made known to the west by the Portuguese, *c.* 1500. Its members, who believed that their founder was the apostle Thomas (*q.v.*), knew nothing of the papal obedience nor the Chalcedonian decrees. Regarded as Nestorian heretics and schismatics, they were made to accept the pope at the synod of Diamper (1599), but in 1653 about half became Syrian Orthodox in allegiance (*see* ANTIOCH, SYRIAN ORTHODOX PATRIARCHATE OF). In the 19th century, under the influence of English missionaries, a

reforming group broke away and came to be known as the Mar Thoma Church. A few families became Anglican. Thus, there are four sections: the Syrian Roman Catholic, the Syrian Orthodox, the Mar Thoma and those former Malabar Anglicans now in the Church of South India.

In the first half of the 20th century the Syrian Orthodox were deeply divided, one section recognizing the jurisdiction of the patriarch of Antioch, the other the Indian catholicos of the east. After much litigation, these two churches were again united in 1958. In worship and doctrine the Malabar Christians are purely Syrian; their liturgical language is Syriac, though largely translated into Malayalam. In culture and ways of life, however, they are Indian, and their family pride and communal exclusiveness enabled them to fit easily into the Hindu caste system. The 20th-century breakdown of caste and renewed contact with other churches has given them a wider outlook; they are to be found all over India.

See L. W. Brown, *The Indian Christians of St. Thomas* (1956).

(L. M. Sc.)

MALABAR COAST, a term long applied to the southern part of the western coast of India, roughly from Goa southward. Occasionally it has been extended to the whole western coast of peninsular India. Until 1956 Malabar was also the name of a district (whose chief town was Kozhikode or Calicut) in Madras. The Malabar coast is perhaps best defined as being coextensive with the old kingdom of Chera, thus including most of Kerala state together with parts of Kanara (now in Mysore) and lying between the Western Ghats or their southern extension and the sea. The people speak Malayalam and have many customs and traditions peculiarly their own. Cochin is the only important port.

The coast trends in a south-southeasterly direction with a few headlands and small bays. Powerful waves breaking on shore during the period of the southwest monsoon have piled up a continuous belt of sand dunes largely clothed with coconut palms that yield coconuts and coir. Behind this belt is an almost continuous succession of shallow lagoons and backwaters round which are rice-growing lands and numerous villages. Connected by artificial canals, they form sheltered waterways much used by local traffic. Inland the land rises in wet forested hills, with valuable timber, to the crest of the Ghats. The Southern railway from Madras, passing through the Palghat gap, reaches the coast south of Kozhikode and is continued northward to Mangalore.

(L. D. S.)

MALACCA, a state of Malaya in the Federation of Malaysia (*q.v.*), constituted in 1957 under a governor appointed on the advice of the federal government; a town of the same name is its administrative capital.

The state was previously a civil division known as Settlement of Malacca, a British colony which it became in 1824 by arrangement with the Dutch in exchange for Bencoolen (Bengkulu) and a few other minor places in west Sumatra following the Napoleonic Wars. (*See* MALAYA.) The state, covering 640 sq.mi., has a population of 335,127 (1961 est.); the racial composition according to official returns was 49.1% Malaysian, 41.5% Chinese and 8.1% Indian. It is shaped like a triangle and is framed by the west coast and boundaries with Johore to the south and Negri Sembilan to the north and east. Low hills reach the sea to form a coast that was more hospitable to settlement than were other parts of the west Malayan lowlands.

Substantial agricultural production of *padi* ("rice") was possible from early times. Malacca now has less forest than any other Malayan state; by the early 1960s it had about 27,000 ac. under *padi*, chiefly along the slow-flowing rivers, and 215,000 ac. under rubber. The rubber production indicates an evolution of highly commercialized agriculture consequent to early established overseas trade connections. Malaccan Chinese, now about a third of the rural population, were the first to go into rubber planting following its introduction by the British and there are now large areas of Chinese estates and small holdings. In the Kesang river to the south there is a little mining for tin (by Chinese) but production in the 1960s was insignificant. The Malays maintain their rice-growing tradition but, profiting by long contact with resident Chinese, many have also taken to small rubber holdings.

The state has mosques in the rural areas and Chinese temples in the villages; a strong Roman Catholic tradition is also maintained. There are small market towns at Alor Gajah and Jasin.

MALACCA town (pop. [1957] 69,848), roughly midway along the coast, lies astride the sluggish Malacca river 125 mi. N.W. of Singapore. Immediately to the south on a low hill stand the ruins of a 16th-century fort built by Affonso de Albuquerque, viceroy of the Portuguese Indies, who conquered Malacca to acquire the rich far eastern trade already established there by Chinese, Indians and Arabs. The small Malacca estuary, then kept open only by two long moles that deflected the heavy longshore drift, sheltered the Asian sailing craft from the strong local squalls, which were dangerous because of shallows, banks and rocks offshore. Early trading vessels were attracted there by local food supplies and freshwater springs at the foot of the Malacca hills. The approaches proved inadequate as European shipping increased in draft and volume.

Until World War II a railway spur linked Malacca to the main lines through the peninsula, but ocean-going commerce thereafter declined and the harbour facilities (limited to offshore anchorage) are negligible. Peninsular trunk-road traffic bypasses the state which however retains road links to Kuala Lumpur and Singapore, the Singapore road being hindered by ferries across the rivers of Johore.

The town is a sun-drenched, sleepy backwater with single-storied houses, including many relics of the Dutch and Portuguese colonial periods. It is now mostly occupied by Chinese, some of whose families have been settled there for four centuries and have adopted the dress and speech of the Malays, with whom they have intermarried; this mixed strain, together with Malay-Portuguese-Dutch admixtures, is a feature unique in Malayan peoples.

THE STRAIT OF MALACCA, a sea link between latitudes 6° N. and 1° N. from the Indian ocean to Singapore strait and the South China sea, has a funnel shape, barely 40 mi. wide in the south, broadening northward to 300 mi. between Sabang and the Kra isthmus. Subject to tides from the Indian ocean, the strait is silting on both sides, particularly south of Medan, where it has formed the huge, low-lying swamp forest of east Sumatra. It has been the scene of major historic movements of early Hindu colonists, of Arabic merchants trading oriental produce to classical and medieval Europe and of Portuguese, Dutch and British navigators and traders. During the 20th century the strait was the channel by which Chinese immigrants moved to trade and to settle along both Sumatran and Malayan shores, where all towns and villages contain large numbers of Chinese. The strait continues to be one of the world's most used shipping channels, almost a natural Suez canal, but intracoastal trade is negligible. *See* also references under "Malacca" in the Index.

(E. H. G. D.)

MALACHI (MALACHIAS), **BOOK OF,** the last book of the English Protestant and the Eastern Orthodox Old Testament (followed in Roman Catholic Bibles by the Books of Maccabees), one of the 12 Minor Prophets; in the Hebrew Bible it appears at the end of the Prophets, the second of the three major divisions of the Hebrew canon (Law, Prophets and Writings). The book is anonymous, the name Malachi ("my messenger") being taken from the opening words of ch. iii, "Behold, I send my messenger to prepare the way before me." Since the two preceding sections of the canon of Scripture (Zech. ix–xi and xii–xiv) are also by general agreement anonymous compositions, and also, like Malachi, each begins with the curious word "oracle" (or, as in the King James and Douai versions, "burden"), it seems probable that these three collections of unidentified prophetic discourses were at one time simply added to the end of the book of the Minor Prophets as an appendix. Later, when it was felt desirable to have exactly 12 divisions, the first two of these anonymous collections were included in the Book of Zechariah while the third, of very different character and origin, was set apart as a separate division and given a title arbitrarily derived from iii, 1.

Contents and Themes.—The book may be outlined as follows:

i, 1:	superscription
i, 2–5:	punishment of the Edomites
i, 6–ii, 9:	corruption of the priesthood

ii, 10–16:	degradation of marriage
ii, 17–iii, 5:	divine judgment to come
iii, 6–12:	sins of the common people
iii, 13–iv, 3:	argument based on the coming judgment
iv, 4–6:	conclusion

The time was one of spiritual depression. The promised age of supernatural prosperity and universal dominion which should have followed the end of the Babylonian Exile (Isa. xlviii, 20 ff.; xlix, 22 ff.; liv, 1 ff.) had failed to materialize; the small body of faithful people who had attempted to restore the glories of ancient Israel found that life in their ancestral land was a series of discouragements—poverty and famine (Hag. i, 6), drought (Hag. i, 11), internal strife and social disorder (Isa. lix, 3–15). As a result, the services of the Temple were neglected and there was widespread skepticism in regard to the justice of God and his good will toward his people. It was to this situation that the oracles preserved in the Book of Malachi were addressed. The prophet had a threefold answer to those who doubted the justice of God: First of all, he pointed out that God had but recently manifested his continuing favour toward the people of Israel ("Jacob") by punishing their treacherous neighbours, the Edomites ("Esau"), who had been driven out of their homeland by Arabs from the desert (the Nabataeans). In the second place, if Israel failed to be prosperous, it was not to be wondered at in view of the nation's shameful neglect of the Temple services, a neglect to which no parallel could be found even among the heathen (i, 11). Finally, even though there might seem to be grounds for complaint in the apparent inequities of the present age, these would be eliminated in the final divine judgment which was to come, when it would be evident who had served God faithfully and who had not (iii, 18).

Literary History.—Although neither the name of the prophet nor the events of his life are known, there is a general consensus as to his date and the historical circumstances in which his oracles were uttered. The land was ruled by a governor (i, 8), not a native king; the Temple had been rebuilt (i, 10; iii, 1, 10) and the services had been carried on long enough for both priests and people to become somewhat weary of them (i, 7, 12, 13); the lethargic spiritual life of the community had not yet been stirred by the reforms of Nehemiah and Ezra (whose activity is almost certainly to be dated after 444 B.C.); while the Law code presupposed by the book seems to be that of Deuteronomy (introduced in 621 B.C.) rather than the later Priestly Code, which modern scholars are inclined to associate with the work of Ezra. All these indications point to a date in the Persian period toward the middle of the 5th century B.C. Inasmuch as the abuses attacked by the prophet are similar to those that were to be the principal concern of Nehemiah, the book may safely be dated shortly before his arrival, and therefore *c.* 450 B.C.

The last three verses of ch. iv, important as background for certain passages in the New Testament, are not properly a part of Malachi but are rather a late editorial conclusion to the entire collection of the Twelve (Minor) Prophets.

Interpretation.—Brief as it is, Malachi contains several remarkable passages which are worthy of special notice: In i, 11 the prophet suggests that the worship that the gentiles ignorantly offer to God may be more pleasing than the careless, though better instructed, worship of his own people (the translation of the Revised Standard version is to be preferred). In ii, 10 (with which *cf.* i, 6), the doctrine of God's Fatherhood is made the major premise of an argument that men (the Jews, at least) should live as brothers. In the following verses this principle is applied specifically to the manner in which the privilege of divorce was currently abused, the passage concluding with the striking words "I hate divorce, says the Lord" (ii, 16). These magnanimous sentiments, which are scarcely paralleled elsewhere in the Old Testament, show that a priestly and ritualistic type of Judaism such as that represented in this book was not necessarily incompatible with profound ethical sensitivity.

BIBLIOGRAPHY.—The chief modern commentaries in German are those by F. Horst (1936, 1954) and K. Elliger (1956); in English, there are commentaries by G. A. Smith (1898, 1927), S. R. Driver in the *Century Bible* (1906), J. M. P. Smith in the *International Critical Commentary* (1912), and R. C. Dentan in the *Interpreter's Bible* (1956).

(R. C. DE.)

MALACHITE, a bright green mineral, consisting of a basic copper carbonate. It is one of the commonest ores of copper and perhaps the most conspicuous, being a useful guide in prospecting. It is found in the upper oxidized portions of copper deposits, and is formed by the action of water, air and carbon dioxide on primary copper sulfides, especially where calcium carbonate is present. The soluble copper salts set free by oxidation of the sulfides react with limestone or other carbonates and precipitate the insoluble malachite. The mineral is found in nearly all copper-mining districts; specially fine specimens have come from various mines in the U.S.S.R., where it has often been used as a polished ornamental stone. Other well-known localities for good specimens have been the Copper Queen mine, Bisbee, Ariz., the old Burra Burra mines, Kooringa, South Australia, and southwest Africa.

The composition of malachite is $CuCO_3Cu(OH)_2$. It belongs to the monoclinic system, but rarely forms good crystals, occurring mostly as nodular, botryoidal (grapelike) or reniform (kidney-shaped) masses, with pronounced radial and concentric structure, successive layers often varying much in colour. It may also be quite compact or earthy and often forms thin films or mere stains on rocks. It is very commonly associated with the deep blue azurite (*q.v.*). The density is about 4 and the hardness 3.5–4.0. It is soluble in acids with effervescence. (R. H. RA.)

MALACHOWSKI, STANISLAW (1735–1809), Polish statesman who dominated the historic Four Years' diet of 1788–92, was born at Konskie, the son of the grand chancellor of the crown, Jan Malachowski (1698–1762). When the diet met in 1788, he was elected its marshal or speaker. Tactful, authoritative and conspicuously honest, he worked tirelessly for reform of the Polish state in order to give it sound finances and a strong army; and he was one of the framers of the constitution of May 3, 1791, exceeding all his colleagues in liberalism and advocating the extension of the franchise to the towns (*see* POLAND: *History*).

In 1807, during the Napoleonic Wars, Malachowski was appointed head of the executive committee set up in Warsaw after its evacuation by the Prussians; and when the duchy of Warsaw was created he became president of the senate. In the negotiations with the Austrian government concerning the Galician salt mines he assisted the treasury by mortgaging all his estates as an additional guarantee. He died in Warsaw in 1809.

See E. Michalski, *Stanislaw Malachowski, marszalek Sejmu Czteroletniego* (1936).

MALACHY, SAINT (MAEL MAEDOC UA MORGAIR) (1094–1148), archbishop of Armagh and papal legate in Ireland, the prominent figure of church reform in the 12th century, was the son of the *ard fer legind* (chief lecturer) at the school of Armagh, Mugron Ua Morgair. Before 1119, Malachy put himself under the spiritual direction of the recluse Imar Ua hAedagain. He was ordained priest in 1119. When Cellach, the reforming bishop of Armagh, took into his hands the bishopric of Dublin, vacant by the death of Samuel (1121), he appointed Malachy to rule Armagh. The young priest undertook to bring the Irish church to accept the general reformation then in full motion on the continent and associated with Pope Gregory VII. Malachy later returned to the monastic life, at Lismore, under the guidance of another reformer, Mael Isa Ua hAinmire (Malchus). In 1124 he was consecrated bishop of Connor (and Down) and restored the monastery of Bangor (County Down), but violent disputes about the succession compelled him to go south again to Lismore.

Cellach on his deathbed (1129) tried to persuade Malachy to abandon his monastic retreat and to accept the succession of Armagh, both as abbot and as archbishop, in a way of devolution directly contrary to time-honoured Irish custom, thus to establish the cardinal principle of reform throughout Ireland. Malachy felt that opposition would be too strong just then, but three years later, deferring to the instances of Bishop Malchus and of Gilla Espuic (Gillebertus), bishop of Limerick, he went north to take up his burden. For five years he ruled the diocese and the whole province of Armagh without setting foot in the city, leaving the temporalities to Muirchertach and to Niall, son of Aed, who came after him. At last, in 1137, he had Gilla mac Liag (Gelasius), the abbot of Derry, appointed in his stead at Armagh, and returned to Down.

In 1139 he set out from Ireland to solicit from the pope the pallium for Gilla mac Liag. Innocent II made him papal legate in Ireland, but refused to grant the pallium until it had been unanimously applied for by a "general council of the bishops, clergy and nobles." Malachy took the opportunity to visit Clairvaux and thus began his friendship with St. Bernard. He introduced the Cistercians to Ireland by founding Mellifont (1142). To promote the reform of the Irish dioceses, Malachy also introduced the canons of Arrouaise, who followed the rule of St. Augustine, to serve the cathedrals. On his second journey to Rome to make fresh application for the pallium he died in the arms of St. Bernard at Clairvaux in the night between Nov. 2 and 3, 1148. The object of his life, the establishment of a regular hierarchy, was realized at the council of Kells (1152). He was canonized in 1190 and his feast day is Nov. 3.

No writings of St. Malachy are known to exist, but his name was attached to the Prophecy of the Popes by a 16th-century forger whose sources, though not his motives, have been demonstrated. It consists of a list of mottoes supposed to fit the popes from the mid-12th century to the end of time (the last being Peter II). Up to *c.* 1590 they allude to the popes' names, places of origin and careers before their election, never to their activities as pontiffs; the remaining mottoes, supposed to predict the future, are vague devices deprived of any connection with historical realities. It was first published (and ascribed to Malachy) by a Belgian Benedictine monk, Arnold Wion, *Lignum vitae*, book ii, ch. 40 (1595), and often reprinted. The critical view is set forth by H. Thurston and by E. Vacandard. An alleged prophecy of St. Malachy on the length of English domination in Ireland and a third on the succession of the kings of Castile are still more modern concoctions.

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For the Prophecy of the Popes, *see* H. Thurston, *The War and the Prophets* (1915); E. Vacandard, *Études de critique et d'histoire religieuses*, vol. iv (1923). For the other prophecies, *see* P. Grosjean, *Analecta Bollandiana*, vol. li (1933) and vol. liv (1936).

(PL. GN.)

MALACOSTRACA, the largest subclass of Crustacea (*q.v.*), including the shrimps, crabs, lobsters, beach "fleas," sowbugs and their near relatives. Excepting the Leptostraca, they may be defined as Crustacea having the body composed of 19 somites, all typically bearing appendages, the trunk limbs differentiated into two series, a thoracic of eight and an abdominal of six pairs; and the genital openings of the female on the sixth, those of the male on the eighth thoracic somite.

ORIGIN AND RELATIONSHIPS

On the basis of the comparative morphology of the Malacostraca a scheme for the probable course of evolution of the group may be drawn up that is, at least, not contradicted by the scanty knowledge of its fossil representatives. According to this scheme, the earliest Malacostraca exhibited what has been called the "caridoid facies"; that is to say, they were shrimplike in general form, with a carapace enveloping but not coalesced with the thoracic somites; with stalked eyes; two-branched, or biramous, antennules, and a scalelike exopodite on the antenna; with the thoracic limbs forming walking legs having swimming exopodites and branchial epipodites and a tendency for one or more of the anterior pairs to be assimilated to the mouth parts as maxillipeds; and with the abdominal appendages forming biramous swimmerets, except the last pair, which are large, lamellar, and form with the telson a "tail-fan."

The earliest fossils that can be definitely referred to the Malacostraca occur in the Carboniferous rocks and present, with little modification, the caridoid facies described above. Some of them (*Pygocephalus*) have a brood pouch formed by overlapping plates (oöstegites) from the bases of the thoracic legs and appear, therefore, to be referable to the order Mysidacea. From the caridoid Mysidacea a series can be traced in which the carapace is progressively reduced, the thoracic exopodites are lost and the eyes become sessile. Although paleontology gives no help, the steps of this series are indicated by the specialized offshoots that have given rise to the orders the Cumacea, Thermosbaenacea, Tanaidacea and Isopoda. The Amphipoda belong to the same series but their precise place in it is less clear. The other orders of Malacostraca have no brood pouch and appear to have diverged very early from the primitive stock.

Already in Carboniferous times the Syncarida had lost the carapace and had much the same general structure as the recent *Anaspides* and its allies. Another series in which the carapace coalesced with the thoracic somites gave rise to the great group of the Decapoda, from which the Euphausiacea are perhaps an offshoot. The Decapoda, beginning with caridoid forms, have, in several independent lines, assumed the crablike or "carcinoid facies" by reduction of the abdominal region (Brachyura or true crabs, and crablike Anomura). The Stomatopoda had assumed nearly their typical structure in Jurassic times, but their earlier history is unknown.

This phylogenetic scheme so far has dealt with only certain groups of the series Eumalacostraca. The rest of the malacostracans, belonging to the series Leptostraca, are generally considered primitive, forming a link with the subclass Branchiopoda. They differ from the other Malacostraca in having an additional somite in the abdomen, the telson terminating in a "caudal fork," and a bivalve carapace provided with an adductor muscle. The thoracic limbs are more or less flattened and leaflike and have a general resemblance to the trunk limbs of the Branchiopoda, though a close comparison is difficult. The existing genera, *Nebalia* and its allies, are believed to show affinity with the fossil *Ceratiocaridae*, the earliest of which appear in Cambrian rocks and are thus vastly more ancient than any other Malacostraca. Recent work, however, tends to diminish the significance of the differences between the Leptostraca and Eumalacostraca, and, in particular, the recognition of a vestigial seventh abdominal somite in certain primitive Mysidacea suggests that the Leptostraca may be related more closely to the peracaridan malacostracans than has been supposed.

CLASSIFICATION AND SURVEY

The six superorders of Malacostraca assigned to the Leptostraca (1) and to the Eumalacostraca (2–6) are as follows:

Phyllocarida.—This group, the sole superorder under the series Leptostraca, may be characterized in part by a large carapace that is not fused with any of the thoracic somites, by stalked eyes and by an abdomen of seven segments (six in all other Malacostraca). The single order, Nebaliacea, includes only three or four living genera, all marine mud burrowers, in part scavengers. They are widely distributed in all seas, usually occurring at moderate depths. Some, such as the large *Nebaliopsis typica*, which attains a length of more than 1½ in., live at depths exceeding 1,000 fathoms. The doubtful affinities of these Leptostraca are mentioned above.

Syncarida.—A small group of fresh- and alkaline-water survivors of crustaceans that lacked a carapace and were more widely distributed in Carboniferous and Permian times. Included are the stalk-eyed mountain shrimp (*Anaspides*) of Tasmania; the sessile-eyed *Koonunga* in the Australian region; and the Bathynellidae, minute, blind, subterranean forms from central Europe, Africa, South America, India and some Indo-Pacific islands.

Pancarida.—The Thermosbaenacea are the only order of this superorder. The known species are minute, blind crustaceans, up to several millimetres long, with a carapace covering thoracic segments one to three and forming a dorsal marsupium characteristic of the group. One, *Thermosbaena mirabilis*, is found in Tunisian hot springs (temperature 120° F. or more); a few closely related species of *Monodella* occur in fresh and brackish subterranean waters in Italy and Yugoslavia.

Peracarida.—A carapace, if present, is not fused with more than four thoracic somites; eyes, when present, are stalked

(Mysidacea, stalks movable; Tanaidacea, stalks fixed) or sessile (Cumacea, Isopoda, Amphipoda). The Mysidacea comprise generally small shrimplike swimming forms, nearly all marine. They are called "opossum" shrimps because of the brood pouch formed of oöstegites attached to the coxae of the thoracic legs, in which the young undergo their entire metamorphosis after hatching out as nauplius larvae. Their size range is considerable, running from the tiny *Anchialus pusillus*, $\frac{1}{8}$ in. long, to *Gnathophausia ingens*, which may attain almost 14 in. in length. Probably all serve as the food of other animals. Several species occur in fresh water. One of these is *Mysis relicta*, a widely distributed lake dweller in the northern hemisphere.

The Spelaeogriphacea are cave-dwelling forms scarcely more than half a centimetre long, with club-shaped, movable ocular plates, or lobes, lacking visual elements or pigment. As in other Peracarida the brood pouch or marsupium is ventral. Cumacea are marine mud burrowers but the males are, to some extent, free swimming. Tanaidacea are also part of the microfauna of the sea bottom, less able to swim than the Cumacea.

Isopoda are a very varied and successful group, creeping, mud-burrowing and sometimes actively swimming in the sea and a few in fresh water. The destructive wood-boring crustaceans are principally isopods. The most widely distributed of them in both Atlantic and Pacific oceans, the gribble (*Limnoria lignorum*) is often accompanied by a boring amphipod, *Chelura terebrans*. Next to the molluscan shipworms or teredos, the tiny gribble ($\frac{1}{8}$ to $\frac{1}{6}$ in. long) is the worst known destroyer of submerged timbers. Infested piling may carry 300–400 individuals to the square inch of surface in favoured localities. An untreated test piece of Oregon fir 5 ft. long by 3 in. square, set in Port Jackson, Austr., was 60% destroyed in six months by a combined attack by *Limnoria* and *Chelura*. By the time nine months had elapsed, it was utterly riddled, with the assistance of shipworms that had by this time invaded the timber. Several species of *Sphaeroma*, though larger ($\frac{3}{8}$ in. long, more or less), also attack wood, but not so generally as *Limnoria*, and less in American than in Australian waters. *Sphaeroma quoyana* is reported to have honeycombed claystone or "papa rock" used in harbour works in New Zealand to such an extent that blocks of concrete overlaying it sank several feet.

Parasitism appears in many different families and leads to extremes of specialization and degeneration. One suborder, Oniscoidea, consists of the terrestrial, air-breathing wood lice. Creeping and swimming forms of Amphipoda, another varied and successful order, abound in fresh water and in the sea. A few of these sand-hoppers or beach "fleas" may become wholly terrestrial. The vast majority of amphipods belong to one suborder (Gammaridea), that includes both free-living and parasitic forms; members of a smaller suborder (Hyperiidea) are planktonic, occur at times in vast swarms and are consumed in great quantities by seals, cetaceans and other marine animals; a third suborder (Caprellidea) contains the exclusively parasitic family Cyamidae, the whale lice.

Eucarida.—This group is recognized by stalked eyes and the carapace fused dorsally with all thoracic somites. The order Euphausiacea is a small group of planktonic, phosphorescent shrimps, except for a few living in the deep sea at 1,000 fathoms or more. The pelagic, open-sea species are important food of whale-bone whales. The Decapoda, on the other hand, form the most extensive and diversified of all the orders of Crustacea. It includes the largest representatives of the class and, indeed, of all living Arthropoda, and, since many of them are used for food, they are more generally familiar and more thoroughly studied than any other Crustacea. They are classified into two suborders: —Natantia, comprising the shrimps and prawns; and Reptantia, comprising three sections, burrowing shrimps, true and spiny lobsters, crayfishes and their relatives (Macrura); hermit and lithodid crabs, sand bugs and allied forms (Anomura); and true crabs (Brachyura). The headquarters of the group is in the sea but many of its members have invaded fresh waters (river prawns and river crabs in the tropics and crayfishes in temperate regions). Although a few are so far terrestrial as to deserve the name of land crabs, and may—like the coconut or robber crab—even climb lofty trees, they all pass their young stages in salt or fresh water.

Hoplocarida.—The members of this superorder differ from all other Malacostraca in having the first antennae and the stalked eyes attached to movably articulated segments of the head. The carapace is small and shallow, fused with two or three thoracic somites, leaving four well-developed somites free. Species of the single order Stomatopoda are sometimes known as "mantis" shrimps from the resemblance of their large prehensile claws to those of the mantis insect. They are exclusively marine, burrowing in sand or lurking in crevices in the shallow waters of all the warmer seas. A few go into brackish water. Many species are rare, known only from a few specimens, yet others are found in greater abundance, such as *Squilla investigatoris*, of which 500 were taken in a single haul from 110 fathoms in the Indian ocean.

Despite their vicious claws, they have numerous enemies among the fish and octopuses. They are much used for food in the Mediterranean region, in the Philippines, Malaya and elsewhere. In Japan they are cheaper than other edible crustacea. One of the largest stomatopods on record is a Philippine specimen of *Lysiosquilla maculata*, slightly more than 15 in. in length.

See CRAB; CRAYFISH; HERMIT CRAB; LOBSTER; SHRIMP; WOOD LOUSE. (W. T. C.; W. L. Sr.)

MÁLAGA, a city of southern Spain in the region of Andalusia, the capital of a province of the same name. It is situated on the Mediterranean in the centre of the Costa del Sol, 140 km. (87 mi.) S.W. of Granada by road. Pop. (1960) 301,048. The Guadalmedina river, which before the construction of the dam at Agujero caused frequent severe flooding, flows through Málaga from north to south, while above the city towers the Monte de Gibralfaro, crowned by an ancient Arab fortress. Sheltered from the north winds by the surrounding sierras, Málaga enjoys a mild climate throughout the year, the temperature almost never falling to the freezing point. Nearby are a number of shallow beaches some of which, *e.g.*, Marbella and Fuengirola, have pine woods reaching to the seashore. The city is a popular centre for water sports.

The main streets of the city are the Calle del Marqués de Larios, with fine marble paving; the Calle de Granada; and the Avenida del Generalísimo Franco. At no. 16 in the Plaza de la Merced is the house where the artist Pablo Picasso was born. The cathedral, in the centre of the old city, was begun in 1528 on the site of a mosque; the interior, main façade and one of the towers were completed in 1782, but the second tower remains unfinished. The choir contains carvings by Pedro de Mena. Other important churches are those of Santisimo Cristo de la Salud, Sagrario and Victoria, the latter being notable for the macabre decorations on the tomb of the Villalcázar de Sirga. The provincial museum of art has a collection of 17th-century masterpieces, as well as modern works including some by Picasso. The Muslim castle, the Alcazaba, has been reconstructed as a museum and garden, but the Gibralfaro fortress remains in its original form.

Málaga is the foremost Spanish port on the Mediterranean after Barcelona. Its harbour can accommodate more than 30 vessels of medium tonnage and it possesses a silo for wheat with a capacity of 4,000 tons and automatic operation. There is a dry dock capable of handling small vessels. The main exports are dried fruit, almonds, iron, olive oil, oranges, lemons, olives, canned anchovies and the famous Málaga sweet wine; principal imports are petroleum, manufactured goods, corn, chemicals, iron and steel. A railway connects Málaga with Granada, Córdoba and other points in Spain. Air services to Madrid operate from Churriana airport 8 km. (5 mi.) S.W. The principal industries of the city are concerned with the manufacture of building materials and foodstuffs.

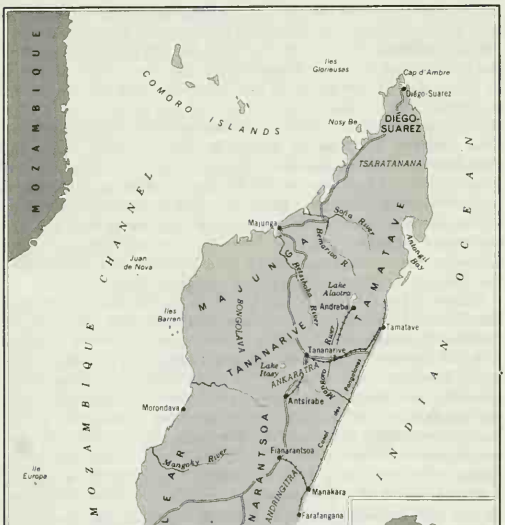
Málaga was founded by the Phoenicians in the 12th century B.C. It was conquered successively by the Romans and the Visigoths, and was taken by the Moors in 711. Under Muslim rule it became one of the most important cities in Andalusia. When the caliphate of Córdoba disintegrated, the kingdom of Málaga was founded, ruled over by amirs who named it "terrestrial paradise." After several unsuccessful attempts, the Christians took the city on Aug. 14, 1487. It was occupied from 1810 to 1812 by the French. In 1831 it was the scene of an abortive revolutionary attempt by

53 insurgents who landed there from Gibraltar.

MÁLAGA PROVINCE, one of the eight modern subdivisions of Andalusia, is bounded on the west by Cádiz, north by Seville and Córdoba, east by Granada and south by the Mediterranean. Area 7,276 sq.km. (2,809 sq.mi.). Pop. (1960) 775,167. The northern half of the province belongs to the Andalusian plain watered by the Guadalquivir; the southern is mountainous and rises steeply from the coast, along which there is a narrow strip of lowland. The Sierra de Alhama, separating the province from Granada, rises above 6,800 ft.; it continues westward in the Sierra de Abdalagís. Not far from the Cádiz boundary the sierras of Ronda, Mijas, Tolox and Bermeja converge in a summit of nearly 6,500 ft. The principal river is the Guadalhorce, rising in the Sierra de Alhama; the only other considerable stream is the Guadiaro. There is an extensive salt lagoon near the northern boundary. The province is largely agricultural, and fruits, vegetables, olives and grapes are raised along the coastal lowlands and in the rich interior valleys. The vineyards were severely affected by the *Phylloxera* outbreak of 1878. There are considerable mineral resources in the mountains, chiefly iron and lead. Besides Málaga, the most important cities in the province are Ronda, with its 330-ft.-deep gorge separating the old and modern parts of the town, and Antequera, which has in its neighbourhood the famous Menga, Viera and Romeral caves. The almost tropical climate of the coast makes it a popular tourist resort; the district of Torremolinos, 12 km. (7 mi.) S.W. of Málaga, is noted for its beaches. There is a national hunting region in the Serranía de Ronda, 12 km. (7 mi.) from Marbella. (A. C. A.)

MALAGASY REPUBLIC (RÉPUBLIQUE MALGACHE) occupies the island of Madagascar and minor adjacent islands in the Indian ocean off the east coast of Africa. It was a French colony from 1896 to 1946, a territory of the French Union until 1958 and thereafter a member state of the French Community.

Madagascar is one of the largest islands in the world. Its area is 229,849 sq.mi., with a maximum length of 995 mi. and a maximum width of 360 mi. It lies in the southern hemisphere between latitude 11° 57′ and 25° 38′ S. and longitude 43° 12′ and 50° 17′ E. and is thus almost entirely within the tropics; the Tropic of Capricorn crosses the southern end of it. The Mozambique channel separating it from Africa is 248 mi. wide at its narrowest part. Madagascar is surrounded, at a distance of 185 mi. to 560 mi., by small groups of volcanic islets: the Comoro Islands, the Mascarene Islands and the Seychelles (*qq.v.*).



MAP OF MALAGASY REPUBLIC SHOWING PHYSICAL FEATURES, MAJOR TOWNS AND TRANSPORTATION ROUTES

PHYSICAL GEOGRAPHY

Geology and Paleontology.—The former hypothesis that the island of Madagascar was at one time part of Gondwanaland (*q.v.*), an immense continent joining southern Africa to India, is now disputed. It seems probable that a gulf corresponding to the southern part of the Mozambique channel existed from the end of the Paleozoic era and that the subsidences or slow driftings that have brought the island to its present position took place at the beginning of the Mesozoic era. Very ancient Pre-Cambrian foldings have affected an assemblage of paragneissic formations with granitic intrusions. On these formations rest three more recent series, also traversed by granitic intrusions of which the youngest, schists and quartzites, are of the Devonian period; they have been distorted by movements of the Hercynian orogenesis, as is shown by the faults and subsidences that divide up the central massif. The interior of the island has the appearance of a horst to which are opposed the western plateaus with their regular sedimentary layers. From the foot of the hills to the Mozambique channel the strata run from Carboniferous to Middle Jurassic; these formations are called Karroo by analogy with the similar African ones. At the end of the Cretaceous, the sea invaded the east coast for the first time; the advances and withdrawals of the sea occurred from then on in regular succession and different layers accumulated: Upper Jurassic marls, Cretaceous marl-sandstone deposits, Eocene and Miocene limestones that seem to mark the end of marine sedimentation. The Neogene is continental everywhere, yellow sands on the west coast, southern clay sheets passing into the Androy sands laterally, lacustrine deposits in the interior. Tertiary movements have only slightly modified the sedimentary layers of the coastal regions, but have on the other hand violently affected the old shelf. Ancient fractures have come together again and new ones have appeared, accompanied by volcanic manifestations everywhere. Cretaceous eruptions showed in basaltic flows, Miocene eruptions in the extreme north, pro-Quaternary eruptions represented by basaltic flows and the recent systems of the Montagne d'Ambre, of the Ankaratra and of the Itasy. Violent earthquakes have often shaken the island and still bear witness to the strength of orogenic forces.

Numerous fossil remains have shown the existence of a whole giant fauna, giant land tortoises and Lemuridae (*Megaladapis, Archoeoindris*) much bigger than the modern species. A giant bird, *Aepyornis,* was perhaps contemporary with the first inhabitants of the island. It was about the size of an ostrich, but it was completely wingless and had enormous feet. Its eggs, whose fossils have been found until recently, were bigger than ostrich eggs. Reptiles also seem to have been very large, *e.g.*, the *Bothriospondylus,* related to the *Diplodocus,* which measured more than 66 ft. Finally, traces of fossil fishes whose species have disappeared are very often found in the lacustrine deposits.

Relief and Drainage.—Madagascar consists of three large parallel longitudinal zones: the central plateau formed from ancient systems; a narrow littoral strip to the east; and a zone of sedimentary formations comprising low plateaus and vast plains to the west.

The Plateau.—Between 2,500 and 4,500 ft. the plateau is composed of ancient crystalline and eruptive rocks. It has been several times folded and worn down and is tilted to the west where the slope is less sheer than it is to the east. The whole is covered with a red soil, a lateritic clay resulting from the breakdown of the rocks by rain and heat, which owes its colour to the iron oxide it contains. Where this red soil is covered with humus it bears forests and crops, but where it has been leached it forms a sterile lateritic covering.

EDITIONS HOA-QUI

PLATEAU LANDSCAPE NEAR TANANARIVE (ANTANANARIVO)

Three massifs of the plateau are over 6,500 ft. in height: the Tsaratanana in the north, separated from the rest of the plateau by the ridge of Androva, whose volcanic summit (9,468 ft.) is the highest point on the island; the Ankaratra in the centre, an enormous volcanic mass whose summit, Tsiafajavona, is 8,674 ft. high. The Ankaratra is a watershed separating three basins: the Imerina in the centre of the island where Tananarive (Antananarivo) stands on the Betsimitatra plain; the Itasy with its famous lake of volcanic origin; the Vakinankaratra, full of extinct volcanoes and hot springs. Farther south, the Andringitra, a vast granitic massif, dominates the Betsileo district. The plateau slopes more regularly toward the extreme southern plain but its boundaries to east and west are more abrupt. To the east it descends in a sharp fault by steps of 1 to 200 ft. This cliff, called the Great cliff or Cliff of Angavo, is often impassable and is itself bordered by an escarpment (Betsimisaraka) that overhangs the coastal plain. Behind the scarp face are the remains of ancient lakes (Alaotra). To the south the two steep gradients meet forming the plateaus of the Mahafaly and the Androy, which in most places overhang the sea in precipitous cliffs. Toward the west, on the other hand, the descent is made in a series of steps, like the Tampoketsa which leads to the plains of Majunga or the plateaus of the Isalo. Sometimes, however, the plateau is bordered by an escarpment, less high than that of the east but still impassable (Cliff of Bongolava). Finally, to the extreme north, the plateau is separated by the low sedimentary belt of the Ambre massif, which includes a series of volcanic craters.

The Eastern Coastal Zone.—This zone has an average width of 30 mi., and is a narrow alluvial plain terminating at the sea in a low coast line bordered with extensive lagoons linked together by the Canal des Pangalanes. To the south of Farafangana, the coast becomes rocky but still inhospitable, and it is only in the southeastern tip of the island that there are little bays. There, at Sainte Luce and Fort-Dauphin, were the first French settlements.

The Western Zone.—This is everywhere broader, being from 62 mi. to 124 mi. wide. Its sedimentary layers slope toward the Mozambique channel and produce a succession of hills, especially in the Sakalava country. One side of these steep hills dominates the hollows formed in the soft sediments, while the other descends to the sea in rocky slopes (Borna-Bamaraha). The coast itself is straight, bordered by small dunes and fringed with mangroves. The currents in the Mozambique channel have favoured the deposit of alluvium and the growth of deltas. On the northwestern coast there are estuaries and bays (Diégo-Suarez). This coast is bordered by coral reefs and volcanic islands like that of Nosy Be which protects the bay of Ampasindava.

The hydrography of the island is also to be explained by the asymmetry of its relief. The rivers of the east are short, turbulent and have an abundant flow. They discharge either into the lagoons through sandy mouths which are constantly shifting, or directly onto the coast with rapids and waterfalls. These are the rivers Maningory (whose source is Lake Alaotra), Loky, Bemarivo and the northern Mananara in the northeast; the Ivondro, Mananjary, Faraony, Manatsatrana rivers in the east. The most important rivers are those which have captured plateau streams: the Mangoro, in the centre, which drains part of the intermediate slope and receives the Onive from the plateau; and the southern Mananara, which receives two tributaries from the slope and one from the plateau. The western rivers are much longer, regular and often navigable over long stretches, but they carry masses of alluvium which block their estuaries. The chief are the Soña; the Betsiboka, which is in Tananarive province and navigable for over 150 mi.; the Tsiribihina, formed by three rivers of which two come from the plateau; the Mangoky, which ends in a huge delta; and the Onilahy, which flows through arid country and has a less abundant flow (it has a well-sheltered estuary to the south of Tulear).

All these rivers are very important, not only for navigation but because, intersected by dams, they can provide power and water for irrigation of crops. There are numerous lakes of volcanic origin (Itasy, to the west of the Ankaratra, Titriva near Antsirabé). Lake Alaotra is the last survivor of the immense lakes that once occupied the eastern slope. To the southwest Lake Tsimanampetsotsa is a salt lake covering 7¾ sq.mi. without outlet.

Climate.—The individuality of Madagascar's climate is explained essentially by the asymmetry of the relief and the winds. The plateau forms a permanent obstacle to the winds and is the major factor in the differentiation of the climatic regions.

The winds are of three kinds: sea breezes, trade winds and monsoons. The sea breezes have only a local effect in cooling the shores, and their influence is hardly felt inland. The trade is the dominant wind. Caused by the anticyclone situated over the Indian ocean between Madagascar and Australia, it blows from the southeast almost continuously, but is particularly violent during the southern winter (May to September). The east coast is thus to windward and has a high rainfall (139 in. per year at Maroantsétra in Antongil bay). But once past the Cliff of Angavo and over the plateau, the trade wind loses its humidity and behaves like a föhn; it does not bring rain to the Sakalava country, which receives its rainfall from the monsoon. The latter is most noticeable during the southern summer (October–April) when the sun is near its zenith. It comes from the north as a continuation of the Indian monsoon but produces northwesterly winds because of deviation (Majunga has a rainfall of 64 in. from November to April, and an annual total of 65 in.). The southwest receives scarcely any rainfall, except from occasional storms, and so is a semidesert region. The central plateau enjoys a tropical mountain climate with well differentiated thermal seasons (at Antananarivo the hot season lasts five months, the cool season seven) and there are 53.5 in. of rainfall, of which only 4 in. occurs during the six winter months. Lastly, the influence of the cyclones must be noted as they devastate the island periodically. Madagascar lies in the path of the southwestern cyclones of the Indian ocean, and Tamatave is one of the most exposed places.

Vegetation.—The vegetation zones are likewise longitudinal. The screw pines and palms of the east coast dunes are succeeded inland by the reeds of the lagoons and by the *viha*, a kind of wide-leaved arum which grows in the marshes, and, on the low hills, by scrub. Most of the swamps have been turned into rice fields and the slopes have been planted. Toward the escarpment the vegetation becomes more dense: the *savoka* is sometimes formed by scrub (*Longozo, Haronga, Citrus*) and sometimes by a denser brushwood (*Ravenala*, the traveler's-tree, with giant leaves at the top of a smooth trunk; *sevabe* and *dingadinga*, varieties of bam-

boo), but it is never suitable for timber. The true forest (*ala*) is higher up though it now covers only a small area (about 7% of the island). It consists of small, thin trees 65–80 ft. high and of varied kinds. At their base grow ferns, dwarf palms and grasses; there are also numerous lianas and epiphytes. The plateau is an area of grassland, and there are no trees except round the villages. The grasses are mostly burned by the cattle raisers and gradually disappear allowing the red earth to be seen. In the plains of the west the grassland gives place to savanna: the grasses, which are taller, are scattered with fire resisting trees like the *satrana*, a large variety of palm. The savanna, which produces a very monotonous countryside, is tending to spread into the Sakalava country and into the forest of deciduous trees that formerly wooded the whole west of the island. On the western plateaus, however, there remain the baobab trees and in the lower parts the raffia palm.

In the north and northeast (Montagne d'Ambre, Tsaratanana, Nosy Be) the vegetation is the same as in the east, *savoka* (secondary forest) tending to replace the original forest. By contrast, the Androy region in the extreme south is characteristic. It is the region of Karroo scrub, with spiny succulents. A great number of the plants in the island are unique and many are in danger of becoming extinct through constant burning.

Animal Life.—The unique form of Madagascar animal life is equally remarkable. At first, the island had no monkeys, deer or snakes. It has, nevertheless, three-quarters of the known Lemuridae of the world; about 40 species are found there, including the *Indri*, 39 in. high (eastern forests, around Tamatave and Antongil bay) and the *Microcebus*, the size of a fist. *Propithecus* is found in the south and east and it has been possible to tame other species of lemur like the maki and the varika.

The nocturnal aye-aye (*Daubentonia madagascariensis*) is a species peculiar to Madagascar. Other vertebrates include many kinds of hedgehogs, bats, civet cats and rodents. Birds are very numerous: guinea fowl (*akanga*), partridge, pigeons, herons, ibis, flamingoes, egrets, owls, birds of prey (*papango, voromahery*). Crocodiles are found in all waters, except in the coldest parts of the plateaus.

Various land and sea tortoises are found, chameleons of all sizes, geckos, lizards, snakes, including the *do*, which is 10–13 ft. long but is harmless. There are few fresh-water fish, but marine fish and crustaceans abound on the coasts and in the lagoons. Certain species are peculiar to the island, like the globefish, bristling with spines, and the cofferfish. Insects abound: grasshoppers, termites, cockroaches, all sorts of mosquitoes (some of which attack cattle), the Madagascar *Bombyx* (moth) which gives a valuable silk and more than 800 species of butterfly. Man has imported domestic animals: the zebu, which has great importance in Madagascan life, the fat-tailed sheep, dogs, poultry and pigs, these last being mostly raised by Europeans. (J. D.)

THE PEOPLE

The people of Madagascar, collectively known as Malagasy (in French Malgache), appear to be a mixture from very ancient times of Indonesians and Africans who arrived there by sea at various periods. The majority exhibit a blend of Indonesian and African characteristics. In general one can distinguish 18 peoples who correspond to geographical regions or to kingdoms no longer existent. The principal peoples are as follows: (1) In the east the Betsimisaraka ("the inseparable multitude"); the Antemoro, of whom the noble orders claim Arab descent and who use Arab script; the Tanala ("people of the forest"); the Antesaka (Antaisaka); and the Antanosy. These peoples are in general of medium stature and dark. (2) On the plateau the Merina (*q.v.*), around Tananarive, of whom the higher castes, the nobles (Andriana) and the bourgeois class (Hova) are often of an almost pure Indonesian type; the Betsileo (around Fianarantsoa); the Sihanaka around Lake Alaotra; to the north the Tsimihety; to the south the Bara who are tall and of African type. (3) In the west the Sakalava; the Vezo, who are fishermen; the Mahafaly and the Antandroy ("people of the brambles"), who inhabit the dry southern region; and some Makoa, who came from Africa, often as slaves, and are distributed among the Sakalava.

Language.—The Malagasy language belongs to an Indonesian group, with some peculiarities of its own such as the vocalization of final letters, the existence of a definite article and the "relative" mood of verbs. It contains some words of Bantu, Swahili, Arab, English and French origin. The existence of dialects, involving changes in certain consonants and final letters and some differences in vocabulary, does not affect the basic unity of the language.

From 1820 the Merina dialect, written in Latin characters, has become the official language. In this the letter *o* is pronounced as French *ou* (English *oo*); final *a* and *y* are almost silent. Malagasy literature includes proverbs, orations, stories, folk tales and poems. The soft and musical quality of the language has earned it the title of "the Italian of the Indian ocean."

Religion.—The traditional religion is founded on ancestor worship. The dead are mostly buried in stone tombs, by family or clan, and are believed to keep watch over the living and to reward or punish them according to their deserts. They are invoked, either on special occasions of illness or disaster, or in special ceremonies such as the festival of the dead in the southeast and the Famadihana, "festival of returning," when the dead are moved from one tomb to another, on the plateau. The supreme being, called Zanahary, "the Creator," or Andriamanitra, "the Fragrant One," stands above the dead in the divine hierarchy and is associated with them in the ceremonies. There is also a belief in invisible beings who inhabit trees and stones, in water spirits and in certain animals as ancestors or kin. Divination is employed, based mainly on *sikidy*, akin to Arab geomancy. The mass of taboos (*fady*), imposed either by custom, by the date of birth or by sorcerers, fill the life of the Malagasy with inhibitions, and there is also the fear of spellbinders.

Formerly various kinds of trial by ordeal were practised in order to discover spellbinders and criminals. Notable among these was the tanghin poison ordeal. Now almost half of the people, especially among the Merina and the Betsileo and in the towns, have been converted to Christianity about equally divided between Protestant and Catholic. In the northwest there are about 70,000 Muslims.

Social Customs.—The traditional Malagasy family is patrilineal and includes collateral branches. The title of father and mother is given to all the elders, and that of children to all the younger generation. The clan (*foko*) includes families of the same origin. The *fokon'olona* is that part of a clan which lives in the same village and whose decisions are taken by the heads of its families. This patriarchal system is on the decline in the Christian areas and in the towns, but respect for elders persists. The artificial relationship of blood brotherhood between two persons can be created by a special ceremony. Malagasy society is divided into castes, which are in most cases limited to three: nobles, freemen and former slaves. Intermarriage between the castes is prohibited in principle. Polygamy has disappeared in the Christian areas. Marriage involves various ceremonies: a delegation to the prospective bride's family, sacrifices, the carrying off of the bride, etc. Children are always desired and the chief fear of women is sterility. Adoption is easy and is frequently undertaken.

The Malagasy house is always rectangular with the long sides running from north to south, the door on the west and an acutely angled roof. The materials vary with the region: clay is used in the central area, wood and branches on the coasts. On the east coast the houses are built on piles or stilts. Clothing consisted formerly of the loincloth (of bark or cotton), the sheath dress (of rush matting or raffia) and the *lamba*, a kind of toga made of cotton or silk. These are giving way increasingly to imported clothing and materials. Traditional art, which is much less rich than that of Africa, comprises wooden statues, rush matting and coloured baskets, and decorated plates and spoons. Musical instruments betray especially African or Indonesian ancestry; notable is the *valiha*, a kind of zither made from bamboo. The same is true of the traditional dances that still accompany certain festivals. A love of music and poetry is a characteristic of the Malagasy.

HISTORY

The island was certainly inhabited during the Iron Age by Indonesian and African navigators. For many centuries the Malagasy have been divided into a number of peoples, separated from one another by a wide extent of uninhabited country.

The Indian ocean was frequented during the early middle ages by Indonesians and the Indians, who left traces in the population of Madagascar. From the 9th century the "Arabs" (correctly, Muslims of diverse origins), already established on the east coast of Africa and on the Comoro Islands, formed settlements on both the northwest and southeast coasts of the island. In the southeast they became merged in the general mass of the people, especially among the Antemoro. In the northwest were several large "Arab" colonies, which occupied the ports of Anorotsangana, Mojanga (Majunga) and several others, retaining their distinct nationality.

Early European Connections.—The Alexandrian geographer Ptolemy speaks of an island called Menuthias, which might be Madagascar. Marco Polo has a chapter upon "Madeigascar," but his accounts of it are confused with those of the mainland of Africa, even the name later adopted for the island being a misunderstanding of that of the mainland port of Mogadishu.

The first European voyager to see the island was a Portuguese named Diogo Dias, captain of one of the ships of a fleet bound for India. Separated from his companions by a storm near the Cape of Good Hope, he sighted the eastern coast of the island on Aug. 10, 1500. That day being the feast of St. Lawrence, Madagascar was named the "Isle of St. Lawrence." Portuguese missionaries between 1600 and 1619 made unsuccessful efforts to convert the tribes on the southeast and western coasts. In the time of Charles I unsuccessful attempts were made to form English settlements in the southwest and on the island of Nosy Be. From 1642 the French held the extreme southeast point of the island at Fort-Dauphin, and the governor, Étienne de Flacourt, gave the first substantial description of the island. But in 1674 the garrison was partly massacred and partly evacuated. The king of France, however, maintained his claims to the sovereignty of the whole island.

In the late 17th and early 18th centuries Madagascar was the haunt of many pirates, including John Avery, Captain Misson and William Kidd. Between 1768 and 1786 two fresh attempts at settlement were made by the French, one by the comte de Modave at Fort-Dauphin and the other by D'Aladar de Benyowski at Antongil bay. In 1750 the island of Sainte Marie became French. In 1803 Sylvain Roux set up a French agency at Tamatave, which was occupied by the English in 1811.

The First Kingdoms.—Trade in arms and slaves allowed the development of Malagasy kingdoms. At the beginning of the 17th century the most important, those of the Antemoro, Antesaka, Betsileo and Merina (Hova), were still confined to small areas, the last named to the neighbourhood of Tananarive. In that century a southern Sakalava chief, Andriandahifotsi, conquered all the western plains, and his son conquered the northwest (Boina) and the extreme north. The Sakalava dominions, held by descendants of the founder, occupied half the island, but they disintegrated in the 18th century. In this century the half-caste Ratsimilaho (son of an English pirate) set up the kingdom of Betsimisaraka, which very soon disappeared. At the end of the 18th century the disunited Merina kingdom was unified by the great king Andrianampoinimerina (1787–1810). Imerina was soundly organized and the Sakalava incursions checked. Turning his attention to expansion, the king brought the Betsileo into subjection. At his death he bequeathed to his son Radama a single political ambition: "The sea will be the boundary of my ricefield" (*i.e.*, of his kingdom).

Merina Rule.—Radama I (1810–28) was a shrewd and enterprising man. He was helped by the British governor of Mauritius, Sir Robert Farquhar, who, failing to obtain the backing of the British government to replace the French in Madagascar, adopted a policy of supporting the Merina. Radama saw that his people must be educated and civilized, and, making a treaty with Farquhar to abolish the export of slaves, he received in compensation an annual subsidy of arms, ammunition and uniforms, as well as British training for his troops. He was thus enabled to establish his authority over a large part of the island. For some years a British agent, James Hastie, resided at Radama's court. During the same period (1820) Christian teaching was begun in the capital by the London Missionary society. The language was reduced to a systematic written form, and the art of printing introduced; the Scriptures were translated and many schools were formed.

The bright prospects thus opening up were clouded by the death of Radama at the age of 36 and the seizure of the royal authority by his first wife, Queen Ranavalona I. She looked with much suspicion upon the European ideas then gaining ground. In 1835 the Christian religion was declared illegal. Of the Christian Malagasy about 200 suffered death, while many hundreds were punished by fine, degradation, imprisonment and slavery. A few Europeans remained in Madagascar, notably the Frenchman Jean Laborde, who introduced many industries and was influential with the queen. During the queen's rule there were frequent rebellions and distant provinces were desolated by barbarous wars; for some years all Europeans were excluded, and foreign commerce almost ceased. An ill-managed attack upon Tamatave in 1845 by a combined British and French force ended in failure.

This reign of terror was brought to an end in 1861 by the death of the queen and the accession of her son, Radama II. He opened up the kingdom to Europeans, and signed a concession, giving great powers to a French company. But his weakness soon brought an end to his reign and his life. He was put to death in his palace (1863) and his wife Rasoherina was placed on the throne. The new sovereign refused to ratify the agreement with the French company, but treaties were concluded with the British, French and United States governments. Besides the London Missionary society, other Christian agencies were permitted to work, including the Jesuits and the Anglicans, the Society of Friends and the Norwegian Lutherans. The French explorer Alfred Grandidier explored the island and brought back much scientific information.

At the death of Rasoherina in 1868, she was succeeded by her cousin, Ranavalona II. One of the first acts of the new queen was the public recognition of Christianity; and soon afterward she and her husband, the prime minister, were baptized, the Merina in general soon putting themselves under Christian instruction. Ranavalona II, her predecessor and her successor were in turn married to the prime minister, Rainilaiarivony, who became virtual ruler of the country. Many measures tending to improve the administration were introduced. The Merina then ruled the central part of the plateau directly; the kingdoms of the east and northeast were vassals; but the south and part of the west were independent. The Merina army, well organized under Radama I, had since declined and Merina expansion had consequently ceased.

Revenue was derived from customs, duties, fines and from a money offering, called *hasina*, presented on a great variety of occasions to the sovereign. The government also claimed the unpaid services of the community for public work. Consuls appointed by the British, French and U.S. governments were accredited to the Malagasy sovereign.

Relations With the French.—Although Merina rule would have satisfied British interests in the island, it was otherwise with the French. The tradition of their former settlements and influence was strong; in 1840 they had taken under their protection the Sakalava ruler of the northwest coast. But a treaty concluded in 1868, while establishing French consular jurisdiction, recognized Ranavalona II as queen of Madagascar. A change came under the third republic. The French government revived its claim to a protectorate over the Sakalava of the northwest coast, and in 1883, following Malagasy rejection of French demands, Tamatave was bombarded and occupied by marines. By a treaty signed on Dec. 17, 1885, it was agreed that the foreign relations of Madagascar should be directed by France; that a resident should live at the capital; and that Diégo-Suarez bay, together with surrounding territory, should be ceded to France. Queen Ranavalona II had died on July 13, 1883, and had been succeeded by her cousin Rana-

valona III. In 1890 the British government, in return for concessions in Zanzibar, consented to recognize a French protectorate over Madagascar, but Rainilaiarivony, continued to arm and train, with the help of British officers, a large body of native troops. Toward the close of 1894, the French government sent an ultimatum and war followed. An expeditionary force under Gen. J. C. Duchesne landed at Majunga and met with no effectual resistance. On Sept. 30, 1895, the French forces reached Tananarive, and on the evening of the same day the French entered the capital. The protectorate was established. Early in 1896, however, a serious rebellion broke out in several parts of Imerina. This movement was not only anti-French but also anti-Christian. Gen. J. S. Galliéni was sent out to relieve the then resident general.

French Rule and Independence.—Galliéni abolished royalty; Madagascar had already been declared a colony of France. Queen Ranavalona III was exiled to Réunion and subsequently to Algeria, where she died in 1917. Meanwhile, by 1898, the authority of France had been established throughout the island. Galliéni, whose firm and vigorous administration and desire to treat the Malagasy justly made him respected, retired in 1905. In accordance with the usual French colonial system the tribes were all placed under the direct control of French officials, but large numbers of natives were employed in the French administration, and a few Malagasy who became thoroughly assimilated were given French citizenship.

Notwithstanding these measures the growth of a sense of Malagasy nationality could be discerned among the Merina. During World War I a secret society, the V.V.S., was discovered. Madagascar enjoyed considerable economic development during the governorships general of Marcel Olivier (1924–30) and Léon Cayla (1930–40). World War II brought economic crisis with the cessation of exports. The island declared for the Vichy government in 1940, and to prevent its invasion by the Japanese it was occupied in 1942 by the British, who handed it over to the Free French authorities in 1943. It had been considerably disturbed by these events. In 1946, all the Malagasy had been granted French citizenship; but in 1947 a nationalist rising took place on the east coast. Subsequently new political institutions (in particular, local assemblies) were established without difficulty. On Oct. 14, 1958, the congress of the elected assemblies proclaimed an autonomous republic within the French Community and Philibert Tsiranana, a Tsimihety, was elected president. In June 1960 the Malagasy Republic gained complete independence while remaining a member of the Community.

In March 1961 President Tsiranana presided over a conference of 12 states at Yaoundé, Cameroon, where the formation of a Union Africaine et Malgache was announced. A conference of ten African states at Antananarivo the following September confirmed this decision to strengthen mutual ties and a charter which aimed at political co-ordination, economic co-operation and joint defense was established. This project was advanced by the subsequent conferences at Monrovia, Liberia (May 1961), and Lagos, Nigeria (Jan. 1962). The latter was attended by the heads or representatives of 19 states.

POPULATION

The population of Madagascar at the first census in 1900 was 2,500,000; in 1956, 4,934,375; and by the early 1960s exceeded 5,500,000. Increase is at the rate of more than 100,000 a year. The average density exceeds 23 to the square mile; in the rice-growing regions of the east coast and the alluvial valleys and lake basins of the plateau it exceeds 77 but is less than 13 in the pastoral west and the forest-covered cliff regions. The most numerous peoples are the Merina (1,200,000), the Betsimisaraka (800,000) and the Betsileo (600,000). The population other than Malagasy is less than 100,000, including 70,000 French, 16,000 Indians and 8,000 Chinese. The number of Comorans (about 50,000) is increasing on the northwest coast.

The people are essentially peasants. The capital is Antananarivo (*q.v.*; pop. [1960] 247,917), which stands on a steep hill jutting into the surrounding rice fields. There are four towns with a population of 30,000 to 50,000: Tamatave, Majunga, Diégo-Suarez and Fianarantsoa (*qq.v.*). The other principal centres, each with 10,000 to 30,000 inhabitants, are Antsirabé, Tulear, Manakara, Mananjary and Fort-Dauphin. Internal migrations brought the rice cultivators of the southeast (Antesaka) and those of the plateau (Merina and Betsileo) to the almost empty plains of the west, which they put under cultivation. This Malagasy "far west" already has an immigrant population greater than the Sakalava. The Tsimihety have expanded in all directions. Some Antandroy, to escape from the famines of the extreme south, find paid employment all over the island. There is a large proportion of Merina in the towns, where they are merchants or officials.

ADMINISTRATION

The constitution of the Malagasy Republic, which became law on April 29, 1959, established a presidential regime. The president is elected for seven years and is also the head of state. The parliament comprises a national assembly elected for five years by universal suffrage (male and female) and a senate representing national organizations; two-thirds of the senators are nominated by the provincial councils general. The dominant political party is the Parti Social Démocrate which holds an overwhelming majority of seats in both the senate and national assembly. The Malagasy Republic is represented in France by a *haut représentant* and in certain other countries by ambassadors.

The republic is divided into six provinces: Diégo-Suarez, Majunga, Tamatave, Tananarive, Fianarantsoa and Tulear. The provinces, which have a large measure of financial autonomy, are themselves divided into districts and communes (formerly cantons) varying in number, which are administrative units. Large towns have elected municipal councils. Rural communes constitute centres of economic advancement. Many French officials are employed in the central and provincial services. Medical services in the early 1960s included 10 hospitals and about 390 medical centres and infirmaries. The fight against endemic diseases has succeeded in removing the plague and reducing malaria.

About half the children of school age (more than 425,000) attend public or private schools. There are eight *lycées* and institutes of scientific research and agriculture. A university was founded in Antananarivo in 1961. Education is conducted in Malagasy and French.

THE ECONOMY

The traditional economy is based principally on the cultivation of rice and the raising of oxen. The rice fields are of Asiatic type with water levels and embankments. The grazing of oxen often takes the place of cultivation. Food consists of millet (in the south), cassava, potatoes, taro or coco, beans and some fruits (bananas, guavas and mangoes), together with fish from the streams, *brèdes* (a green vegetable similar to spinach) and berries and wild roots. The zebu (humped ox) is used both for tillage and for sacrifice, the beef being eaten during the ceremonies, and it provides visible capital. Poultry is abundant in all the villages. This subsistence economy has been changing during the 20th century through the opening up of the island to world commerce. The traditional products have been improved and new products created. Rubber is no longer cultivated but wax from wild bees is gathered. Scientific study has been devoted to fishery, especially that of tunny, prawns, mullet and whales. The forests have had to be protected and replanting has altered the denuded appearance of the plateau. Raffia fibre is a product peculiar to the island.

The rice-growing area has been doubled. Rice is grown mostly for local requirements but some special varieties of high quality (such as the long *vary lava*) have been developed for export. The American rices of the Carolinas had their origin in Madagascar. Cassava meal and tapioca are prepared from manioc (*Manihot*). "Cape pea," a kind of large haricot grown in the southwest, is exported to England.

Robusta coffee is the chief product of the east coast and the most important item of exported produce. The Malagasy Republic is the world's chief producer of vanilla and ranks second for cloves (east coast). Perfume plants, peanuts (Lake Alaotra), "Maryland" tobacco (west and plateau), sugar (northwest), sisal

(extreme south), potatoes (plateau) are substantial items.

There are more than 6,000,000 head of zebu cattle on the natural pastures of the west and the plateau. Pigs are raised in the centre, sheep and Angora goats in the south.

The main resources are graphite, mica and phosphates. A seam of coal in the southwest (Sakoa) has not been worked. There are some uranium and thorium deposits in the southern part of the island, and precious stones (beryl, amethyst and garnet) are found.

The main industries are agricultural and chief among these are rice husking, the manufacture of starch from manioc, sugar refining, tobacco curing, meat preserving and tanning. Cotton is woven and soap and cement are produced locally. There is abundant water power, but the two main barrages on the Mandraka and Tsiazompaniry rivers supply electricity chiefly to Antananarivo. Nine-tenths of the inhabitants live by agriculture and the variety of products avoids serious food crises. Most of the peasants are owner-farmers. Europeans own some plantations (sugar, tobacco and sisal), sawmills and mines. The trade-union movement is widespread in the towns and the two largest organizations are the Conféderation Chrétienne des Syndicats Malgaches and the Union des Syndicats des Travailleurs de Madagascar.

The distance of the main markets of the world is a handicap to Malagasy exports because of the high cost of freight. The lack of domestic industry necessitates the importation of most manufactured goods. Wholesale trade is principally the care of French companies and retail trade is, to a large extent, in the hands of Indians and Chinese. The chief exports are coffee, rice, cloves, tobacco, vanilla, sugar, dried vegetables, raffia and preserves. Of secondary importance are graphite, perfumed oils, sisal, manioc starch and hides. Coffee represents about half the total value. About two-thirds of the exports are bought by France and one-sixth by the United States. Principal imports include materials and clothing, motor vehicles, petroleum products, machinery, iron, tools and cement; approximately two-thirds of these come from France.

Revenue is derived mainly from direct taxation that includes poll and land taxes and taxes on houses and cattle, and indirect taxes such as those from customs, markets, posts and telegraphs.

In former times all transport was on foot; important personages were carried by *filanzane* (palanquin) and goods were slung at the two ends of a pole across the shoulders. Roads have now been constructed all over the country; they are mostly simple tracks suitable for motor traffic but subject to seasonal interruptions. The principal centres are linked by asphalt roads. The total mileage of roads is about 20,000. Two railways cross the cliffs to link the plateau with the east coast: the Tananarive-Côte Est (T.C.E.) to Tamatave, about 230 mi., and the Fianarantsoa-Côte Est (F.C.E.) to Manakara, about 102 mi. The former has branches to Lake Alaotra and to Antsirabé. The island has about 1,550 mi. of navigable rivers supplemented by the Canal des Pangalanes. The latter forms a 403-mi. waterway comprised of lagoons that are strung along the east coast and protected by a line of coastal sand dunes. Sandy or rocky bars (*pangalanes*) are cut at several points to permit the passage of large barges.

The chief port is Tamatave, which has equipment and quay berths. Diégo-Suarez, which has one of the finest roadsteads in the world, is unfortunately too remote from the centre. Majunga has only a lighterage port. Minor ports are Manakara, Fort-Dauphin, Tulear, Morondava, Analalava and Vohémar. The principal airport is Arivonimano, 32 mi. W. of Antananarivo. Secondary airfields are numerous and local airlines provide daily services.

The government-controlled Radiodiffusion Nationale Malgache at Antananarivo broadcasts in French and Malagasy.

See also references under "Malagasy Republic" in the Index.

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Current history and statistics are summarized annually in *Britannica Book of the Year.*

(HU. DE.)

MALAKAND, a Northwest Frontier agency of the Peshawar division of West Pakistan, administered by a political agent residing in the town of the same name, 41 mi. N.N.E. of Peshawar. Pop. (1961) 1,536,766; area 12,344 sq.mi. The agency includes the former princely states of Chitral, Swat and Dir (*qq.v.*), Kalam, the Malakand protected area (Swat Ranizai), Sam Ranizai, and Bajaur and Utmankhel. At Malakand is a 20,000-kw. hydroelectric power station, opened in 1938. The Malakand pass connects the Mardan and Peshawar districts with the Swat valley.

(K. S. AD.)

MALALAS, JOHN (*c.* 491–*c.* 578), was a Byzantine chronicler of Syrian origin (*melel* is the Syrian for the Greek *rhetor*). His *Chronographia* in 18 books beginning with the Creation continued certainly to 565, perhaps to 574, but in its extant form it ends in 563. The greater part of it stresses the importance of Antioch (where Malalas may have been born) and has a monophysite flavour. The last part of book 18 appears to have been produced later, perhaps in Constantinople. It was written in the popular language for unlearned Christian circles, and although often inaccurate and uncritical it is of some value as a source for the first half of the 6th century. It was much used and was translated into Slavonic. Some scholars identify John Malalas with John III Scholasticus, patriarch of Constantinople 565–577, who had earlier been a lawyer in Antioch.

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(J. M. HY.)

MALAN, DANIEL FRANÇOIS (1874–1959), prime minister of South Africa, remembered as the man who established Afrikaner political control over the Union and used it to initiate the policy of racial segregation known as apartheid and pave the way for a South African republic, was born on a farm near Riebeeck West, Cape colony, on May 22, 1874. He was educated at the Riebeeck-West school, Victoria college, Stellenbosch, and the University of Utrecht, Neth. Returning to South Africa in 1905, he became a minister of the Dutch Reformed Church and also took an active part in the Afrikaans language movement. The Boer rebellion quickened his interest in politics and in July 1915 he left his pulpit to become editor of *Die Burger,* a Cape Town newspaper, founded to support J. B. M. Hertzog's Nationalist party.

Malan presided at the first Cape Province congress of that party later in 1915. He entered parliament in 1918 and in 1919 he was a member of the deputation that went to Versailles to ask for republican independence for South Africa. As a member of Hertzog's cabinets from 1924 to 1933, Malan was responsible for the laws that created a South African nationality and flag and that made Afrikaans an official language of the Union (previously English and Dutch had been recognized), and for the Cape Town agreement concerning the status of Indians in the Union.

When the Nationalist and South African parties fused into the United party in 1934, Malan broke with Hertzog and became the leader of a "purified" Nationalist party which, though small, was the official opposition. The defeat of Hertzog's neutrality motion, which Malan supported, the formation of Jan Smuts' government, and South Africa's entry into World War II, led to a political splintering of Afrikanerdom. Doggedly, patiently and with great skill Malan welded together a "reunited" Nationalist party, which obtained 43 seats in the 1943 election and, in alliance with N. C. Havenga's Afrikaner party, won a narrow majority in 1948. This enabled Malan, aged 74, to form the first exclusively Afrikaner government of the Union.

The primary concern of this government was to implement the policy of apartheid. One of these acts, to give Coloured voters separate and fixed representation, was declared invalid by the supreme court in 1952; the crisis was still unresolved when, after increasing his majority in the 1953 general election, Malan retired in 1954. He died at his home at Stellenbosch on Feb. 7, 1959.

See also SOUTH AFRICA, REPUBLIC OF: *History*. (L. M. T.)

MALANG, the name of a *kabupaten* (regency) in the province of Djawa-Timur (East Java), Indonesia, and of its administrative headquarters. Malang town is situated at an altitude of 1,460 ft. at the foot of the Semeru mountains, 50 mi. S. of Surabaja. Pop. (1961) 341,452 (municipality). At the end of Djalan Kajutangan, the town's busiest street, is the building that formerly housed the Komite Nasional Indonesia Pusat (parliament), which had its first session in Feb. 1947 and was burned down during the revolution. In front of the town hall is the public park with a Freedom memorial in the centre. Industries include the manufacture of cigarettes, ceramics and soap. Malang is connected by road and rail with Surabaja.

Malang has an ancient history, and in the surrounding area are ruins of palaces of the kings of Dinojo, Tumapel and Singosari (*see* JAVA: *History*), which attract many tourists. Under the Dutch it became a municipality and a garrison town in 1914, and its modern growth dates from that time. In 1939 the Dutch military headquarters was transferred to Malang, which after independence became the headquarters of the 5th division of the Indonesian army. The Indonesian air force base, Abdurrachman Saleh, is 8 mi. E. of the town.

Malang *kabupaten* was formed after the republic was established. Area 3,413 sq.mi. (8,840 sq.km.). Pop. (1961) 1,474,106. Under the Dutch this was the name of a residency (earlier named Pasuruan) with an area of 3,413 sq.mi. The main occupation of its inhabitants is agriculture, principal products being vegetables, fruits and flowers.

MALANJE (MALANGE), a north central district of the Portuguese overseas province of Angola in west Africa and the name of its capital town. The district had a population in 1960 of 452,285. Area 44,039 sq.mi. Administratively it consists of the *concelhos* (counties) of Malanje, Cacuso and Duque de Bragança and the circumscriptions of Songo, Cambo, Bondo and Bângala. Stock raising (mainly goats) and cultivation are carried on, the chief products being cotton, maize (corn), oil fruits and oil nuts, cassava, sisal and tobacco. The district supplies Luanda with fruit and vegetables. Mineral resources include manganese. The town of Malanje lies on the central Angolan plateau. Pop. (1960) 25,766. It has a Roman Catholic cathedral, beautiful public gardens and several hotels. Tourist attractions include the Duque de Bragança falls (330 ft.) on the Lucala river, other neighbouring waterfalls and the Pungo Andongo black stones, gigantic black monoliths associated with the story of the native queen Ginga. Malanje is linked with the provincial capital, Luanda, on the coast, by road and also by rail (280 mi.). Eastward links to Vila Henrique de Carvalho and Portugália are provided by road and by scheduled airline services. (A. A. G. P.)

MÄLAREN (LAKE MALAR), Sweden, extends 75 mi. W. from Stockholm, which lies at its junction with the Saltsjön, an arm of the Baltic sea. The height of the lake normally reaches only one foot above sea level, and its outflow is sometimes reversed. The area is 440 sq.mi.; the deepest sounding is 210 ft. Mälaren contains numerous islands and its outline is very irregular; the mean breadth is about 15 mi. but an arm extends northward for 30 mi., nearly to the city of Uppsala. With Hjälmaren it drains an area of 8,160 sq.mi.

The lake is connected by navigable channels with Hjälmaren to the southwest and by the Södertälje canal and two channels at Stockholm with the Baltic to the south. The more important towns, besides Stockholm, are Västerås on the north, Södertälje and Eskilstuna near the south shore.

The lake provides a recreational area fully appreciated by the inhabitants of Stockholm, many of whom have residences on its shores. On the island of Drottningholm (Queen's Island, named in honour of Catherine, wife of John III) is a palace with a fine park and formal gardens, a summer residence of the royal family. It was built by Nicodemus Tessin and his son Nicodemus in the second half of the 17th century, on the site of a palace built by John III. Associated with the palace is the delightful Court theatre which was built in the 1760s and, along with that at Gripsholm castle, is the only 18th-century theatre maintained in a workable condition. Near Mariefred, on the south shore, is the picturesque castle of Gripsholm, begun in 1537 by Gustavus I Vasa, which contains a large collection of portraits. Strängnäs, also on the south shore, became an episcopal see in 1291, when the fine cathedral, later much altered, was consecrated. In the episcopal palace there, a 15th-century building later used as a school, Gustavus Vasa was elected to the throne of Sweden in 1523.

On the northward arm of the lake is the palace of Rosersberg, later used as a gunnery school, in a well-wooded park. On a branch of the same arm is Sigtuna, a village whose ruined churches attest to its former rank among the principal towns of Sweden after its foundation in the 11th century. Remains prove that on Björkö, an island in the eastern part of the lake, there was a large settlement of earlier importance than Sigtuna. There, a cross commemorates the preaching of Christianity by St. Angsar in 829.

On the northern arm of Mälaren, about 10 mi. S. of Uppsala, is the château of Skokloster, occupying the site of a nunnery. It was presented by Karl IX to Field Marshal Hermann von Wrangel, whose son Karl Gustav von Wrangel stored it with remarkable collections of trophies from Germany, taken during the Thirty Years' War, including a library, an armoury and a great collection of curios. (A. C. O'D.)

MALARIA, an infection principally of man, apes, monkeys, birds and reptiles. It is caused by several species of Protozoa (one-cell animal organisms) which are classified as blood Sporozoa (suborder Haemosporidiidae) and belong to the single genus *Plasmodium* (*see* PROTOZOA: *Natural History*). As far as is known, all are transmitted by mosquitoes.

A given species has a limited ability to infect both vertebrate and mosquito hosts. Thus, *Plasmodium brasilianum* can be transmitted to several species of new world monkeys and marmosets but never has been successfully transmitted to old world monkeys. The culicine genera *Culex* and *Aëdes* are the most important transmitters of bird malaria, whereas the genus *Anopheles* is the sole known transmitter of the human species. In a zoological sense, the mosquito in which the parasite undergoes its sexual processes is the definitive host, and man or other vertebrates are the intermediate hosts.

The stages of the malarial parasites that invade mature red blood cells containing hemoglobin in the vertebrate host have the interesting biochemical habit of splitting hemoglobin into its pigment, heme, and the protein carrier, globin. The parasite utilizes the globin and discards the heme. When the heme accumulates in the red cells and in various organs, it is known as malarial pigment. The same method of producing pigment occurs in infections caused by close relatives of the malarial parasites that belong to the genera *Haemoproteus*, infecting birds, and *Hepatocystis*, infecting monkeys, bats and squirrels. These infections are frequently, but inappropriately, referred to as malaria.

The present article will deal chiefly with the malarial parasites of man. In addition to the knowledge gained by the study of the naturally acquired disease, much information about malaria in man has been obtained by inducing malaria in volunteers and, as a treatment of the late stages of syphilis, in neurosyphilitic patients. The laboratory study of simian, rodent and avian species of malaria in various hosts also has contributed to the understanding of the disease.

Clinically, malaria is characterized by periodic paroxysms, popularly known as chills and fever, and a tendency to assume a chronic form with frequent relapses. During World War II there were marked advances made in the treatment of the disease and the discovery of efficient insecticides gave promise of removing the disease as one of the leading scourges of the inhabitable world, particularly in the tropic and subtropic areas.

History.—Malaria is one of the most ancient infections known to man, having been noted in some of the earliest records (5th

century B.C.) when Hippocrates differentiated the fever into different types: namely, quotidian (daily), tertian (alternate days) and quartan (fever three days apart) types. He further observed that those who drank the stagnant marsh water had large stiff spleens, a characteristic of the disease, and fatal dropsy was common among them. It is not known when malaria first made its appearance in the Americas, but it is highly probable that it was a post-Columbian importation; some rather severe epidemics were first noted in 1493. The origin of the word malaria is not known, although reputedly it refers to *mal aria*, meaning "evil air." There has always been recognition of the association between swampy, marshy areas and the disease, although the exact roles of the mosquito and the parasite were not known until the beginning of the 20th century.

An effective treatment was known long before the cause of the disease was understood. Many legends indicate that the countess of Chinchón, suffering from chills and fever, was treated in the 1630s with an infusion of the bark of a certain tree in Peru. The reason why the infusion was used is not exactly clear, although certain Jesuits were thought to have learned about it from the natives. Discovery of the countess' diary failed to reveal that she had ever had malaria. The fact remains, however, that the tree with the therapeutically active bark was named for her as the cinchona tree; and from 1700 its most active principle, quinine, was used universally for the treatment of malaria.

The first person known to have described the malarial parasite and to have recognized it as the cause of the disease was Alphonse Laveran (1880, Algeria). In 1886 the Italian investigator Camillo Golgi, known best for his studies on the structure of the nervous system, pointed out that the paroxysms are coincident with the segmentation of the blood parasites. Detailed knowledge of the tissue stages came later and represents the work of many investigators. The development of the early tissue stages was described first (1934–35) in the avian malarias and later (1948) in the simian and human malarias.

The discovery of the mosquito transmission of the disease was preceded by an exciting race toward the end of the 19th century. Two U.S. investigators, Theobald Smith and F. L. Kilborne, had shown between 1889 and 1893 that the tick is the carrier of the piroplasm producing Texas fever of cattle and thus laid the basis for the demonstration of the role not only of ticks but also of other arthropods, such as mites, crustacea and especially insects, in the transmission of human and animal diseases. Various people had speculated that malaria is transmitted by mosquitoes; they included Sir Patrick Manson, who in 1894 strongly supported this theory. In 1898 Sir Ronald Ross, a British physician in India, proved that bird malaria is transmitted by *Culex* mosquitoes and described the entire development of the parasite in the mosquito. Just the year before he had seen pigmented cysts in anopheline mosquitoes fed on patients with falciparum malaria. In Nov. 1898 the Italian investigators A. Bignami, G. B. Grassi and G. Bastianelli first infected man by mosquitoes, described the full development in man and noted that malaria is probably transmitted only by anopheline mosquitoes, an observation that continues to hold true. The disease can be transmitted unnaturally by common use of a hypodermic needle, as among drug addicts, or by blood transfusion from infected donors.

A major event in therapy was the mass cultivation by the Dutch in the East Indies of strains of cinchona trees giving high yields of quinine alkaloids. In 1891 P. Guttmann and Paul Ehrlich found that methylene blue had a slight therapeutic effect. The shortage of quinine in Germany during World War I led to the research of W. Schulemann and his associates that culminated in the discovery of pamaquine (Plasmochin) in 1924. It was made by modifying methylene blue. In the early 1930s W. Kikuth, in collaboration with H. Mauss and F. Mietzsch, produced quinacrine (Atabrine, Atebrine or mepacrine). Both compounds are potent antimalarials. The discovery of improved synthetic compounds just before and during World War II by German, U.S. and British investigators presaged eventual replacement of both quinine and quinacrine.

Outstanding events in the history of malaria control included the vast projects conducted in Panama by William C. Gorgas, who practically eliminated the disease that, with yellow fever, had previously prevented the construction of the canal; the restoration of the Pontine marshes as a place of healthful habitation for the Italians; the species eradication of *Anopheles gambiae* from Brazil by the Brazilian government, initiated and directed by the Rockefeller foundation; and the elimination of malaria in many other areas of the world. The acute problem in Brazil resulted from the transmission by aircraft or surface craft of an effective vector from Africa; the vector spread over many thousands of acres and was responsible for an epidemic in which thousands of persons died. Although pyrethrum and kerosene sprays had been used to kill the larvae and adults of mosquitoes, their effectiveness was surpassed by DDT (dichloro-diphenyl-trichloroethane), first synthesized in 1874 by O. Zeidler in Strasbourg, France. In 1939 a small quantity was produced in Switzerland and was found to be lethal for potato bugs. In 1942 it was found to be effective against lice, and samples were transported to the United States. The U.S. department of agriculture proved it to be an effective killer not only of lice but also of mosquitoes, flies and fleas.

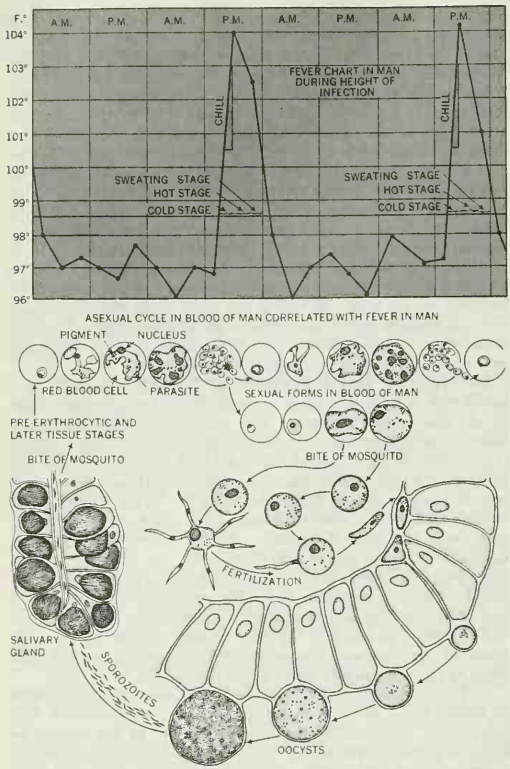
Distribution and Prevalence of Malaria.—Malaria is a world-wide disease, and there are probably more cases of it than of any other major infection. It is most common in the tropics, where climatic conditions are favourable for the mosquito and for transmission of the disease throughout the year. As one approaches the poles it becomes less prevalent, although it has been recorded as far north as Archangel, U.S.S.R. In the United States malaria was once a severe menace in the south, the Mississippi river basin and lower California. By the early 1960s, however, it was at its lowest ebb in history; in 1961, for example, only 85 cases were reported in the U.S. and 77 of the cases were of foreign origin. Endemic areas are in Central and South America, north and central Africa, some countries bordering the Mediterranean and the near, middle and far east. Areas still malaria-free because of the absence of mosquito vectors include such Pacific areas as the Fiji Islands, Hawaii and Guam.

In 1955 it was estimated that malaria caused 250,000,000 cases of illness and 2,500,000 deaths annually in the world and that more than 1,100,000,000 people were exposed to the disease by living in malarious areas. By 1962 the World Health organization estimated that the number exposed to malaria risk had been reduced to 406,000,000.

Vivax malaria is the most widespread variety because of its ability to withstand therapy and remain chronic. Falciparum malaria, the most malignant, requires higher temperatures for optimal development; hence it is confined more closely to the tropical areas. In west Africa, for example, it exists almost to the exclusion of the other varieties. Malaria caused by *Plasmodium malariae* is very prevalent in some areas. Instances of this infection persisting without active relapse for 40 years or more have been recorded. Many factors determine the distribution and incidence of malaria: in addition to those of cardinal necessity—the anopheline mosquito, a reservoir of infection and a susceptible human population—are included climate, rainfall, occupation, housing conditions, agriculture, wars, migrations of peoples, economic conditions, etc.

The Parasite.—Four species of the parasite are known to produce disease in man, *P. vivax*, *P. falciparum*, *P. malariae* and *P. ovale*. They cause, respectively, vivax (tertian), falciparum (subtertian or malignant tertian), malariae (quartan) and ovale tertian malaria. Each species has an asexual cycle in the tissues and blood of man and a sexual cycle that starts in the red blood cells of man and is completed in the mosquito.

The accompanying figure illustrates the life cycle of *P. vivax*. The infective stage (sporozoite), which is introduced into man by the bite of the mosquito, initiates a series of generations of pre-erythrocytic stages that occur in liver cells before parasites invade the red cells. These in turn develop into erythrocytic stages, so named because they infect red blood cells. (Except in *P. falciparum*, the pre-erythrocytic stages also give rise to exo-erythrocytic stages that not only can maintain themselves in cells but also can develop into erythrocytic stages. Since the persistent tissue stages are resistant to most drugs, they probably



MODIFIED FROM W. H. TALIAFERRO, "MICROORGANISMS AND THEIR ROLES IN NATURE," "THE WORLD AND MAN," AND FROM C. G. HUFF, "A MANUAL OF MEDICAL PARASITOLOGY," BY COURTESY OF W. H. TALIAFERRO, C. G. HUFF AND THE UNIVERSITY OF CHICAGO PRESS

LIFE CYCLE OF PLASMODIUM VIVAX IN MAN AND THE FEMALE ANOPHELINE MOSQUITO, SHOWING THE FEVER CURVE IN MAN AS IT IS CORRELATED WITH THE ASEXUAL CYCLE OF THE PARASITE IN THE BLOOD AND WITH THE BEGINNING OF THE SEXUAL CYCLE IN THE BLOOD. (*See* TEXT.)

keep the infection going and relapsing. As far as is known, they do not produce clinical symptoms.)

During the erythrocytic asexual cycle, a young ring stage in *P. vivax* requires nearly two days to grow and develop into a segmenter containing 12 to 24 daughter parasites (merozoites). (Other species require different lengths of time for development and produce different numbers of merozoites.) The infected red cells then rupture and each daughter parasite that survives—many die—invades a new red cell. A remarkable aspect of the asexual cycle is that the parasites grow and divide synchronously and therefore at the time of segmentation the parasitized erythrocytes disintegrate in batches and liberate malarial pigment and other residues of parasite and red cell. This process, provided enough parasites are present, produces the typical, regularly recurring malarial paroxysm, which lasts four to ten hours and consists successively of a cold stage (chill), a hot stage and a sweating stage. The cold symptoms of the chill are subjective as they occur after the body temperature is elevated. Between paroxysms, the temperature may be normal or subnormal. The chart shows the relation of the asexual blood cycle and the paroxysms of chills and fever resulting from a single brood of *P. vivax*.

A regular tertian fever because of the two-day cycle is produced by *P. vivax* and *P. ovale*. A quartan fever is produced by *P. malariae*. (The terms tertian for a two-day interval and quartan for a three-day interval arise from the classical method of including the first and last day of each interval.) The development of *P. falciparum* may be asynchronous at times so that the fever is more or less continuous with chills and sweating at irregular intervals. In this species, only the young rings (*i.e.*, the small mononuclear parasites at the start of the asexual cycle) and sexually mature stages of gametocytes are usually seen in blood smears; the other stages develop in the deeper blood vessels of the body. Infections with one or more species can occur simultaneously. Furthermore, a double brood of tertian parasites can segment on alternate days, giving a daily, or quotidian, fever. Double or triple broods of the quartan parasite, *P. malariae*, may occur with chills and fever for two days followed by a free day or with fever every day.

After the blood stages have developed asexually about ten days, ring stages similar if not identical to the asexual ones initiate the sexual cycle. The young sexual parasites do not segment but grow into male forms (microgametocytes) or female forms (macrogametocytes), which eventually perish if not taken up by a susceptible female anopheline mosquito. In a susceptible mosquito, they undergo maturation and fertilization similar to that of the germ cells of higher animals. The process of forming microgametes (equivalent to spermatozoa in higher forms) is termed exflagellation because the filamentous microgametes behave very much like flagellums as they lash about in freeing themselves from the original gametocyte. After becoming free, a single microgamete fertilizes a macrogamete (equivalent to an ovum). The resulting oökinete (so-called because it actively moves) becomes an oöcyst on the outside stomach wall. Within a week or ten days, these oöcysts produce hundreds of sporozoites, which are the infective form and which migrate to many parts of the mosquito, especially the salivary gland. From this site they are injected by the bite of the mosquito into the vertebrate host, initiating a new infection.

Malarial parasites have been difficult to cultivate in the laboratory. Some progress, however, has been made with parasites of the asexual and sexual cycles. The parasites remain viable at extremely low temperatures, −65° C., and this characteristic has been utilized to preserve various strains for research.

The Mosquito Vector.—Anopheline mosquitoes are the only known vectors of human malaria, and approximately 65 different species perform this function in different parts of the world. These mosquitoes undergo an aquatic larval stage, pupate and hatch into flying adults in about ten days, depending on the temperature of the water. The females require blood meals to produce fertile eggs; the males, which cannot bite, live on plant juices. According to the species, some prefer animal to human blood, hence are not good malaria vectors. Different species may live preferentially in streams, ponds, hoofprints, tree holes, in shade or sunlight. Usually their flight range is one mile or less from the source of human blood and infection. These mosquitoes are distributed throughout the world, more prevalently in the tropics, but some are present at latitude 50° N. They have been reported at an altitude of 9,000 ft.

The Disease in Man.—The disease in man is recognized by periodic chills and fever, anemia and, later, cachexia (general poor health) and an enlarged spleen. The different patterns of chills and fever have been described above. In falciparum malaria the symptoms are much more severe than in the other types. This type may be accompanied by various symptoms depending largely upon the localization of the asexual parasites. Intestinal localization may produce diarrhea and vomiting, and cerebral localization may cause delirium or coma. Only prompt treatment can prevent death in these severe infections.

Diagnosis.—Once clinically suspected, the disease is diagnosed by identification of the parasite in stained blood smears. A dehemoglobinized drop of blood can also be stained. The parasites take a characteristic stain, and all stages can be identified if present and properly stained. There are no satisfactory serological diagnostic tests such as precipitin or agglutination. The white blood cell (leucocyte) count is usually low and mild anemia is a constant finding. Usually an enlarged spleen can be palpated, especially in children.

Immunity.—A malaria infection confers a low-grade but specific immunity upon its host after the acute attack has subsided. This acquired immunity in man is of short duration, since an organism may produce repeated attacks in a person within a relatively short space of time. In experimental animals the residual immunity following complete eradication of the infection persists only a few weeks. There is no cross immunity in human malaria, as it is frequently observed that a person may have a simultaneous infection with two or more types of malaria. It is highly probable that a person develops resistance only to the malaria in his particular locality; for example, it has been shown that a person immune to a strain of vivax malaria in Florida reacts normally when exposed to infection from a vivax parasite from Cuba. Immunity is fundamentally antiparasitic, *i.e.*, directed against the parasite, and is not antitoxic. Immunological suppression of the blood infection is brought about chiefly by macrophages (sometimes called scavenger cells) of the spleen and liver and, to a lesser extent, the bone marrow. These organs are the most important of the so-called filter organs of the blood and their macrophages, which are part of the reticuloendothelial system, are so oriented as to remove material from the blood. The macrophages phagocytize (eat) many parasites and parasitized red cells throughout the infection and especially after the development of active immunity, which is due, undoubtedly, to specific antibodies. Moreover, the macrophages themselves markedly increase in number chiefly by development from lymphocytes and monocytes. Immunity against pre-erythrocytic and exo-erythrocytic stages also occurs in some avian malarias and may occur in man. It has not been thoroughly studied.

Drug Treatment and Prophylaxis.—Antimalarial drugs may be used either curatively to treat malaria or prophylactically to prevent the disease. Suppressive treatment or clinical cure primarily involves the administration, during acute attacks, of drugs that will quickly suppress the population of blood asexual parasites so that symptoms disappear. In general, such treatment does not eliminate the exo-erythrocytic stages in the tissues. Regular suppressive treatment may be used in infected persons to prevent the asexual blood stages from reaching a level at which symptoms appear. However, an infection acquired during suppressive treatment may flare up after treatment is stopped unless an adequate immunity has been built up. It was the only type of drug prevention available when quinine was the sole antimalarial. Causal prophylaxis occurs only with drugs that prevent the infection by killing or inhibiting the development of sporozoites and pre-erythrocytic tissue stages. Radical cure is brought about by drugs that can eradicate all stages of the parasite, both in the blood and in the tissues. After such a cure, no relapse is possible, but a new infection can take place. It would seem at first glance that only those drugs should be used that give true causal prophylaxis and radical cure. The suppressive drugs, however, often act on the blood parasites much faster than do the curative drugs. Therefore, both kinds of drugs are often prescribed, particularly with vivax malaria, to relieve symptoms quickly and to eradicate the infection eventually. Under certain conditions, such as active military operations, suppression (clinical prophylaxis) may be superior to causal prophylaxis. Thus, suppression with drugs allows the development of a low-grade infection during which immunity develops and is maintained under conditions where it is very difficult to maintain an effective dosage level of a causal prophylactic drug.

Treatment of malaria depends upon the species of parasite involved. Untreated vivax, ovale and quartan infections eventually subside, but untreated falciparum malaria may be fatal. In fact, falciparum malaria is responsible for practically all uncomplicated deaths from malaria. It is, however, easier to cure than the so-called benign malarias, which is perhaps due to a difference in the tissue stages. Pre-erythrocytic stages of *P. falciparum* in the liver presumably are not long lived and give rise only to initial erythrocytic forms that usually are easily and radically cured by modern drugs. In contrast, *P. vivax, P. malariae* and *P. ovale* produce, in addition to blood stages, persistent tissue exo-erythrocytic stages that are responsible for long-term relapses. The tissue exo-erythrocytic stages can be eradicated only by a few of the newer drugs. In this connection, it is interesting that a vivax infection, when transmitted by a transfusion of blood from an infected person, can be cured by any effective suppressive drug including quinine because no tissue stages occur.

Older Drugs.—The importance of quinine cannot be overemphasized. Without it many of the most fertile areas of the world would never have become habitable. Its chief shortcoming has been its inability to eradicate relapsing infections such as vivax malaria. It may also give rise to partial deafness. Quinacrine is effective; its disadvantages are that it also does not cure vivax infections, it discolours the skin and, at times, leads to gastric disorders, skin rashes and, rarely, serious mental disorders. In 1928 the English investigators J. A. Sinton and W. Bird discovered in India that pamaquine (Plasmochin), an 8-aminoquinoline, would cure vivax malaria, as indicated by a greatly reduced relapse rate. The drug was too toxic for wide use but led directly to the development of other 8-aminoquinolines. The best of these, primaquine, was first found effective in man by Alf S. Alving and his associates.

Later Drugs.—Because of the shortage of quinine, an intensive research program was initiated during World War II by the National Research council of the United States. As a result, United States and British investigators developed several drugs with superior therapeutic properties. In one group, called the 4-aminoquinolines, is the drug chloroquine, whose chemical name is 7-chloro-4-(4-diethylamino-1-methylbutylamino)-quinoline. It was first synthesized in 1934 by German scientists. It is superior to quinine or quinacrine because it is less toxic, relieves symptoms more quickly by eliminating the asexual blood stages more rapidly, can radically cure falciparum infection and prolongs subsequent latent periods. The ultimate total relapse rate for the vivax type of parasite, however, is the same for all three drugs.

Amodiaquin, like chloroquine also a 4-aminoquinoline, was discovered in 1946 by J. H. Burckhalter and his co-workers. It is similar to chloroquine in its nontoxicity and effectiveness. Other members of this group include hydroxychloroquine and amopyroquin.

Primaquine, or 8-(4-amino-1-methylbutylamino)-6-methoxyquinoline, is an 8-aminoquinoline that is much less toxic than pamaquine. Its outstanding characteristic is that it can radically cure vivax malaria. It is not, however, very active in eliminating the blood parasites. Hence, during an acute attack or during an appreciable parasitemia, it is combined with an effective suppressive drug such as quinine, chloroquine or amodiaquin. Quinacrine is not used for this purpose as it seems to increase the toxicity of primaquine. Pentaquine and isopentaquine, two other 8-aminoquinolines that were developed a few years earlier by U.S. workers, have not been widely used because they are more toxic than primaquine. Chloroguanide, a biguanide, was developed by the British. It has a very low toxicity, acts against the blood and tissue stages and is relatively cheap. However, its clinical action is relatively slow and, in addition, many strains of malaria have become resistant, thus limiting its usefulness.

A more recent drug, pyrimethamine, or 2,4-diamino-5-*p*-chlorophenyl-6-ethylpyrimidine, was first synthesized in the United States and tested there and in England. It is relatively nontoxic and has a marked prophylactic value. Not only is it a suppressive prophylactic to both vivax and falciparum malaria when given at weekly intervals but it also acts as a true causal prophylactic, when begun soon enough, by arresting the early pre-erythrocytic stages. It is also effective against *P. malariae*. Pyrimethamine only slowly suppresses acute attacks. It is, therefore, often supplemented by such drugs as chloroquine, amodiaquin, quinacrine or quinine.

It is interesting that some of the antimalarial drugs have been found to be effective in other infections. Thus, chloroquine and amodiaquin are used to treat the dysentery amoeba *Endamoeba histolytica* when it has invaded the liver; quinacrine has been found to be active against infections with some of the intestinal tapeworms and the intestinal protozoan *Giardia lamblia*.

Acquired drug resistance is an important factor in antibiotic

therapy. It does not occur to any appreciable extent with quinine and was first noted in the case of chloroguanide. Resistance against chloroguanide and pyrimethamine has developed in several species. *P. falciparum* resistance against the 4-aminoquinolines (chloroquine, amodiaquin, etc.) was reported in the 1960s in South America and Asia. Because of the widespread use of these drugs, such resistance is important.

Control.—The methods of control of malaria are varied according to the habits of the particular mosquito involved. Elimination of all breeding places of *Anopheles* by drainage or filling is essential wherever practical. Human beings should be protected from the bites of mosquitoes. Dwellings should be screened and bed nets used, since most *Anopheles* feed at night. The use of residual sprays of the chlorinated hydrocarbon series of insecticides (DDT, lindane, dieldrin) is the most important method of controlling mosquitoes. The mosquitoes that rest on the walls or surfaces covered by the insecticide absorb a lethal dose of the chemical. When applied on water surfaces, DDT and dieldrin can kill the mosquito larvae. Mosquito control has become complicated, however, by the development of resistance to insecticides. At least 18 vectors had become resistant by the 1960s to either DDT or dieldrin. When resistance occurs to one, the other may be used but seven species of mosquitoes were known to be resistant to both types. Organophosphorus compounds, such as malathion, also were used. However, they are highly toxic and great care in handling is necessary. A gaseous insecticide (DDVP, or dimethyl-dichloro-vinyl-phosphate), also a phosphorus compound, was tested in the early 1960s for possible use.

There are other natural methods, such as the introduction of the surface-feeding minnow *Gambusia*, a natural enemy of the mosquito; increasing the salinity of water near the seaside by tide gates; raising and lowering water levels; and eliminating protruding vegetation and debris from the breeding places, thus making it unfavourable to the mosquito. In some areas it is possible to reduce the reservoir of infection, thus interfering with transmission, by the use of drugs, particularly the later ones. These are but a few of the many applicable methods.

Blackwater Fever.—Blackwater fever is the most serious and the least understood complication of malaria. It is characterized by a rapidly developing and severe anemia, passage of dark-red to black urine, signs of severe toxicity and a high mortality. It is usually a complication of malaria of the falciparum variety, although occasionally it may appear after an attack of vivax or quartan malaria. The incidence of blackwater fever seems to be in proportion to the amount of malaria in a certain area. Nonimmune immigrants in heavily endemic areas are frequent sufferers from this complication. In west Africa, where blackwater fever is prevalent, it was found to occur once in every 900 attacks of malaria. It seldom appeared in a person until he had had at least four attacks of malaria and had been in the area for six months. The disease does not appear to be caused simply by repeated attacks of vivax malaria because it was not observed by L. T. Coggeshall in more than 5,000 relapsing cases with an average of 14 relapses per patient. It is theorized that after repeated attacks of malaria, usually with *P. falciparum*, a factor is formed that lyses the red blood cells. Other predisposing factors may be quinine, a previous attack of hemoglobinuria and intense malaria infections.

Symptomatology.—The onset is usually accompanied by single or multiple rigors and extreme prostration. There is no characteristic pattern of fever, although it is usually high, 103° to 105° F. (39° to 41° C.). The pulse is rapid, and the patient usually exhibits a considerable degree of pallor. With the hemolytic crisis there is a profound drop in the number of red cells, so that the count may be as low as 2,000,000. Jaundice makes an appearance early in the course of the disease. Vomiting and anemia are frequently observed.

Prognosis and Treatment.—The general mortality rate is 25%–50%. If the patients are anuric (lacking in the excretion of urine) the rate may be higher. Repeated hemolytic crises tend to affect the prognosis adversely. One attack of blackwater fever predisposes to others; the patient should therefore be removed from the endemic malarious area upon recovery. Treatment is entirely supportive; if parasites are present, antimalarial drugs other than quinine or the 8-aminoquinolines should be given.

Simian Malaria.—There are about 19 species of simian malarias, several of which were first described in the 1950s and 1960s. Some of these, such as *P. rodhaini* of chimpanzees and *P. knowlesi* of monkeys, have been transmitted to man by the inoculation of infected blood. When induced malaria was the principal method of treating neurosyphilis, *P. knowlesi* was used in some cases because it ran a short mild course of fevers.

It has been demonstrated that a vivax type of monkey malaria, *P. cynomolgi*, can be transmitted experimentally to man, from man to man, and from man to monkeys by infected mosquitoes. It was believed possible that additional simian species also can be transmitted experimentally to man.

A few instances of the transmission of human malaria to monkeys, such as the transmission of *P. falciparum* to the howler monkey, have been reported. The communicability of the malaria parasites between man and other animals had, at the mid-1960s, been shown only under experimental conditions. There was no proof that zoonotic malaria is of any importance in the prevalence of human malaria in nature.

See also references under "Malaria" in the Index.

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MALASPINA, an Italian feudal family, with extensive possessions mainly in the western Apennines and the Lunigiana. It appears to descend from the margrave Otbert II, who opposed the emperor Henry II in the 11th century. The situation of their lands, largely in mountainous regions and scattered over a wide area, helped the Malaspina to resist, in the 12th century, territorial expansion by Piacenza and Genoa. Like other feudal houses of medieval Italy, they were, however, weakened by repeated partitions: in 1221 their possessions in the Lunigiana as well as in the Val Padana and in Sardinia were divided between the line of the *Spino Secco* and that of the *Spino Fiorito;* then in 1266 the lands of the *Spino Secco* line were divided among the branches of Mulazzo, of Val di Trebbia, of Villafranca and of Giovagallo; and in 1275 the lands of the *Spino Fiorito* line were divided among the branches of Filattiera, of Olivola and of Verrucola and Fivizzano. Despite this fragmentation of their territories, the Malaspina remained, during the 14th century, one of the leading feudal houses of Tuscany. SPINETTA MALASPINA (d. 1352) of Verrucola even extended his dominions in the Lunigiana and the Garfagnana. But the partitions finally undermined the resistance of the Malaspina to municipal pressure: in the 15th and 16th centuries, most of their dominions came under Genoese or Florentine control. The descendants of Spinetta's great-nephew Spinetta (d. 1398) were more fortunate: the latter's son ANTONIO ALBERIGO acquired Massa and Carrara (1421, 1428); and the marriage of RICCIARDA MALASPINA (Antonio Alberigo's great-granddaughter) to Lorenzo Cybo (1515) enhanced the importance of this branch's dominions, which under Cybo Malaspina became in 1568 the principate and in 1633 the duchy of Massa.

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MALATESTA, an Italian family which ruled Rimini (*q.v.*) and a number of adjacent cities in Romagna and Le Marche during the later middle ages. Like their hostile neighbours, the Montefeltro (*q.v.*), the Malatesta first appear as feudal lords and land-

owners of the Apennine hinterland of Rimini, who in 1197 and again in 1216 were forced into formal submission to the commune. Since they kept their seigniorial rights and property—property to which they steadily added during the 13th century, especially by marriage and emphyteutic grants from churches—they simply carried their influence with them into the town, where by the second half of the century they had captured the leadership of the local Guelphs, not only in Rimini but in Romagna generally. At that time the head of the Riminese branch of the family (there was another, Ghibelline, branch at Sogliano) was MALATESTA DA VERRUCCHIO (d. 1312), and it was he who, after the usual vicissitudes of urban faction, compromise and exile, finally expelled the Ghibelline leaders, the Parcitadi, in 1295 and became effective lord of the city. The best-known episode of Malatesta history also occurred during this period, in 1283 or 1284, when GIANCIOTTO (d. 1304), son of Malatesta, murdered his wife, Francesca da Polenta, and his brother, PAOLO, for adultery (Dante, *Inferno*, v, 73 ff.).

Forty years elapsed before the lordship of the Malatesta in Rimini was given constitutional form. During that time, under Malatesta da Verrucchio's sons MALATESTINO (d. 1317) and PANDOLFO (d. 1326) and Malatestino's son FERRANTINO (d. 1353), they gradually extended control to the nearby towns of Cesena, Fano, Pesaro and Senigallia; but they also fell out among themselves, which was one reason why for a short time (1331–33), while Bertrand du Pouget was papal legate, they altogether lost possession of Rimini. They recaptured the city in 1333; and in 1334 Pandolfo's sons MALATESTA II (d. 1364) and GALEOTTO (d. 1385), after driving Ferrantino out, were finally created lords of Rimini by "popular" suffrage. Once again the Malatesta proceeded to establish a large territorial state, based on Rimini; and by the arrival of Cardinal Albornoz (*q.v.*) in 1353 they had occupied most of the march of Ancona as far as Ascoli. Albornoz compelled them to surrender many of their conquests but allowed them to remain, as papal vicars, in Rimini, Fano, Pesaro and Fossombrone (1355). The vicariate was later renewed, and Malatesta II was succeeded by his sons MALATESTA UNGARO (d. 1372) and PANDOLFO (d. 1373) and by his brother GALEOTTO. Pandolfo Malatesta ruled over Pesaro and started the independent line of the Malatesta of Pesaro, which came to an end in 1445 when his grandson GALEAZZO MALATESTA (probably d. 1457), oppressed by debt and harassed by his neighbour Sigismondo Pandolfo Malatesta, sold Pesaro and Fossombrone to Francesco Sforza and Federigo da Montefeltro. Rimini and the other towns passed on Galeotto's death to his sons CARLO (d. 1429), PANDOLFO (d. 1427), ANDREA (d. 1416) and GALEOTTO BELFIORE (d. 1400), who divided the state among them.

For many years after 1355 the Malatesta of Rimini remained faithful to their peace with the church and were rewarded by the powerless popes of the schism with comprehensive vicariates and grants of land and lordship. They were also active in the wars accompanying the formation, dissolution and reformation of the Milanese dominion in upper Italy under Giangaleazzo Visconti and his sons. Carlo was for a time governor of the Milanese state after Giangaleazzo's death, while Pandolfo possessed himself of Brescia (1404) and Bergamo (1408), which he had to relinquish in 1421. Carlo also achieved a momentary prominence in European politics by his association with Pope Gregory XII and his activity on behalf of Christian unity at the councils of Pisa and Constance. At Constance in 1416 he presented Gregory's formal renunciation of the papacy.

The end of the schism, however, and the election of a single pope, Martin V, in 1417, portended a revival of papal authority. The Malatesta were among the first to feel the change. Though Martin V consented to legitimate Carlo Malatesta's only heirs, namely Pandolfo's three bastards GALEOTTO ROBERTO (d. 1432), DOMENICO (called Malatesta Novello; d. 1465) and SIGISMONDO PANDOLFO (1417–1468), he also favoured their enemies, the Montefeltro and the Malatesta of Pesaro, and on Carlo's death deprived them of much of their territory (1430). Malatesta Novello, who governed Cervia and Cesena, was more dedicated to letters than to arms (he built the beautiful library at Cesena). For Sigismondo, however, the events of 1430 represented a compelling challenge to reprisal against his neighbours, and when Galeazzo Malatesta sold Pesaro to them in 1445, his sense of injury became obsessive.

Sigismondo has been regarded as embodying the type of Italian "Renaissance" prince. A generous and cultivated patron of writers and artists, he built the most splendid monument of Rimini, the elaborately symbolic Malatesta "temple," the church of S. Francesco. With the exercise of patronage he combined popularity as a ruler, distinction as a mercenary captain and a reputation for impiety, vice and brutality. This reputation he owed chiefly to systematic defamation by Pope Pius II. The most certain feature of his character was impetuosity, which made him impatient of keeping faith with princes often more powerful than himself. This was why, after years of feud with his detested rival Federigo da Montefeltro, he stood virtually alone when Pius II launched a crusade against him in 1461. By the peace of 1463 Sigismondo lost most of his dominions, and he and his brother were allowed to keep Cesena and Rimini only until their death.

All attempts to undo this decision failed. But after Sigismondo's death, thanks to the favour of other Italian powers, his son ROBERTO "il Magnifico" (d. 1482) managed to recover Rimini (1469) and bequeath it to his own son, PANDOLFO (d. 1534). The price of this restoration, however, was increasing dependence on other states, especially Venice. At the same time, under Pandolfo Malatesta particularly, the family lost all popular support. So, when Cesare Borgia advanced against Rimini in Oct. 1500, the Malatesta had to flee. They tried three times to return (1503, 1522, 1527–28), but found no welcome or success.

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MALATYA, the administrative centre of an *il* (province) of the same name in east-central Turkey, lies in an upland plain watered by a tributary of the Euphrates, the Tohmasuyu, and surrounded by high mountains (Nuruhak Dagi 10,138 ft., Buz Dagi, Saksak Dagi and Kartal Tepesi). Pop. (1960) 84,162. The town is 148 mi. S.E. of Sivas by road and stands at the road and rail junction where the line from Fevzipasa (the junction for Aleppo, Syria) and the Taurus meets lines east from Elazig and Diyarbakir and north from Sivas and Erzincan. Malatya is largely modern and an important industrial and agricultural centre. There are manufactures of cement, sugar and textiles.

The site of the modern town was first occupied in 1838 during the war with Mohammed (Mehemet) Ali of Egypt. The remains of the Roman and medieval city Melitene, now called Eski ("old") Malatya, are about 6 mi. N.E. Within the fortifications are a fine Seljuk mosque (Ulu Cami) and a large *han* (caravansary), both 13th century A.D. About four miles farther north a mound known as Arslan Tepe represents the remains of an even older city, named Milid in the Hittite records of the 13th century B.C. It was excavated from 1932 onward by French archaeologists, who found a palace of the 8th century B.C. with sculptured reliefs and a colossal statue of a king.

Soundings at Arslan Tepe have identified the remains of an early settlement of the 4th millennium B.C. In the later centuries of the 2nd millennium Milid became one of the more important cities of the Hittite empire and, after the destruction of the latter by the Phrygians in the 12th century B.C., survived as an independent city-state, sometimes linked with the "Neo-Hittite" federation (Sakjegözü, Ya'diya-Sam'al [Zenjioli or Zincirli], Carchemish, etc.) and sometimes subject to Assyria. Removed to a new site in Roman times, it acquired the status of a city again under Trajan and became the capital of Armenia Minor. Later it was successively occupied by Sassanian Persians and Arabs, and after its recovery by Nicephorus II, it became an important centre of the Jacobite sect, whose great historian, Bar-Hebraeus, was born there. In the 12th century it fell to the Seljuk sultanate of Rum.

MALATYA IL is divided administratively into eight *ilceler* or

kasalar (districts). Area 4,718 sq.mi.; pop. (1960) 394,172, of whom about 100,000 were urban. Its fertile plain yields fruit, vegetables, cotton, sugar beet, tobacco, rice and grapes and there are available deposits of chrome, lead and copper.

See L. Delaporte, *Malatya: Arslantepe* (1940). (S. H. LL.)

MALAWI, formerly Nyasaland, a country in east central Africa and a member of the Commonwealth of Nations, is bounded north and northeast by Tanganyika (Tanzania), east, south, and southwest by Portuguese East Africa (Mozambique), and west by Zambia. Its area of 45,747 sq.mi. (116,759 sq.km.) includes 9,266 sq.mi. (23,999 sq.km.) of water, mostly Lake Nyasa (*q.v.*, renamed Lake Malawi in 1965). The capital is Zomba (*q.v.*).

PHYSICAL GEOGRAPHY

Geology, Structure, and Relief.—The greater part of Malawi is composed of Precambrian rocks comprising mainly gneisses, migmatites, pyroxene-granulites, quartzites, phyllites, and mica schists, with some crystalline limestones. Minerals associated with these include graphite, garnet, asbestos, iron ore, and ilmenite. Intrusions both of syenite and granite have penetrated these Precambrian rocks. Strata of the Karroo System occur both in northern and in southern Malawi where, in the Shiré Valley, basaltic lavas are found. Later formations include small stretches of Lower Cretaceous strata in the northern part of the Rift Valley (where fossils of reptiles have been discovered) and in the Shiré Valley. A period of igneous activity, which probably began in the Cretaceous, produced alkaline rocks occurring in ring-structures or as dikes associated with these.

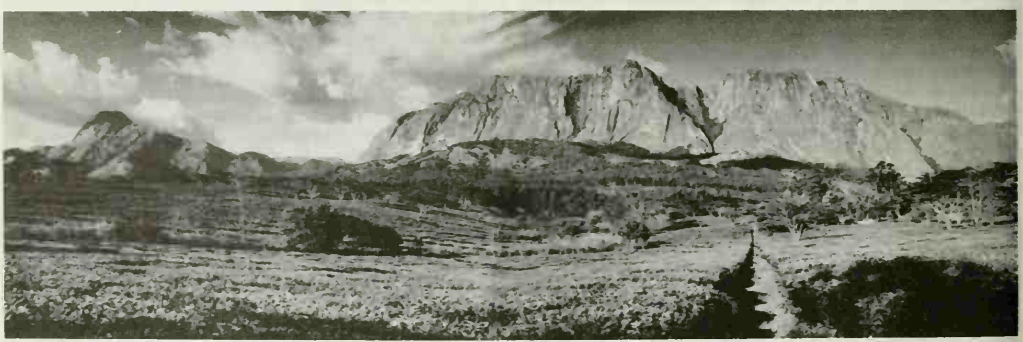
The surface features of Malawi have been profoundly affected by large-scale faulting. The dominant feature of the surface is the north-south trending Rift Valley, formed by renewed rifting in the early Cretaceous along lines of crustal weakness. This rifting movement broke up what was probably an even plateau surface, and the country on either side of the rift is made up of plateaus at various elevations. The Rift Valley may be divided into two parts: the lake basin and the Shiré River Valley to the south of it. The northern part of the lake basin is strongly faulted, the fault scarp of the Livingstone Mountains plunging 1,656 ft. (505 m.) below the lake surface (about 1,550 ft. above sea level), and the Ruarwe Scarp on the western side, submerging to 1,656 ft. below lake level off Usisya Bay. This faulting continues on either side of the Shiré Valley almost to the confluence of the river with the Zambezi, the main scarp on the western side being the Mwanza "step" and that on the eastern side the Chileka "step." To the east of the Shiré Valley, at the Mozambique border, rises the great syenite mass of the Mlanje Peak, which attains an altitude of 9,848 ft. (3,002 m.), the highest point in Malawi. The broad Muchinga watershed links the Zambian highlands with the Malawi highlands to the west of Lake Nyasa: Nyika Plateau, 6,500–8,550 ft. (1,980–2,606 m.); Nganda Hill, 8,551 ft.; and the Vipya Mountains, 5,000–6,000 ft. (1,500–1,800 m.). Three distinct physiographic regions may be recognized in Malawi: the highlands (land over 4,000 ft. [1,200 m.] in altitude); land between 2,000 ft. and 4,000 ft. in the western part of the country; and the Nyasa-Shiré trough (Rift Valley).

Climate.—There are two main seasons: the dry season from May to October and the wet season from November to April. Altitude has an important effect upon temperature as is clearly seen in a comparison of the temperature of Nsanje (Port Herald) in the Shiré River plain, which has a July mean of 21° C (69° F) and an October mean of 29° C (84° F.), and Dedza at 5,355 ft. (1,632 m.) in the highlands of the Central Region, which has a July mean of 14° C (57.2° F) and an October mean of 20.5° C (68.9° F). On the Nyika Plateau in the Northern Region, at altitudes of about 8,000 ft. (2,400 m.) frosts are not uncommon in July. Annual rainfall is highest over parts of the northern highlands and on the Mlanje Peak, where it is about 90 in. (2,286 mm.), and lowest in the lower Shiré Valley where it ranges from 25 to 35 in. (635 to 889 mm.).

Vegetation.—Along the Shiré Valley and on parts of the shore of Lake Nyasa the characteristic vegetation is the baobab, the knobthorn (*Acacia nigrescens*), other species of acacias, a doum palm, and also, to a limited extent, mopane woodland. On the higher plateau areas vegetation is dominated by savanna or open woodland, the species most frequently found being the *Brachystegia* and *Julbernardia*. True forest is found in areas of high rainfall: the Mlanje Mountains and parts of the highlands in the north of the country. In these places grow the yellowwoods, the cedar, and species of *cussonia, aphloia, croton,* etc. At lower levels the red and brown Rhodesian mahoganies (*Khaya nyasica* and *Lovoa swynnertonia*) are common. Pure grassland occurs on the Vipya and Nyika highlands above about 6,000 ft. (1,800 m.). Swamp vegetation occurs in the Shirwa-Chiuta depression and in the lower Shiré Valley.

Animal Life.—Because of the pressure of population there are no large areas in Malawi where game abounds, although there is a fair selection of various species in the reserves. Elephants are found in Mijete, Kasungu, and Kota Kota areas. Among the primates are the vervet, Samango monkey, and larger bush baby. Carnivores include the lion, cheetah, leopard, serval, civet cat, genet, mongoose, black-backed and side-striped jackal, honey badger, and skunklike zoril. The great anteater and ground pangolin are other mammals of interest. The hippopotamus can be seen along the shores of Lake Nyasa and the eland (including Livingstone's eland) occurs in large herds. Other Bovidae are the bushbuck, klipspringer, common waterbuck, reedbuck, inyala, oribi, hartebeest, and duiker. Other notable mammals are the zebra, Livingstone's suni, clawless otter, and white-necked otter. Reptiles are numerous and fish (bass, catfish, perch, carp, etc.) abound in the lakes and rivers. More than 600 species of birds have been recorded and there is a wide variety of insect life.

National Parks and Reserves.—There are five game reserves in Malawi: Kasungu (approximately 1,400 sq.mi. [3,600 sq.km.]) and Kota Kota (approximately 700 sq.mi. [1,800 sq.km.]) in the



BY COURTESY OF FEDERAL INFORMATION DEPARTMENT

MLANJE MASSIF, SOUTHEAST MALAWI

Central Region; Mwabvi (60 sq.mi. [160 sq.km.]) in the Nsanje District; and Mijete (70 sq.mi. [180 sq.km.]) and Lengwe (50 sq.mi. [130 sq.km.]) in the Chikwawa District. The country also possesses two "controlled areas," in which hunting was restricted: the Nyika grasslands (400 sq.mi. [1,000 sq.km.]), in the Rumpi District; and the Vipya controlled area in Nkata Bay District. (J. H. Wn.; X.)

HISTORY SINCE INDEPENDENCE

Malawi achieved independence as a member of the Commonwealth of Nations on July 6, 1964. Soon after a serious dispute arose between the prime minister, Hastings Banda, and other ministers. In September 1964 three ministers were dismissed and three others resigned in sympathy. Subsequently clashes occurred between supporters of the former ministers and members of the Malawi Young Pioneers and others who were loyal to Banda. Henry Chipembere, one of the dismissed ministers, escaped from house arrest and defied attempts to recapture him. By the early months of 1965 order was being maintained with the aid of strict security regulations enforced by European-officered troops and police. (For previous history *see* NYASALAND.)

POPULATION

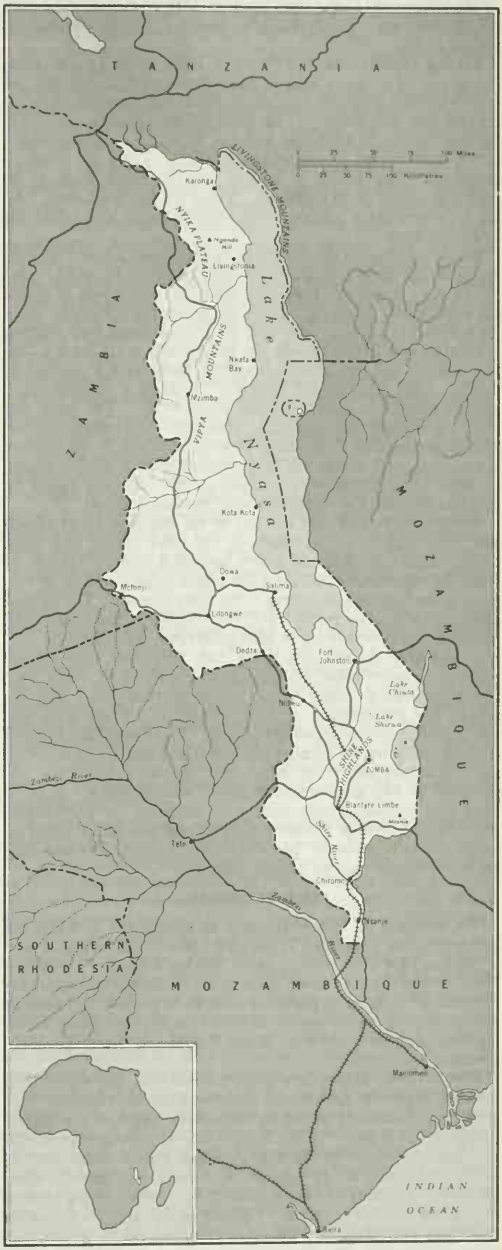
In 1965 the estimated total population of Malawi was 4,000,000, the vast majority being Africans. At the 1956 census the African population was estimated at 2,570,000, and at the 1945 census it was 2,044,707. Between 1931 and 1945 it increased by more than one-third and between 1945 and 1965 by nearly 100%. Part of this increase was, however, the result of immigration into southern Malawi from Mozambique. At the September 1961 census of non-Africans there were 8,750 Europeans, 10,630 Asians, and 1,490 other non-Africans. The European population, which had been 1,975 in 1931, increased rapidly after 1945, when it stood at 1,948, reaching 6,732 in 1956, mainly as a result of immigration from the United Kingdom. The Asian and other non-African peoples (3,259 in 1945) maintained a consistently high birthrate, and had increased to 9,703 by 1956. The estimated population of the chief towns (European population, 1961 census, in parentheses) is: Zomba 7,200 (1,200); Blantyre-Limbe 59,700 (4,090) (*qq.v.*); and Lilongwe 8,100 (870). Most of the population of Malawi is concentrated in the southern part of the country.

The African people of Malawi are of Bantu origin and the vast majority belong to the eastern section of the Bantu peoples. This is subdivided into a number of tribal groups, of which the most important are the Chewa (Chipeta), Lomwe, Nyanja, Yao, and Tumbuka. There is a considerable amount of intermixture among the various tribes. They are agricultural peoples, who cultivate maize (corn) and sorghum, who follow matrilineal descent, and practise uxorilocal marriage. The Ngoni (*q.v.*), however, who established kingdoms by conquest in Malawi and are mixed tribally, cannot easily be fitted into this classification. Tribes were generally organized into small units led by chiefs with limited secular and spiritual powers. But from the beginning of the 20th century the African people have been increasingly subjected to the influence of western European civilization, many have been converted to Christianity, and some tribal customs have tended to fall into disuse.

The official languages are English, Nyanja, and Tumbuka. Nyanja is the lingua franca in the Central and Southern regions; Tumbuka is widely spoken in the Northern Region. (J. C. Mi.; X.)

ADMINISTRATION AND SOCIAL CONDITIONS

Malawi is a constitutional monarchy and a member of the Commonwealth of Nations acknowledging the British sovereign as head of state. Executive authority is normally exercised on behalf of the British sovereign by the governor-general, who is, however, generally required to act in accordance with the advice given to him by the Cabinet. Parliament consists of a National Assembly of 53 members, 3 of whom are elected by special-roll constituencies presided over by a speaker elected by the members of the National Assembly from among themselves. The governor-general appoints as prime minister the member of the National Assembly who appears most likely to obtain the support of the majority of members of the Assembly. The Cabinet is composed of the prime minister and the other ministers appointed by him. The Cabinet's function is to advise the governor-general in the gov-



PRINCIPAL COMMUNITIES AND PHYSICAL FEATURES OF MALAWI

ernment of the country and it is collectively responsible to Parliament for any advice which it gives.

For local government purposes Malawi is divided into three regions, Northern, Central, and Southern, which are in turn divided into 20 districts. Each district has an elected district council, which controls its finances and is empowered to levy rates. Five of the larger towns have town councils, with councilors appointed by the governor. Blantyre-Limbe, however, has an elected municipal council.

Living Conditions.—In the early 1960s about 130,000 African people of all races were in paid employment in Malawi, the largest number in agriculture. Many Malawians continued to work outside their own country in the more industrialized countries like Zambia, Southern Rhodesia, and the Republic of South Africa which could attract labour with high wages. There are about 20 employees' trade unions in Malawi and the employment of labour is governed by an ordinance. There are also ordinances dealing with workmen's compensation, rates of wages, and conditions of employment.

Beside encouraging improvements in traditional housing the government pays close attention to housing problems in urban areas; in the most important townships land has been made available for high-density planning. There are government-financed housing schemes in certain towns and an urban housing loan scheme.

Health and Welfare.—In the early 1960s apart from a central hospital and two general hospitals, there were a number of district, rural, and special hospitals, including a mental and a leprosy hospital (leprosy is quite widespread). The main diseases are malaria, schistosomiasis, hookworm, and relapsing fever. The Department of Community Development and Social Welfare is concerned with village self-help schemes, adult literacy, training in homecrafts, youth work, recreation, the problems raised by urbanization, and the rehabilitation of the handicapped.

Justice.—The judiciary consists of the Supreme Court of Appeal, the High Court, (comprising the chief justice and three puisne judges), magistrates' courts, and local courts. Appeals lie from the subordinate courts to the higher courts, and in certain cases to the Judicial Committee of the Privy Council. The Malawi police force, totaling nearly 3,000, is divided into three territorial police divisions, which are in turn subdivided into districts.

Education.—In the early 1960s there were more than 360,000 pupils in primary schools, a considerable number of which were run by missions, many being government-assisted. Primary schools are administered by local authorities. There were also nearly 3,000 pupils in secondary schools. There were nine teacher-training institutes for primary schoolteachers and Soche Hill College trained secondary schoolteachers. Technical education was provided by two government technical schools and a college of commerce offered a wide variety of subjects. A polytechnic, which would provide a more advanced and specialized range of subjects, was being built. More than 400 students were attending higher education courses outside Malawi.

THE ECONOMY

The economy of Malawi is based on agriculture, in which the majority of the population is engaged. More than sufficient food is produced for the country's needs, leaving a surplus for export. Natural conditions, however, make much of Malawi unsuitable for cultivation. It has also proved impossible to exploit the country's known mineral wealth because of its inaccessibility. Manufacturing industries developed after World War II and now make an appreciable contribution.

Production.—*Agriculture and Fisheries.*—In the early 1960s the most important agricultural crops were tea and tobacco. Tea, grown on plantations owned by Europeans, employs the biggest proportion of labour. In the early 1960s with more than 30,000 ac. planted, annual production averaged nearly 30,000,000 lb. About 35,000,000 lb. of tobacco were marketed annually from plantations covering just under 130,000 ac. An increasing amount of Turkish tobacco is grown. Peanuts (groundnuts) are also an important cash crop. Among grain crops are maize (corn), sorghum, millet, rice, and wheat, grown mainly for local consumption, although some maize and rice are exported. Other export crops include cotton and tung oil. Some coffee is grown, chiefly by Africans in the Northern Region. The marketing of the chief African cash crops is handled by the Farmers' Marketing Board which aims at enabling the African producer to obtain a steady price and to improve the quality of his crops. By the early 1960s there were more than 120 cooperative societies, which purchased and marketed produce.

BY COURTESY OF THE FEDERAL INFORMATION DEPARTMENT, SOUTHERN RHODESIA; PHOTO BY R. L. KINSEY

TEA ESTATE IN MALAWI

In the early 1960s there were about 380,000 cattle, 500,000 goats, nearly 80,000 sheep, and 100,000 pigs. Good progress in controlling various diseases has led to a considerable increase in the cattle population, notably among Africans in the Southern Region.

There is a fishing industry along Lake Nyasa, and other fisheries at Shirwa (Chirua) and Malombe lakes. The government encourages fishing by loans and other means, and is attempting to establish it on a regular commercial basis. Production is between 12,000 and 14,000 tons annually.

Forestry.—Of Malawi's 9,000 sq.mi. (23,300 sq.km.) of indigenous forest, about 3,700 sq.mi. (9,600 sq.km.) are set aside as state forest reserves. About 26,000 ac. (10,500 ha.) are plantations, mainly of softwood. Annual production of timber usually exceeds 2,300,000 cu.ft.

Mining, Industry, and Power.—Although exploration has revealed a considerable variety of minerals in Malawi, only a few (notably bauxite) are known to exist in quantities sufficient to be worth exploitation, and the geographical location of these has so far made it impossible to work them on a commercial scale. There has been notable progress in light industry and there are factories for assembling motor vehicles, and for the manufacture of cigarettes, soap, clothing, bricks, cement, furniture, fishing nets, and edible oils and fats. The Malawi Electricity Supply Commission is responsible for the generation and distribution of power, and covers the industrial areas of the Southern Region.

Trade and Finance.—The most important exports are tobacco, tea, peanuts, cotton, and other agricultural products. Only a few manufactured articles are exported. Among the chief imports are metals and metal manufactures, machinery and vehicles, textiles, clothing, and foodstuffs.

Currency issued by the Bank of Rhodesia and Nyasaland remains legal tender in Malawi until the establishment of the Reserve Banks of Malawi. Beside regulating the issue of currency the bank is empowered to control banking, to deal in gold and foreign currencies, and exercise exchange control functions. There are also two commercial banks: the Standard Bank, with branches at

Blantyre-Limbe, Zomba, and Lilongwe; and Barclays Bank, Dominion, Colonial and Overseas (DCO), with branches at Blantyre-Limbe and Lilongwe.

Current expenditure by the Malawi government is financed from revenue: capital expenditure is charged to a special development fund instituted in 1957. In the mid-1960s revenue on the current account totaled about £9,000,000 annually and on the development account about £3,000,000. The main sources of revenue were income tax, customs and excise duties, and grants and loans from the United Kingdom. Expenditure on the current account was about £8,000,000 and on the development account £3,000,000. The main items of expenditure were education, public works, maintenance of law and order, and social services. The budget deficit was balanced by the British government.

Transport and Communications.—The railway runs from Salima near Lake Nyasa through Blantyre-Limbe down to Beira in Mozambique, where it links up with the line from Southern Rhodesia. In the early 1960s there were about 280 mi. (450 km.) of permanent way in Malawi and almost 1,000,000 tons of freight were carried annually. The total road length was about 6,000 mi. (9,650 km.), of which nearly 250 mi. (400 km.) were bituminous, and there were about 17,000 motor vehicles in the country. Roads link Malawi with Zambia and Mozambique, and through both these countries with Southern Rhodesia. Malawi Railways also operates a steamship service on Lake Nyasa; vessels call at various ports in Malawi and also cross to Tanganyika. There are airports at Blantyre-Limbe and Lilongwe, and airfields at a number of other towns. Air Malawi operates internal services and there are also flights to Salisbury and Lusaka. Malawi has a broadcasting studio at Blantyre-Limbe and a station at Zomba. Programs are broadcast in English and in the vernacular languages.

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MALAY, a people of southeast Asia and adjacent islands. It is thought that the neolithic ancestors of the Malays (proto-Austronesians, proto-Malays, Mongoloid Indonesians or Malaysians) descended from Yünnan province, southern China, between 2500 B.C. and 1500 B.C., down the valley of the Mekong river to the Malay peninsula, thence to Indonesia and on to Madagascar and Easter Island. They had already cultivated banana, sugar cane, millet and rice, domesticated pigs and buffaloes, and could count up to a thousand. They were boatbuilders and fishermen as well as hunters and agriculturists. These early peoples built houses of bamboo or wood on piles, made pottery in great variety, erected megaliths to dead chiefs and practised head-hunting. At about the beginning of the Christian era immigrants from India came to spread their cultural influence along with Buddhism, Sivaism and Vishnuism, until, between the 13th and 15th centuries, Islam ousted all religions except in Bali, which remained Hindu, and the Philippines, where the Spaniards introduced Roman Catholicism. The modern or deutero-Malays are the primitive Malay with strains derived from intermarriage with the Chinese, Indians, Siamese and Arabs. The Malay groups bore many local names until, probably in the 13th century, they got their generic name from Jambi (*q.v.*; also called Melayu) in Sumatra.

Religion and Folklore.—Relics of animism survive in the Malay fear of malignant spirits of the soil and jungle, in dread of banshees hostile to pregnant women and in respect for holy places, rocks, trees, persons and animals. Except in remote hamlets, these beliefs now count for no more than a European's dislike of walking under a ladder. A thousand years of Hindu influence left ceremonials for weddings and the installation of rulers, many Sanskrit terms (even the word raja denoting an Indian rank) and a host of gods and demons for the invocations of the obsolescent shaman (*see* SHAMANISM: *Southeast Asia and Oceania*).

In 1292 Marco Polo found Islam established on the north coast of Sumatra by missionaries from the Coromandel coast; early in the 15th century the rulers of Malacca embraced it, and from there it was carried to Java, Borneo and other islands until (apart from the Philippines and Bali) almost all peoples of Malaysia became orthodox Muslims of the school of Shafi'i.

After the conversion to Islam, Arabic script with some Persian additions and three new letters took the place of earlier alphabets based on Sanskrit. Malay translations of the Ramayana and Mahabharata (*see* SANSKRIT LITERATURE) gave way to the early romances of Islamic heroes, and to Muslim stories as well as many Muslim treatises on religion from the Persian and Arabic. Malay in the 1960s is written either in Arabic or romanized script (*see* MALAY LANGUAGE).

Social and Political Structure.—Except in the state of Negri Sembilan in southwestern Malaya, where a matrilineal system derived from the Menangkabau (*q.v.*) prevails, Malays reckon descent and relationships bilaterally, through both male and female lines (*see* DESCENT, SYSTEMS OF: *Descent Systems in Asia*). Separation and divorce are relatively easy and common; husband and wife both have property rights in case of divorce or death. Women traditionally are influential in economic affairs, often carrying on trade and handling money matters. In the state of Kelantan in northeastern Malaya, about a quarter of the women earn a regular income and half are employed from time to time. In Malay villages or kampongs, often located along coasts or streams, the rather widely dispersed houses are separated by fruit trees and vegetable gardens. Village economy revolves round rice or rubber cultivation and fishing; men do the heavy work and women sell garden produce or cooked food and plant and harvest rice. Women also may weave or make floor mats and baskets, wash for alluvial tin or gold, tap rubber or teach in schools. Malays were not slow to plant rubber after the tree was introduced early in the 20th century and have adjusted to an industrial age.

Hinduism replaced Malay tribal chiefs with territorial rulers, to be advised by high court officials and governing through district chiefs. As incarnations of Hindu gods these rulers tended to wield absolute power until the British period. Its source forgotten, a political structure of 4 great, 8 major and 16 minor chiefs, whose numbers were determined by Hindu astrological notions, survived to modern times.

The main class division is between raja and commoner, though within both there are degrees based on birth, means, profession and personal characteristics. A ruler can marry a woman of any class though a raja woman loses social standing unless she marries a raja or a noble or distinguished man called a sayyid (*e.g.*, a descendant of the prophet Mohammed). Before the British period, there were also slaves who might have been Malay debt-bondsmen, criminals, pagan aborigines or Africans brought by pilgrims to Mecca. As a Muslim, a Malay may marry a Christian or a Jew but not a polytheist or a pagan, unless the prospective mate converts to Islam.

All classes and national groups meet on the football field. Malays enjoy all forms of sport within their means: football, swimming, boat racing, physical drill. The tin and rubber capital invested in the Malay peninsula and archipelago under British protection provided revenue for an educational system extolled before World War I as unrivalled in Asia outside Japan, and for a medical service that abolished cholera, yaws, beriberi and smallpox, and confined malaria to remote rural areas. Better health and changed social and political conditions have stopped the notorious amok (homicidal mania); suicide among Malays is almost unknown and serious crime very rare. Far from conservative, Malays have welcomed innovation in custom, law, medicine, politics and dress, whether introduced by Hindu, Muslim or European.

Costume and Weapons.—Except for a bark loincloth and a blowpipe for killing game, the early Malay had neither clothes nor weapons. The men's coat of more recent times, bearing a Persian name, and the skirt (sarong) worn by both sexes came from India. Malay trousers may have been copied from the Chinese but have an Arabic name, as also has the velvet cap now worn by males; the rice planter's sun hat was brought from Yünnan and the elaborately tied headkerchief (now seen only on ceremonial occasions) probably was of Hindu origin. The usual jacket for women in the Malay peninsula is a coat of cotton or silk, knee-length and pinned with three brooches, and was introduced by the Portuguese

in the 16th century. Women wear this jacket, or a more modern short jacket, with the sarong down to their ankles. For formal dress men wear trousers covered from waist to knee by the sarong. The most prized sarongs, heavily interwoven with gold thread, come from Batu Bara and Palembang in Sumatra, though silk sarongs of mottled patterns and interwoven with gold thread are made in Trengganu and sarongs of modern type in Kelantan. Most sarongs are imported.

The two-edged Malay dagger (kris) came from Java, though its prototype belongs to the Bronze Age culture of Dongson in Annam. It is never represented in early Indo-Javanese sculpture. By the end of the 13th century it had changed from a one-piece weapon to a dagger with a separate hilt of gold, ivory or wood, carved to represent Vishnu's bird the Garuda, or a Hindu demon Raksasa or rarely Hanuman the monkey-god. The blade became wavy to represent serpents or Nagas (dragons, spirits). Bronze knives of 1000 B.C. from An-yang in China and bronze knives from Ordos in Mongolia together with the kidney-shaped guard of the Scythian sword are identical with the shape and guard of the small Malay dagger known as the pepper crusher. The needs of piracy led to the Bugi (*q.v.*) sundang (short swords with blades straight or wavy and cockatoo hilts). There is a great variety of wood knives. A finger knife for cutting rice stalk by stalk has a stone prototype unearthed in Tonkin.

Further discussions of the Malay people and affiliated groups may be found in BORNEO; INDONESIA, REPUBLIC OF; INDONESIAN ARCHAEOLOGY AND ART; JAVA; MALAGASY REPUBLIC; MALAYA; MALAYA ARCHIPELAGO; MALAYO-POLYNESIAN LANGUAGES; MORO; OCEANIA; PHILIPPINES, REPUBLIC OF THE; SABAH; SUMATRA.

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(R. O. WT.; X.)

MALAYA (Malay TANAH MELAYU), was from 1957 until 1963 an independent kingdom within the Commonwealth of Nations, comprising a federation of the nine states of Johore, Negri Sembilan, Kelantan, Kedah, Trengganu, Selangor, Perlis, Pahang and Perak (*qq.v.*), and the two former British colonial settlements of Penang and Malacca (*qq.v.*). In Sept. 1963 the Federation of Malaya ceased to exist as a political entity, and its component states, henceforth known collectively as the states of Malaya, became part of the new Malaysia (*q.v.*) federation. Malaysia's constitution is based on that of the Federation of Malaya (see *Administration and Social Conditions*, below) and after the establishment of Malaysia the various departments of the Malayan government continued to discharge their respective responsibilities until they were replaced by Malaysian federal bodies. The greater part of this article is concerned with that part of the Malayan peninsula now occupied by the states of Malaya.

This article has the following sections:

I. Physical Geography
  1. Geology, Relief and Drainage
  2. Climate
  3. Soils and Vegetation
  4. Animal Life
II. The People
  1. Ethnic Composition
  2. Languages
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  1. The Kingdom of Malacca
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  5. Transport and Communications

I. PHYSICAL GEOGRAPHY

1. Geology, Relief and Drainage.—The federation is a forested, mountainous country surrounded by wide, often swampy plains nearly at sea level apart from rocky islands jutting through them. Malaya's mountains (highest Gunong Tahan, 7,186 ft.) have a moderate altitude, carrying vegetation on their summits. They are more massive and continuous to the north, diminishing in height and separating to the south, where they continue as the hills of the Lingga and Riouw (Rhio) archipelagoes. In mid-Malaya two sets of ranges meet: (1) a northern group staggered skewwise on a north-northeast south-southwest axis; and (2) a southern group of lower altitudes set on a similar orientation, with extensions to the Trengganu coastal ranges. The ranges have igneous cores intruded into late Mesozoic fold systems now so extensively eroded that granitic rocks are much exposed on the heights. Flanking these are steeply inclined limestones and calcareous shales, the former often standing out distinctively on otherwise smooth landscapes as the steep hills of massive limestone undergoing solution; such karst hills and their *polje* (known as *wang* in Malaya) are seen in Perlis, Kinta, Selangor and west Pahang. Substantial quartzite, conglomerate and shale beds occur at many levels. Across the eastern half of the peninsula are irregular exposures of the pre-Mesozoic Pahang volcanic series, including ash, pumice and lava bed with rhyolites and basalts. No volcanoes, active or extinct, have been found. Among the shales are a few lignitic coal formations as at Batu Arang (near Kuala Lumpur), Kepong and Enggor; only the Batu Arang lignites are worked, but their output has rapidly declined because of the competition with imported oil fuels. Landforms among the ranges include many infacing parallel scarps originating from the erosion of the anticlines to expose their igneous cores. Scarps of this kind are well developed in Pahang and establish the alignment of the Sungei Pahang's tributaries. One of these is the anomalous Sungei Bera, flowing north through the large Tasek (lake) Bera, the only natural lake in Malaya, which, partly by silting and partly by ingrowing vegetation, is little more than an overgrown swamp for much of the year. Its headstreams in Negri Sembilan are being captured by the Sungei Muar which flows into the Strait of Malacca. Because Malayan rocks are heavily weathered they are often concealed by thick (up to 100 ft.) covers of laterized material which impede geological survey; these consist of red and yellow clays interspersed with ironstone pans and the remnants of quartz veins. Beneath the coastal swamps are unconsolidated marine and river alluvials in places 450 ft. deep and extending as far as 40 mi. inland.

Alluvials at foot-of-hill locations and along valleys vary according to origin; clays, sands, gravels, peat (of old lagoons) and ironstone pans are common, white kaolins and coarse grits often adjoining the granite outcrops. Among the alluvials from granite-limestone contact zones occur metallic ores partially broken down by weathering and sorted by flowing water, whence most Malayan tin is mined. Tin-bearing gravels (cassiterites) vary in depth and thickness; surface deposits have by now been exhausted, others lie as deep as 200 ft. below ground or are lodged among the solution cavities of subsurface limestone. Lode or vein tin is met only at depth and is difficult to find so that it has not entered production except at Sungei Lembing in east Pahang. Through the coastal swamps and separated by infilling lagoons run lines of old sandpits (permatang) providing good wells for potable water and favoured by Malays as village sites.

PHYSICAL FEATURES, MAJOR TOWNS AND TRANSPORTATION ROUTES OF MALAYA

Because of Malaya's narrowness and longitudinal ranges, its rivers are short, violent in flow in the mountains, sluggish and meandering on the coastal plains where equatorial vegetation presses into them. The rivers commonly have trellis drainage patterns among scarps and north to south alignments. The longest stream on the east is the Sungei Pahang (271 mi.), once significant as a highway for canoe-borne Malays, now traversing Malaya's least developed and most swampy area. The largest western stream is the Sungei Perak (252 mi.), itself little used but having as a tributary the Kinta, whose valley is the country's richest tin field. The only Malayan installation for hydroelectricity is at Chenderoh lake on the Perak.

Malaya's coasts are with few exceptions lined with mangrove swamps and have shallows extending far from shore, which offer easy approach for native craft but impede all modern shipping and deter harbour development. Heavy silting obstructs the approach to river mouths. Even where a rocky outcrop occurs at the coast it is commonly isolated by difficult swamp-forest inland.

Both the Strait of Malacca and the South China sea are shallow inundations of the Sunda platform, the continental shelf underlying southeast Asia and its islands, whose history through the Quaternary glacial periods seems to have been a rising and falling of water levels, the present phase being one of the high sea level. Across their floors may be traced extensions of Malayan streams, evidence of a stage when they were tributaries to large rivers which once flowed northward roughly parallel to the present coasts. Tides on the west coast derive from the Indian ocean where semidiurnal tides prevail; on the east coast, Pacific type tides interact with Java sea tidal streams to produce semidiurnal tides with phases when days have a single high and a single low tide. Down the west coast a steady longshore drift from north to south induces heavy silting; one huge sandspit created by it in south Johore extends the Malayan coast well south of the southernmost corner of Singapore Island.

2. Climate.—Since Malaya spreads between 2° N. and 6° N. and is surrounded by seas, its climate is equatorial, characterized by uniformly high temperatures through the year (a mean of 81° F.) and from place to place; the ranges are so low that only a few peaks rise above the tree line and at Cameron Highlands, the one hill station, the temperature is only about 8° below that of the plains. Greatest seasonal variation comes from the interplay of the north tropical and south tropical air masses, bringing wind change rather than temperature change. During the northern winter, winds from northeasterly points cover the peninsula; in summer, it is subject to winds from the southwest. Seasonal raininess varies with exposure to these winds, both of which are warm and moist. Peak rains are often during the transitional months between these wind seasons. The northeasterlies bring heavy rains and rough seas to the east coast, then subject to floods and very dangerous for shipping. Thunderstorms usually accompany the rains, which are often convectional. During the southwesterlies small, intense and short-lived squalls called *sumatras* move across the Malacca-west Johore coasts. Strong land and sea breeze effects are felt at many points on the plains. Many stations report more than 70 days a year of heavy rain (above ¼ in.) and totals from town stations are a few inches either side of 100 in. per year. Alor Star has 90 in. with maximums in October and April and the minimum in February; Kota Bharu on the opposite side of north Malaya has 122 in. with a maximum in November and minimum in February. Kuala Lumpur, an inland and central station, has 94 in. with maximums in October and April and a minimum in July; Kluang (in south Johore) has 92 in. with maximums in November and May and the minimum in February.

3. Soils and Vegetation.—Additional to swamp and peaty soils, the Malayan surface shows many varieties of the transition between black forest soil and multicoloured laterites, the stage depending chiefly on the extent of leaching after the ground is cleared of vegetation. When clearing takes place in such a way that the forest soil and its humus content is lost, what remains is poor agriculturally and within a few years may become sterile. The exceptions to this are soils in valleys in which accumulate the finer particles from all the drainage basins, and those soils weathered from the Pahang volcanic series. This accounts for the early and continued agriculture by the Malays along the river banks and in the deltas; the richness of soils on the Pahang volcanic series has been recognized only recently, chiefly because they are less accessible. (E. H. G. D.)

The natural vegetation of Malaya consists of the high, continuous evergreen rain forest. It comprises an enormous variety of trees, the tallest mainly belonging to the dipterocarp family, which furnishes most of the commercial timber of the country. A notable feature of the rain forests is the epiphytic plants, which are mainly orchids, aroids and ferns. About 800 species of orchid are known. Lianas are also present in variety and their ropelike stems are a feature of the jungle. One group, the rattans, have exceedingly long, tough, flexible stems, and climb by means of small recurved thorns on the prolonged leaf tips. Rattan forms the basis of an important furniture-making industry and is used for a variety of other purposes. The largest known flowers, species of *Rafflesia*, are found parasitic upon the woody vines of certain lianas.

Large bamboos grow in the lowland and foothill forest and are used by the aborigines and country people for making containers, rafts for river use and in house building. Palms are abundant and varied. More than one-half the country is still covered by forest of this type. The mangroves of the coastal belt form forests of very distinct type, which are valuable as a source of firewood, and on the sandy shores coconut palms and casuarina trees are the main form of vegetation.

4. Animal Life.—The zoological affinities of Malaya are more with the Greater Sunda Islands, Borneo, Sumatra and Java, than with the Asiatic continent, a circumstance derived from the fact that during the Ice Age the whole Sunda shelf was continuous land. Elephants are still fairly numerous and the large blackish-gray wild cattle called gaur or seladang are found in the more extensive forested areas. Two species of rhinoceros are listed in the fauna, the larger of which, the Javan rhinoceros, may be extinct, but the two-horned Sumatran form still exists in small numbers in the remoter hilly areas. The strange parti-coloured Asiatic tapir is

found, and sambar, muntjac (barking deer), two species of mouse deer and two of wild pig are among the other ungulates. Carnivores include tiger, leopard (mostly the black variety), clouded leopard and a variety of smaller cats and civets. The large black siamang and two smaller forms of gibbon represent the anthropoid apes, and there are five species of monkeys. There is a single lemuroid, the slow loris; the primitive primates called tree shrews are common.

Of the smaller mammals, bats and rodents are present in great variety, the former including the large flying fox whose wing span may exceed four feet. In the flying squirrels, a membrane of skin between fore and hind limbs serves as a parachute and enables the animal to glide from one tree to a lower point on another. Similarly equipped is the so-called flying lemur, or cobego, whose affinities among the mammals are obscure.

Birds are numerous and varied. Bulbuls, tiny sunbirds, brilliant kingfishers and the black and white magpie robin are familiar garden birds; a host of others, many seldom seen, live in the forest. Notable among these are the large grotesque hornbills, the magnificent argus pheasant and the brightly coloured trogons and pittas.

Reptiles include the estuarine crocodile of the coastal mangrove and the Malayan gharial of the inland swamps. Snakes are numerous, but only a small number are venomous. Known deaths from snakebite are rare; of those that do occur the majority are caused by sea snakes. The largest snakes are the reticulated python and the hamadryad or king cobra, the latter being the biggest venomous snake in the world. Among the most remarkable reptiles are the flying lizards, which glide from tree to tree as the flying squirrels do. The most familiar ones are the little house geckos, which astonish newcomers by their ability to run upside down on the ceiling.

A very large variety of fish is found in the surrounding seas and in the ditches, lakes, swamps and rivers. Important fisheries exist all around the coast. Insects and other invertebrates are diverse beyond computation and many groups are imperfectly known. An example of this diversity is the presence of nearly 950 species of butterflies in the country. The Taman Negara National park is the largest of several wildlife reserves. It is situated on the east side of the main mountain range and includes the isolated Mt. Gunong Tahan.

II. THE PEOPLE

1. Ethnic Composition.—The indigenous population comprises a majority of Malays and a minority of jungle-dwelling aboriginal people. The distinction between the two is not always sharp and is determined rather by religious belief and custom than by race. Physically the Malays are a brown-skinned Austro-Asiatic people of very similar type to the Indonesians. Although they are homogeneous it is difficult to speak with certainty of their origin. Some, particularly those of the southwestern states, are certainly related to the Menangkabau (*q.v.*) in Sumatra. Many of them are probably descended from the early settlements of various Indonesian seafaring people on the coasts of the peninsula. They occupy themselves chiefly with agriculture and fishing.

The greater number of the aborigines live in the jungles of the main range. They can be divided racially into three types: Negritos, small Negroid people; Senoi, slimly built, wavy-haired, relatively fair-skinned people; aboriginal Malays, more stoutly built, dark skinned, with straight or slightly wavy hair. Most of them live by hunting and by rather primitive agriculture, including the planting of hill rice and sweet potatoes. They hunt animals of all kinds by trapping and with the blowgun. This is most usually made of a slender bamboo enclosed and supported in a stouter one, about eight feet long. A slender wooden dart with a soft pith butt is shot from the blowgun by a sharp expulsion of the breath; the dart itself inflicts only a trivial wound and to make it effective it is invariably poisoned at the tip; vegetable poisons of two types are used, the brown latex of the ipoh or upas tree (*Antiaris toxicaria*) and a preparation made from creepers of the genus *Strychnos*. A less common type of blowgun is made like a lead pencil without the lead; two hemicylindrical pieces of wood are carefully grooved and fitted together to form a tube. The traditional weapon of the Negritos was the bow, but they have now mostly adopted the blowgun. The word Sakai is often used to comprise all the Malayan aborigines, but it is without exact meaning and is regarded by the people themselves as derogatory (*see* also MALAY; SENOI; NEGRITO).

The considerable number of Chinese and Indian immigrants are referred to below.

2. Languages.—Malay, with minor variations, is uniform throughout the country and also provides a lingua franca over all the Indonesian region. Although Malay is the national language, many other dialects and languages including Chinese (with separate linguistic groups of Hokkiens, Cantonese, Hakkas, Hailams and Teochews), Panjabi, Tamil, Arabic, Telugu and Malayali are spoken. Several distinct languages are spoken by the aborigines and they include words of the Mon-Khmer family, thus pointing to the Indochinese origin of these people. (*See* also MALAY LANGUAGE; MALAYO-POLYNESIAN LANGUAGES.)

3. Religion.—Islam is the official religion and Malays are practically all Muslims. The constitution guarantees the freedom of other religions, which generally follow ethnic lines—the Indians are mostly Hindus and Parsees, the Pakistanis are Muslims and Sikhs, and the Chinese are generally Confucian-Buddhists with some adherents to Christianity and Islam. Aboriginal groups such as the Negrito Semang and Jakun (*qq.v.*) follow their own traditional beliefs.

III. ARCHAEOLOGY

A fairly complete Stone Age record has been found in Malaya, the Paleolithic, Mesolithic and Neolithic all being represented. The Paleolithic Tampanian culture was discovered by H. D. Collings in 1938 at Kota Tampan on the Sungei Perak. In a raised terrace he found large, crude stone tools, mainly roughly made choppers and flakes; later research suggests that the terrace was formed in the second glacial period of the Pleistocene. Although this dating is rather earlier than that of the Javanese Pajitanian, the Soanian of India and the Choukoutienian of China (all generally regarded as Middle Pleistocene), the Tampanian probably belongs to the same complex of early Asiatic cultures. No fossils have been found with the Tampanian artifacts, but if correlation with the Choukoutienian is correct, its author was probably a being of the *Pithecanthropus* type.

The Mesolithic is represented by remains in midden deposits in the floors of caves and rock shelters. The similarity of this culture to the Hoabinhian, classically developed at Hoabinh in Indochina, is so close that the same name has been applied to it. Abundant stone tools made from river pebbles are found in the middens, some being "biface" tools in which opposite sides of the pebble are entirely flaked away, others "uniface," having one side of it left intact. Animal bones, evidently food remains of a hunting people, are of existing species, suggesting a postglacial age, and associated human remains are of a type close to the present day Melanesians. An interesting feature of these Hoabinhian remains is the presence of soft red hematite, pieces of which often shows signs of rubbing or grinding. It has been suggested that it was used to make red pigment for ritual blood symbolism.

In Province Wellesley, not far from the coast, accumulations of molluscan shells are associated with artifacts of Mesolithic type, human remains and, again, red hematite. They are clearly food remains of a people who lived near the shore, the sea having since retreated. Evidence from a human lower jaw suggests that, like the Hoabinhian people, they were of a Melanesian type.

The Neolithic is represented by the Quadrangular Adze culture, whose characteristic artifact is a polished stone adze with quadrangular cross section. These adzes are often found by the country people in river beds after floods and in the course of alluvial mining, but the richest finds have been in rock shelters used by the Neolithic people as burial places. In these the burials were accompanied by grave furniture consisting of stone tools and ornaments, ornaments of shell and diversely shaped and decorated pottery vessels. Stone bark cloth beaters have also been found, indicating that they used bark cloth for clothing.

There is no evidence of an indigenous Bronze Age, but bronze-socketed celts of a type widespread in Europe and Asia and some artifacts of the Dong-son culture comprising two ornamented bronze drums and three large bells have been found.

The richest site representing the Early Iron Age is at Kuala Selinsing on the coast of Perak. There I. H. N. Evans found large numbers of beads of glass and semiprecious stones, a cornelian seal inscribed with Palava script, quantities of pottery and some gold ornaments. These were accompanied by human burials in dugout canoes. Evidence from the beads and pottery suggests that the site was inhabited from about the 8th to the 11th or 12th century A.D. Inland, peculiarly shaped iron artifacts and graves, lined with granite slabs and containing beads and pottery, probably belong to the same period.

Evidence of early Hindu colonization, extending from about the 4th to the 12th century A.D., was found and reported on by H. G. Quaritch Wales. Most of the sites are in Kedah, one of the northernmost states, and finds include a fine bronze image of the Buddha of the Gupta age (5th century), a clay tablet inscribed in early 6th-century Palava script and a bronze casket containing a treasure of miniature gold objects.

In Singapore an inscribed monolith, which formerly stood at the mouth of the Singapore river, and a treasure of gold bracelets and rings found at Ft. Canning, are regarded as relics of the Majapahit empire and dated to the 14th century.

The National Museum of Malaya (in Kuala Lumpur) and the Perak museum house collections of Malayan archaeologic and ethnographic antiquities.

See also INDONESIAN ARCHAEOLOGY AND ART. (M. W. F. T.)

IV. HISTORY

Descending from Yünnan, bark-clad Mongoloid tribesmen destined to become by intermarriage with other races the deutero- or civilized Malay reached the Malay peninsula and archipelago between 2000 and 1500 B.C. They lived in houses on piles, with bamboo flooring, and cultivated bananas, gourds, sugar cane and coconut palms; rice and millet provided them with cereals and fermented drink. They domesticated the buffalo and pig. Many kinds of trap and noose were employed for catching game. They paddled catamarans and used fishing traps of bamboo and wood. They were head-hunters and erected megaliths to dead chiefs.

Then about the time of Christ this primitive people came under the influence of two foreign races. One was the Yuë whose traders left bronze drums on the Tembeling river in Pahang and near Klang in Selangor and bronze adzes along the Kenaboi river in the Jelebu district. They taught the craft of weaving cotton and decorating it by the tie-and-dye method. They bequeathed a large vocabulary to Malaya's aborigines but the art they brought, termed Dong-sonian after the site of a cache in Indochina, did not become established in the peninsula, partly because most of the materials for making bronze were absent but chiefly because the nearness of India soon caused Indian influence to swamp all others, giving to the Malay alphabets, religions, astrology, medicine, law in place of tribal custom, a political system, literature, and the crafts of goldsmithing, silversmithing and silk weaving. For at the beginning of the Christian era the luxury of the Persian and Roman empires called for the gold and spices of the east. The construction of large Indian ships on the Persian model, the discovery of the Arabs' secret knowledge of the monsoon winds and the rise of Buddhism with its disregard for caste prejudices against crossing the sea all stimulated Indian voyaging to Indonesia and Malaya. The first important Hinduized kingdom in southeast Asia was Fou-nan (a Chinese transcription of *phnom*, "mountain"), which covered the north of Malaya, Siam (Thailand) and Indochina. Probably one of its subject kingdoms was Langkasuka, according to the Chinese a walled, Buddhist kingdom in northern Malaya in the 2nd century A.D.: it must have straddled the land routes to Siam and Indochina and was trading with China by A.D. 575. Sanskrit inscriptions of the 4th century A.D. in Kedah and Province Wellesley as well as Buddhist bronzes from Kedah and Perak attest that the Indian pioneers in Malaya were Buddhists. Except for an interval when Fou-nan became Shivaite, Mahayanistic Buddhism predominated until the fall of Fou-nan's successor in northern Malaya, the Buddhist kingdom of Sri Vijaya (7th–14th centuries A.D.). Sri Vijaya, the San-fo-ts'i and Chi-li-fo-che of the Chinese and the Zabag of the Arabs, long controlled the Sunda strait from its capital at Palembang and the Strait of Malacca from Kedah. Its stranglehold on commerce led to constant fighting with Java from 992 onward and to several attacks on Kedah by the Chola kings of southern India, culminating in a great raid in A.D. 1025, when Rajendra I claimed the conquest of Palembang, Jambi (or Malayu) in Sumatra, Langkasuka and Kedah, though Sumatra and Malaya were too far away for the raider to maintain his suzerainty. In the 13th century Sri Vijaya's Sumatran rival, Jambi (Malayu), broke away and gave its name to the Malay race. Between 1338 and 1365 Java's Hindu empire, Majapahit, raided Sumatra and Sri Vijaya's dependencies in Malaya. The Tais invaded Malaya from the north and finally missionaries of Islam gave the death blow to the old order in Malaya, Sumatra and Java.

1. The Kingdom of Malacca.—The next kingdom of consequence in Malaya was Malacca, founded *c.* 1403 by a Palembang prince who had married a Javanese princess and ruled Tumasik or Temasek (Singapore) with the title of Parameswara. The Siamese then owned the island and the Parameswara, having got it by killing the Siamese governor, eventually had to flee. Malacca had fresh water and a harbour for ships; it lay remote from Siam with possibilities of capturing some of the trade enjoyed by Kedah when part of Sri Vijaya. Kedah, though then subject to Siam, still claimed suzerainty over the western Malay states down to Malacca, while at the same time an important Sumatran Muslim state, Pasai in Atjeh, claimed suzerainty over Kedah. Perhaps it was this that led the Parameswara in old age to marry a Pasai princess, become a Muslim and take the title of Megat Iskandar Shah. His successor reverted to the title of the Buddhist kings of Sri Vijaya, namely Maharaja, and established a constitution on the Hindu pattern adopted by Fou-nan. About 1445, however, Muslim Tamil merchants murdered the rightful heir to the Malacca throne and elevated his younger brother (whose mother was a Tamil) with the title Sultan Muzaffar Shah. Malacca then began its conquest of the whole of Malaya including Patani and Kedah and fought off several Siamese attacks. It also subjugated Sumatran states across the strait. From conquered states it exacted tribute of gold, tin, or fighting men but its fleets protected them. The port had one quarter for Chinese merchants, another for Indians and another for Javanese. Inhabited by seafaring Malays ("sea gypsies"), Malacca had to import rice and other foodstuffs. A spurt in Chinese overseas trade and the mercantile activities of Muslim Indians led Duarte Barbosa, the Portuguese adventurer, to call it "the richest seaport with the greatest number of merchants and abundance of shipping to be met in the whole world." Its court was a centre of culture old and new.

2. Portuguese and Dutch Conquests.—In 1498 Vasco da Gama landed in India and by Aug. 1, 1509, a Portuguese fleet had entered the Malacca roads to reconnoitre but had to retire. In Aug. 1511, Affonso de Albuquerque captured Malacca. Portugal's small population made it impossible to hold extensive colonies, so Albuquerque built a great fort there called "A Famosa," established a new currency, executed a Javanese headman for trying to corner rice and then left Malacca to a governor. Forces of the exiled Malay sultan Mahmud and his allies frequently cut off the port's food supplies and even invested the fort. The Portuguese insistence on monopolies led to the creation of the Sumatran pepper-trading state Atjeh. The Javanese and Atjehnese both attacked the fort. Tomé Pirès (who had been Albuquerque's druggist) lamented the absence of qualified administrators and expert traders and condemned the officials as "arrogant, undisciplined and dissolute." St. Francis Xavier condemned their corruption. It was recorded that the captain of the fort got £50,000 a year from perquisites and illegal private trade.

In 1602 the famous Dutch East India company was created and in 1619 Jakarta in Java became its capital under the name of Batavia (modern Jakarta). By 1635 the Dutch were capturing or intercepting all Portugal's ships and had ruined the trade of

Malacca. In Jan. 1641 after a siege of 5 months and 12 days the Dutch wrested the city from Portugal. Malacca as a centre was supplanted by Batavia. Under Portugal Malacca's population was estimated at 20,000; a quarter of a century of Dutch occupation reduced it to 4,884 persons. Like the Portuguese, the Dutch tried to secure the sale of cloth and the purchase of tin and spices at their own figure, but their monopoly was challenged by Atjehnese, Javanese and Indian traders. The cheapness of Indian textiles won them a large market in Malaya and the archipelago. Finally in 1786 the founding of the British free port, Penang (later George Town), ended Dutch monopolies.

3. Britain and the Straits Settlements.—As a rival to Dutch Malacca, a port of call between India and China and as a repair station for warships, the island of Penang was rented by the English East India company in 1786 from the sultan of Kedah at the instance of a young trading captain, Francis Light. The sultan stipulated that the company should promise to help him against the attack of any enemy from the interior, meaning Selangor and Siam. Light pledged this military aid and Penang was occupied by the British. But William Pitt's India act of 1784 required the sanction of the British government for any agreement that might lead to war, because (after the loss of the American colonies) "schemes of conquest and extensions of dominions" were "repugnant to the wish, the honour and policy of the nation." The British government refused to implement Light's assurance to the sultan. However in 1791 a treaty was signed guaranteeing Kedah an annual rent for the island (paid down to modern times). Besides Penang (with Province Wellesley which was ceded by Kedah in 1800) there were two other Straits Settlements, Malacca and Singapore. Fear of French warships capturing Malacca led to the British occupying it in 1795 and, though after Napoleon's downfall it was returned to Holland, it was later ceded to Great Britain by the treaty of London (1824). In 1819 Stamford Raffles (*q.v.*) had taken the first steps to acquire an almost uninhabited mangrove swamp, Singapore, from the *de jure* (though not *de facto*) sultan of Johore and in 1824 (fear of Dutch action against it removed) the whole island became British territory. The Straits Settlements were the property of the East India company until after the Indian mutiny when the company was abolished and the India office took control (1858). In 1867 agitation by British and Chinese merchants led to the three settlements being proclaimed a crown colony, when for the first time nonofficials, British and Asian, obtained a voice in their government. In 1946 Penang and Malacca ceased to be British possessions, being included in the abortive Malayan Union and later, in 1948, in the Federation of Malaya. Singapore (*q.v.*), which remained a crown colony after 1946, was granted internal self-government in 1959. In 1963 it joined the Malaysia federation, but withdrew in August 1965.

4. The Malay States.—After 1511 the fugitive sultan of Malacca settled in the Riouw (Rhio) archipelago, but driven out by the Portuguese he fled to Sumatra where he died in 1528. His eldest son, by a Kelantan princess, became Perak's first sultan: his second, by the daughter of a Bendahara (principal minister) of Malacca, became sultan of Johore. In the north Kedah, Kelantan and Trengganu became tributaries of Siam. Over the southern Malay states Johore claimed to be overlord, until in the 17th century Bugis from Makasar occupied and ruled Selangor and in the 18th century Menangkabau princes from Sumatra created and ruled Negri Sembilan. The Bugis occupied Riouw also and the sultan of Johore settled in the island of Lingga. His cousins, the two greatest chiefs of the broken empire, were cut off at Pahang and Johore and in the 19th century made themselves independent rulers. Except in Perak the old Malacca royal line had died out in 1699 and all later rulers of Johore and Pahang and Trengganu were of the Bendahara family.

The breakup of the Johore empire led to fratricidal wars among the Malay rajas. Feuds also started among the secret societies of newly arrived Chinese tin miners, who took sides in the Malay civil wars. Merchants, British and Chinese, in the Straits Settlements begged the British government to intervene to protect their lives and property in the Malay states. Only a fear lest Germany might intrude upon the Malayan scene made Great Britain reluctantly decide in 1873 to consider the appointment of British residents in the Malay states, with their rulers' consent. The first treaty, signed at Pangkor on Jan. 20, 1874, with Perak, followed the Singapore precedent in being made with a *de jure* but not *de facto* sultan. In 1874 residents were accepted by Perak, Selangor and one of the Negri Sembilan, Sungai Ujong. By 1888 they had been accepted also in the whole of Negri Sembilan and in Pahang. In Perak the tactlessness of the first resident in abolishing the feudal perquisites of chiefs without compensation led to his murder, a minor war and the banishment of the *de jure* sultan. In Pahang one chief rebelled against the sultan for accepting British advice and in the ensuing guerrilla fighting 40 were killed and 30 wounded. But understanding of Britain's good will came quickly. Slavery was abolished. For the first time the rulers consented to admit non-Malays, British, Chinese and Indians to membership of state councils and to accept a British code in place of Muslim criminal law with its sentences of mutilation for theft and of death for adultery. Land titles were issued giving security of tenure and the revenue was employed for public services. In 1895 to secure uniformity of legislation and administration (and so to encourage foreign capital) the four states accepted federation. Soon the increase of capital expended on tin mining and on the newly introduced Para rubber provided revenue not only for roads and railways but for medical and educational services, the advance of which was so rapid that before World War II the International Labour office at Geneva reported that outside Japan they had no rival in Asia.

5. The Unfederated States.—After the British rented Penang from Kedah and refused to become involved in any war with Siam, Kedah was forced by Bangkok to conquer Perak. Weakened by that distasteful task Kedah was itself overrun by Siamese forces and the sultan driven into exile. In 1826, however, Siam acknowledged the independence of Perak and Selangor and undertook not to obstruct English trade in Kelantan and Trengganu. In 1862 Col. (later Gen. Sir Orfeur) Cavenagh, governor of Singapore, required Siam not to depose a friendly sultan of Trengganu and bombarded the sea front to secure compliance, disregarding Siam's claim to suzerainty. Sir Frank Swettenham, as governor of Singapore, also challenged that claim in 1902 by visiting Trengganu in his official yacht. He showed such eagerness to extend British protection over the Malay states under Siamese rule that the foreign secretary, Lord Curzon, described him as "a swashbuckler of a most truculent type." There was some excuse for his eagerness. For £2,000 and 2,000 shares the sultan of Kelantan had disposed of 3,000 sq.mi. of territory, with wide powers and privileges, to a police inspector, R. W. Duff, who hoped to emulate Raja Brooke of Sarawak. The buying back of these powers and privileges was later to lead to costly litigation that hampered the state for years. The government of Trengganu was medieval, crime was rampant and the peasants were downtrodden. In 1905 Kedah's indebtedness forced Siam to appoint a British member of the Indian civil service to superintend its finance and administration. Meanwhile the entente cordiale of 1904 had removed the fear that if Great Britain extended its influence in northern Malaya, France might occupy Siam and damage British trade. In 1909, anxious to build a railway connecting Bangkok with the Malayan line to Singapore, Siam, in return for a loan of £4,000,000 at 4% interest and Great Britain's surrender of extraterritorial rights for its subjects in Siam, transferred to Great Britain Kedah, Perlis, Kelantan and Trengganu, four states that had never brought Siam any revenue.

The last Malay state to come under British protection was Johore. In 1885 Johore undertook by treaty not to enter into engagements with any foreign state and not to alienate land to other than Asians or British subjects; Great Britain undertook to protect the state against foreign attack. The sultan had a constitution drafted by British lawyers, which was later taken by other Malays as a pattern for all their states to follow. By 1914 an increase of population and the development of the rubber industry made administration too complex for his subjects and the sultan accepted the appointment of a general adviser. All Malay states south of Siam were then under the protection of Great Britain.

6. The Japanese Invasion.—That protection had always been taken as beyond challenge, with Singapore as the "Malta of the east," until on Dec. 7, 1941 (Dec. 8 west of the Hawaiian Islands), Japanese airmen sank the U.S. fleet at Pearl Harbor and bombed Singapore, and Japanese forces were landed in Kelantan. A British naval attempt to halt that landing ended on Dec. 10 with the sinking of the battleship "Prince of Wales" and the battle cruiser "Repulse" in the Gulf of Siam. Japan had about 300 bombers and 800 fighters against 141 obsolete British aircraft and that preponderance, with Britain's loss of the control of the sea, meant that 150,000 Japanese crack troops could advance 550 mi. down the peninsula to Singapore at the rate of 10 mi. a day, landing soldiers by sea in the rear of the defense. On Jan. 30, 1942, all British forces were withdrawn to Singapore Island, which with its Johore water supply cut fell on Feb. 15. Until 1945 Malaya was occupied by the Japanese. (*See* WORLD WAR II; *The War in the Pacific.*)

7. Developments After World War II.—When the Japanese were expelled, the British were welcomed back. Concerned at the cumbrousness of 11 governments in a small country, the British government decided to get the Malay rulers to transfer their sovereignty to the king of England and accept a Malayan union. Sir Harold Macmichael was sent on this mission of virtual annexation and also to recognize on behalf of the king the four rulers who had succeeded to thrones since 1942. The rulers were told that the object of the mission was secret and not to be revealed to their subjects. They signed the required agreement but, finding that this highhanded procedure was denounced in the *Times* by retired civil servants and judges and in both houses of parliament, the Malays started a mass movement of non-cooperation. They formed a United Malays National organization (U.M.N.O.) and for the first time learned their political power. The one good feature in a sorry business was that British army trucks helped to convey them to a mass meeting. The government yielded and appointed a committee of Asians and British officials to recommend a constitution. This committee advised that instead of a union under a governor there should be a federation with a high commissioner and the novelty of an executive council. A prime minister and executive council were also to be appointed in each state. The federation was established in 1948. Later, in 1955, elections were introduced for a majority of the members of the federal legislature, and every seat but one was captured by the "Alliance" of U.M.N.O., the Malayan Chinese association (M.C.A.), and a Malayan Indian congress under Tengku Abdulrahman, barrister son of a Kedah sultan.

This sweeping victory hastened the demand for independence coupled with the suggestion that the grant of it would end Malaya's war with the Communists, for in 1948 an armed Communist revolt had started. Operating from jungle camps about 4,000 Chinese Communists, former guerrillas from the Japanese war, together with schoolboys and criminals, attacked lonely police stations and the bungalows of European planters and miners, slashing rubber trees and stealing latex for their own support. Though they failed to paralyze commerce or establish Communist areas, they murdered informers and forced Chinese squatters near the jungle to give them food. To deprive the terrorists of food, more than 550 new villages were built for the Chinese squatters and were surrounded by barbed wire, the transport of rice was controlled and villages that helped the bandits had their food supplies rationed. In 1951 the high commissioner, Sir Henry Gurney, was murdered by the terrorists and Gen. Sir Gerald Templer succeeded with military as well as civil powers. With untiring energy he employed to the full the measures ready to his hand. A federal volunteer regiment was created, and when 81% of the volunteers proved to be Malays a new law was introduced making two years' service compulsory for young men of all races. Leaflets promised immunity to Communist guerrillas who surrendered. Villages that helped the bandits were fined and the inhabitants confined to their houses by curfew. Helicopters were used to surprise jungle camps. The worst was over by 1954 and Templer left Malaya, but the small hard core of terrorists continued to give trouble. In nine years the Communist terrorists, who were constantly reinforced, are known to have lost 6,710 men; 1,865 British and Commonwealth (including Malay) police and soldiers were killed; civilian losses (mostly Chinese) were 2,473 killed and 810 missing.

The British continued to provide troops even after Aug. 31, 1957, when the nine Malay states, together with the British settlements of Penang and Malacca, were granted independence. On that date the queen ceased to be sovereign of Penang and Malacca and to have jurisdiction over the protected Malay states, though the new Federation of Malaya decided to remain within the Commonwealth of Nations and Great Britain guaranteed its external defense. The federation has a head of state elected by and from the Malay rulers every five years. The first chosen was the *yang di-pertuan agong* of Negri Sembilan, a namesake but no relation of Tengku Abdulrahman, leader of the "Alliance" that won independence and first prime minister of the new Malaya. The state of emergency (declared June 16–19, 1948) was ended July 31, 1960. In July 1961 Malaya joined with Thailand and the Philippines in the establishment of the Association of Southeast Asia (A.S.A.), the purpose of which was to bring about closer economic and cultural grouping.

Discussions were held during 1961–62 regarding the creation of a Malaysia federation, a union to comprise the Federation of Malaya, Singapore, Brunei, Sarawak and British North Borneo. The political fusion of the Federation of Malaya with Singapore, the peninsula's greatest port, was clearly economically advantageous and the consequent preponderance of Chinese voters would be countered by the inclusion in the union of the other territories. The Malaysia federation (excluding Brunei) came into existence on Sept. 16, 1963. In August 1965, however, Singapore withdrew from the federation. *See* MALAYSIA. (R. O. WT.)

V. POPULATION

The 1957 census showed the total population as 6,278,758, giving an average density of 124 per square mile or 500 per square mile of used surface. The greatest state densities were in Perak and Malacca, and the least in Perlis and Pahang. Though the economy is agricultural, one-quarter of the population is grouped in the towns, principally Kuala Lumpur, George Town (Penang), Ipoh, Malacca, Johore Bahru, Trengganu (*qq.v.*), Taiping, Seremban, Klang, Alor Star, Batu Pahat, Telok Anson, Kota Bharu, Butterworth, Kampar and Port Swettenham. The rural population became more nucleated after a regrouping of Chinese squatters into "new villages" planned to deny food to Communist guerrillas. Between 1950–55 more than 500,000 previously scattered persons were resettled into over 500 villages located along the roads. The total population increased at an average of 2.7% per year over 1957–61 when the crude death rate averaged 8.9 and the crude birth rate 39.4 per thousand.

The federation has a plural society with different racial and cultural communities living side by side. Throughout its history the peninsula has been the scene of convergence of people from separate parts of Asia but the present mixture results from Asian pioneers who arrived since the last quarter of the 19th century; the flow was most pronounced from 1874 to 1910 when, under British administration, the modern economic pattern of the territory became established. The population now consists of 3,854,-

Area and Population

State (capital in parentheses)	Area (in sq.mi.)	Population (1957 census)	Population (1961 est.)	Density (1961; per sq.mi.)
Johore (Johore Bahru)	7,330	926,850	1,064,814	145.3
Kedah (Alor Star)	3,660	701,964‡	783,993	214.2
Kelantan (Kota Bharu)	5,750	505,522	570,998	99.3
Malacca (Malacca)	640	291,211	335,127	523.6
Negri Sembilan (Seremban)	2,565	364,524	422,694	164.8
Pahang (Kuantan)	13,873	313,058	354,316	25.5
Penang* (George Town)	398	572,100	642,221	1,613.4
Perak (Ipoh)	7,980	1,221,446	1,384,321	173.8
Perlis (Kangar)	310	90,885	101,357	327.0
Selangor (Kuala Lumpur)	3,167	1,012,929	1,159,914	366.3
Trengganu (Kuala Trengganu)	5,027	278,269	317,049	63.1
Total	50,700	6,278,758†	7,136,804	140.8

*Formerly Penang and Province Wellesley.
†Excludes an estimated 2,000 fugitives and hostile aborigines.

000 Malaysians, *i.e.*, native Malays and immigrant Muslims from Sumatra, Java and eastern Indonesia; 2,843,000 Chinese; and 858,000 Indians and Pakistanis, the proportions being 50%, 37% and 11% respectively. Because immigration is now strictly controlled, importance attaches to differences in the natural growth of the communities; over the quinquennium 1957–61 the Indians were increasing at 2.54% a year, Chinese at 2.58% and Malaysians at 2.88%.

Differing in speech, religion and culture, the communities have separate economies, stratified socially within themselves, thus creating a cellular pattern in local society. The indigenous Malays have a scattered distribution mostly in small rural hamlets (*kampongs*) among paddy fields or engaged in fishing along the coasts. The Chinese, dominating in commercial and industrial activities of towns and ports, are more urban than rural, though in the states of Penang, Perak, Selangor and Johore they are the rural majorities as well, concentrating on the mines and rubber plantations. Indians and Pakistanis were brought in as labourers for the early rubber plantations where most still live, but an increasing number work in the mines and on the railways and wharves; another type of Indian immigrant is prominent in medicine and law. The federation contains 13,000 Eurasians of Portuguese, Dutch and British extraction. Each community has divisions: Sumatrans, Javanese and Bugis retain linguistic and customary distinction from the Malays with whom, however, they intermarry fairly easily. However intermarriage between the major communities is infrequent.

Internally a distinction is made between Malays, the largely indigenous Muslim people resembling Indonesians, and Malayans, a general term for anyone born in or long resident in Malaya.

(E. H. G. D.)

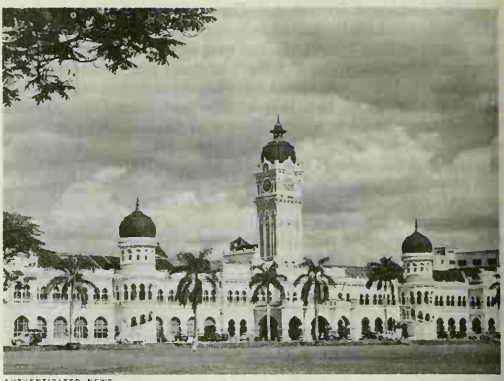
VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—The constitution of the Federation of Malaya dates from Aug. 31, 1957, known as *Merdeka* ("freedom") day, when the country achieved complete independence within the Commonwealth of Nations. On that day the former British territories of Penang and Malacca joined with the nine princely Malay states to form the federation. The constitution, based on the report of a commission under the chairmanship of Lord Reid, with members from the United Kingdom, Australia, India and Pakistan, established a strong central government but allowed a measure of autonomy to Penang and Malacca and safeguarded the position of the nine Malay rulers. It also established a common nationality for the whole of the federation and safeguarded the special position of Malays and the legitimate interests of other communities.

Citizenship, which raises important issues in this multiracial nation, is open to all who were citizens before Aug. 31, 1957, and all born within the federation on or after that date. Those who were noncitizens before independence can qualify for citizenship if they satisfy certain requirements (seven years' residence, an intention to remain in the federation, character qualifications, an elementary knowledge of Malay). Citizenship rights can be withdrawn for disloyalty.

The nine Malay rulers, in the Conference of Rulers (*majlis raja-raja*), elect one of their number as paramount ruler (*yang di-pertuan agong*). The conference also elects a deputy paramount ruler and deals with state boundary issues and religious matters. Holding office for five years, the paramount ruler is a constitutional monarch with functions comparable with those of the British sovereign. He is responsible for the appointment of a prime minister (*perdana mentri*) and is commander in chief of the armed forces and head of the Muslim religion in Penang and Malacca.

The federal parliament consists of a senate (*dewan negara*) and a house of representatives (*dewan ra'ayat*). The senate, with a life of six years, comprises 2 members from each state, elected by the state legislative assemblies, and 16 appointed by the paramount ruler, on the advice of the prime minister, with special emphasis on the representation of smaller minorities (Ceylonese, Eurasians, aborigines) and economic and labour interests. The house of representatives, with a maximum life of five years, has 100 members elected in single-member constituencies by adult universal suffrage. The powers of the senate are broadly similar to those of the British house of lords but ministers in the senate may speak (but not vote) in the lower house.



AUTHENTICATED NEWS

STATE SECRETARIAT IN KUALA LUMPUR

The constitution lays down the division of functions as between the federal government and the states. The federal government has responsibility for foreign affairs, finance, defense, internal security, citizenship, communications, power, education, medical services and labour relations. The responsibilities of the state legislatures include land tenure, agriculture, forestry, local government and certain state works.

Local government authorities comprise the elected city council of George Town, the financially autonomous municipality of Malacca and elected town councils, together with nominated town boards which are still subject to control by state authorities, and a growing number of elected local councils with powers similar to those of British parish councils. In 1961 Kuala Lumpur, having had previously an elected municipal council, came under the direct control of the federal government, being administered by a nominated board of advisers.

2. Political Parties.—Malaya's leading political party is the right-wing Alliance party, comprising the United Malays National organization, the Malayan Chinese association and the Malayan Indian congress. Led by the prime minister, Tengku Abdul-rahman, who was also president of the U.M.N.O., the Alliance party achieved power in the first general elections held in 1955. In 1962 it had 71 seats in the house of representatives. The Pan-Malayan Islamic party, which appeals chiefly to Malays on the east coast and aims to strengthen ties with Indonesia, had 13 seats in the house of representatives. The Malayan People's Socialist front, with eight seats, relies on support from urban areas, and the People's Progressive party, with four seats, gains most of its votes in Perak.

3. Living Conditions.—With the exception of Japan, the average standard of living in Malaya is higher than in any other country in Asia. However, there are still considerable slum areas in the towns (many squatter zones being a legacy from the time of the Japanese occupation) and poverty and malnutrition exist in many rural areas, particularly on the east coast. The main feature of the second five-year plan (1961–65) was the "rural revolution"—the opening up of rural areas and the use of scientific methods not only in farming but in matters of sanitation, diet and training in domestic science. It was hoped that by such developments the movement of population from rural areas to the towns might be halted. In crowded centres such as Kuala Lumpur large numbers of flats have been built for working people both by municipal authorities and by private enterprise. In the mid-1960s there was one doctor to about 6,500 population and more than half the doctors were in private practice. There was a shortage of hospitals and staff but the five-year plan included the

building of a training hospital in Kuala Lumpur. The country's chief scourge was still infective tuberculosis from which about 4% of the population suffered.

4. Trade Unions.—Despite individual affiliations the trade union movement as a whole is not linked with any political party. By the mid-1960s there were about 280 trade unions with a total paying membership of more than 200,000. The biggest union (and one of the largest in Asia) is the National Union of Plantation Workers which is affiliated with the Malayan Trade Union council and covers those engaged in the rubber, oil palm and tea industries. Many unions embrace the skilled and the unskilled, the office worker and the factory worker alike.

5. Justice.—The control of executive actions of the courts is maintained by proceedings in the nature of the English writs of habeas corpus, mandamus and the like. The judicial system of the federation comprises a supreme court, divided into the court of appeal and the high court, which has unlimited civil and criminal jurisdiction. There are, in addition, sessions courts and magistrates' courts with limited civil and criminal jurisdiction, from which appeal lies to the high court and thence, conditionally, to the court of appeal. A final appeal from all courts lies to the judicial committee of the British privy council. The attorney general is the principal legal adviser to the government, and he is also, in his capacity as public prosecutor, responsible for the direction and conduct of all criminal prosecutions. The chief justice and other judges of the supreme court are appointed by the paramount ruler in consultation with the prime minister, the Conference of Rulers and the Judicial and Legal Services commission.

6. Education.—Primary education, which is free but not compulsory throughout the federation, is available in Malay, English, Chinese and Tamil. At government-aided postprimary and secondary schools the teaching language is Malay or English, but provision is also made for study in Chinese or Tamil. Although there is increasing emphasis on the national language only a minority of the Chinese secondary schools remain outside the national education system.

Postprimary vocational training is given in junior technical trade schools, rural trade schools, technical institutes and commercial schools. Postsecondary professional education is given at the Technical college, Kuala Lumpur, at the College of Agriculture (1931), Serdang, and at the Kuala Lumpur division (founded 1959) of the University of Malaya (founded 1949 in Singapore), with faculties of arts, science, engineering and agriculture. Apart from teachers' training colleges in Malaya, training facilities are provided in the United Kingdom at Brinsford Lodge, Wolverhampton.

7. Defense.—The largest unit of the army is the Royal Malay regiment, which had many years of experience in fighting Communist terrorists. In clearing-up operations it was still being assisted in the mid-1960s by commonwealth forces stationed in Malaya under the terms of a defense agreement. A new commonwealth strategic reserve base was built in the state of Malacca. A Malayan contingent was part of the UN forces sent to maintain order in the Democratic Republic of the Congo in 1960.

In the early 1960s the Royal Malayan navy, consisting of several mine sweepers and motor launches, all acquired from Britain, was based at Singapore. A start had also been made in building up an air force, initially consisting of transport aircraft. (F. M. H.)

VII. THE ECONOMY

Three-quarters of the federation's land surface remains under forest contributing little to the economy because of the high cost of extraction from such a mixed, dense, equatorial vegetation. Of the 7,800,000 ac. used in 1960, 5,700,000 ac. were agriculturally productive, 3,750,000 ac. being under rubber and 920,000 ac. under paddy. Rubber growing is thus the chief land use, and trade in rubber is the basis of Malaya's commerce, although the estimated number of workers employed full time on rubber is not much greater than that of workers on paddy fields. Though tin mining attracted finance and labour during the initial development of the peninsula, its significance is now diminishing, workers totaling only about 20,000 (1959) working on about 350 mines. In 1961 these major activities produced about 740,000 tons of rubber, 600,000 tons of rice and 56,000 tons of tin concentrates. Malaya's economy has become more diversified but industry still plays a minor part, being limited to assembly, repair and maintenance trades for imported equipment and vehicles, and the production of soap, rubber products, shoes and foods for the domestic market. A large segment of the population is still dependent on subsistence agriculture.

Malaya is a member of the Colombo plan (*q.v.*), the International Rubber Study group, the International Tin council and the International Tin Study group.

1. Rubber.—Although the federation produces about one-third of the world's natural rubber, the Para rubber tree (*Hevea brasiliensis*) is of Brazilian origin, having been brought by British planters at the end of the 19th century when attempts to commercialize coffee and sugar growing in Malaya were failing. The spread of rubber over so large an acreage represented one of the most spectacular transplantations from one part of the tropics to another. Although the equable, moist climate of Malaya was eminently suitable, rubber planters faced the reluctance of indigenous Malays to leave their own social economy and go to areas which were being opened up in virgin jungle. The spread of rubber plantations became possible on the basis of immigrant workers coming largely from India and in part from China. With the commercial success of rubber a new economic system grew up in localities never previously settled by Malays, based on large plantations of trees, exporting a raw commodity overseas and importing labourers and food supplies. The Malays mostly continued their subsistence small holdings of paddy, using an almost horticultural technique. These contrasting economies remained separate, not least because the differing languages of the groups practising them impeded the communication of ideas. Rice continues to be grown in the federation much as it was, unresponsive to commercial forces, with holdings increasingly subdivided by inheritance, effectively isolating Malays from the stream of economic development. Rubber, like tin, was subject to the normal economic forces: the effects of tropical overproduction; the swing of boom and depression as world events in the 20th century varied the demand for raw materials; rivalry between small-scale and large-scale producers, between one method and another, and between natural and synthetic rubbers; and later economic and racial tensions between European management and oriental labour. In time all Malayan communities came to own rubber small holdings, and there are large estates owned by Chinese and Indians as well as non-British Europeans. By the early 1960s nearly one-half of Malayan rubber came from Asian small holdings of less than 100 ac. and local Chinese held large blocks of shares in companies which had been wholly British by management and finance. Some estates had broken up into small holdings but there remained 1,800,000 ac. of rubber estates employing 290,000 workers. The national rubber yield averages 360 lb. an acre, but more scientific producers can exceed 1,200 lb. and the yield on some small holdings is less than 200 lb. Rubber is largely processed on the spot into smoked sheets and transported by truck to the ports. A small proportion travels by rail as unprocessed latex and is shipped in liquid form.

2. Other Crops and Fisheries.—Only a small proportion of the rice crop moves from the villages where it grows. The towns, plantations and mines import from abroad most of the rice they need and this Asiatic staple enters the country through all the ports. The world shortage of vegetable oils after World War II promoted trade in coconut oil. Once part of Malay subsistence farming, coconuts are now produced by small holdings and some estates for export in the form of copra. From more than 500,000 ac. estimated to be under coconuts in the mid-1960s, production was equivalent to more than 100,000 tons of oil a year, of which three-quarters was accounted for by small holders. Oil palms, transplanted by a British company from west Africa in 1935, proved successful on estates covering about 100,000 ac. in Johore, Perak and Selangor, the oil being refined on the estates and moved by tanker to the ports; more than 90,000 tons were shipped an-

nually. Pineapples from 18,000 ac. of Chinese small holdings in southern Johore were canned for export by way of Singapore but after 1956 the trade was increasingly handicapped by labour difficulties.

Livestock rearing is on a very small scale and is mainly limited to a few hundred thousand pigs, oxen, buffaloes, equines and goats. Oxen and buffaloes are used mainly as draft animals. Chinese market gardens and pig and chicken farms surround most towns. Sugar, maize (corn), gambier (for tanning), tea, coffee, spices, derris (for insecticides) and peanuts (groundnuts) are also grown for local use. Tapioca is widely cultivated by Chinese for feeding pigs and making starch. Fishing, originally fundamental to the self-contained Malay economy, is commercialized at only a few places where motorized trawlers and large sea traps are run by Chinese. In the mid-1960s landings of fresh fish, which exceeded 150,000 tons annually, were inadequate for local needs, and a considerable quantity of dried fish was imported from Sumatra and Thailand.

3. Mining.—Tin mining was the original basis of the commercial economy in the peninsula, centring on Taiping and Kuala Lumpur, which were mining camps of southern Chinese immigrants as late as 1870. Approached originally by river, these tin fields led to railway construction which enabled other mining areas to come into use and facilitated the spread of rubber estates. As the original surface ores were exhausted, gravel pump mines and then dredges came into use to reach deeper deposits. British companies were responsible for the more costly forms of mining. The Kuala Lumpur tin field is still productive; that round Taiping is in the last stage of exhaustion; and the newer Kinta Valley field has far surpassed both. Tin leaves the mines in sacks of a black sandy material (cassiterite) and the greater part is shipped in that form from Singapore, Penang and Port Swettenham; two smelting works round Penang harbour and another in Singapore produce the metal in ingots for export. The federation is responsible for about one-quarter of the world's production of tin.

Iron ore is mined at Kuala Dungun, Trengganu, and at Batu Pahat and Rompin, Johore; more than 6,000,000 tons of ore were exported to Japan in 1961. As by-products the tin mines produce wolfram, ilmenite, monazite and columbite, exports of which fluctuate widely with world prices. Bauxite is mined opencast (open-pit) in Johore, about 290,000 tons being exported annually.

BY COURTESY OF BRITISH INFORMATION SERVICES

WASHING CASSITERITE. TIN ORE, AT AN OPEN-PIT MINE ON THE WEST COAST OF MALAYA. THE ORE IS SMELTED AT PENANG AND SINGAPORE

4. Trade and Finance.—Malaya's trade turns upon tropical commodities and mineral raw materials moving outward to industrial regions overseas and on foodstuffs, machinery and textiles moving inward. Of the exports, two-fifths went to continental Europe, one-fifth to the United States, one-sixth to the United Kingdom and rather less to Japan. Two-fifths of the imports came from continental Europe, one-third from the United Kingdom and very little from Japan and the United States.

The standard currency is the Malayan dollar (of 100 cents), linked to sterling and valued at 2*s.* 4*d.* since early in the 20th century. This currency is common to the federation, Singapore and British Borneo.

In the 1960s the chief items of public expenditure were capital expenditure, defense, education and health services. Revenue is drawn mainly from import and export duties (chiefly on rubber and tin) and from income tax. Most of the banks in Malaya are foreign owned, but in 1958 legislation was passed that barred foreign state-owned banks and established a central bank (Bank Negara Tanah Melayu).

5. Transport and Communications.—Rivers, the sole means of transport until about 1880, have ceased to be significant. They were first replaced by the railway which opened the way for modern economic development in the federation. Originally using local coal but now largely diesel driven, the government-owned railway totals more than 1,000 route-miles. The main line runs the length of the country, on average about 30 mi. away from the western coast, and passes through the capital, Kuala Lumpur. Still largely a single track, it is linked at Gemas with a branch line running east of the central range to reach Kota Bharu on the extreme northeastern coast. The railway continues northward into Thailand, carrying direct trains to Bangkok, and southward across Johore to Singapore, the chief freight terminal and primary port and distribution centre for Malaya. The main line reaches the west coast at Prai, opposite George Town, and also at Port Swettenham. Of total rail freight two-thirds is now general merchandise, rubber forming about one-sixth and tin only a small fraction of its volume. These two staples of Malayan exports are increasingly handled by road services which also steadily absorb passenger traffic. The federation has 62,000 mi. of metaled roads carrying the densest automobile and truck traffic of any Asian country, with the possible exception of Japan. Urban and interurban bus services dominate passenger movements. The road network is densest along the western side of the country and, like the railway, is linked northward to Thailand and southward to Singapore. An arterial road from near Kuala Lumpur crosses the mountains to end at Kuantan, a minor port on the east coast which otherwise has few roads, sparse population and extensive swamps that hinder development. Kuala Lumpur has an international airport and facilities for internal air services to George Town, Kota Bharu, Kuantan, Singapore and minor local airstrips.

In external communications the heaviest passenger and commodity traffic is by road and rail across the Johore strait to the harbour and marketing facilities of Singapore. Traffic across the Thai border is slight. Of the Malayan ports, George Town has the oldest and most complex facilities, based on the natural shelter between the island and Prai. Every year nearly 3,000 seagoing vessels use George Town harbour, which acts as entrepôt for Sumatran and Thai trade. Port Swettenham, a modern artificial port at the mouth of the Sungei Klang, despite political pressures and a rich hinterland, is used by barely half as many vessels as use George Town. The historic port of Malacca is now almost as little used as other shallow harbours at Kota Bharu, Johore Bahru and Kuantan where seagoing vessels cannot tie up. Long-distance air services link Kuala Lumpur directly with Ceylon, India, western Europe and Australia. There are also regular services from George Town to Medan, Indon., and Bangkok. Hong Kong and Japan may be reached by way of Singapore.

The federation has 95,000 telephones in use. Radio Malaya broadcasts from Kuala Lumpur and the British Broadcasting corporation service is rebroadcast from Johore. A television service

was introduced in 1963. *See* also references under "Malaya" in the Index. (E. H. G. D.)

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MALAYALAM, one of the four literary languages of the Dravidian family, is spoken on the west coast of southern India. It developed out of Tamil between the 5th and the 10th centuries. In general it differs from Tamil in the absence of personal terminations in the verb. The colloquial and even more the literary language uses many words borrowed from Sanskrit. There were estimated to be 14,000,000 speakers at mid-20th century. *See* DRAVIDIAN LANGUAGES. (M. B. E.)

MALAYALAM LITERATURE. The literature of Malayalam (*Malayāḷam*), the language of Kerala (*q.v.*), though less ancient than the other three Dravidian literatures of south India (*see* DRAVIDIAN LANGUAGES; TAMIL; KANARESE LITERATURE), has a history going back to the 13th century.

Early Period and up to the 19th Century.—Held to belong to the earliest times are ballads and folk songs, which are entirely indigenous. Two outside sources, however, contributed much to the development of the later literature: Sanskrit, which was the language of scholarship (*see* SANSKRIT LANGUAGE), and Tamil, which was the language of administration over a long period.

Rāmacaritam (13th century ?), a poem based on the *Yuddhakāṇḍa* of the *Rāmāyaṇa* (*q.v.*), is the most important of the works influenced by Tamil; both in its grammar and its vocabulary it appears to be a mixture of Tamil and Malayalam. Less markedly dependent on Tamil are the works of a family of poets from Niranam in central Travancore who flourished in the late 14th and 15th centuries. Their works include translations of the *Rāmāyaṇa,* by Rāma Paṇikkar, and of the *Bhagavadgītā* (*q.v.*), by Mādhava Paṇikkar.

The importance of Sanskrit in the development of Malayalam culture lies not only in its position as a literary source, but also in its influence on the language. A special literary dialect arose containing a large admixture of Sanskrit and likened in its name, *Maṇipravāḷam,* to a necklace strung with "pearls and coral." (*See* also INDIAN LITERATURE: *Dravidian Literatures.*) It is described in detail in the *Līlātilakam,* a 14th-century treatise in Sanskrit on Malayalam grammar and poetics.

Among the many *Maṇipravāḷa* works are *sandēśa kāvyas* and *campus.* The former, modeled on the *Meghadūta* of Kālidāsa (fl. *c.* A.D. 400; *q.v.*), are "message poems" consisting of two parts: the first giving an account of the circumstances in which the message must be sent and the route by which it should go; the second describing the heroine and the actual message. The finest extant work in this form, the *Uṇṇunīli sandēśam,* was probably written in the 14th century, but the tradition of this type of poem has continued into the 20th century. *Campus* are elaborate compositions dealing with a given theme in alternating passages of verse and prose.

Though it was customary for writers of the Sanskrit school to use Sanskrit metres and figures of speech in their poems, local forms were not forgotten. An outstanding example of a work in a purely Malayalam metre is the 15th-century *Krishṇa gātha* ("Song on Krishna"), usually attributed to Ceruśśēri Nampūtiri.

The greatest figure in Malayalam literature is Tuñcattu Ezuttacchan (the second name meaning "father of letters"). Little is known with certainty about his life, though he is generally believed to have been born early in the 16th century. He was a poet in the Hindu tradition of *bhakti* (personal devotion to God: *see* HINDUISM). His main compositions, though based on Sanskrit works, show great originality of treatment. Thus his *Adhyātma Rāmāyaṇam* makes the hero, Rāma, an ideal figure both as man and god, and his *Mahābhāratam* (*see* MAHĀBHĀRATA) omits all episodes not strictly relevant to the story of the Pāṇḍavas.

Dance Drama.—Kerala is widely known as the home of Kathakaḷi (*see* also DANCE: *The Orient: India and Pakistan;* INDIAN MUSIC). In this form of dance drama the actors concentrate on mime and gesture, while others recite or sing the verses. The verses belong to a literary genre known as Āṭṭakatha, which has been cultivated since the 15th century and takes most of its themes from the Purāṇas (*q.v.*). These stories also form the basis of the literature of Tuḷḷal, a popular art form in which the story of the verses is told by recitation supplemented by the performance of a single dancer. Its literature began in the 18th century with the work of Kuñcan Nampyār, an innovator who satirized the society of his day in popular language.

Modern Period.—*Prose.*—In the 19th century, as a result of the work of Christian missionaries, the uses of prose were greatly extended. The process was accelerated by the production of textbooks for schools. Furthermore, the spread of knowledge of European literature led to attempts at literary composition on western lines. In 1889 there appeared the first novel in Malayalam, O. Cantu Mēnōn's *Indulēkha,* which portrays the effect of western ideas on an orthodox Hindu family. The historical novel was introduced by C. V. Rāman Piḷḷai (1858–1922), who was later followed by the versatile historian, statesman and man of letters, K. M. Paṇikkar (*q.v.;* 1895–1963). The modern trend in the novel and short story, particularly during the years after Indian independence (1947), has been to concentrate increasingly on the life of the ordinary man, and this is nowhere better exemplified than in the work of Takazi Śivaśankara Piḷḷai (1914–).

Poetry.—Before independence the work of poets writing in the various national languages gave impetus to the nationalist movement. The outstanding representative of Malayalam was Vaḷḷattōḷ Nārāyaṇa Mēnōn (1879–1958). Before he turned to patriotic verses he translated Sanskrit works and wrote a number of poems on Sanskrit models. Several of his compositions are religious in inspiration and often show a sympathetic understanding of the faiths of others. In his later years he took social justice as his theme, as did many younger poets.

All other branches of literature known in the west are cultivated, and Malayalam literature seems likely to flourish no less than when in earlier centuries it adopted Tamil and Sanskrit forms.

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MALAY ARCHIPELAGO, also known as the East Indies and (formerly) Malaysia, the largest group of islands in the world, consisting of the more than 3,000 islands of Indonesia and the 7,000 islands and unnamed rocks of the Philippine group. New Guinea is usually arbitrarily included in the Malay archipelago while the Andaman and Nicobar Islands in the northwest and the Bismarck archipelago in the east are not. The principal islands and groups of Indonesia include Sumatra, Java, Borneo (Kalimantan), Celebes (Sulawesi), the Lesser Sunda Islands and the Moluccas, including Halmahera. The Philippines include the large islands of Luzon in the north and Mindanao in the south, with the Visayan group between. For political divisions, *see* the table in the section on *Population.*

The archipelago extends along both sides of the equator for a longitudinal distance of more than 3,800 mi. and is 2,200 mi. in its greatest north-south dimension. The festoons of islands with their enclosed seas are situated between the Pacific and Indian oceans. Stretching from the mainland of Asia to Australia, the archipelago is separated from mainland Asia in the west by the 30-mi. Strait of Malacca, from Formosa in the north by the 100-mi. Bashi channel and from Australia by the 100-mi. Torres strait.

This island bridge is an area of physical and cultural transition between Asia and Australia. Because of its transitional nature and physical fragmentation, the region is one of great variety in physical landscape, climate, vegetation, animal life, land use and stage of economic development. The different peoples, their distinct cultures, myriad languages and many religions add to this diversity. The region has been subject to Indian, Chinese, Australian, Melanesian and European influences, all contributing to its cultural multiformity.

PHYSICAL GEOGRAPHY

Geology and Physical Features.—Structurally the Malay archipelago divides into three parts: the Sunda platform, the Sahul shelf and the area of recent tectonic activity which lies between the two. The Sunda platform is a stable continental extension of mainland southeast Asia. Most of the platform is covered by shallow seas averaging less than 25 fathoms. Borneo and parts of Java, Sumatra and associated islands are sections of the platform above sea level. These are areas of worn-down mountains of old metamorphic rock and are of complex geologic origin. The Sahul shelf, of which New Guinea and related islands are a part, is an extension of the Australian continent similar in structure to the Sunda platform and also covered by shallow seas. Between these stable continental platforms is a zone of recent tectonic activity: faulted and folded steep young mountain systems arranged in long mountain ranges or chains of islands. The main arc runs from Burma through the line of the Andaman and Nicobar Islands, forms the main ranges of Java, Sumatra and the Lesser Sunda Islands and then curves back through the Moluccas to Celebes. A circumpacific arc runs southward through the Philippines, through Halmahera and eastward along New Guinea. Other arcs run from the Philippines to Celebes and from the Philippines to Borneo. Around Celebes is a confused area of fragmented arcs and downfaulted basins.

Tectonic activity is characterized by frequent earthquakes, more than 1,500 a year occurring on the island of Banda in the Moluccas. Along the fracture lines associated with Tertiary folding are found a string of volcanic peaks, dating from the Late Tertiary and Quaternary. There are more than 300 cones, of which 50 are still active. Volcanic cones are scattered through the Philippines, northern Celebes and the Moluccas, and form the impressive chain of peaks which dot the Lesser Sunda Islands and march majestically down the length of Java and Sumatra. Eruptions are often of the explosive type but the benefits from volcanoes far outweigh the harm. The ejecta and ash weather into extremely fertile soil; the forest-covered permeable ash cones collect and store rainfall which is later made available for agriculture by surface streams.

Associated with the arcs are deep offshore trenches or basins. More than 20 are located in the area between the continental shelves and are occupied by deep seas, many over 2,500 fathoms deep. Coral growth reaches its greatest development in the Great Sunda reef which marks the edge of the Sunda platform off the east coast of Borneo. Coral reefs and atolls are found throughout eastern Indonesia and the southern Philippines.

The mountainous nature of the islands plus the generally high annual rainfall results in many short, steep-gradient rivers with erosive power. On the islands which lie on the continental shelves, the rivers deposit eroded material in the shallow surrounding seas and rapidly build extensive flood plains and deltas. Across these lowlands develop long rivers, such as the Musi in Sumatra, the Kapuas and Barito in Borneo and the Sepik and Fly in New Guinea. The islands which rise steeply from the deep seas between the continental shelves have little opportunity to build coastal plains and deltas in the surrounding deeps; level lowlands are limited and the rivers are usually short and steep.

Climate.—The Malay archipelago lies entirely within the tropics and, with the exception of the northern islands of the Philippines, within 10° of the equator, which bisects the major islands of Indonesia. Because of this equatorial location, temperatures are high, averaging 80° F. The annual variation in temperatures is only a few degrees at the equator, but increases away from the equator to about 20° F. in northern Luzon. Annual variation in temperature is modified by the maritime influence of the surrounding seas. Temperatures are also modified by elevation, and many hill stations such as Baguio (*q.v.*) in Luzon and Prapat in Sumatra have been established in the highlands to take advantage of the lower average temperatures.

The variable element in the climate is rainfall, which ranges from more than 320 in. annually on exposed mountain slopes in Sumatra and Java to less than 20 in. in rain-shadow areas of western Celebes and the Lesser Sunda Islands. Most of the archipelago averages more than 80 in. of rainfall well distributed through the year, but the total decreases and the length of the dry season increases from central Java eastward through the Lesser Sundas and from Mindanao northward in the Philippines. Timor, in the Lesser Sunda Islands, has a dry season of more than six months per year. There is also great local variation in rainfall depending on elevation, relief and wind direction.

Another climatic element is the typhoon. More than 20 of these storms arise each year in the Southwest Pacific from July through November and then swing westward and northward, bringing violent winds and heavy rains to the Philippines north of Mindanao.

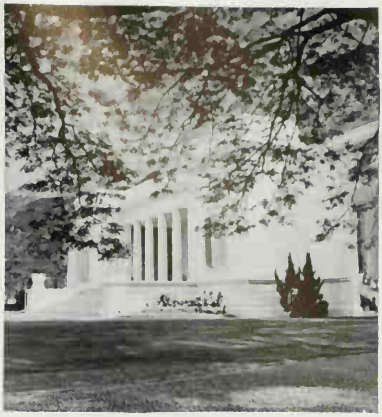
The region is usually under the effect of the doldrums or intertropical front, a zone of convergence of the northeast trade winds from north of the equator and the southeast trades from the southern hemisphere. Rising moist air in this zone of convergence results in heavy rainfall. This frontal zone of convergence moves north and south with the seasons. The proximity of the two continents of Asia and Australia further influences the wind pattern and consequently the rainfall pattern of the archipelago. During the northern hemisphere winter the northeast trades are reinforced by cold air masses from a high-pressure area over the middle of Asia. Thus reinforced, the northeast trades sweep over the islands toward the low-pressure centre in Australia and this is known as the northeast (or northwest) monsoon. In the northern hemisphere summer this pattern is reversed and the southeast (or southwest) monsoon results. Most islands receive rainfall from both monsoons.

Vegetation.—The natural vegetation of the islands reflects their transitional climatic nature and differences in total rainfall and its annual distribution. Throughout most of the area heavy rainfall and high temperatures result in continuous, rapid plant growth of great variety. Evergreen tropical rain forest with a great variety of large dipterocarps covers areas with ample rainfall. In drier areas there is a semideciduous monsoon forest, including such trees as teak and eucalyptus. This forest has seasonal rather than continuous growth. Other forest types include coastal forests (mangrove, nipa palms, pandanus), swamp forests and mountain forests. There are more than 150 species of palms, including the coconut, lontar, sugar, sago and areca palms, and bamboo is found in all areas. Large areas of the natural forest have been repeatedly cleared and dominated by cogon grass (*Imperata cylindrica*).

The flora of the Malay archipelago is probably the most varied in the world. More than 30,000 species of trees, shrubs and grasses belonging to more than 2,500 families have been recorded. This wealth of different species is the result of the heavy rainfall, long growing period, relief, variety of environments and the position of the Malay archipelago as a bridge between Asia and Australia. Mingling of the flora and the fauna of these two continents takes place in the islands. Some species have undergone a complex evolution as a result of geologic changes; island groups have been joined together, then separated, then rejoined, increasing the almost unimaginable diversity and complexity of plant and animal life.

Animal Life.—While the fauna of the archipelago is very rich,

Balinese farm. In the foreground cattle graze under coconut trees; in the background are terraced rice paddies



Istana Merdeka (Freedom palace), residence of the president of Indonesia, Jakarta, Java

Hanging sheets of rubber to dry in a processing plant at Medan, Sumatra

Balinese dancer

Street scene, Medan, Sumatra, largest city of the island

SCENES OF BALI, SUMATRA AND JAVA

PHOTOGRAPHS, (TOP LEFT) RICHARD HARRINGTON FROM THREE LIONS, (TOP RIGHT) WAAGENAAR—PIX FROM PUBLIX, (CENTRE RIGHT, BOTTOM LEFT, BOTTOM RIGHT) AVA HAMILTON

MALAY ARCHIPELAGO

Balinese boy tending herd of geese

Hindu temple of carved stone at Boni, Bali

Modern building of the People's Agricultural centre, Jakarta

Farm women returning from the fields. In the background is Merapi ("Fire mountain"), an active volcano of central Java

Gabensis, a typical village of the Morobe district, eastern New Guinea

VIEWS OF INDONESIA AND NEW GUINEA

BY COURTESY OF (CENTRE LEFT) INDONESIAN EMBASSY, LONDON, (BOTTOM RIGHT) AUSTRALIAN NEWS & INFORMATION BUREAU; PHOTOGRAPHS, (TOP LEFT) EBRI FROM THREE LIONS, (TOP RIGHT) RICHARD HARRINGTON FROM THREE LIONS, (BOTTOM LEFT) W. SUSCHITZKY

Typical thatched house, raised on bamboo stilts, near Macassar, Celebes

Jungle vegetation along the banks of the Rejang river, Sarawak, British Borneo

Rubber worker gathering latex at a plantation near Pematangsiantar, central Sumatra

Typical Sumatran girl

Farmer sowing rice seeds, Java

Hillside rice terraces, Bali, an important rice-growing island of Indonesia

Land Dayak of British Borneo

PEOPLE, PLACES AND ECONOMIC ACTIVITIES OF THE ARCHIPELAGO

BY COURTESY OF (CENTRE RIGHT) UNITED NATIONS; PHOTOGRAPHS, (TOP LEFT) K. PELZER FROM BLACK STAR, (TOP RIGHT, CENTRE LEFT, CENTRE, BOTTOM RIGHT) AVA HAMILTON, (BOTTOM LEFT) SPAA—PIX FROM PUBLIX

MALAY ARCHIPELAGO

Costumed actor in a temple drama, Bali

View from the shore of Lake Sentani, northern New Guinea

Women and children of Kuching, capital of Sarawak, Borneo

Women washing their clothes in the canal which runs along the main street of Jakarta

Minj tribesman of the western highlands district of the Territory of New Guinea

INDONESIA AND BRITISH POSSESSIONS OF THE REGION

BY COURTESY OF (BOTTOM RIGHT) AUSTRALIAN NEWS & INFORMATION BUREAU, PHOTOGRAPHS, (TOP LEFT, CENTRE RIGHT, BOTTOM LEFT) AVA HAMILTON, (TOP RIGHT) J. B. GUSS FROM BLACK STAR

there are few large animals. Elephants, tigers, rhinoceros, wild cattle, tapir and orangutan are all part of the Asian fauna. They are unevenly distributed on the islands of the Sunda platform and indicate differing periods of connection between these islands. Of the Australian fauna, kangaroos are found in New Guinea and other marsupials have moved beyond the Sahul shelf as far as Timor and Celebes. Some of the islands in between have endemic species, such as the anoa or dwarf buffalo and the giant monitor lizard or "dragon" of Komodo Island near Flores in the Lesser Sundas. Insects and birds have wider distribution, and the archipelago has probably the richest insect and bird life of the world. Particularly notable are the large longicorn beetles, the giant butterflies, the exotic birds of paradise, argus pheasants and myriad-coloured cockatoos.

The transitional flora and fauna of the area early attracted the attention of naturalists and after extensive work in 1854–62 A. R. Wallace attempted to fix a line between the Asian fauna and that of Australia. Later work established that Asian species extend to the edge of the Sahul shelf and that the area between represents a zone of mixing, transition and local evolution.

For a more detailed discussion of the geography of the archipelago, *see* the articles dealing with separate islands or island groups such as JAVA; MOLUCCAS; SUMATRA; etc.

NATURAL RESOURCES

Agriculture.—The raw material wealth of the Indies is legendary and brings to mind rare spices and precious metals. Of the great variety of resources the most important is agricultural production, which provides employment for almost 90% of the population. Productive agricultural areas are based on favourable water and soil conditions. Most islands have ample water in all seasons, but the Lesser Sunda Islands from Sumbawa eastward are chronically short of water and large areas support only extensive grazing. Eastern Indonesia and the northern Philippines suffer severe seasonal drought.

Most upland soils are of weathered lateritic types of low fertility. Tree crops can be grown on some lateritic soils and shifting cultivators also make temporary use of these areas. The intensively cultivated irrigated rice areas are on the fertile alluvial soils of river valleys, deltas and coastal swamps. Basic volcanic rocks, ash and mudflows develop into fertile soils and support intensive cultivation in parts of Sumatra, Java and Bali.

The agricultural economy is varied. Nomadic hill cultivators raise subsistence dry crops of rice and corn in upland areas. The majority of the rural population are sedentary cultivators, usually growing irrigated rice, but sometimes corn, yams or cassava as their principal food crop. Many commercial crops such as rubber and tobacco, although introduced on plantations, are now grown by these sedentary small holders. The small holder produces most of the region's sugar, copra, pepper, nutmeg, spices, kapok, sago, tobacco and abacá. The plantations, introduced in the colonial period and located principally in Sumatra and Java, provide valuable exports of rubber, palm oil, sisal, cinchona (quinine) and tea, as well as some coffee, tobacco and copra.

Other Resources.—Forests provide valuable resources in timber and in rosins, rattans and other gathered forest products. Timber exports are particularly important in the less-developed economies of Sarawak, North Borneo, Mindanao, Sumatra and Indonesian Borneo. Fishing and livestock production are important for domestic consumption only.

Petroleum is the chief mineral deposit of the archipelago, exploited in Sumatra, Indonesian Borneo, Brunei and West New Guinea. Production in the 1960s was only 3% of the world total but was important in the petroleum-poor areas of Asia. Tin mines on Singkep, Bangka and Belitung provide about 20% of the world's production. Deposits of bauxite are available in the Riouw archipelago and iron ore is mined in the central Philippines. Nickel is found in Celebes, and gold, chrome, manganese and copper in the Philippines. Coal resources throughout the archipelago are limited and of only fair quality; hydroelectric power potential is great although little developed.

Manufacturing is not greatly developed. Most important are handicraft industries and industries engaged in primary processing of agricultural and mineral products for export. Light manufacturing is expanding with spinning mills, paper, glass, soap and cigarette factories as well as some heavy industry. For a more detailed consideration of the economy, *see* the articles on each major island or island group. (L. A. P. G.)

ANTHROPOLOGY

Prehistory.—The prehistory of the area goes back to Pleistocene deposits in Java, where several exceedingly primitive manlike beings, collectively known as *Pithecanthropus erectus*, have been found. In strata of the third interglacial appear Neanderthal-like humans, there known as *Homo soloensis;* while in still later horizons the fossil remains of Wadjak man seem to be related to the modern Australoids. On the mainland, skeletal remains give evidence of a Negroid physical type which in Late Paleolithic (Mesolithic) times was moving eastward into the Pacific toward New Guinea. No groups of large Negroes now exist in southeast Asia but remnant bands of Pygmy blacks, known as Negritos or Semang, are found in the Andaman Islands, the Malay peninsula and the Philippines. The Neolithic or New Stone Age introduced a new, non-Negroid physical type, possibly of a Veddalike people which once occupied the coasts from southern India and Ceylon eastward into the Malay archipelago. The Senoi (Sakai) of the Malay peninsula and minor groups in Sumatra, Celebes and some eastern islands of the archipelago appear to be related to this once widespread population. (*See* VEDDA; SENOI.)

Pygmies and Senoi.—The Pygmies are nomadic hunters and food gatherers who roam the jungles in small unorganized bands. They build only frail shelters and have scanty bark-cloth garments and few permanent possessions. The Senoi combine a limited agriculture with hunting, in which they employ the blowgun and poisoned darts. Their typical dwelling is a one-room structure raised high above the ground on piles, but some communal houses appear. Each settlement is under a headman—usually an elder—who exercises a limited authority. Considering the simplicity of their material culture, the Senoi have a rather intricate set of religious beliefs, including superior beings, wandering spirits and life after death. An unorganized group of individuals, called *halak*, deals with the spirit world by means of ceremonies and magic rites. The Senoi are of slight build, with rather long heads and angular faces. Skin colour is light reddish-brown; hair is dark and wavy and when worn uncut falls to the shoulders.

Proto-Malays.—The dominant population of the archipelago appears to have entered the area from the Asian mainland, probably by following the river courses which spread south and southeast from the Tibetan borders. The character of the country did not permit mass migration but there was a steady drift of a people much like the Malay, although of stockier build, with longer heads, heavier features and wavy hair. Because of their earlier appearance and their evident relationship to the Malays they are known as Proto-Malays. As they advanced they drove out or absorbed most of the aboriginal peoples. They were followed by an infiltration of a related but more definitely southern Mongoloid physical type. Amalgamation of the two produced the present-day Malayan. Isolated groups of the Proto-Malays are found on the mainland, while powerful tribes such as the Igorot-Ifugao of the northern Philippines, the Tenggerese of Java, the Toradja of the Celebes and in less pure strain the Batak of Sumatra still remain.

Malays.—The Malayan peoples spread over the mainland nearly to the borders of China, down the peninsula and out into the Pacific until they had occupied Formosa, the Philippines, Borneo and Indonesia. In later centuries, as they became competent seafarers, they went east to the coasts of New Guinea, while to the west they reached and colonized Madagascar off the coast of Africa. On the continent, except for the peninsula, they were eventually dispossessed or absorbed by incoming peoples such as the Mon-Khmer, Thai, Burmese and Assamese. Even there small islands of Malay-speaking groups still exist. Both Malay and Proto-Malay speak dialects of Malayo-Polynesian. (*See* MALAY LANGUAGE.)

The typical Malay is of slight build; men are about 5 ft. 4 in., women slightly shorter. They have brachycephalic heads, broad

faces and noses of medium size. The Mongolian (epicanthic) fold of the eye is common; the chin is prominent. Skin colour ranges from olive to a reddish-brown; eyes and hair are dark and the latter ranges from straight to wavy. In both the Proto-Malay and the Malay there is evidence of Caucasian mixture, probably due to crossing in the interior homeland.

The early Malayan kampong (village) was a small, largely self-sufficient unit. Bamboo and thatch houses of one or two rooms were raised high above the ground on piles. Close to the settlements were plots of rice, sweet potatoes, taro and in some places spices. Always coconut and betel nut palms were nearby. Industries consisted of weaving, mat- and basketmaking, handmade pottery and ironworking. Such a village was governed by a headman and a council of elders, but there was no higher, organized rule. Religion was highly developed around a belief in spirits, some good, some bad, some ancestral, some self-existing through time. Contact with the spirit world was through mediums who, in trances, conducted elaborate ceremonies for the general welfare. A rich folklore gave the background for the religious beliefs as well as for the near-universal practices of magic and head-hunting. Today the bilateral family, with inheritance and descent in both lines, is typical but a highly specialized variant type exists among the Menangkabau of Sumatra and in some other areas. There is found a clan and phratry system with inheritance and descent through the female line. In such areas the long house or community dwelling is prevalent. (*See* also MALAY.)

Other Elements.—Early in the Christian era Indian traders and petty princes entered the area in search of spices. Soon they set themselves up as rulers. Out of such beginnings empires arose (see *History*, below). Indian influence became dominant at the higher levels; elaborate courts were established together with Buddhistic and Brahmanistic rites. The Indian epics, given a local setting, became the literature of the people. During this period there was some intermarriage between the newcomers and the upper-class natives. Into this situation came Arabian traders and teachers who in a short time succeeded in introducing the religion of Mohammed. Only in Bali did the Indian religion persist, but the cultural influence of India is still strong in the archipelago. In the Philippines, Christianity, introduced by the Spanish, resisted the spread of Islam.

The 15th century witnessed the appearance of the colonizing powers of Europe. Their influence has been great, especially as related to the economic life. In the Philippines, Spain wrought great changes and succeeded in establishing the only Christian population in Asia. European exploitation of such natural resources as tin and rubber called for manpower, a need answered in part by the introduction of Chinese and Indian labourers. Chinese contacts had begun in the East Indies by the 5th century but extensive immigration did not start until after the advent of the European powers. With settled conditions and opportunities for gain there was a great influx of Chinese, in some areas as traders and shopkeepers, in others as settlers or as coolie labourers. In the Malay peninsula and Singapore they were so successful that many remained and came to constitute about half the population. Another important element, especially in the peninsula, is the south Indian (Tamil), who came primarily as a labourer on the estates. Indians make up about 10% of the population. On the peninsula a pluralistic society emerged, composed of Malays, who are Mohammedans; Chinese, mostly Buddhists; and south Indians, with Hinduism dominant. Because of the differences in religion, language and economic activities, there has been little intercommunication and few community interests are shared. (F.-C. CE.)

HISTORY

The Hindu and Muslim Periods.—Indians—merchants and political refugees—arrived in Indonesia prior to the Christian era. Immigration continued for seven centuries but the number was never large. They intermarried with the Indonesian aristocracy and their descendants formed the governing class. The immigrants affected government and religion and exerted their greatest influence in Java and Sumatra. From there the new culture spread to Bali and the Moluccas, with some traces in Borneo and Celebes.

While the majority of the immigrants were Hindus, some were Buddhists. The two religions coexisted without persecution and provided the models for architecture and sculpture. Chinese traders arrived about the same time as the Indians but had little influence on Indonesia.

The two most powerful kingdoms between the 5th and 9th centuries were Srivijaya (Criwidjaya) and Shailendra (Sailendra or Cailendra). The former, with its capital at Palembang in Sumatra, included part of Sumatra and the Malay peninsula and was a commercial and naval power. The Shailendra dynasty ruled in central Java during the 8th and 9th centuries; under it Indian art reached its highest development in, for example, the Buddhist temple at Borobudur. Later, eastern Java became the most powerful kingdom and in the late 13th century King Kertanagara conquered part of Sumatra, Borneo, Bali and several of the Moluccas. After an interlude of civil war and the intervention of a Chinese fleet and army sent by Kublai Khan, Vijaya (Widjaya) became king in 1294. He founded the empire of Majapahit, whose strength rested upon sea power and control of the spice trade. The empire finally collapsed in the late 15th or early 16th century. (*See* JAVA and SUMATRA for a more detailed history.)

The decay of Majapahit was hastened by the spread of the Muslim religion, introduced by traders. In 1292 Marco Polo visited the islands and found that the northern tip of Sumatra had been converted to Islam. From there it spread gradually through the islands until Hinduism survived only in Bali. The process of conversion was still in progress when the Portuguese arrived, and their efforts to substitute Christianity for Islam had little effect.

The Portuguese and Spanish.—In 1511 a Portuguese expedition under Antonio d'Abreu was dispatched to find a route to the Moluccas and Banda Islands, then famous for their cloves and nutmegs. The explorers reached Amboina and Ternate, after gaining some knowledge of Java, Madura, Sumbawa and other islands. In 1514 a second Portuguese fleet arrived at Ternate, which became the centre of Portuguese enterprise in the archipelago. In 1529 a treaty was concluded between Spain and Portugal by which the boundary between the Spanish and Portuguese spheres was fixed at 17° E. of the Moluccas; the Philippines were included within the Spanish sphere.

Portuguese traders frequented the coast of Java and established a trading port in Sumatra, but annexed no territory in either. Farther east they founded numerous forts and factories, notably in Amboina, Banda, Celebes and Halmahera. Ternate remained the seat of the governor of the Moluccas, the highest official in the archipelago. Portuguese power in the east was weakened by administrative corruption and by incessant war with native states, notably Bintang and Atjeh (Achin); bitter hostility was aroused by the attempts of the Portuguese to establish a commercial monopoly and to convert their subjects and allies.

The Dutch and English, 1595–1674.—The Dutch came to the east to avenge the injuries inflicted on their country by the Spaniards and to break the commercial monopoly of the peninsular states. They already possessed a large interest in the spice trade, for the Portuguese, having no direct access to the principal European markets, sent cargo to the Netherlands for distribution by way of the Scheldt and Rhine. The Dutch now sought to monopolize not only the distribution but the production of spices. The first Dutch fleet, under the command of Cornelius Houtman, reached Sumatra in 1596. In 1602 the Dutch East India company (*q.v.*) was incorporated, and for nearly two centuries played the chief part in the history of Indonesia. The Dutch were the stronger power at sea. They attacked the Portuguese in Ceylon (1602), and defeated a powerful fleet off Banda. In 1608 they forced the Portuguese to assent to an armistice for 12 years, and in 1609 Pieter Both was chosen as first governor general of Netherlands India. In 1611 the headquarters of the Dutch was changed from Bantam to Jakarta (*q.v.*), which in 1619 was renamed Batavia and became the Dutch capital. (The name Jakarta was restored in 1949.)

Meanwhile the English East India company extended its operations to the archipelago. After 1611 the commercial rivalry between the Dutch and British became acute, and commissioners met

to arrange for co-operation between the Dutch and British companies and the maintenance of a joint fleet. But neither company could restrain its agents from aggressive action and many fresh causes of dispute arose. The treaty of defense lapsed in 1637. The Dutch company opened up trade with Japan and China and prosecuted the war against Portugal with great vigour.

A new war between Great Britain and the Netherlands broke out and was terminated by the treaty of Westminster in 1674. Thenceforward the British company devoted its energies chiefly to the development of its Indian possessions, while the Dutch were left supreme in the archipelago.

The system of practical slavery enforced on the native races provoked an insurrection throughout Java, in which the Chinese settlers participated; but the Dutch maintained naval and military forces strong enough to crush all resistance, and by 1749 they were practically supreme in Java.

British Occupation, 1811–16.—The Netherlands Indies were at this time part of the Napoleonic empire, with which Great Britain was at war. A British naval squadron captured Amboina, Banda and Ternate in 1810, and in 1811 a strong fleet captured Java. Thomas Stamford Raffles (*q.v.*) was appointed lieutenant governor and introduced many important changes in the departments of revenue, commerce and judicature. In 1816 the Netherlands Indies were returned to the Dutch, in accordance with the treaty of Vienna.

Restoration of Dutch Power, 1816–1940.—The history of the archipelago was changed by Raffles' occupation of Singapore in 1819 to prevent the Dutch from acquiring a monopoly of trade throughout Malaya and with China. Questions between Great Britain and the Netherlands were settled by treaty in 1824. The Dutch were given freedom of action in Sumatra, while the Malay peninsula was recognized as within the British sphere of influence.

The extension of Dutch political power—notably in Java, Sumatra, Celebes, the Moluccas, Borneo, the Lesser Sunda Islands and New Guinea—involved several wars with various native states. A large expedition was sent to Lombok in 1894 and almost the whole of that island was incorporated in the Dutch dominions. A 30 years' war with Atjeh (*see* SUMATRA) began in 1873.

While the Dutch were consolidating their authority, other countries were acquiring interests in the archipelago. Immigration from China and Japan steadily increased. In 1841 Sir James Brooke (*q.v.*) established British sovereignty in northwest Borneo. In 1885 New Guinea was divided between Great Britain, Germany and the Netherlands. The Spanish-American War of 1898 resulted in the cession of the Philippines to the United States. Australian and Japanese trade in the archipelago was stimulated by the establishment of the commonwealth of Australia (1901) and by the Russo-Japanese War (1904–05).

The effect of World War I was to deprive Germany of the northern part of New Guinea, which was administered under mandate by the commonwealth of Australia. The division of Timor between Portugal and the Netherlands was reminiscent of the struggles of past centuries; the Dutch-Portuguese treaty in 1904 settled all outstanding questions (*see* TIMOR). Apart from the Philippines, the Malay archipelago was before World War II almost wholly in the hands of the British and the Dutch.

After World War II.—In World War II almost the entire Malay archipelago was brought under Japanese control. After Japan capitulated, the Indonesian republic was proclaimed on Aug. 17, 1945, and the transfer of sovereignty from the Netherlands to the United States of Indonesia took place on Dec. 27, 1949. On Aug. 17, 1950, the unitary Republic of Indonesia was proclaimed (*see* INDONESIA, REPUBLIC OF). The commonwealth of the Philippines obtained full independence on July 4, 1946, and became a republic (*see* PHILIPPINES, REPUBLIC OF THE). In 1962 the United Nations assumed caretaker status over Netherlands New Guinea (later West Irian) preparatory to assumption of administrative control by Indonesia in 1963. The former British colonies of Sarawak and North Borneo (Sabah) joined with Malaya and Singapore in 1963 to form the Federation of Malaysia.

(K. G. J.; C. H.; E. S.; G. W. O.)

POPULATION

The population of the Malay archipelago is more than 125,000,000, about 4.0% of the total world population (*see* Table).

Area and Population

Political unit	Area (sq mi.)	Population*
Brunei (British protected sultanate)	2,226	83,877
Indonesia	575,893	96,385,448†
Malaysia‡	27,638	1,198,950
North Borneo (Sabah)	29,388	454,421
Sarawak	48,250	744,529
New Guinea	344,218	2,699,398†
West New Guinea (Indonesian administered)	160,618	736,731†
Trust Territory of New Guinea§ (Australia)	93,000	1,448,919†
Papua (Australian territory)	90,600	513,618†
Philippines	115,707	27,087,685
Portuguese Timor	5,763	517,079
Total	1,121,375	127,972,337

*1960 census, unless otherwise indicated. †1961 census. ‡Includes only archipelago areas. §Includes Bismarck archipelago and Bougainville district (of Solomon Islands). Separate data not available.

The distribution of population shows great variation in density. The most densely settled parts of Java have a rural population of more than 4,000 per square mile while the adjacent island of Borneo averages less than 5 persons per square mile and has large areas without population. This reflects the productivity of land and many historical and cultural factors.

About 80% of the Indonesian and Philippine population is rural. After World War II and independence there was a pronounced movement to the cities, resulting in the rapid growth of such urban areas as Jakarta and Manila (*qq.v.*). Almost 40% of the population is under 20 years of age, accelerating the already rapid rate of annual increase of 2% in Indonesia and 3.8% in the Philippines. Population pressure is severe in parts of Java and Madura in Indonesia. In the Philippines northwest Luzon as well as several islands in the Visayan group suffer population pressure.

Migration, both voluntary and government sponsored, has resulted in the settlement of Javanese in southern Sumatra, around Medan in northeastern Sumatra and along the southern coasts of Borneo. Filipinos from Luzon and the Visayan Islands have settled on sparsely populated Mindanao. Some have migrated outside the Malay archipelago: Indonesians to Malaya and Filipinos to the U.S., particularly Hawaii. But migration alone is an ineffective and temporary solution to population pressure. There are areas of the Malay archipelago where additional settlement is possible but continued rapid population increase will pose many problems.

See also references under "Malay Archipelago" in the Index.

(L. A. P. G.)

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(L. A. P. G.; F.-C. CE.)

MALAY LANGUAGE is one of the Malayo-Polynesian (Austronesian) languages (*q.v.*). It is most closely related to

Menangkabau in west Sumatra and perhaps connected with it by the varied dialects of south and west central Sumatra sometimes called Middle Malay. It is next most closely related with other Malayo-Polynesian languages of Sumatra, Java and Borneo and the Cham languages of Vietnam. It is the native language of about 9,000,000 people distributed over the Malay peninsula, the east coast of Sumatra, the entire coast of Borneo and the smaller islands that lie between these areas, the Riouw archipelago, Bangka, Billiton, the Great Natuna Islands, etc. The local varieties differ noticeably from each other, but not as much as from the native Malay of Jakarta and that of Amboina.

Dialects.—The dialect of highest prestige is that of the Riouw Islands and the southern Malay peninsula. It is regarded as the basis of the standard Malay of the Malay peninsula and also of the Bahasa Indonesia ("Indonesian language") or Indonesian, which is the official language of the Republic of Indonesia. A Malay pidgin often called Bazaar Malay (*mĕlayu pasar* "market Malay") developed as a lingua franca in the East Indian archipelago, probably before the arrival of the Portuguese. This pidgin varies somewhat locally. The variety used by the large Chinese colonies of Malaya and Indonesia is called Baba Malay. The formation of Bazaar Malay is no doubt due to the dominant position held successively by Palembang, Tumasik (old Singapore), Malacca and Singapore as the centre of trade between the East Indies and other countries. The Java form of Bazaar Malay was used by the Dutch as the colonial language. The movement for Indonesian independence adopted Malay in 1927. As the variety of Malay spoken by most of the members of this movement, the same Java form had a noticeable influence on present standard Indonesian. The Japanese sponsored an Indonesian more like standard Malay and this has continued as the Indonesian standard. The European words in standard peninsular Malay are mainly from English whereas those of Indonesian are from Dutch. Another difference is the increase in Indonesian vocabulary fostered by the Indonesian government.

Alphabets.—The earliest records in Malay are Sumatran inscriptions of the late 7th century in a Pallava (south Indian) alphabet. Such an alphabet is used in the so-called *renchong* script of southern Sumatra (Bengkulu, Palembang). With the coming of Islam in the 14th century, Malay became the local language of religious commentaries in converted Sumatra and in the Malay-speaking areas. An Arabic alphabet was developed for these commentaries and this orthography is still used in Malaya and parts of Sumatra for Malay. This alphabet is called Jawi (*huruf jawi* "Jawi letters"), perhaps because Java (Malay *Jawa*) dominated Sumatra and large parts of the peninsula at the time of the conversion.

An orthography with Latin letters was constructed by English scholars and has been used in some publications. The standard Indonesian orthography uses Latin letters, but since its basis was constructed by the Dutch, it differs from its Malay counterpart. After the modifications introduced by the Indonesian government the difference between the two Latin orthographies involved chiefly four letters: Malay *ch, j, ny, y* = Indonesian *tj, dj, nj, j*, respectively.

Structure.—The Malay of the southern peninsula distinguishes the syllabics *i, e, è, ĕ, a, u, o, ò* and the nonsyllabics *k, g, ng, ch, j, ny, t, d, n, p, b, m, y, w, r, l, s, h, q*. Syllabics appear nasalized (*tāōn* "town") or unnasalized (*taon* "year"); *è* appears in loan words (*bèk* "bag"). Likewise *k* is final only in loan words; romanized final *k* (= Jawi *qāf*) or apostrophe (= Jawi *hamzah*) corresponds to a glottal stop (*q*) in pronunciation; *r* is a velar spirant. In pronunciation *é* appears for final orthographic *a*, and *e* and *o* for orthographic *i* and *u* commonly appear before final consonants (in disagreement with the standard orthography): *apĕ* "what," *baeq* "good," *bagos* "fine," orthographic *apa, baik, bagus*. Stress as well as pitch is part of the phrase structure and is conditioned by the shape of the words rather than the particular words.

Malay has a number of parts of speech. The chief ones are particles and full words, of which only the latter appear with attributes. The particles are exclamatory (*e.g., wah* "gosh"), prepositional (*e.g., di* "at," *kĕ* "to"), conjunctional (*e.g., jang* "that," *kalau* "if," *karĕna* "because") and attributive (*e.g., chuma* "only"). The full words are nouns (*e.g., rumah* "house," *saja* "I") and verbals, the latter being further classified as adjectives (*e.g., bĕsar* "big"), numerals (*e.g., satu* "one") and verbs (*e.g., bĕli* "buy," *pĕrgi* "go"). As predicator a noun has the negative *bukan* (*itu bukan rumah* "that is not a house") whereas a verbal has *tidak* (*saya tidak pĕrgi* "I did not go"). An adjective follows the noun it modifies (*rumah bĕsar* "a big house"). A numeral precedes the noun it modifies (*satu rumah* "one house"). Usually there is a choice between a simple numeral as above and a compound numeral (*sĕbuah rumah* "a house"); in such cases the simple numeral calls particular attention to the number (*dua rumah* "two houses," *duabuah rumah* "some two houses").

A noun is followed by a noun which modifies it; such a modifier is either descriptive (*orang mĕlayu* "[person Malay] a Malay") or partitive-possessive (*rumah kawan saja* "[house friend my] my friend's house"). A passive verb is followed immediately by the agent (*itu dibĕli orang* "[that bought person] that was bought by somebody"), although more commonly in Malay and less frequently in Indonesian a phrase with the preposition *oleh* is found (*itu dibĕli oleh kawan saya* "that was bought by my friend"). Subject and predicate are in most cases invertible with a difference in emphasis; besides *dia kawan saya* "he is my friend," there is also the more emphatic *kawan saya dia*. Many common constructions of Malay resemble those of English (*e.g.*, prepositional: *di rumah saya* "at my house"; verb goal: *bĕli rumah* "buy a house").

Words are simple, complex or compound. Simple words contain a single meaningful element: *nama* "name." Complex words contain at least two meaningful elements which differ as affix and root; *e.g., namakan* "to name." Compound words contain at least two meaningful elements neither of which is an affix: *rumah-makan* "(house-eat) restaurant." Longer sequences resemble one or the other type of word.

There is a fair variety of affixes, among which doubling (*e.g., nama-nama* "names") is to be counted. Nouns and adjectives are inflected for number (but noncompulsorily): *rumah* "house," *rumah-rumah* "houses"; *panas* "hot," *panas-panas* "hot" (pl.). Transitive verbs have a passive (*di-bĕli* "be bought") and active (*mĕm-bĕli* "buy") and a simplex which appears in commands (*bĕli* "Buy!") and in other constructions. Various affixes appear in derivation, such as doubling (*e.g.*, with nouns "an analogue of": *jari* "finger," *jari-jari* "spoke," with verbs "diffusely, persistently": *bĕrlari* "run," *bĕrlari-lari* "run around, keep running").

Various affixes appear in derivation and very often these have ill-defined or varied meanings. There are two common suffixes: *-kan* (forms transitive verbs) and *-an* (*makanan* "food," *makan* "to eat"). The suffix *-i* is very rare in colloquial Malay (*lalui* "pass, traverse," *lalu* "go past") but is common in literary Malay and in very wide use in Indonesian. The number of prefixes is much larger (*e.g., bĕr-, tĕr-, pĕng-, mĕng-, kĕ-*). Combinations of affixal elements are found that resemble the addition of a prefix and a suffix or prefix and doubling or the like without, however, showing the meaning of these as separate elements; *e.g., kĕmauan* "desire," *mau* "want," *kĕkuningkuningan* "tinted yellow," *kuning* "yellow," *sĕchĕpatchĕpatnja* "as fast as possible," *chĕpat* "fast."

The combinations of elements in analyzable words are usually transparent. The chief exceptions are the active prefix (*mĕng-*) and others which behave like it. For these the shape of the combination depends on the initial of the following element as it would otherwise appear. If the initial of the base is *p, t, k*, or *s*, then a corresponding nasal appears at the seam (*potong* "cut," *mĕmotong; tipu* "deceive," *mĕnipu; kirim* "send," *mĕngirim; sapu* "sweep," *mĕnyapu*), otherwise the initial appears with the nasal it determines (*e.g., angkat* "lift," *mĕngangkat; bawa* "bring," *mĕmbawa; chari* "seek." *mĕnchari*).

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MALAY LITERATURE. The history and geographical distribution of the Malay language is discussed in MALAY LANGUAGE; this article deals only with the literature itself.

Prose.—*Indian and Javanese Influence.*—No Malay writings in scripts of the Hindu period (4th–late 15th centuries) are extant, except a few inscriptions. One, of A.D. 1380, on the tomb of a Pasai princess, provides the first known example of Malay verse, written in a Malay full of Sanskrit and Arabic. In Perso-Arabic script there are 15th-century versions of the *Ramayana* and *Mahabharata* (*qq.v.*), in a Malay sprinkled with Arabic loanwords, the *Ramayana* translated from a popular Javanese dramatic recension and the *Mahabharata* from a Javanese version written in *kawi* script, which died out *c.* 1400. In the 20th century Islam and the defeat of the shadow play by the motion pictures have killed interest in the two epics, but early Buddhist and Hindu influence survives in folk tales and in beast stories borrowed from the *Panchatantra* (a collection of Indian fables; *see* BIDPAI, FABLES OF), the *Katha Sarit Sagara* ("Ocean of Story"), a 12th-century work, taken from an earlier collection, compiled in Kashmir by Somadeva, and Buddhist Jataka tales (*see* JATAKA). Java's large cycle of Panji tales, which date from the second half of the 14th century, was popularized as far as Cambodia by the shadow play. Part of one early recension, *Kuda Sumirang Sri Panji Pandai Rupa*, has been printed (1931 in Kelantan, Malaya, where many of the tales exist in manuscript) but a later recension in the 15th-century poem *Ken Tambuhan* is better known. Traces of one of the tales, *Chekel Waneng Pati*, a lengthy mythological romance interspersed with many comic interludes, occur in Malay folk romances, the *Hikayat Pĕlandok Jĕnaka* ("Tale of Wily Mouse-deer") and the *Malay Annals* (*see* below). The story of the buccaneer *Hang Tuah*, Malaya's only original romance until the end of the 19th century, is modeled on mythological stories of the Javanese Panji cycle.

Histories.—Between the 13th and 15th centuries Islam gradually ousted Buddhism and Hinduism in the Malay-speaking countries, first gaining ground in Sumatra and southern Malaya; the struggle between the old faith and the new in Sumatra is described in the *Hikayat Raja-Raja Pasai* ("Story of the Raja of Pasai"), the oldest Malay history, and in its imitator, the finest Malay literary work, the *Sējarah Mĕlayu* (*Malay Annals*). This, which must have been drafted in the port of Malacca in the 15th century, was revised in Johore in 1612. Only an author in as cosmopolitan a city as Malacca could have been familiar with Javanese, Tamil, Sanskrit and Persian words and with incidents from the *Ramayana*, the Bhagavad Gita (*q.v.*), the Panji tales, the Persian *Sindibad Namah* and the Arabic account of Alexander the Great as a Muslim conqueror (*see* ALEXANDER ROMANCES). Other notable histories are the *Misa Mĕlayu*, a lively contemporary account of Perak (western Malaya) between 1742 and 1778; the *Kedah Annals*, largely compact of folklore and Buddhist myth; and two important accounts of Malaya in the 18th and early 19th centuries by Raja 'Ali Haji of the Riau (Riouw) archipelago. Such histories have been one of the two original features in a literature of translation, the other being the pantun (*q.v.; see* also *Poetry*, below).

Islamic Literature.—With the acceptance of Islam, Malay authors started to translate numerous folk romances from Muslim India, some of them stories of warrior heroes, gods and demons, others semihistorical, about such Muslim heroes as Alexander (from an Arabic source) and Mohammed (from Persian sources). Islam brought also famous cycles of tales: the *Hikayat Bayan Budiman* ("Tales of a Parrot") translated from Persian in the 15th century; the *Kalila dan Daminah* (the Arabic *Kalila wa-Dimna*), which exists in three Malay versions, two of them modern; the *Bakhtiar* cycle, a succession of stories told by an unjustly condemned prince in an effort to avert his execution, one recension of which is from the late Persian version and another, the *Hikayat Golam* (or *Azbakh*), from two Arabic adaptations of the Persian original. In modern times *Aesop's Fables* and some of the tales from the *Arabian Nights* have been translated into Malay.

Many works on Islamic jurisprudence, dogma and mysticism have been written in Malay, some of the most scholarly by two heterodox Sumatrans, the mystic Shams al-Din of Pasai (northern Sumatra) (d. 1630) and his contemporary Hamzah of Barus, the author of famous pantheist verses. An orthodox critic of both was Nur al-Din ibn 'Ali (d. 1658) who wrote the *Sirat al-Mustakim*, a treatise on Muslim conduct in everyday affairs, and the *Bustan al-Salathin*, a compilation of legend, history and science, as well as polemical treatises. About 1700 the *Risalah Hazar Masa'il* (*Book of the Thousand Questions*) was translated into Malay from two early Persian texts. Between 1778 and 1824 four works by the Persian theologian al-Ghazzali were translated. Palembang (south Sumatra), the Riau archipelago and Patani (Pattani, now in southern Thailand) were centres for Malay theological authors. The first author to use a modern prose style was Munshi 'Abdullah (1796–1854), a Malaccan of Arab and Tamil blood who wrote his autobiography and an account of a business trip up the east coast of Malaya, and translated the Tamil version of Bidpai's fables into Malay. Since the second half of the 19th century Malays have continued the tradition of translation from Arabic and from Dutch and English, most of the works translated being educational.

Poetry.—The earliest Malay poetry was the vers libre of the magician's incantations, tribal songs and tags in folk tales that show the influence of the *Manimekalai*, a Tamil Buddhist classic dealing with the story of a popular goddess, Kannaki (or Pattini). More fashionable until the mid-20th century were long *sha'er* (poems) in stanzas with four rhyming lines, some of them novelettes in verse, others religious, others topical; the oldest is the 15th-century *Ken Tambuhan*. But far the best and most original verse is the pantun, a quatrain in which alternate lines have internal assonance as well as end rhymes. Modern Malay poetry, mostly Indonesian, has rejected traditional vocabulary and structure and copied European forms, often with great success.

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(R. O. Wt.)

MALAYO-POLYNESIAN LANGUAGES (also known as the AUSTRONESIAN LANGUAGES) are a family of related languages with about 110,000,000 speakers in Madagascar, southern Vietnam, the Malay peninsula, Indonesia, the Philippine Islands, Formosa, New Guinea, the Melanesian, Micronesian and Polynesian islands and New Zealand. In pre-Columbian times this was the most widespread language family, extending from the Malagasy of Madagascar to the Rapanui of the Easter Islanders. The number of Malayo-Polynesian languages is more than 300 and perhaps exceeds 500 (depending upon the way in which languages are distinguished from dialects). They constitute 10%–15% of all languages in the world. The vast majority of speakers are in the Philippines and Indonesia, the island of Java containing somewhat less than half. There are four large countries in which a Malayo-Polynesian language is the official language or one of the official languages: Malay in Malaysia, Indonesian in the Republic of Indonesia, Tagalog in the Republic of the Philippines and Malagasy in the Malagasy Republic.

The Malayo-Polynesian languages are widely, but falsely, thought to be phonetically and grammatically simple. Malay and the Polynesian languages do have relatively simple phonemic systems, but their grammatical structures are not particularly simple. On the other hand a language like that of Yap shows complicated phonemic and grammatical structures.

The Malayo-Polynesian languages were once a single language. The original undifferentiated language became diversified locally, and the hundreds of Malayo-Polynesian languages are the result. The features of the original language, called Proto-Malayo-Polynesian, can only be inferred by comparing the modern forms.

Although the classification of the members of the family has not been completed, some close relationships seem to be observable.

Most of the Philippine languages appear to be closely related to each other. With these are often grouped the Chamorro language of Guam and the language of the Palau Islands. The languages of western Indonesia (*e.g.*, Malay, Achinese, Minangkabau, Batak, Sundanese, Javanese, Balinese and some of the languages of Borneo) seem closely related to each other, to the Cham languages of southern Vietnam and to Malagasy. The languages of the Carolines with the exception of Palau, Chamorro (*see* above) and Yapese are closely related to each other and more distantly to Ponapean, Gilbertese and Marshallese. These are likewise closely related to the Polynesian language (*q.v.*). Since the languages of Micronesia and Polynesia are closely related to some of the languages of Melanesia (*e.g.*, the Banks Islands and northern New Hebrides), and since those of the Philippines are probably related to those of western Indonesia, some scholars postulate two subgroups of Malayo-Polynesian: Eastern and Western. The languages of eastern Indonesia and of New Guinea resemble those of Melanesia, but are not clearly of either subgroup.

Not all of the languages in the vast island area demarcated above are Malayo-Polynesian. Most of the languages of New Guinea are non-Malayo-Polynesian. The Malayo-Polynesian area is limited to a large region near the isthmus connecting the northwest peninsula with the main body of New Guinea and the northern (both of the northwest peninsula and the main body) and eastern coasts. Non-Malayo-Polynesian languages are spoken in the northern two-thirds of Halmahera, in Alor and Timor in Indonesia and in the Solomon Islands in Melanesia.

The most likely next of kin of the Malayo-Polynesian languages is the Thai family. The generally accepted hypothesis regarding the Malayo-Polynesian migration states that it came from the continent of Asia via the Malay peninsula and the neighbouring chain of islands to the Pacific. The island of Madagascar was probably settled from Borneo in the first part of the 1st millennium A.D., not long after the Indians came to the Malay archipelago. The latter found the forerunners of the contemporary languages there, and these were no doubt already different from the forerunners of the Malayo-Polynesian languages elsewhere (except Madagascar). Thus the migration must have been well under way by then, perhaps for more than 2,000 years. The connection with the Thai family, however, is not beyond a reasonable doubt.

See also references under "Malayo-Polynesian Languages" in the Index.

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MALAY PENINSULA (sometimes called the KRA PENINSULA), in southeast Asia, is a long, narrow appendix of the mainland extending south through the Isthmus of Kra (latitude 10° N.) in Thailand to Cape Tanjong Piai (1° 16′ N.) in Malaysia for a distance of about 700 mi. It lies between the Andaman sea of the Indian ocean and the Strait of Malacca (west), the Singapore strait (south), and the Gulf of Siam and the South China sea (east). Politically it comprises the southwestern section of Thailand and the former Federation of Malaya (now the states of Malaya within the Malaysia federation), which occupies the main part of the peninsula. The ancient Chersonesus Aurea (Golden Chersonese), it has always formed a physical and cultural link between the mainland and the Malay archipelago. *See* THAILAND; MALAYA; MALAYSIA.

MALAYSIA, an independent federation in Southeast Asia, within the Commonwealth of Nations, consists of the group of states formerly comprising the Federation of Malaya, together with Sarawak and Sabah (North Borneo). Until August 1965 Singapore was also a member. Pop. (1965 est.) 9,374,000. The federation covers an area of 129,468 sq.mi. (335,323 sq.km.) and occupies two distinct regions which are separated by about 400 mi. (640 km.) of the South China Sea: the Malay Peninsula extending southeast from the mainland, and the northwestern coastal area of the island of Borneo. The federation has land frontiers with Thailand on the mainland and with the Republic of Indonesia in Borneo. The Indonesian island of Sumatra lies across the narrow Strait of Malacca, while across the Sulu Sea to the north and northeast of Sabah are the Philippine islands of Palawan and Mindanao. The constitution of Malaysia is based on that of the Federation of Malaya, and the federal government is responsible for, among other things, external affairs, defense, and security.

MAP DEFINING THE BOUNDARIES OF MALAYSIA

The plan for a Malaysia federation (which would also have included Brunei) was first put forward in 1961 by the Malayan prime minister, Tengku Abdulrahman. The United Kingdom and Malayan governments subsequently reached agreement in principle on the plan. Meanwhile, a commission of inquiry reported that a majority of people in Sabah and Sarawak favoured joining the proposed federation. In September 1962 a referendum was held in Singapore to decide on what terms that country would enter the federation. The sultan of Brunei announced acceptance in principle of federation but later withdrew his support. Opposition to the federation came from the Philippines, which laid claim to Sabah and called for the establishment of a wider Southeast Asian confederation, and from Indonesia, which denounced the formation of the federation as a "neocolonialist" move. In an attempt to meet Indonesian objections the Malayan prime minister agreed to the setting up of a UN commission to ascertain the views of the peoples of Sabah and Sarawak. The commission reported that the idea of federation had won general approval. The operation of this commission slightly delayed the date of the establishment of the federation, which finally came into existence on Sept. 16, 1963, in the face of Indonesian hostility. Indonesia's declared aim was to "crush Malaysia" and in its attempts to undermine the new state it made use of economic and political pressure, internal subversion, and sabotage. However, the most noticeable feature of Indonesia's "confrontation" policy was the launching of attacks upon Malaysian territory. During 1964–65 there were armed incursions into Sabah and Sarawak by both guerrillas and regular troops from Indonesian Borneo, and airborne and seaborne landings in Malaya by isolated groups from Indonesia, all of which were successfully resisted by Malaysian and British forces.

The word "Malaysia" was formerly used as a collective term for the islands of the Malay archipelago lying between the Pacific and Indian oceans.

See also BORNEO; BRUNEI; MALAY ARCHIPELAGO; MALAYA; SABAH; SARAWAK; SINGAPORE.

MALBONE, EDWARD GREENE (1777–1807), U.S. artist generally regarded as the greatest of American miniaturists, was born at Newport, R.I., in Aug. 1777. Largely self-taught, he

began his professional career in Providence, R.I., at seventeen and quickly developed a remarkably fine technique. A man of agreeable manners, diligent and blessed with what Washington Allston called "the happy talent . . . of elevating the character without impairing the likeness," Malbone was during his short career the most sought-after miniaturist of his day in Providence, Newport, Boston, New York city, Philadelphia and Savannah. His career was cut short by tuberculosis, of which he died at Savannah, Ga., on May 7, 1807.

Many of his miniatures have survived and are highly prized for their delicacy of drawing, richness of colour and convincing characterization. He had no formal pupils, but freely advised other artists, notably Charles Fraser, William Dunlap and John Wesley Jarvis.

See Ruel P. Tolman, *Life and Works of Edward Greene Malbone* (1957). (D. H. W.)

MALBORK (Ger. MARIENBURG), a town in northern Poland, in Gdansk *wojewodztwo* (province), lies on the right bank of the Nogat river—one of the three mouths of the Vistula, 25 mi. S.E. of Danzig. Pop. (1960) 25,000. It is located on the border of the Zulawy plains and the Masurian lakes. Malbork is a junction for the Warsaw–Danzig, Torun–Braniewo and Olsztyn–Danzig railway lines, and for a number of roads connecting the highlands with the Zulawy region. The town developed on the trade route along the Nogat river from north to south.

Malbork grew up around the castle, founded *c.* 1274 by the Teutonic Order, and the settlement was given town rights in 1276. From 1309 to 1457 it was the seat of the grand master. During the Thirty Years' War the Poles occupied the town (1457), which was included in Poland after the Torun (Thorn) peace treaty of 1466. After the first partition of Poland in 1772, Malbork passed to Prussia. It was retained by Germany in the plebiscite of 1920 and was returned to Poland in 1945.

The huge castle, rebuilt in the 14th and 19th centuries, was badly damaged during World War II. Partly reconstructed by the 1960s, it bears witness to the wealth and military power of the Teutonic Knights. It consisted of three lines of defense: the *przedzamcze* (forecastle) surrounded by a large outer moat, the middle castle and the high castle.

Local agriculture provides raw materials for the Malbork sugar factory, flax works and dairies. (K. M. WI.)

MALCOLM, the name of four Scottish kings.

MALCOLM I (d. 954), king from 943 to 954. He received Strathclyde from the Anglo-Saxon king Edmund I in 945, promising in return to support Edmund by sea and land.

MALCOLM II (*c.* 954–1034), king from 1005 to 1034, was a grandson of Malcolm I. He invaded northern England several times and by the battle of Carham (1016 or 1018) finally secured Lothian for Scotland. He died at Glamis on Nov. 25, 1034.

MALCOLM III Canmore (*c.* 1031–1093), king from 1058 to 1093, was great-grandson of Malcolm II. He succeeded to the throne after defeating Macbeth near Lumphanan in Mar, having spent several years of his youth in exile at the court of Edward the Confessor. After the Norman conquest he gave shelter in Scotland in 1068 to Edgar the Aetheling and his sisters, one of whom, Margaret, became his second wife soon afterward. He did homage to William I at Abernethy in 1072, giving his eldest son, Duncan (afterward Duncan II), as a hostage and receiving lands in England. His frequent raids into England caused castles to be built at Carlisle and Newcastle-upon-Tyne.

A visit to William II at Gloucester in 1093 did nothing to improve their relations, and later that year Malcolm again invaded England, reaching Alnwick, where he was killed with Edward, his eldest son by Margaret. On his death a Celtic reaction brought his brother Donaldbane, to the throne. Of his six sons by Margaret, three succeeded to the throne in turn—Edgar, Alexander I and David I. Of his two daughters, Matilda married Henry I of England, and Mary married Eustace III, count of Boulogne.

MALCOLM IV (1142–1165), king from 1153 to 1165, was the eldest son of Henry, earl of Huntingdon, and grandson of David I, whom he succeeded. By a treaty made at Chester with Henry II of England in 1157, the boundary of the kingdoms was fixed at the Tweed and the Solway. He was knighted by Henry II during the Toulouse campaign of 1159. He died at Jedburgh on Dec. 9, 1165.

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MALDA, a town and district in the Presidency division of West Bengal, India. The town (pop. [1961] 4,885), sometimes called Old Malda, lies on the left bank of the Mahananda river near its confluence with the Kalindri (the main stream of the Ganges). It was the port of Pandua and had a large entrepôt trade in cotton and silk fabrics in the 18th century when the Dutch, French and English built factories there, and it still functions as a distributing centre of rice and jute grown in north Bengal. The Jumma Masjid is an important mosque, and across the river is the tower of Nimasarai, a landmark of the neighbourhood.

MALDA DISTRICT covers an area of 1,436 sq.mi. Pop. (1961) 1,221,923. The Mahananda river divides it into two distinctive regions, the eastern being designated as the Barindra, and the western, the Rarh. The Barindra forms a part of the older Ganges delta and is characterized by rolling plains and low hills. Low-lying flat alluvial plains characterize the Rarh region, the northern part of which is marshy. On the south of the Kalindri river lies the most fertile and densely populated part of the district. Rice, jute, pulses and oilseeds are the principal crops. Mulberry plantations and mango orchards occupy considerable areas in the central and southern parts; and the district's economy depends mainly on the mango trade and silk manufacture.

English Bazar or Angrezabad (pop. [1961] 45,900), founded by the British in 1770, is the headquarters of the district. It has a large trade in silk, jute and mangoes. The ruined city of Gaur (*q.v.*), an ancient capital of Bengal, lies 10 mi. S.W. of English Bazar, and about 20 mi. away (6 mi. N.E. of Malda) are the ruins of Pandua. This city succeeded Gaur as capital of western Bengal about 1340, but in 1455 Gaur resumed its former status and Pandua declined. The 14th-century Adina mosque and the Sona or Golden mosque are conserved by the government. (S. P. C.)

MALDEN, a city in Middlesex county, Mass., U.S., on the Malden river, a branch of the Mystic river, 5 mi. N. of Boston. Pop. (1960) 57,676. It is almost surrounded by Melrose, Revere, Everett and Medford (*qq.v.*), with the Middlesex Fells (a state reservation) forming its northwest boundary.

When first settled, mainly by Puritans, on the north side of the Mystic river, Malden was part of Charlestown (*q.v.*) and was known as the Mystic Side. It was incorporated as the town of Mauldon (for Malden, Eng., the home of some of the early settlers) in 1649 and was chartered as a city in 1881. Its bicameral council was abolished in 1958 in favour of a single chamber council. Of historic interest is Bell Rock Memorial park, named for the bell which in colonial times summoned the people to worship or sounded alarms in times of danger, with a Civil War Soldiers and Sailors monument at its summit.

Malden is a residential community with some industrial development and is also an important suburban Boston shopping centre. Manufactures include rubber footwear, electronic and radio parts, aircraft engine parts, metal cans, paints, drugs, knitted clothing and foods. (L. G. H.)

MALDEN AND COOMBE, a borough of Surrey, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Surbiton and the royal borough of Kingston-upon-Thames to form the new London royal borough of Kingston upon Thames (*see* LONDON). The borough of Malden and Coombe (1936) is a residential area with a few small factories about 10 mi. S.W. of Charing Cross. Pop. (1961) 46,572. Walter de Merton, lord chancellor of England who held both manors at Malden, founded a college there in 1264 for the maintenance of 20 scholars at Oxford. Malden still has connections with Merton college, Oxford. Coombe was the birthplace of John Galsworthy, the playwright and novelist.

MALDIVE ISLANDS, an archipelago under British protection between latitudes 7° 6′ N. and 0° 42′ S., lies 400 mi. S.W. of Ceylon. It consists of a chain of about 2,000 low-lying coral

islands grouped in 12 clusters or atolls. The capital island is Male (pop. [1959 est.] 9,471). The northernmost atoll, Minicoy (lighthouse), which is Indian territory, is separated from the main chain by the Eight Degree channel, 71 mi. across. One and a half Degree channel separates the main chain from Suvadiva, which is again separated from the southernmost atolls of Addu and Fua Mulaku by the Equatorial channel. The climate is hot and humid and malaria prevails.

Only about 220 islands are inhabited and the total population (1963) was 93,293. The Maldivians are a mixed race of probably Aryan stock, speaking a language akin to Elu or old Sinhalese.

Islam was adopted in the 12th century and in the 14th century Ibn Batutah, the Arab traveler and historian, described the conditions there. The ruler was a sultan of the still existing ad-Din (Didi) dynasty. The Portuguese forcibly established themselves there from 1518 for about ten years. Formerly a dependency of Ceylon, the Maldives came under British protection by an agreement in 1887. In 1948, when Ceylon became independent, a new agreement provided that Britain should control the foreign affairs and not interfere internally. The sultan undertook to provide necessary facilities to British forces for the defense of the islands or the commonwealth. The 1948 agreement was reaffirmed by one of 1953, after a republic had been inaugurated with Amir Amin Didi, a cousin of the sultan, as president. After nine months the sultanate was restored in 1954 with Al Amir Mohamed Farid Didi as sultan.

In Dec. 1956 Britain made an agreement permitting re-establishment of a wartime airfield on Gan Island in Addu atoll as a staging post between Britain and the far east and Pacific and undertook resettlement of Gan islanders. The Maldivian government warmly welcomed this proposal and 574 out of 926 inhabitants were resettled on Fedu Island. A change of administration then took place and the new government asked for a review of the Gan and also the 1953 agreement. Britain was willing to discuss the airfield and made generous offers of development, but the Maldivian attitude led to the suspension of negotiations in March 1959. About that time insurrection against the Maldivian government broke out in the southern atolls and a British dispatch of famine relief to the rebellious Huvadu (Suvadiva) atoll, 60 mi. N. of Gan, led to charges of interference in internal affairs and the dispatch of Maldivian armed parties, resulting in violence and loss of life. In Feb. 1960, however, the Maldivian government presented the British government with the use of Gan and other facilities in Addu atoll for 30 years, with effect from Dec. 1956 and in return received a direct grant of £100,000 and a grant of £750,000 to finance specific development projects over a period of years. The new agreement reaffirmed Britain's defense obligations, leaving the Maldivian government to conduct its own external, cultural and economic affairs. There is another airstrip (1960) at Hulele, 300 mi. from Gan.

The archipelago is divided into 17 administrative atolls. The Maldives have a *majlis* (parliament) to which all islands elect members. The atolls are covered with coconut palms, and millets and tropical fruit and vegetables are grown. The principal industry is fishing; "Maldive fish" prepared from bonito and tuna are the main exports. There is also coir and lace making. Most of the trade is with Ceylon.

See H. C. P. Bell, *History, Archaeology and Epigraphy of the Maldive Islands* (1940); T. W. Hockly, *The Two Thousand Isles: a Short Account of the People, History and Customs of the Maldive Archipelago* (1935). (W. H. Is.)

MALDON, a market town, municipal borough and port of Essex, Eng., lies on the south side of the Blackwater estuary, 10 mi. E. of Chelmsford by road. Pop. (1961) 10,509. Finds of prehistoric objects indicate early settlement, and the Anglo-Saxon Chronicle relates that Edward the Elder established a "burg" there in 916. In 991 it was the site of a battle fought by Brihtnoth, ealdorman of Essex, against Danish marauders who were victorious. The incident is commemorated in an Old English poem, *The Battle of Maldon*. It remained a royal town up to the reign of Henry I and thus is entered as being on *terra regis* in Domesday Book. Henry II granted the burgesses their first charter in 1171. Of many later charters, that granted by James II (1686) vested the chief authority in a mayor. The present charter dates from 1810. All Saints church stands on top of the hill and has a unique 13th-century triangular tower; in the churchyard is buried Laurence Washington, great-great-grandfather of George Washington, who was rector of Purleigh, nearby, from 1633 to 1643. Maldon was probably the birthplace (*c.* 1727) of Horatio Gates, the American general. The moot hall, or d'Arcy tower, was built in the reign of Henry VI and was presented to the town in 1440 by Sir Robert d'Arcy. The Plume library, left to the town by Thomas Plume, archdeacon of Rochester, at his death in 1704, contains rare books and manuscripts; he erected the present brick building to house it. The grammar school was founded in 1608. Maldon has many summer visitors and there is yachting on the Blackwater. There are foundries, timber and flour mills, an oyster fishery and some shipping.

Beeleigh abbey (1 mi. W.), a Premonstratensian foundation of *c.* 1180, is a 16th-century residence in which the chapter house and fragments of 13th- and 15th-century date are incorporated.

MALDONADO, a department on the Atlantic coast of Uruguay, is best known for Punta del Este, a fashionable ocean resort area, one of many that dot the long coast line of the department. In the interior of Maldonado, ranching and agriculture are the principal activities. Sheep and cattle are raised, and the major crops include sugar beets, sunflower seeds, forage crops and wheat. Maldonado has a population (1962 est.) of 83,900, of whom about 15,900 (1962 est.) live in the capital, Maldonado. The area of the department is 1,587 sq.mi. (M. I. V.)

MALEBRANCHE, NICOLAS (1638–1715), French Cartesian philosopher whose work was to complete René Descartes's dualistic doctrine of mind and matter in a way compatible with Catholic theology under Augustinian and Neoplatonic influences, was born in Paris on Aug. 6, 1638, the youngest child of Nicolas Malebranche, secretary to Louis XIII, and of Catherine de Lauzon. He suffered all his life from malformation of the spine. At the age of 16 he entered the Collège de La Marche, but with the philosophy there, as with the theology later studied at the Sorbonne, he was profoundly dissatisfied. In 1660 he joined the Congregation of the Oratory, where Augustinian and Cartesian influences were then current.

A chance reading of Descartes's *De Homine* in 1664 determined Malebranche's vocation. The idea and application of "a universal mechanics" in that work fired his imagination, and "the joy of becoming acquainted with so many discoveries caused such palpitations of the heart that he was obliged to stop reading in order to recover his breath." From that moment Malebranche systematically studied mathematics, physics and the writings of Descartes who, he declared, "had discovered in thirty years more truths than all other philosophers together." The first two volumes of his principal work, *De la Recherche de la vérité, où l'on traite de la nature de l'esprit de l'homme et de l'usage qu'il en doit faire pour éviter l'erreur dans les sciences,* appeared in 1674 and in 1675; this work, revised and much enlarged (vol. iii appeared in 1678), passed through six editions during his lifetime and, in a Latin version, became famous throughout Europe. Antoine Arnauld, however, among others, questioned much of its theology, so Malebranche amplified and explained himself in his *Traité de la nature et de la grâce* (1680). A protracted and acrimonious controversy ensued and Arnauld, in his counter-reply *Traité des vraies et des fausses idées* (1683), attacked incisively much of what was essential and distinctive in Malebranche's metaphysics. After issuing a *Réponse* in 1684, Malebranche in 1688 published his *Entretiens sur la métaphysique et sur la religion,* wherein he resumes his philosophy in 14 dialogues of masterly composition, taking into account points previously contested. This is the best and a highly readable introduction to his system.

Besides further polemical writing, Malebranche conducted researches into the nature of light and colour, the foundations of the infinitesimal calculus and the psychological conditions of vision. His book *Des loix de la communication des mouvements* (1692) and the *Réflexions sur la lumière et les couleurs et sur la génération du feu* secured for him election to the Académie des Sciences

in 1699. Malebranche died on Oct. 13, 1715, exhausted by four months of great suffering.

Malebranche's prose is justly praised for its lucidity and grace: Voltaire recommended it as a model of philosophical exposition. The *Méditations chrétiennes* (1683), the *Traité de morale* (1683; modern ed. by H. Joly, 1939) and the *Entretien d'un philosophe chrétien et d'un philosophe chinois . . .* (1708) deserve mention as well as the writings already cited. There are collected editions of Malebranche's works by Jules Simon (1842; 1853–59; and 1871), by D. Roustan and P. Schrecker (1928–) and by A. Robinet, *et al.* (1958–); and there is an edition of his correspondence with J. J. Dortous de Mairan by J. Moreau (1947). Modern editions of individual texts include those of *De la Recherche de la vérité* by G. Lewis (1945), of the *Entretiens sur la métaphysique et sur la religion* by A. Cuvillier (1948) and of the *Traité de la nature et de la grâce* by G. Dreyfus (1958). There is also an English translation of the *Entretiens* of 1688 by M. Ginsberg (1923).

METAPHYSICS

Accepting many of the essential principles of Descartes, Malebranche sought to correct and to supplement the deficiencies of Cartesianism (*see* DESCARTES, RENÉ; also BODY AND MIND) and to harmonize it with the main contentions and spirit of St. Augustine's teaching. Descartes had already hesitantly foreshadowed and inconsistently applied a form of occasionalism (*q.v.*) which, completely developed by Malebranche, formed the ontological basis of the latter's famous epistemological doctrine that "we see all things in God."

All changes, whether of bodies (motions or alterations) or of minds (successive thoughts or volitions), are directly due, not as popularly supposed to those bodies or minds themselves, but to God. For a body at rest cannot set itself in motion or move another, since it is possessed only of extensity and shape, and these cannot determine in what direction or with what velocity it shall move. But if it is to move, it must be in one and no other direction and with a determinate velocity that it does so. Neither can a body exist at a moment unless it exists in one determinate place and at determinate distances from other bodies; therefore its rest in the place where it is, or its motion if it be moving, must have been imparted to it by God in creating it. Further, the continuance in existence of that created body can be only a successive re-creation of it: it exists only so long as God wills to conserve it. But on each occasion of its re-creation it must be re-created somewhere: if re-created in the same place it is said to remain "at rest"; if at successively different places, to be "moving." Thus the motions and rests of all bodies at all times are directly due to God—"impact" of one body on another being but the occasion upon which God "moves" that other (*i.e.*, re-creates it in a different place). What we commonly designate "causes" are not causes but merely "occasions" on which the efficacy of divine volition is modified, and all uniformities and regularities in the course of natural change and productivity are but expressions of the general rules habitually followed by divine volition.

The inability of bodies and minds to interact is simply a special case of the impossibility of interaction between created things in general. Minds are not causally dependent on our bodies; we could have been created without bodies yet having thoughts in succession. All created things—minds, bodies both animate and inanimate—are of themselves inert, wholly dependent upon God. Powerless too are "our" volitions (for they are not truly ours): when we will something, God, in certain circumstances, wills the same; but the effect follows from his, not from our, volition. Our sensory experiences have only a pragmatic value, warning us of harm or of benefit that may accrue to our bodies; they are false witnesses to the real natures of the things perceived. What we customarily regard as sensible qualities of perceived things are not qualities characterizing them independently, or at all; they are "sensations" or momentary modifications of our minds caused by God. Were we not embodied there would be no sensations or sensible qualities to appear deceptively as inherent in things.

Since minds are unextended and without locality, their modifications must be so too; hence sensory qualities (since Malebranche identifies them with sensations) cannot truly pervade or qualify bodies or their surfaces. As with Descartes, bodies possess no sensible characters. Indeed, bodies themselves are not "visible," says Malebranche (*i.e.*, never directly cognized or cognizable). What is directly cognized and mistaken for a body itself is really an idea representative of it, these ideas alone being the immediate objects, timeless and necessary, of our processes of temporal perceiving and thinking. Such idea-objects depend on us not for their existence but only for their being intermittently thought, and our greater or lesser attention to them accounts for the clarity or obscurity with which we know them. Being eternal, these idea-objects need no cause; being archetypes, they constitute together, in independence of our minds, that immutable, hierarchical order which is the divine reason and which God eternally contemplates.

All our ideas of various bodies are contained eternally in the one archetypal idea of the essence of matter which Malebranche calls "intelligible extension" (*i.e.*, infinite space as conceived in pure geometry and as being infinitely divisible into all possible shaped-extensities). Thus God's mind or reason contains ideas of all truths that we can ever discover; and "to see all things in God" is to be immediately aware of ideas that represent them. In this sense God is "the place of spirits just as space is the place of bodies." And not only do we see all things in God but God sees all things in himself, for these archetypal ideas are objects of his eternal contemplation as of our momentary perceptions. God's creation of bodies therefore comes to mean his actualization of certain (only) of the infinite number of possible shaped-extensities implicitly present in intelligible extension. So the vast variety of different determinate shapes present in our clear ideas of actual bodies is contained eternally in intelligible space, much in the same way, Malebranche says, as various statues are implicitly contained in blocks of unwrought stone. This unlimited possibility of creating countless bodies variously extended and differently shaped constitutes God's "immensity" or omnipresence; namely, that perfection or attribute of God of which "infinite intelligible extension" is the clear idea and an immediate object of his contemplation.

There is likewise an archetypal idea of mind. This too is an object of divine contemplation, as is the idea of intelligible extension; but it differs from the latter in that it is not also an object of human contemplation. Particular minds are implicitly contained in the one as are particular bodies in the other. Malebranche here reverses Descartes's conclusion that our clearest and surest cognition is that of our selves and that our knowledge of existent bodies, though clear, is only inferential and problematical. According to Malebranche we do not directly perceive our self by itself, and neither clear idea nor knowledge of its nature is attainable. Only of its existence have we assurance, and this is a "feeling" (*sentiment intérieur*). Thus can I know *that* I am but not *what* I am. Neither can other selves be known to us directly or by representative idea: we can but conjecture their existence by inference from analogy.

Descartes had also maintained that whereas knowledge of our nature and existence was an immediate certainty, undeniable and indubitable, the existence of God was assured to us only mediately —by demonstration. Malebranche conversely affirms God's existence to be an immediate certainty needing no demonstration, but our own nature to be completely unknowable. God's nature cannot be known as other natures are, for there is no representative idea, archetypal or other, of God: his infinite essence, comprehending the perfections of all things, is incomprehensible by us. But from this infinite perfection we may deduce some of the divine attributes, though these will be understandable only equivocally and imperfectly. Here Malebranche is confronted with the difficulty of explaining how, if God's mind be essentially a changeless hierarchy of quasi-Platonic "ideas" constituting the orders of truth, wisdom and righteousness, he can be said to possess knowledge and volition. For even if God's knowing be timeless contemplation and not successively active, can divine volitions be so too? How can intervention which "alters" and "produces," thus ever changing the face of nature, issue from what is itself immutable?

From this and connected perplexities Malebranche fails in the end satisfactorily to extricate himself.

Berkeley's idealism owes much to Malebranche and is essentially a synthesis of his philosophy with that of Locke, as Malebranche's was a synthesis of Descartes's with St. Augustine's.

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MALENKOV, GEORGI MAKSIMILIANOVICH (1902–), Soviet Communist leader, a close collaborator of Stalin and premier from March 1953 to Feb. 1955, was born of middle-class parents on Jan. 8, 1902, at Orenburg, in Russia. He was still at school when the Bolshevik revolution took place, and in 1919 joined the Red army. In 1920 he joined the Communist party and toward the end of the civil war was political commissar of the Bolshevik forces in Turkistan. In 1921 he resumed his studies, at the Moscow higher technical college, from which he received a diploma in 1925. He had been in charge of the Communist organization in the college, and when he left he was appointed immediately to a position in the central committee of the Communist party, where he came into direct contact with Stalin. He became a member of Stalin's personal secretariat and in 1932 was put in charge of it. From 1930 to 1934 he was in charge of the organization bureau of the Moscow party organization; and in 1934 he entered the organization bureau of the All-Union Communist party. In this capacity he played an important role in the elimination of Stalin's opponents from the party through the "purges" of the 1930s. At the 18th congress of the Communist party (1939) he was elected to the central committee and to membership both of the Orgburo (organization bureau) and of the secretariat. In Feb. 1941 he was made a candidate member of the Politburo. After the German invasion of the U.S.S.R. in 1941 he was appointed to the small state defense committee and was responsible for aircraft production. For his work in this field he was later made a Hero of Socialist Labour.

In March 1946 Malenkov became a full member of the Politburo, second secretary of the central committee and a deputy prime minister and was regarded as one of the small group of Stalin's closest collaborators. In 1947 he attended, along with A. A. Zhdanov, the meeting that founded the Cominform organization in Poland. At the 19th congress of the Communist party in Oct. 1952 he made the principal report in Stalin's place.

On Stalin's death in 1953 Malenkov was made chairman of the council of ministers (March 15) and retained briefly his position in the party secretariat. But he was soon replaced there by N. S. Khrushchev and he remained only a member of the party presidium. He thus lost control of the party apparatus, by means of which he had built his position in the Soviet state. His influence waned steadily in the ensuing conflicts. On Feb. 8, 1955, he was forced to resign from the premiership and to confess his responsibility for the unsatisfactory state of Soviet agriculture. He was appointed to a minor ministerial post, in charge of electric stations. At the central committee meeting in June 1957, at which the conflict between Khrushchev and the opposition to him came to a head, Malenkov was denounced as one of the "anti-party group" and expelled from the central committee and its presidium. This appeared to mark the end of his political career. He was reported to have been put in charge of a power station at Ust-Kamenogorsk, but he did not appear in public. (D. Fd.)

MALESHERBES, CHRÉTIEN GUILLAUME DE LAMOIGNON DE (1721–1794), French administrator and statesman respected for his policy of tolerance in the last decades of the *ancien régime*, was born in Paris on Dec. 6, 1721, the son of the future chancellor Guillaume de Lamoignon (*see* LAMOIGNON). He became a counselor in the Paris *parlement* in 1744 and premier president of the *cour des aides* in 1750. In the same year his father, then chancellor of France, made him *directeur de la librairie* or head of the press censorship. In this function (till 1768), Malesherbes gave effective protection to the *philosophes* of the Enlightenment. He made it possible for the *Encyclopédie* to continue to appear and to circulate in France works that had been printed abroad in order to evade the censorship.

An opponent of the chancellor René de Maupeou's *coup d'état* against the Paris *parlement* (1771), Malesherbes was exiled to his lands at Ste. Lucie, near Pithiviers. When the *parlement* was restored under Louis XVI (1774) he resumed his presidency of the *cour des aides* till he became secretary of state for the royal household (July 1775). This latter appointment made him responsible for the police, for ecclesiastical affairs and for a considerable part of the government of Paris and of the provinces, as well as for the household's concerns. He gave disinterested, but hardly energetic, support to Turgot's reforming activities, devoted himself to prison reform and did much to control the misuse of *lettres de cachet;* but he failed to win the king's support for many projects and resigned in April 1776.

A member of the Académie des Sciences from 1750, of the Académie des Inscriptions from 1759 and of the Académie Française from 1775, Malesherbes divided the following years between travel in Switzerland, Germany and Holland, literary and botanical studies and campaigning for the recognition of the civil status of Protestants. He also produced a memorandum for the king on the political and economic situation. He was readmitted to the king's council in 1787–88, but without any secretaryship of state.

During the Revolution, Malesherbes emerged from retirement (Dec. 1792) to offer his services to Louis XVI, on trial before the Convention. He assisted François Denis Tronchet and Raymond de Sèze in the defense and broke the news of the verdict to Louis. Himself arrested in Dec. 1793 and condemned by the Revolutionary tribunal for counterrevolutionary activities, he was guillotined with his daughter and grandchildren, on April 22, 1794. Posthumous publications of his writings are *Mémoire pour Louis XVI* (1794), *Observations sur l'histoire naturelle de Buffon* (1796), *Mémoires sur la librairie* and *La Liberté de la presse* (1809).

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MALET, CLAUDE FRANÇOIS DE (1754–1812), French general who conspired against Napoleon, was born at Dôle in Franche-Comté on June 28, 1754, of a noble family. He joined the king's musketeers in 1771 but retired from military service on their dissolution in 1775. When the French Revolution broke out, his republican opinions alienated him from his family, and in 1791 he rejoined the army. Although he had held staff posts behind the lines and had been in action only once (Sept. 1793), he was promoted general after the crisis of Aug. 1799, when Gen. J. E. Championnet, organizing defenses in the Alps, had no one else to send to the Little St. Bernard pass. Napoleon gave him appointments in France and, from 1805, in Italy; but in May 1808, having been found guilty of contraband dealing, Malet was pensioned. He thereupon began to associate with malcontents in Paris and was soon arrested; but from July 1810 he was allowed to live under surveillance in a private house in Paris. On Oct. 23, 1812, during Napoleon's absence in Russia, Malet left this house, obtained his uniform and announced at the barracks of the 2nd Paris guard that Napoleon had died and that he, Malet, was commandant of Paris for the provisional government. His story was accepted, and with a guards' escort he seized offices and released from prison two generals, the Provençal Maximilien Guidal and J. V. Moreau's friend Victor Fanneau de Lahorie. They arrested Savary, the minister of police. Malet went to the governor of Paris, Gen. Pierre Hulin, and shot him, but was himself seized by Col. Pierre Doucet. A court-martial condemned him and he was shot in Paris on Oct. 29, 1812. (I. D. E.)

MALEVICH (MALEVITCH), **KAZIMIR** (CASIMIR) (1878–1935), Russian painter, the founder of abstract painting, was born in Kiev on Nov. 2, 1878. In his early work he followed Impressionism as well as Fauvism and after 1910 was influenced by Picasso and Cubism. In 1913 Malevich started to follow his own

line of painting by creating abstract geometrical patterns in a manner he called Suprematism. From 1919 to 1921 he taught painting in Moscow and Leningrad. In 1926 he visited the Bauhaus in Weimar, met Wassily Kandinsky and published a book on his theory under the title *Die gegenstandslose Welt* ("The Non-objective World"). Malevich first exhibited in the U.S. in 1924. When Russian politicians decided against modern art, Malevich and his art were doomed. He died in poverty and oblivion in Leningrad in 1935.

Malevich was the first to exhibit paintings composed of abstract geometrical elements; Piet Mondrian and Theo van Doesburg were influenced by him. One of his best-known paintings, "White Square on a White Background," is owned by the Museum of Modern Art, New York city; a number of other paintings are in the Stedelijk Museum in Amsterdam.

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MALFEASANCE, the doing of an illegal or unauthorized act by a public officer in the discharge of his official duties. Malfeasance is distinguished from misfeasance, the doing of a lawful or authorized act in a negligent or unlawful manner (*e.g.*, the exercise of a lawful discretion with corrupt or improper motive), and nonfeasance, the omission or refusal of a public officer to perform a legally imposed duty.

All three brands of official misconduct were indictable offenses at common law and were grounds for removal from office. Under modern statutes the definitions of official misconduct vary greatly. In some the terms malfeasance and misfeasance are used without qualifiers and made grounds for removal (*e.g.*, Virginia code, sec. 15–500).

Under such a provision it has been held that it is not necessary to show corrupt or evil motive. It is usual, however, to define misconduct in more restricted terms, especially where criminal penalties are added to removal from office (*e.g.*, Illinois code, ch. 38). (J. D. Ls.)

MALGACHE, RÉPUBLIQUE: *see* MALAGASY REPUBLIC.

MALHERBE, FRANÇOIS DE (1555–1628), French poet who described himself as "*un excellent arrangeur de syllabes*" but who was a greater poet than his reputation as a verse technician would seem to imply, was born at or near Caen in 1555. His father, a lawyer of ancient but impoverished nobility, had Protestant sympathies and the son received a Protestant education at Caen and Paris, and later at the universities of Basel (1571) and Heidelberg (1573). He was soon converted to a lukewarm Catholicism. His earliest surviving poems, in the style of the Pléiade (*q.v.*), date from 1575.

In 1577 he went to Provence as secretary to the governor, Henri d'Angoulême. There in 1581 he married Madeleine de Coriolis, the daughter of the principal judge of the *parlement* of Aix. In 1586 he returned to Normandy. His first published poem, *Les Larmes de saint Pierre*, a florid imitation of Luigi Tansillo's *Lagrime di San Pietro*, appeared in 1587. A second period in Provence began in 1595 and proved decisive in the forming of Malherbe's character and genius, mainly through his friendship with two great lawyers of Aix, the Stoic philosopher Guillaume du Vair and the polymath Nicholas Claude Fabri de Peiresc. In 1600 an ode to the new queen, Marie de Médicis, made his name more widely known.

It was in 1605 that Malherbe, now 50, went to Paris, supported by his friends Peiresc, Du Vair and Cardinal du Perron (*qq.v.*). Henry IV was not greatly interested in poetry nor notably generous, but Malherbe soon attained the position of court poet and a modest living from court patronage. In his lodgings in the rue Croix-des-Petits-Champs he gathered a group of disciples, of whom Racan and François Maynard (*qq.v.*) are the best known, and much of his critical influence was exercised in the form of sharp verbal thrusts, some of them preserved in Racan's life of him and in the pages devoted to him in Tallemant des Réaux's *Historiettes*. In 1626 his son Marc Antoine was killed in an affray and the loss affected him deeply. In pursuit of justice he followed Louis XIII to La Rochelle and there, it seems, contracted the illness from which he died in Paris on Oct. 6, 1628.

Malherbe's prose writings consist of translations of Livy and Seneca, possibly suggested by Du Vair and illustrating his stoical temper; about 200 letters to Peiresc, of interest for their picture of court life; and the commentary on Philippe Desportes. Malherbe's marginal annotations on his copy of the works of the older poet (edited by F. Brunot, 1891; see *Bibliography*). These notes are detailed and entirely negative, fastening critically on minute points of workmanship. Nevertheless, certain positive principles emerge by implication: verbal harmony, propriety, intelligibility (loose syntax, dialectal expressions, obscure mythological allusions, mixed or extravagant metaphors are all condemned), above all the conception of the poet as craftsman rather than prophet.

Malherbe's own poetic work, which is not voluminous, may be divided into state poems; religious verse (*Les Larmes de saint Pierre* and a few Psalms); consolations (in which Malherbe specialized); love poems; and occasional verses. The first group bulks largest and in his mature period Malherbe appears as a poet laureate, a composer of official odes and panegyrics. He greets Marie de Médicis on her arrival in France, praises the military exploits of kings or ministers or writes love poems for courtiers. His main weakness lies in poverty of imagination: he wrote little and very slowly, his ideas, images and rhymes are repeated from one poem to another. But there is compensation for this painful labour in the dignity and even grandeur of his best poems. They offer little to the lover of the ingenious but give satisfaction through their harmony and monumental strength:

> La terre en tous endroits produira toutes choses;
> Tous métaux seront or, toutes fleurs seront roses,
> Tous arbres oliviers.
> ("Récit d'un Berger," ll. 67–69)

This is what Baudelaire meant when he spoke of "*un vers de Malherbe, symétrique et carré de mélodie.*" (*Curiosités Esthétiques:* Pléiade ed. by Y.-G. Le Dantec, p. 865).

Malherbe's influence on French poetry was profound. However, it must be remembered that his classical reforms were to some extent anticipated by Jean Bertaut, Du Perron and even Desportes himself, and that the general evolution of poetry is reflected in his own work, which is not all of a piece. But in essentials French verse retained the characteristics stamped on it by Malherbe up to the Romantic period and beyond.

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MALI, REPUBLIC OF (RÉPUBLIQUE DU MALI), is a landlocked republic in west Africa, until 1958 known as French Sudan (Soudan Français). It is bounded north by Algeria, west by Mauritania, Senegal and Guinea, south by Ivory Coast and Upper Volta and east by Niger. Pop. (1960 est.) 4,100,000 including 7,000 Europeans. Area 464,873 sq.mi. (1,204,021 sq.km.).

Physical Features.—The republic covers much of the southern Sahara, with the vast plains of the Tanezrouft and Taoudenni in the north and those of Meriyé and Azaouak in the south. The only marked relief is in the east, where the Adrar des Iforas rises in rounded granites and ruiniform heights to about 2,000 ft. above the neighbouring plains. This region is more moist and has pastures which allow the Tuareg to raise cattle. In the south the Sahara gives place to the Sahel, where the annual rainfall is 4–8 in. and lasts regularly for two months. The dunes are covered with cram-cram (*Cenchrus biflorus*), mimosa, clusters of doumpalms (*Hyphaene thebaica*) and palmyra (*Borassus flabelifer*). In this region is the great bend of the Niger river. In the west this forms

the immense interior delta of the Macina, where branches spread and communicate in time of flood with isolated lakes such as Faguibine and Débo. The district is partially inundated in time of flood, which in January reaches the vicinity of Tombouctou (Timbuktu).

Only toward Gao in the east does the Niger valley contract. In the Sahel are shepherds, including Tuareg and Moors who seek dry-season pastures and Fulani (Peul) who move their herds from the river to the dry plains. Cultivators include the Sarakolé (Soninke) in the west and the Songhai, who grow millet and rice along the Niger; river fishing is done by the Bozo and Somono (Bambara). Where the annual rainfall exceeds 20 in. and lasts longer than three months the Sahel gives way to savanna, which covers all the southern part of the republic. It extends over wide plains of alluvium or laterites covering ferruginous beds, dominated by plateaus of Primary sandstone. The Mandingo plateau between upper Senegal and the Niger continues eastward toward Upper Volta and northeast along the right bank of the Niger through the Dogon plateaus and Bandiagara cliffs and the knolls extending them to Hombori. The main axis of the savanna zone is still the Niger and its right-bank affluent, the Bani. But the inhabitants are also distributed between the rivers, with peasants on the plateau escarpments (the Dogon and Bambara in the northern plains) and the Mandingo more to the south; Fulani populations have settled among them.

The climate is tropical and there is no real winter. The dry season (November to April) is marked by the hot, dust-laden wind known as the harmattan. Wildlife includes lions, hippopotamuses and antelopes. (J. D.)

The People.—The most important ethnic group, numbering about 1,200,000, is that of the peoples speaking Mandingo dialects. Of these, the Malinké and Dioula are Muslims and the Bambara are mostly pagans. Other groups such as the Sarakolé and Bozo speak languages derived from Mandingo and are also Muslims. The Dogon of the Bandiagara escarpment, the Senufo and the Sikasso practise paganism with a great variety of myths and ceremonies. The Songhai, Muslims living along the Niger, speak a most peculiar language. Some of the inhabitants from neighbouring republics (the Tukulor or Toucouleur of Senegal and the Mossi peoples and Bobode of Upper Volta) have spread into Mali. All these peoples are Negroes and essentially agriculturalists, dwelling in the southern zone or on the banks of the Niger. Millets are the principal crop and cattle and sheep are bred. Among these peoples are artisan castes (smiths, woodworkers, leatherworkers, potters) and a caste of *griots* or magicians. The Dioula are merchants and are found in all regions; the Bozo and some of the Songhai groups are exclusively fishermen.

The Fulani are all stockbreeders, occupying various territories in the semiarid steppes. Originally fair-skinned, having dwelt in the desert in prehistoric times, they are now much cross-bred. They share their language with the Tukulor. Most of them are Muslims and the rest pagans.

The desert zone is inhabited by two peoples of white race, occasionally somewhat crossbred: the Tuareg and the Moors. Both groups are Muslim and subsist by nomadic stockbreeding of cattle and camels. The Tuareg in the northeast speak a Berber dialect and their Islamic creed is mixed with paganism; they have spread south of the Niger. The Moors speak Arabic; Muslim brotherhoods play an important part in their lives. Most of the Moors in this part of Africa live in Mauritania, but the Kounta and Berabish tribes live as nomads in Mali north of Tombouctou.

It is estimated that 63% of the republic's population are Muslims, 36% are animists and 1% profess Christianity. (*See* separate articles on the principal groups or tribes.)

History.—Evidence of prehistoric habitation of the Malian Sahara is furnished by Paleolithic and Neolithic remains and by rock paintings and carvings. The "Asselar man," the earliest human fossil with Negroid features, was discovered in 1927 about 250 mi. N. of Tombouctou. Elsewhere in Mali have been found Mousterian remains, raised stones of the Neolithic period and, along the Niger, numerous traces of protohistoric civilizations.

From the early middle ages caravan routes between the bend of the Niger and Morocco and southern Algeria carried ivory, gum, ostrich feathers, slaves and gold. Around the starting points of these routes were founded the Sarakolé empire of Ghana (8th–13th centuries) between the Niger and Senegal rivers, and the Mandingo empire of Mali (13th–16th centuries, from which the republic derives its name), on the upper and middle Niger. (*See* AFRICA: *History: Sahara and Sudan: Empires of Mali and Gao.*) In the 15th century the Songhai in the Tombouctou-Gao region gained their independence and spread their rule over much of the country extending eastward to the Hausa kingdoms. The Songhai power was in 1591 broken by the Moroccan army of Ahmed IV al-Mansur, and Tombouctou remained under the Moors for another two centuries. Thereafter, the Niger valley was divided between the Tuareg in the region of Gao, the Fulani in Macina and the Bambara in the kingdom of Ségou.

PAUL CONKLIN—PIX FROM PUBLIX

GOUNDAM, ONE OF THE LARGEST CITIES IN THE MID-NIGER BASIN, REPUBLIC OF MALI. IT CHIEFLY TRADES IN GUM AND HIDES

The 19th century was marked by the resurgence of Islam and by the French conquest from Senegal. Between 1848 and 1864 Omar el-Hadj absorbed the Bambara and Fulani kingdoms; his son Ahmadou reigned at Ségou. The French had occupied upper Senegal, and in 1881–83, Col. Gustav Borgnis-Debordes seized Kita and built a fort at Bamako. Later, Col. J. S. Gallieni compelled Ahmadou and Samory to accept a French protectorate.

Under Gallieni's successor, Col. Louis Archinard, the struggle was resumed. Between 1888 and 1893, Ségou was captured, Ahmadou put to flight and Samory driven back to the Ivory Coast. In Dec. 1893, Lieut. H. G. M. Boiteux occupied Tombouctou with a flotilla. The Tuareg massacred the column under Col. T. P. E. Bonnier advancing to reinforce Boiteux, but the situation was saved by Col. (later Marshal) J. J. C. Joffre. In 1899 French trading posts were established at Gao and downstream of it. The southern Sahara was pacified by *meharists* ("camel companies"). The capture of Sikasso in 1898 completed the conquest of the country, which as French Sudan became a territory of French West Africa. The territory was divided into *cercles* ("districts") in which civilian administrators gradually replaced military officers. The Sudanese —particularly the Bambara—provided contingents of sharpshooters called Sénégalais who played a leading part in the French colonial wars. Road and rail communications were established and in 1925 the first automobile crossing of the Sahara was made.

In 1946 French Sudan became an overseas territory of the French Union and was given a territorial assembly, followed in 1957 by an elected government. As the Sudanese Republic (Soudan) the country was proclaimed an autonomous state of the French Community on Nov. 24, 1958. In the following year it joined with Senegal to form the Mali Federation, which was dissolved in Aug. 1960. In September the country was proclaimed as an independent republic. French troops in 1961 evacuated their bases, and although Mali remained outside the French Community, agreements were made providing for French technical and cultural assistance. Agreements relating to trade, loans or aid were also made with the United States, the U.S.S.R., the People's Republic of China and Czechoslovakia. In July 1961 Mali joined Ghana

and Guinea in the Union of African States, designed to foster friendship and co-operation and to provide mutual assistance in the event of aggression. In Jan. 1963 Mali signed a mutual assistance treaty with Ivory Coast and in May became a founder-member of the Organization of African Unity. Frontier agreements with Mauritania also were signed and better relations with Senegal were established. (Hu. De.)

Administration.—The Sept. 1960 constitution describes the Republic of Mali as being "indivisible, democratic, secular and social." Legislative power rests with a national assembly elected for five years by direct universal suffrage. The president, who is the head of state, is vested with executive power. He is designated by the assembly for five years and chooses his council of ministers, which includes the premier. In the 1959 election the Union Soudenaise party won all 80 seats in the assembly. French is the official language.

Mali's judicial system was being reorganized in the 1960s. There are three tribunals of first instance, at Bamako, Kayes and Ségou; eight courts of the peace with broad jurisdiction, at Gao, Mopti, Sikasso, Tombouctou, Bougouni, Koutiala, Nioro and San; and also courts of the peace with limited powers and ordinary police courts, destined to disappear under the reorganization. The court of appeal for penal, civil and commercial cases is at Bamako.

In the early 1960s there were more than 350 primary schools with about 55,000 pupils, 13 secondary schools with 2,500 students and 4 technical schools with an enrollment exceeding 1,000. In Bamako there are the Islamic Research institute, a veterinary school, a leprosy and trachoma institute and a national trade school (for training African artisans, especially in gold, silver, leather and ivory work).

Economy.—The savanna zone is the most active. Its wealth derives from the cultivation of food crops (millets, rice) along the river and from herding. Progress has been made in agricultural techniques and controlled agriculture, with cassia trees planted to regulate rice cultivation along the river. The Office du Niger was established by the French administration to utilize the Macina downstream of Ségou, with a dam at Sansanding to raise the level so that water may be directed into canals on the left bank. There, more than 30,000 peasants have been settled to grow rice and, in a small way, cotton on 52,000 ha. of irrigated land; but results have not always reached expectations. Together with cotton and peanuts, Mali exports foodstuffs (rice, meat, fish) to neighbouring countries. Livestock, which includes about 3,125,000 cattle and 12,000,000 sheep and goats, is the main resource. Some animals are exported to Senegal, Ghana and Ivory Coast, while leather and hides are exported to France. Supplies of Mali rice have enabled Senegal to do without rice from the far east. There is a caravan trade in salt, which is exploited around Taoudenni.

Although manganese and bauxite exist in quantity, deposits remain unexploited because of their remote location in the interior. Mali's inland situation also explains the importance of communications with its neighbours. It is linked with Senegal and Dakar by the metre-gauge Dakar-Niger railway, which is continually under improvement and reaches the Niger at Bamako, and by a metaled road parallel to the railway for most of its length. Upstream of Bamako the Niger is navigable as far as Kouroussa in Guinea; downstream it winds past the Sotuba rapids, reaching at Kulikoro a stretch that can be navigated to Kabara, the port of Tombouctou (Timbuktu; *q.v.*), and beyond Gao. The road system has been improved and is extended by the trans-Saharan track between Gao and Colomb-Béchar, Alg. Radio Mali at Bamako broadcasts in French and Bambara.

Bamako (*q.v.*), the capital, serves as a great redistribution market, particularly for cola nuts. Kayes has an active trade in livestock to Senegal. The other towns are also markets; some, like Djenné, of diminishing importance, others favoured by their situation on or near rivers (such as Tombouctou, Mopti, Ségou and San), or on roads (Sikasso), or on both (Gao). Scheduled air services link Bamako with Dakar, Senegal, and with the main centres in Ivory Coast.

After brief membership (May–June 1962) in the West African Monetary union, Mali withdrew but remained in the franc area.

See also references under "Mali, Republic of" in the Index. Current history and statistics are summarized annually in *Britannica Book of the Year*. (J. D.)

MALI FEDERATION, a short-lived union between the autonomous territories of the Sudanese Republic and Senegal in west Africa. The federation took effect on April 4, 1959, achieved complete independence on June 20, 1960 (remaining within the French Community), and was dissolved by Senegal's secession on Aug. 20, 1960. Thereafter both countries became independent republics, Senegal continuing within the French Community and the Sudanese Republic becoming the Republic of Mali. *See* Mali, Republic of; Senegal, Republic of. (Hu. De.)

MALIK IBN ANAS (*c.* 715–795), Muslim jurist, whose work laid the foundations for one of the four orthodox schools of Islamic law, the Malikite, which now predominates in north and west Africa and in Upper Egypt. He lived most of his life in Medina where he studied jurisprudence under Rabi'a ibn Farrukh. Rising to a position of eminence in Medina, he gave support to the rebellion of Mohammed ibn 'Abd Allah against the caliph al-Mansur in 762 by declaring in a *fatwa* (a formal legal opinion given by a jurist of standing) that the allegiance pledged to al-Mansur was not binding, because it had been given under compulsion. After the failure of Mohammed's rebellion, Malik was punished by flogging but subsequently regained the favour of the caliphs as indicated by the visit of the celebrated Harun al-Rashid during the latter's pilgrimage to Medina in 795. Malik died in the same year and was buried at al-Baqi'.

Malik is known chiefly for his composition of the *Kitab al-Muwatta'* ("Book of the Leveled Path"), one of the earliest surviving lawbooks. In his work he attempted to survey and systematize Islamic law according to the consensus prevailing in Medina and to provide principles for the resolution of disputed points. He gave precedence to the Medinian practices and traditions over the more generally prevailing traditions and exercised independent judgment in cases in which there was no clear guide. His main contribution, however, was systematization rather than personal interpretation. *See* also Islamic Law. (H. B. Pa.)

MALIK SHAH (1055–1092), third and most famous of the Seljuk sultans (*see* Seljuks), was born on Aug. 6 or 16, 1055. He succeeded his father, Alp Arslan, in 1073 under the tutelage of the great vizier Nizam al-Mulk (*q.v.*), who was the real manager of the empire until his death. Malik Shah had first to overcome a revolt of his uncle Qavurt (Kavurd) and an attack of the Qarakhanids of central Asia on Khurasan; thereafter he consolidated and extended his empire more through diplomacy and the quarrels of his enemies than by actual warfare. He suppressed the former vassal principalities of upper Mesopotamia and Azerbaijan, acquired Syria and Palestine, and established a strong protectorate over the Qarakhanids of Bukhara and a measure of control over Mecca and Medina, Yemen and the Persian gulf territories. His control of the Turkmens of Asia Minor was contested by a rival Seljuk dynasty.

With the encouragement of Nizam al-Mulk, Malik Shah displayed a great interest in literature, science and art. His reign is memorable for the splendid mosques of his capital Isfahan, for the poetry of Omar Khayyam and the reform of the calendar. His people enjoyed the blessings of internal peace and religious tolerance.

There were however shadows amidst this glory. His brother Takash, governor of Khurasan, revolted and was imprisoned and blinded. Under the leadership of Hasan ibn al-Sabbah there arose the antiorthodox terrorist movement of the Assassins who murdered Nizam al-Mulk in 1092. Before this he was partly estranged from his vizier who favoured the claims to succession of Malik Shah's eldest son by his first wife against those of a son by his second wife, Turkan Khatun. Further, his relations deteriorated with the caliph of Baghdad who had married his daughter and neglected her. He had ordered the caliph to leave Baghdad when he himself died there suddenly in Nov. 1092. After his death his empire quickly disintegrated through internal quarrels. (Cl. Ca.)

MALINES: *see* Mechelen.

MALINKE, a west African people (known also as the MANDINGO proper) occupying parts of Guinea, Ivory Coast, Mali, Senegal, Gambia and Portuguese Guinea. Their population in the 1960s was estimated at 1,500,000, of whom about one-fifth are Muslims. They are sedentary farmers and cattle herders, with millet as their main food. Politically they are divided into numerous independent states ruled by hereditary kings (*mansa*). One of these, the king of Kangaba (in modern times a small town on the upper Niger river), represents one of the world's most ancient dynasties still in power, a dynasty which has ruled for 13 centuries with a single interruption of 15 years (1285–1300). Beginning in the 7th century A.D. as the centre of a small state, Kangaba became the capital of the great Malinke empire known as Mali (Melle). This was the most powerful and most renowned of all the empires of the western Sudan, indeed the largest of African empires, now memorialized in the name of the Republic of Mali.

In the 11th century the king of Kangaba was converted to Islam and made a pilgrimage to Mecca, establishing new trading relations. Thereafter his mines became the principal source of gold for the Moroccan caravans which had formerly traded with ancient Ghana, and Mali's growth began. Mansa Musa, who ruled from 1200 to 1218, made four pilgrimages to Mecca. Musa's grandson, Mari Djata, conquered the Susu (*q.v.*) in 1235 and destroyed the capital of Ghana in 1240. Each king in turn made a pilgrimage to Mecca and enlarged the empire, including a serf, Sakura, who usurped the throne (1285–1300) and conquered Jenne and the Tukulor.

The most celebrated pilgrimage was that of the greatest Malinke king, Mansa Gongo-Musa, which aroused great interest at Cairo and Mecca in 1324. Malinke chroniclers record that his caravan included 60,000 persons and his camels carried 12 tons of gold. Gongo-Musa added Timbuktu and Gao to his realms, bringing Mali to the height of its power. In 1332, in the reign of Mansa Suleiman, the capital was visited by Ibn Batutah (*q.v.*), who described its wealth, pomp and extent. During the 14th century Mali controlled much of the Sahara and most of the Sudan west of Gao. It declined during the 15th century as the Songhai empire expanded, and was conquered by Songhai in the war of 1501–13. *See* also MANDINGO; MALI, REPUBLIC OF.

See *West African Directory* (published annually). (WI. B.)

MALINOWSKI, BRONISLAW KASPER (1884–1942), Polish-born British anthropologist, one of the leading figures in the development of modern social anthropology, was born on April 7, 1884, in Cracow. Attracted to anthropology by Sir James G. Frazer's *The Golden Bough,* he studied at the University of Cracow (Ph.D., 1908), Leipzig university and the London School of Economics, where he successively became lecturer, reader and first professor (1927–42) of social anthropology. His analyses of Melanesian society, based upon four years of field work in the Trobriand Islands and northwest Melanesia (1914–18), set a standard of depth and comprehensiveness that revolutionized field research and gained him a world-wide reputation. His functional approach to the study of societies, which he saw as integrated systems of institutions subserving basic and derived needs, drew into the discussion of anthropological theory specialists in a wide range of human studies from law to psychology, and did much to obtain a secure position for anthropology in British university curriculums. He also was a pioneer in applied anthropology, and many of the British advances in colonial administration stemmed from the inspiration he gave scholars and administrators from Africa and Asia. His talent attracted to his seminars almost all the leading British specialists of the first half of the 20th century. His contributions to *Encyclopædia Britannica* include MARRIAGE, PRIMITIVE. From 1939 until his death at New Haven, Conn., on May 16, 1942, Malinowski was visiting professor of anthropology at Yale university.

His studies include *The Family Among the Australian Aborigines* (1913); *Argonauts of the Western Pacific* (1922); *Sex and Repression in Savage Society* (1927); *Coral Gardens and Their Magic,* 2 vol. (1935); *The Foundations of Faith and Morals* (1936); works which were published posthumously include *A Scientific Theory of Culture* (1944); *The Dynamics of Culture Change* (1945); *Magic, Science and Religion* (1948); *Freedom and Civilization* (1960).

See also references under "Malinowski, Bronislaw Kasper" in the Index.

See M. Gluckman, *Analysis of the Sociological Theories of B. Malinowski* (1949); and P. Murdock, "Bronislaw Malinowski," *Amer. Anthrop.,* vol. xlv (1942), with bibliography. (H. N. C. S.)

MALIPIERO, GIAN FRANCESCO (1882–), Italian composer, born in Venice on March 18, 1882. He studied harmony at the Vienna conservatory in 1898 and later composition at Venice and Bologna under Enrico Bossi. In 1921, after a journey to Paris where he was influenced by contemporary French music, he was appointed professor of composition at Parma conservatory. Subsequently he became director of the Istituto Musicale Pollini at Padua and in 1939 director of the Liceo Marcello in Venice. With Alfredo Casella he played a leading part in Italian music in the 1920s. Rebelling against the principles of *verismo,* the realistic aesthetic that inspired Puccini, he rediscovered the qualities of Italian preromantic music. His work reflects the spirit of 17th- and 18th-century Venetian music and his operas, inspired by Claudio Monteverdi, represent a fusion of modern and archaic styles. His instrumental music avoids both development of themes and contrapuntal elaboration.

His most important stage works include *L'Orfeide* (1918–22), *Torneo notturno* (1929), *I capricci di Callot* (1941–42) and *Venere prigioniera* (Florence, 1957). His symphonic music includes symphonies, the three sets of orchestral pieces entitled *Impressioni dal vero* (1910–22), and the *Pause del silenzio* (1917). Among his chamber works are seven string quartets and works for various instrumental groups. Between 1926 and 1942 he published the complete works of Monteverdi (16 vol.) and later collaborated in the collected edition of the works of Vivaldi.

See M. Bontempelli, *Gian Francesco Malipiero* (1942); G. M. Gatti, *L'Opera di Gian Francesco Malipiero* (1952).

MALLARMÉ, STÉPHANE (1842–1898), French poet, the leader and greatest poet of the Symbolist movement (*see* SYMBOLISTS), was born in Paris on March 18, 1842. Educated at Passy and the Lycée de Sens (renamed Lycée Mallarmé in 1961), he passed his *baccalauréat* in Nov. 1860. His family traditionally registered and taxed real estate transactions; he preferred teaching, but his passion was for poetry. To perfect his English, he went to London in Nov. 1862 with Maria Gerhard, a German governess he had met in Sens. After many channel crossings and much heart searching, they were married at the Brompton oratory, London, on Aug. 10, 1863. They had two children, Geneviève (1864–1919) and Anatole (1871–79). In Sept. 1863 Mallarmé qualified as a teacher of English: but he never obtained a *licence* or doctorate. His career, though a long martyrdom, was reasonably successful: he taught in Tournon (1863–66); Besançon (1866–67); Avignon (1867–70); and in various Parisian *lycées,* Fontanes-Condorcet (1871–84), Janson-de-Sailly (1884–85) and the Collège Rollin (1885–93). He revisited England in 1871, 1872 and 1875. In 1875–76, through Arthur O'Shaughnessy (*q.v.*), a friend and admirer of the Symbolist poets, he contributed anonymously to the London *Athenaeum.* His many English friends and correspondents included Swinburne. His cottage at Valvins, a village on the Seine near Fontainebleau, became his favourite holiday haunt from 1874 and, after his retirement in Jan. 1894, his main residence. He enjoyed sailing on the river and loved the autumnal splendour of the forest. From about 1880 he held in his tiny Paris flat his famous Tuesday receptions, the *"Mardis de la rue de Rome,"* attended by André Gide, Paul Claudel and Paul Valéry, and by the Symbolist poets Henri de Régnier, Gustave Kahn, Francis Vielé Griffin and Stuart Merrill. Like Baudelaire, Mallarmé loved all the arts, especially painting, music and ballet. He defended Édouard Manet (*q.v.*) against the hostility of his critics: Manet painted his portrait and illustrated his work, and Manet's model, Méry Laurent, inspired some of Mallarmé's most exquisite poems. Later Whistler was his friend, and Mallarmé translated his *Ten o'Clock* (1888). From 1885, Mallarmé attended the Concerts Lamoureux and wrote for Édouard Dujardin's *Revue*

Wagnérienne. In 1890 he toured Belgium, delivering a noble funeral oration on his friend Villiers de l'Isle Adam (*q.v.*); in 1894 he lectured in Oxford and Cambridge on music and letters. In 1896 he was elected prince of poets in succession to Verlaine. He died, aged only 56, at Valvins on Sept. 9, 1898.

Works.—Mallarmé began writing poetry early. In 1859–60 he wrote a group of 55 poems entitled "Entre quatre murs" (of which 40 were first published in 1954): they imitate Lamartine, Musset and Hugo. He also compiled a vast anthology, including 9 poems by Edgar Allan Poe and 29 from *Les Fleurs du Mal* by Baudelaire, who decisively influenced Mallarmé's first truly creative phase. This culminated in 11 poems published in the *Parnasse contemporain* of 1866, edited by Catulle Mendès. Mallarmé described these as "intuitive revelations of [his] temperament"; the clash between the ideal and the real is expressed with great intensity and subtlety by means of the Baudelairean technique of *correspondances* between sensations, emotions and ideas. A severe crisis followed. Mallarmé's religious faith faded before "the terrible light of Science." But he soon found a new and enduring faith: "Beauty alone exists, and it has only one perfect expression, Poetry." He planned a great book which would embody in symbolic form his vision of the evolution of beauty through innocence and experience to a serene synthesis. His poem *Hérodiade*, begun in 1864, before the crisis, was to be its "overture." A dialogue between Hérodiade and her earth-bound nurse appeared in the second *Parnasse contemporain* in 1871: the untamed virgin with her massive golden hair, her great mirror and her fierce quest of inviolable purity, is evoked in language of incomparable harmony and splendour, dominated by images of jewels, of ice and snow, and chill, glittering stars. In complete contrast stands Mallarmé's other poetic masterpiece, *L'Après-midi d'un faune*, begun in 1865, rejected in 1875 by the editors of the third *Parnasse contemporain*, and published in 1876 by Mallarmé in a sumptuous rare edition illustrated by Manet. In the shimmering heat of a drowsy summer afternoon a young faun recreates his vision of two nymphs, one fair, blue-eyed and chaste, the other dark and sensual, who had escaped from his embrace. The poem exemplifies in verse of extreme musicality the power of art to evoke, by means of sublimated reminiscences, the ideal essence of fleeting phenomena. It inspired Debussy (*q.v.*) to write the work called after it (1894). In the *Toast funèbre* (1873), commemorating Théophile Gautier, and the enigmatic *Prose pour des Esseintes* (1885), poetry is extolled, in flower symbolism of great beauty, as the means of recreating Eden. In 1887 Mallarmé "published" his *Poésies* in a photolithographic facsimile of his manuscript, limited to 40 copies. Thenceforward, apart from a number of adamantine sonnets, he wrote comparatively little serious poetry, but much charmingly witty and frivolous light verse, including postal addresses in the form of quatrains, later collected in the *Vers de circonstance* (1920).

Mallarmé wrote some exquisite poems in prose, first published in *La Revue des lettres et des arts* (1867–68). "Les Poèmes d'Edgar Poe" first appeared in *La Renaissance artistique et littéraire* (1872) and *La République des lettres* (1876–77): they were later (1888) published by Edmond Deman of Brussels, a man after Mallarmé's own heart, who also brought out the prose volume *Pages* (1891) and the posthumous *Poésies* (1899). In 1874 Mallarmé produced singlehanded eight numbers of the fashion review, *La Dernière Mode*, in which he first tried out his highly original prose style, further developed in his preface to William Beckford's *Vathek* (1876). *Les Mots anglais* (1877) is a curious study of English vocabulary, exploring connections between the sound and sense of words. *Les Dieux antiques* (1880), adapted from several works by George W. Cox, interprets all myths as solar phenomena. Mallarmé contributed to *La Revue indépendante* (1885–88), W. E. Henley's *National Observer* (1892–93) and *La Revue blanche* (1894–97). After the anthology *Vers et prose* (1893), with a portrait by Whistler as frontispiece, he published in 1897 his collected prose under the title *Divagations*. The same year saw his poem "Un Coup de Dés" published in the review *Cosmopolis;* it is a bold experiment in typography, in which various interlocking themes are set out in types of different size. It is not the great work planned in 1866, nor even part of it: on the eve of his death Mallarmé ordered the destruction of his notes in terms implying that the work proper remained to be begun. His swan song was the beautiful "Cantique de saint Jean" (first published in the posthumous *Poésies* of 1913): the saint proclaims the triumphal liberation of his spirit by death.

Status as Poet and Critic.—Mallarmé has steadily risen to a high place in the history of French poetry. His life was one of exemplary dedication to his art and for many of his contemporaries he was the incarnation of the ideal poet. His poems are few, but they have a musical perfection that makes them immediately and enduringly memorable, while their magic density constitutes a challenge to find meanings worthy of their form—a condition too often overlooked by his commentators. His critical theories have exercised a deep and lasting influence. He distinguishes among the different functions of language and rejects narration, description and instruction as proper tasks for poetry, whose primary role he sees as the imaginative creation of metaphorical relationships. He insists that poetry should recapture from music the art of evocation and suggestion while retaining its own supremacy as the intelligible "word." His correspondence reveals his exquisite courtesy, his delicate wit and irony, his genius for friendship, his generosity toward his fellow artists and the central position he held in the literary and artistic life of Paris.

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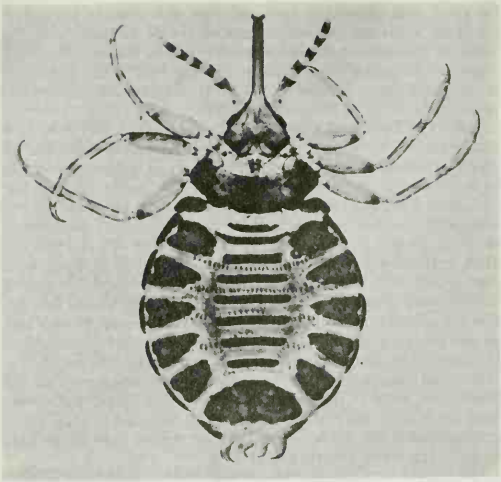
MALLEABLE CAST IRON: *see* CAST IRON.

MALLECO, an inland province of southern Chile in latitude 38° 15′ S.; area 5,442 sq.mi.; pop. (1960) 174,300, of whom several thousand are Araucanian (Mapuche) Indians. Malleco was created out of Arauco province in 1887, absorbed by Bío-Bío and Cautín provinces in 1927 and then formed again in 1937. The province embraces coastal range, central valley and cordilleran terrain. The cordilleran ridges and volcanoes (Tolguaca, Lonquimay and Llaima), forests, lakes and hot springs (Tolguaca, Río Blanco and Manzanares) are prime attractions for summer vacationers. However, recreation is of secondary economic importance to farming, stock raising and lumbering. The processing industries, based upon agricultural and forest products, are centred in the provincial capital, Angol (pop. [1960] 18,637) and in the lesser administrative and commercial centres of Victoria, Traiguén, Curacautín and Collipulli. The main north-south railway, and its branches, and seasonal roads serve these communities. (J. T.)

MALLOPHAGA, an order of insects comprising the biting or chewing lice; minute, wingless forms parasitic on birds and mammals. They are sometimes treated as a suborder along with Anoplura, the sucking lice, to form the order Phthiraptera. About 2,800 species are recorded, with many more, especially among the bird lice, still undescribed. Their life cycle is spent on the feathers or hair of the host, though one genus lives in the throat pouches of pelicans and cormorants.

The eggs, attached to the feathers or hairs, or occasionally laid inside quill feathers, give rise to young which pass through three nymphal stages which resemble the adult. A single bird or mammal species may be parasitized by one or more (sometimes as many as 15) species of biting lice. They often show host-specificity, being unable to survive on any but their own or a related host. Their present distribution suggests that they became parasitic at



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ELEPHANT LOUSE (HAEMATOMYZUS ELEPHANTIS)

an early stage in the evolution of their hosts and evolved with them so that, with some exceptions due to subsequent transference having taken place, related hosts are parasitized by related biting lice; a particular genus may be restricted to one group of birds, and a particular species may be found on only one species of bird or on a group of related species.

Biting lice on birds feed on feathers or feathers and blood, the blood sometimes being taken from the shafts of the developing feathers; some live on blood alone and their normal chewing mandibles may then be adapted to piercing the skin. Probably all species of birds have biting lice. Preening keeps down the numbers, and birds with damaged bills are often particularly heavily infested because they cannot preen themselves properly. Normally, lice do no damage, but if they are too numerous the irritation may cause the bird to damage itself by scratching and may even interfere with egg production and fattening in poultry.

Biting lice parasitic on mammals feed on skin secretions and skin debris; it is uncertain whether they eat hair. They are less widespread than those of birds, comprising fewer genera and species, and occur on marsupials, primates, rodents, land carnivores, hyraxes and ungulates. The elephant louse, *Haematomyzus,* if of questionable affinity, is usually considered to belong to the Mallophaga. *See* LOUSE.

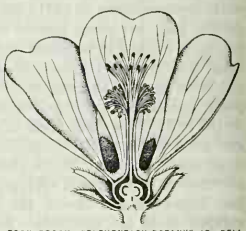
See M. Rothschild and T. Clay, *Fleas, Flukes and Cuckoos,* 3rd ed. (1957). (T. CL.)

MALLOW (MALA), a town, urban district, rail and road junction of County Cork, Republic of Ireland, lies astride the Blackwater river, 149 mi. S.W. of Dublin and 22 mi. N. of Cork by road. Pop. (1961) 5,545. The ford was defended by a castle built by the Desmonds, the ruins of which remain in Castle park. Mallow received a charter of incorporation from James I, and in the 19th century it was a popular spa and was known as "the Bath of Ireland." The medicinal spring is still there, but the spa house is no longer used. Thomas Osborne Davis, the poet, and William O'Brien, Irish patriot, were born in Mallow. The town is the market centre for a rich agricultural region and has factories for mineral waters (soft drinks) and condensed milk, cornmills and tanneries, and there is a large sugar-beet factory to the west. Mallow is also known as an angling and hunting centre, and it has a racecourse.

MALLOW, any plant of the family Malvaceae, especially of the genera *Hibiscus* and *Malva,* the latter embracing about 30 species of annual and perennial herbs, widely distributed throughout the northern hemisphere, some of which are cultivated in the garden. The mallows possess the kidney-shaped one-celled anthers that characterize the Malvaceae (*q.v.*). The petals also are united by their base to the tube formed by the coalesced filaments of the stamens. The special characters that separate the genus *Malva* from others most nearly allied to it are the involucre, consisting of a row of three separate bracts attached to the lower part of the true calyx, and the numerous single-seeded carpels disposed in a circle around a central axis, from which they become detached when ripe. The flowers are mostly white or pinkish, never yellow, the leaves radiate-veined and more or less lobed or cut.

The common mallow (*Malva sylvestris*), the *mauve* of the French, is an erect biennial or perennial plant with long-stalked roundish-angular serrate leaves, and conspicuously axillary reddish-purple flowers, blossoming from May to September. Like most plants of the order it abounds in mucilage, and hence forms a favourite domestic remedy for colds and sore throats. The aniline dye called mauve derives its name from its resemblance to the colour of this plant. Besides the foregoing, three other species have become naturalized in various parts of North America.

Three species are found in Britain. The musk mallow (*Malva moschata*) is a perennial herb with five-partite, deeply cut leaves and large rose-coloured flowers clustered together at the ends of the branched stems and is found growing along hedges and borders of fields, blossoming in July and August. It owes its name to a slight musky odour diffused by the plant in warm dry weather when it is kept in a confined situation. The round-leaved dwarf mallow (*Malva neglecta*) is a creeping perennial growing in waste sandy places, with roundish serrate leaves and small pinkish-white flowers produced in the axils of the leaves from June to September. It is common throughout Europe and the north of Africa, extending to western and northern Asia.



FROM GROOM, "ELEMENTARY BOTANY" (G. BELL AND SONS)

VERTICAL SECTION OF COMMON MALLOW (MALVA SYLVESTRIS) FLOWER

The marsh mallow (*Althaea officinalis*), the *guimauve* of the French, belongs to the same genus as the hollyhock (*q.v.*). (For rose mallow, *see* HIBISCUS.) The mallow of Scriptures (Job xxx, 4) has sometimes been identified with Jew's mallow (*Corchorus olitorius*), a member of the allied family Tiliaceae, but more plausibly with *Atriplex halimus,* the sea orache of Europe. Once widely used in medicine, mallows are no longer considered of value.

MALMÉDY, a small town acquired by Belgium from Germany through the treaty of Versailles, 1919. It lies in a deep basin on the Warche, 20 mi. S. of Aachen, Federal Republic of Germany, by rail via Eupen. *See* EUPEN-ET-MALMÉDY.

MALMESBURY, JAMES HOWARD HARRIS, 3RD EARL OF (1807–1889), English statesman, was born on March 25, 1807, in London, and educated at Eton and at Oriel college, Oxford. Member of parliament for Wilton in 1841, when he succeeded to the title, Malmesbury first became prominent after the Conservative split over the corn laws in 1846. He was a staunch old-fashioned Tory and active supporter of Lord Stanley, later Lord Derby, under whom he served as foreign secretary in 1852 and 1858–59. Despite his lack of experience, Malmesbury, who was naturally pacific and dubious of Palmerstonian methods, proved adequate to a difficult task. Francophile through inclination and his acquaintance with Napoleon III, he concentrated upon improving Anglo-French relations. He was the first to recognize the establishment of the Second Empire; over the Italian question he attempted, with little success, to combine neutrality, tempered by a preference for the Habsburg position, with benevolence toward France. Though never holding executive office again, Malmesbury remained a respected and influential figure in Conservative circles. From 1866 to 1868 and from 1874 to 1876, he was lord privy seal; he died on May 17, 1889, at Heron Court, Hampshire.

Malmesbury's political career owed much to his friendship with

Derby, and to the paucity of talent in his party after the secession of the Peelites. Cosmopolitan in his tastes and connections, his extensive if casual knowledge of European problems and personalities was his main qualification for the foreign office, although his performance there surprised the critics. In 1884 he published his *Memoirs of an Ex-Minister,* a valuable source for a crucial period in the history of the Conservative party. (A. F. T.)

MALMESBURY, a market town and municipal borough (1885) of Wiltshire, Eng., 22 mi. N.E. of Bath by road, stands on a ridge between the Salisbury Avon and its tributary, the Inglebourne. Pop. (1961) 2,610. Maildulf or Maelduib, a Scottish or Irish monk, built a hermitage near the site of the modern Malmesbury about 635. This formed the nucleus of the later abbey, of which Aldhelm, his pupil, became the first abbot. Aethelstan, who was buried there, rebuilt and endowed the monastery, and there William of Malmesbury (*q.v.*) was brought up from childhood. A Benedictine abbey church was built on this site in the 12th century and part of it, restored in 1928 by Sir Harold Brakspear, is now the parish church. The nave is transitional Norman and Decorated and the south porch is Norman. At the time of the Dissolution, the abbey and its lands were bought by a rich clothier. The abbey church was fitted with looms for weaving, and later presented to the townspeople to replace their decaying parish church. All that remains of the latter is the tower which contains the town clock and the abbey bells. In the market square stands a fine market cross of the 16th century, borne upon an octagonal battlemented basement. The 13th-century hospital of St. John of Jerusalem survives as fragments in a corporation almshouse.

The town grew up round the abbey and at the time of the Domesday survey it was one of the only two boroughs in Wiltshire. The building of a castle by Henry I (pulled down in the 13th century) gave further impetus to the growth of the town. Following earlier charters, the first charter of incorporation was granted in 1635. The borough returned two members to parliament from 1295 to 1832 and one member from then until 1885. Thomas Hobbes, the philosopher, was born in Malmesbury in 1588. From the middle ages to the 1750s the town possessed a considerable cloth manufacture, and silk industries flourished during the 19th century. It now has an agricultural trade and firms making electronic, radar and striplighting equipment.

The churchyard at Garsdon village, 2 mi. E., contains the graves of some of George Washington's ancestors.

MALMÖ, a seaport and industrial city of Sweden, capital of the *län* (county) of Malmöhus, is located on the Sound, 26 km. (16 mi.) E.S.E. of Copenhagen, Den. Pop. (1960) 228,878. In Stortorget, in the centre of the city, stands the town hall, the oldest parts of which date back to 1546. Nearby is the residence of the provincial governor, originally built in 1730. Stortorget also contains an equestrian statue of Charles X Gustavus, who captured Skåne, Halland and Blekinge (the southernmost part of Sweden) from Denmark. The old main street of the town, lined with historic buildings, leads to the Malmöhus, a 16th-century castle and fortress, now a museum. St. Peter's, Malmö's oldest church, dates from the early 14th century and is a beautiful example of early Baltic Gothic. Malmö has a modern municipal theatre, opened in 1944, and one of Sweden's largest town libraries. Folkets park is the oldest amusement park in the country. During the 1950s and early 1960s considerable building was done in Malmö, chiefly of blocks of flats.

Malmö is an important traffic junction. From it, trunk rail lines lead to Stockholm, Göteborg and, via train ferry from Trelleborg, to the rest of Europe. There is a lively passenger traffic between Malmö and Copenhagen by boat and ferry across the Sound. The city has a busy harbour with a free port. Chief imports include coal, fuel oil, metals and chemicals; principal exports are grain, fodder, sugar, cement and clay. There is an international airport at Bulltofta. The city has a diversified industry including shipbuilding, manufacture of rail freight cars, textiles, clothing and cement, and food processing.

The name "Malmö," derived from *malm,* "sand," and *högar,* "hills," is mentioned in the 12th century. During the late middle ages the city was an important centre of the herring fishery, and it experienced a period of greatness during the 16th century, when it played an important part in northern European politics and in the Reformation. It suffered an economic decline following its union with Sweden in 1658. With the building of the harbour in 1775 its fortunes revived, and from the middle of the 19th century it developed rapidly as an industrial and transportation centre. (L. LJ.)

MALMÖHUS, the southernmost *län* (county) of Sweden, which, with Copenhagen (Den.), controls the Sound. Area 4,865 sq.km. (1,878 sq.mi.). Pop. (1960) 625,667. It extends for 108 km. (67 mi.) north-south and 90 km. (56 mi.) east-west. Faulting has produced a gentle relief, trending northwest-southeast; the highest point is Kläggerödshöjden (610 ft.). The fault-formed coast has few harbours. The only Swedish coal field is behind Hälsingborg, but the coal is poor. Malmöhus is the principal Swedish sugar-beet area. Industrial activity includes textile mills, cement works, shipbuilding, manufacture of margarine and brewing.

A ship canal traverses the Falsterbo peninsula. Malmö (*q.v.*), a free port from 1922, is capital of the *län* and the third city of Sweden. Trelleborg is Sweden's southernmost port. (A. C. O'D.)

MALNUTRITION. Maintenance of proper nutrition (*q.v.*) depends primarily on the provision of appropriate quantities of all the nutrients. Wrong proportions among these quantities result in a condition of malnutrition; an insufficient total amount of nutrients results in undernutrition, of which condition the extreme degree is starvation. Malnutrition also may be caused by impaired physiology as, for example, in certain diseases, even though the dietary intake may be adequate. Such malnutrition, usually called conditioned malnutrition, is a problem of clinical medicine and will not be discussed in this article.

Various meanings have been applied to the word malnutrition. While its literal meaning is "faulty or imperfect nutrition," the word is frequently used only to describe deficiencies. Malnutrition may also result, however, from excessive food intake. This is particularly evident in the case of excessive consumption of calories, but there is also reason to suppose that excessive consumption of carbohydrates and fats, quite apart from calories, may produce various forms of malnutrition. Obesity, the result of this type of unsatisfactory nutrition, is associated with much ill-health and in severe cases with a greatly increased mortality rate. In this review the word malnutrition will be used in its literal meaning and will be applied to conditions caused by deficiencies and excesses in the supplies of nutrients.

Detecting Malnutrition.—Various types of evidence indicate malnutrition. Presumptive or suggestive evidence includes vital statistics (growth rates, maternal mortality, infant mortality, etc.) and statistics of national available food supplies. Statistics, however, have many serious limitations as diagnostic evidence. Vital statistics, for example, reflect the collective effects of disease, environment and many factors of which nutrition is only one.

Indirect evidence must be supplemented by more specific information from nutrition surveys. The basic method is clinical appraisal combined with dietary surveys. Simple laboratory tests may usefully supplement the basic method. Clinical assessment includes a general inspection and a detailed inspection. The former includes the appearance of health, intelligence and vitality or their opposites conveyed to the mind of the examiner. The detailed examination includes inspection of the eyes, skin, mucous membranes, bones and subcutaneous deposits of fat. These body areas are those most likely to manifest evidences of undernutrition, deficiency disease and obesity.

DISORDERS OF MALNUTRITION

Nutrition surveys have revealed alarming evidence of malnutrition, the problems varying in different parts of the world. In underdeveloped areas the deficiencies, such as undernutrition, protein malnutrition, anemia, nutritional disorders of the eye and beriberi, are predominant. In regions in which food supplies are abundant and economic levels high, overnutrition is the main problem.

Deficiency States

A nutritional deficiency may be caused by anything that diminishes the availability of a nutrient or nutrients to the tissues. Thus, although adequate amounts may be eaten, there may be a failure of the body tissues to absorb nutrients, or over-rapid excretion may occur. Deficiency states are frequently multiple, hence the clinical picture is often complex.

General Undernutrition or Chronic Partial Starvation.—In places where, or in times when, food is scarce, cases of starvation occur because of insufficiency but not entire lack of food. Diets are predominantly rich in carbohydrates and deficient in most of the other nutrients. Further, coarse and unfamiliar food may be eaten, causing indigestion and diarrhea. The clinical symptoms presented by the afflicted vary with the nature of the food available. The commonest disturbances are low basal metabolic rate, slow pulse, lowered blood pressure, suppression of menses in women, dry, coarse, cold skin, bloodshot eyes, insomnia and fractures from osteoporotic changes in the bones. Nutritional edema, burning sensations in the feet and hands and sore mouth with increased salivation are common symptoms in chronic starvation. Classification of the possible degrees of undernutrition is given in the table.

Degrees of Undernutrition

State of undernutrition	Weight loss (% underweight)	Effect on functions and characteristics
Slight	10	No serious functional deterioration
Moderate	10–20	Substantial change, but condition often compatible with light or moderate work
Severe	20–30	Profound changes—may be able to do light work but condition is potentially serious
Extreme	more than 30	Patient grossly abnormal—rarely capable of any useful work
Very extreme	50	Severe and often fatal

The simplest way of treating starvation is to get the patient to take easily digested, highly nutritious food. The first to be given should be skimmed milk and well-strained vegetable and meat soups; glucose should be added to the milk. As soon as the patient is able to digest these, the diet can be gradually expanded to include whole milk, lean meat, fish, vegetables and fruits.

Protein Malnutrition.—Protein deficiency is widespread in many parts of the world, particularly in the tropics. Kwashiorkor, a form of protein malnutrition commonly occurring in infants and young children who have been fed on a diet low in protein and composed mainly of foods rich in carbohydrates, has been recognized in many parts of the world, particularly in Africa, India, Indonesia, southeast Asia and Central and Latin America. The main characteristics are retarded growth and development, apathy and anorexia, edema, pellagroid skin lesions, alterations in skin and hair pigmentation, fatty liver and diarrhea. There may be signs of associated vitamin deficiency.

Protein malnutrition is found in a continuous range from the classical forms in which calories are adequate, even abundant, to those in which there have been a severe calorie deficit and considerable wasting. The latter type is often called marasmic kwashiorkor.

Treatment of patients suffering from protein malnutrition is essentially dietetic. The protein-rich diet may consist of a mixture of powdered skim milk and suitable forms of carbohydrate such as ripe bananas. As soon as the digestive function will permit, return should be made to a well-balanced normal diet suitable for the child's age, since milk alone will not satisfy calorie and other requirements. In areas where kwashiorkor is prevalent a long time would be required before adequate supplies of animal protein could be provided; hence, attention is focused upon improving the quality of protein of vegetable origin, as from soybeans, peanuts and legumes.

Nutrition and Anemia.—Anemia constitutes a public health problem of great magnitude, particularly in the underdeveloped and tropical areas of the world. Malnutrition underlies most of the anemias in these areas, affecting particularly expectant and nursing mothers, infants and young children. Deficiency anemias are classified as (1) deficiency in nutrients (iron and protein) necessary for the formation of hemoglobin (nutritional deficiency anemia); and (2) deficiency in such substances as folic acid and vitamin B_{12}, necessary for red cell formation. (*See* Anemia.)

Nutritional Deficiency Anemia.—The symptoms may be vague or concrete. The patient may complain only of unusual fatigue or a feeling that he is "run down." Nausea and vomiting, laboured breathing, headache and dizziness may develop after the anemia has continued for some time. The number of red cells may be low or near normal, but they are pale and small; the hemoglobin concentration is low. Anemia is corrected by supplements of iron, given as ferrous sulfate.

Pernicious Anemia.—This disease, due to a deficiency of vitamin B_{12}, usually occurs after the age of 40. Numbness and tingling of the hands, yellowing of the skin and a burning sensation in the mouth are the first signs. Diarrhea, loss of appetite, loss of weight and weakness also are common complaints. Later the patient begins to suffer from shortness of breath. Eventually, if given no treatment, the patient becomes exhausted and finally comatose. There is a marked decrease in the red blood cell count, and a number of immature blood cells appear in the blood. Other characteristic symptoms include a decrease in the hydrochloric acid of the stomach and disturbances of the central nervous system. An unexplained phenomenon is the periods of remission during which the patient becomes almost symptom-free. The diet for pernicious anemia is a normal diet that contributes to the patient's general nutrition, supplemented by vitamin B_{12}.

Vitamin A Deficiency.—Clinical signs and symptoms include night blindness, xerophthalmia (producing dry, dull eyeballs), softening of the cornea and dermatosis characterized by eruptive lesions of the hair follicles with keratinization. Each of these manifestations may occur alone or in combination with other signs and symptoms. Treatment is with daily supplements of vitamin A, which causes prompt regression of night blindness and xerophthalmia.

Riboflavin Deficiency.—This deficiency is prevalent throughout practically all the underdeveloped world, especially among infants and children in areas where other deficiency diseases are endemic. Manifestation of this deficiency involves the eyes, lips and skin. There is vascularization of the cornea, circumcorneal infection and, later, development of opacities. Angular lesions on the lips at the corners of the mouth (cheilosis) appear. The lesion of the skin is of the seborrheic type with flaking and greasiness over a reddened base. Milk and organ meats, the rich natural sources of riboflavin, should be prescribed but other water-soluble vitamins should be given as well.

Beriberi.—This is a chronic disease endemic among people who subsist almost entirely on polished rice. Though it may be due to multiple deficiencies, the most important is that of vitamin B_1 (thiamine). Three types of beriberi have been described: (1) dry, characterized by multiple peripheral neuritis with muscular atrophy; (2) wet, where edema is present; and (3) cardiac or acute, with cardiovascular changes. Manifestations of thiamine deficiency are loss of appetite, nausea, gastrointestinal disturbances, degenerative changes in heart muscle and multiple neuritis. Treatment consists in supplying thiamine daily by mouth or injection. (*See* Beriberi.).

Pellagra.—This chronic disease due to deficiency of niacin is found principally among maize-eating populations, who are particularly predisposed because the principal protein of maize, zein, lacks tryptophan, an amino acid the body can convert into niacin. The symptoms characteristically involve the skin, the gastrointestinal tract and the nervous system, forming the classical clinical triad of dermatitis, diarrhea and dementia. The skin lesions tend to appear bilaterally symmetrically on the areas of the body exposed to sunlight. Treatment consists in giving niacin daily in divided doses with supplements of yeast, liver by injection and thiamine and riboflavin to combat the deficiency of the other B vitamins. (*See* Pellagra.)

Other Deficiency Diseases.—The occurrence of other deficiency diseases is now relatively uncommon. These include scurvy, due to a lack of vitamin C (ascorbic acid); rickets (*q.v.*), a manifestation of vitamin D deficiency; goitre, due to iodine de-

ficiency; and hypovitaminosis K, which accounts for the occurrence of hemorrhagic disease of the newborn.

See also VITAMINS.

OVERNUTRITION

In most of the highly developed countries of the west, overweight in adults probably represents the commonest form of malnutrition. The prevalence of overweight and obesity is accompanied by increased mortality from a number of degenerative diseases, one of which is arteriosclerosis, a leading cause of death in many technically developed and well-fed countries (*see* ARTERIES, DISEASES OF).

The exact point at which obesity begins is difficult to define, but as a general rule a person is considered obese when the body weight increases by 20% above the average weight of healthy persons aged 25 and of the same height. This average weight at age 25 is termed desirable weight.

The immediate cause of obesity is the consumption of food providing calories in excess of energy requirements. However, there are multiple remote causes related to factors that cause an inappropriately positive calorie balance and eventually an inappropriately high body lipid content. The possible roles of genetic factors, hypothalamic lesions, hormonal disturbances and increased peripheral glucose utilization, which have afforded a means of study of obesity in experimental animals, do not seem to apply broadly in explaining the pathogenesis of obesity in man; obesity is generally regarded as a psychosomatic disorder of multiple cause featuring a disturbance in the mechanism that matches food intake to energy expenditure.

The most useful treatment for obesity is diet therapy—a reducing diet that should supply an intake of calories substantially less than an obese person's customary food intake (1,000 to 1,200 cal. per day) but that should contain at the same time adequate quantities of protein and the various nutrients. Exercise increases the energy requirement and stimulates basal metabolism and is, therefore, a special factor in the management of obesity. The psychological aspect is also particularly important; the pleasure of eating usually influences greatly the desire for food and may be seized upon to replace other satisfactions of living. An effort must be made to discover the cause of a person's emotional disturbance before demanding his co-operation in a reducing diet. Some substitute for the satisfaction obtained from food must be found.

CAUSES AND PREVENTION

There are a number of distinct causes of malnutrition, most of which are interrelated. The fundamental causes include agriculture, economics and social and cultural factors.

Only about one-third of the population of the world has an adequate available food supply. The areas in which deficiency diseases predominate are technically underdeveloped and agricultural yields are low. In certain countries the amount of arable land available per head of population is small. Where the population is dense, pressure on land available for cultivation is high. In many cases the growth of the population is outstripping the supply of food that can be produced at existing levels of agricultural development. In areas where such conditions obtain, the population must depend on consumption of direct products of the soil. Land must be devoted largely to such major staples as rice, maize, cassava, millets and wheat that give a high calorie yield per unit of area. Green and leafy vegetables, for example, are important "protective" foods, yet the calorie yield per acre is so low in comparison to that of the major staples that many parts of the world cannot afford to grow them.

Throughout the underdeveloped parts of the world, therefore, the diets of the people contain a predominance of cereals or tubers or both. Other foods, and particularly foods of animal origin, are included in the diet in relatively small amounts. Diets that contain so high a proportion of cereal are inevitably deficient in terms of modern standards of nutrient requirements, thus leading to malnutrition. Typically, adults seem to survive quite well on even these predominantly cereal diets; it is among the more vulnerable groups—infants, preschool children, pregnant and nursing women—that malnutrition first appears. Improvement in agricultural practices, in varieties of crops, in storage practices, in transportation and marketing arrangements are fundamental to prevention of malnutrition in these areas of the world.

Moreover, people in these areas usually depend for their existence almost entirely on agriculture in the broad sense of this term; industry on a large scale has not been developed. Economic levels, therefore, are low and people cannot afford to buy foods to supplement the staple cereal. Families that purchase their food must spend a high proportion of the family income—often 70% or more—in obtaining their present meagre and ill-balanced diet. Until their economic condition is improved, such families cannot afford to buy supplementary foods in sufficient quantity even when they are available. Another way in which poverty influences diet is in forcing small producers to sell more expensive protective foods of which they are themselves in need in order to be able to buy the staple foods and other essentials.

With poverty go illiteracy and ignorance, and in such circumstances the improvement of food habits through education is difficult. Social systems have important effects on food habits and nutritional problems. For example, it is common to find a system of priority within families that gives the father the first choice of available food; the mother comes second and the children last. Food taboos, unsound food beliefs and food practices are encountered: there are groups who have eggs but will not eat them, regarding egg eating as a sign of greed; the main and cheapest source of animal protein in some areas, dried fish, may be thought to cause worms and "bad eyes"; there are groups who believe that cow's milk is not a proper food for children; and in some communities the taking of milk by girls and especially by married women has powerful emotional connotations. Food habits also are affected by religion.

While awaiting the slow improvement in agriculture and economy, malnutrition can be alleviated by nutrition education. The fundamental aim of nutrition education should be to improve utilization of existing resources. Teaching and practical demonstration should aim at countering food taboos; increasing local production of food, use of appropriate methods of preserving foods, and selection of well-balanced low-cost diets composed of locally available foods; introducing methods for the preparation of food based upon good hygiene and sound nutritional principles; and preparing correct diets for infants and young children.

The predominantly cereal diets of many areas of the world also can be improved by enrichment with certain vitamins, minerals and certain amino acids such as lysine. In the past this was not feasible economically, but improvements in the production of many synthetic nutrients now make it possible. Thus, the protein of wheat and rice can be substantially improved by the addition of lysine, giving great promise for future decrease in protein malnutrition.

See also DIET AND DIETETICS; NUTRITION; OBESITY.

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MALOLOS, a municipality, capital of Bulacan province on Luzon Island, Phil., lies on a flat, poorly drained plain, about 20 mi. N.W. of Manila. During the revolution against the U.S. the insurgent congress met there and framed the "Malolos constitution," by virtue of which the constitutional Philippine republic was proclaimed on Jan. 23, 1899. The insurgent leader, Emilio Aguinaldo, established his headquarters in Malolos and it served as the insurgent capital until it was captured by U.S. forces in March 1899.

Malolos is an important trading centre in a heavy rice- and vegetable-producing region. Major fish-pond areas are located south and west of the administrative centre.

The municipality lies astride the main highway leading north

through the central plain northward from Manila and is also bisected by the rail line to the Lingayen gulf. Pop. (1960) 48,968.
(R. E. He.)

MALONE, EDMOND (1741–1812), Irish Shakespearean scholar and editor, a pioneer in the establishment of an authentic text and chronography of Shakespeare's works, was born in Dublin on Oct. 4, 1741. The son of a barrister, he was educated at a private school, at Trinity college, Dublin, and at the Inner Temple, which he entered in 1763. After visiting France and working in Ireland as lawyer and journalist, he settled in London in 1777. There his friends included Samuel Johnson, Sir Joshua Reynolds, whose works he collected and published (1797), Horace Walpole, Edmund Burke, George Canning and George Steevens. He helped James Boswell to revise the *Life of Samuel Johnson,* of which he himself edited and annotated four reissues.

Malone's "Attempt to ascertain the Order in which the Plays of Shakespeare were written" (1778) and his three supplemental volumes (1780–83) to the Johnson-Steevens edition of Shakespeare, containing the poems, apocryphal plays, additional notes and textual emendations, are landmarks in Shakespeare studies. His essay on the history of the Elizabethan stage was the first authoritative treatise on English drama. His own edition of Shakespeare, in 11 volumes, appeared in 1790. At the time of his death on April 25, 1812, he was working on a new octavo edition which was completed by James Boswell, son of the biographer, and published in 21 volumes, with a memoir of Malone, in 1821. Known as the *Third Variorum,* or "Boswell's Malone," it remained for over a century the standard complete edition. Although unimaginative in aesthetic criticism, Malone was immensely industrious and learned. His scrupulous scholarship is attested to by his edition of Dryden's prose works (1800), as well as by his work on Shakespeare. The zeal for truth displayed in his editing showed itself also in his denunciation (1782) of the Chatterton "Rowley" poems and (1796) of the Ireland Shakespeare forgeries (*see* Chatterton, Thomas; Ireland, William Henry).

See Sir James Prior, *Life of Edmond Malone* (1860). (Jo. C.)

MALONIC ACID crystallizes in large colourless plates, dissolving readily in water, alcohol or ether, and melts at 135.6° C. Although the sparingly soluble calcium malonate occurs in beetroot, the acid itself, $HO_2C{\cdot}CH_2{\cdot}CO_2H$, is generally produced by laboratory methods, such as the oxidation of malic acid or the hydrolysis of cyanoacetic acid, $CN{\cdot}CH_2{\cdot}CO_2H$. When carefully heated at 140°–150° C., malonic acid partly decomposes into acetic acid and water, but 10%–12% undergoes dehydration with formation of carbon suboxide, C_3O_2.

The outstanding importance of malonic acid in systematic chemistry arises from the varied syntheses which can be effected with its ethyl ester, diethyl malonate, commonly called malonic ester, $CH_2(CO_2C_2H_5)_2$. This ester, usually prepared by passing hydrogen chloride into a solution of cyanoacetic acid (obtained from chloroacetic acid) in absolute alcohol, is a colourless fragrant liquid boiling at 198° C. Its very reactive methylene group, CH_2, is instrumental in effecting syntheses of higher mono- and dibasic acids. The replacement of one hydrogen of this methylene group by sodium gives sodiomalonic ester; this on treatment with an alkyl iodide gives the ester of the corresponding alkyl malonic acid. In the presence of sodium ethoxide the esters of malonic acid and diethylmalonic acid undergo condensation with urea to furnish respectively barbituric and diethylbarbituric acids, the latter being the well-known soporific drug veronal (*see* Barbiturates). By a similar condensation with urea ethylphenylmalonic ester yields the drug phenobarbital.

MALORY, SIR THOMAS (d. 1471), English writer, author of the book known as *Morte Darthur,* the best-known prose account of the rise and fall of King Arthur and the fellowship of the Round Table, and the first in modern English. Even in the 16th century the identity of Malory was unknown, although a tradition associating his name with Maelor (a district in the county of Flint), and thus crediting him with Welsh connections, has persisted since the time of John Bale (1495–1563). In 1894 George L. Kittredge suggested that he was in fact Thomas Malory, knight, of Newbold Revell, in the parish of Monks Kirby, Warwickshire. Subsequent research has amply confirmed this hypothesis. According to Sir William Dugdale (1605–86), Malory of Newhold Revell served in the train of Richard Beauchamp, earl of Warwick, at Calais (presumably in 1436), was knight of the shire for Warwickshire in 1445 and died on March 14, 1471. The name Thomas Malory occurs in a list of knights who went with Edward IV on his expedition into Northumberland in Nov. 1462, and this may well be our Malory. Other reliable information from judicial records shows that he was accused of various offenses at different times, notably of a series of felonies (including rape, conspiracy to murder and armed assault on the Cistercian abbey of Coombe) in Warwickshire in 1450–51, horse stealing and planning to attack property in Essex in 1454. He was imprisoned on various occasions between 1451 and 1460 and committed to Newgate in 1460. In Aug. 1468 he was excluded from a general pardon. The colophon to William Caxton's edition of the *Morte Darthur* states that the book was "ended the ninth yere of the reygne of kyng edward the fourth [*i.e.*, March 4, 1469–March 3, 1470] by syr Thomas Maleoré, knyght" and adds a prayer for "good deliverance" (from prison), while the Winchester manuscript discovered in 1934 contains several references to the author's imprisonment. The Malory family had several branches and at least one other Thomas Malory appears in contemporary records, but it seems hardly possible that the "knight prisoner" of the Winchester manuscript can be any other than the unfortunate gentleman from Newbold Revell. That an energetic and reckless individual, living in a lawless age, should commit deeds of violence and at the same time take pleasure in retelling tales of a warlike king and his bold companions does not seem in any way improbable.

The Morte Darthur.—Malory's book was printed by William Caxton, who named it the *Morte Darthur,* in 1485, and reprinted by Wynkyn de Worde in 1498. Until the discovery by W. F. Oakeshott in 1934 of a late 15th-century manuscript in the fellows' library at Winchester college, no other 15th-century form of the text was known. The Winchester manuscript contains a much longer, and obviously more authentic, version of book v than does Caxton; the other significant differences between the two texts occur in *incipits,* colophons and rubrics. The monumental critical edition by Eugène Vinaver (1947) is based on the Winchester manuscript.

Sources.—Book v of the *Morte Darthur* is an adaptation of a 14th-century English poem, the alliterative *Morte Arthure.* The rest of the work consists almost wholly of material from the 13th-century French Arthurian prose romances (*see* Arthurian Legend). The narrative content of these is not fundamentally altered, but numerous changes in detail and Malory's free and vigorous stylistic treatment have produced a result much nearer to genuine creative writing than to translation. More than one-third of the work (books viii–xii) is taken up by Malory's translation of the first two-thirds of the prose *Tristan.* (*See* also Tristan.) This unwieldy work, an adventure romance containing a great wealth of incident and bringing in a whole host of characters, has no real connection with the story of Arthur, and does not fit into any consistent account of his reign. Leaving aside the prose *Tristan,* what remains is an account, in chronological sequence, of the great events of the Arthurian saga: the birth and early exploits of the king, the war with Rome, the coming of Galahad and the quest of the Holy Grail, Lancelot's adultery with Guinevere; the civil war that arises because of this, followed by the revolt of Mordred and the final battle on Salisbury plain in which Arthur receives his death wound. The source of book vii ("The Tale of Sir Gareth") is unknown, but it may have originated in a lost French romance which arose as a late offshoot of the prose *Tristan.* The main part of the *Morte Darthur* (books i–iv, xiii–xxi) consists of an adaptation of the other great prose romances, the "Vulgate cycle" and the "post-Vulgate" romance—the fully developed series of prose romances covering all the Arthurian stories. The opening portion of the latter (the so-called "Huth Merlin") provides the subject matter of books i–iv, which recount the birth, youth, coronation and early adventures of Arthur. The Vulgate cycle of romances is represented by its two concluding branches: the *Queste del Saint Graal* and the *Mort Artu,* which form the substance of

books xiii–xvii and books xviii and xx–xxi respectively. The pathetic story of the maid of Astolat and the account of the great war between Lancelot and Arthur that breaks out after Agravain, Gawain's brother, has revealed the adultery of Lancelot and Guinevere to Arthur occur in the *Mort Artu* and are recounted fully by Malory. The third branch of the Vulgate cycle, which relates the courtship and early exploits of these two lovers, is given rather cavalier treatment. Book vi reproduces a few uninteresting adventures of Lancelot and book xix contains a grotesquely distorted form of the "knight in the cart story"; *i.e.*, the account of Guinevere's abduction and her rescue by Lancelot. Otherwise, the third branch is completely neglected.

Treatment.—Malory's approach differs in some respects from that of his French models. Deeds of arms and martial valour, and the virtues (faithfulness, constancy and devotion to one's friends) normally associated with these, seem to have appealed to him particularly. For French courtly love, and the ingenious and often casuistical analysis of sentiment that went with it, he had little sympathy. The *Queste del Saint Graal* is faithfully translated and its ascetic outlook is well preserved, but the distinctive doctrinal content of the work has suffered from Malory's tendency to abridge or omit the sermons and exhortations which bulked so large in the original. His own additions show that he failed to sympathize with the challenge that it offered to the ideals of romantic chivalry. The episode of Sir Urré, whom Lancelot heals of his wounds when all others have failed (book xix), seems like an invention of Malory's own, designed to restore the balance between Galahad and Lancelot by making the latter's career culminate in a miracle of healing which turns him and the Round Table into a special channel of God's grace. It is not surprising that an author at once more emotional and more simple-minded than the French writers should be especially attracted to the *Mort Artu*, the most successful branch of the Vulgate cycle, in which the fall of Arthur is preceded by a clash of elemental loyalties. Malory, for whom mutual trust and devotion were the highest virtues and the Round Table a real and living brotherhood, exploited fully the tragic implications of the theme and, aided by suggestions from the stanzaic *Le Morte Arthur*, gave it a strong lyrical quality. In Malory's version the characters are caught up in a web of obligations that are repugnant to the deepest instincts of their nature. When Guinevere's adultery is discovered, and Arthur clearly sees that Lancelot is now against him, the fellowship of the Round Table is destroyed. Gareth, who loves Lancelot "of all men earthly," obeys Arthur's command to conduct the queen to execution with the greatest reluctance; when Lancelot rescues Guinevere, Gareth is slain and his brother Gawain, Lancelot's closest companion-in-arms, has to take vengeance. As a result the great civil war that "dispeoples" the Round Table begins, but all that Lancelot does is done in sorrow and not in anger. The treachery of Mordred and the death of Arthur form a mere appendix to this tale of strife. The great concluding speeches, on the other hand, ending with the threnody of Ector over the dead Lancelot, have a passionate intensity that raises Malory to the first place among the authors of his century.

Achievement.—In Caxton's edition the *Morte Darthur* is treated as a continuous work and divided into books and chapters. The Winchester manuscript divides it into a series of self-contained tales, each with its own explicit. To underline the autonomous character of each story Vinaver abandoned Caxton's spurious and misleading title and called his own edition *The Works of Sir Thomas Malory*. If, however, this new title implies that even the arrangement of the tales in the chronological sequence is not the work of Malory but the result of early editorial intervention, then it may itself be misleading. Nevertheless, it seems clear that Malory's work can be regarded as in some sense the end product of a process by which the early Arthurian prose-romances, with their multiplicity of ramifying and interwoven incidents, were transformed into a series of smaller works "each circumscribed within its own boundaries." It could therefore be maintained that, while Malory's book can obviously be treated as a chronicle of the Arthurian kingdom from its beginning to its close, it possesses no real artistic unity; rather it is the result of the juxtaposition of elements that have the literary form of tales each complete within itself, in which the form, as well as the content, of each tale is determined by the character of the source of material. If this is the case, a fair assessment of Malory's achievement can be arrived at only by regarding each tale as a separate experiment in adaptation. It is perhaps therefore not altogether inappropriate that Caxton should have chosen for the whole book a name already familiar to English readers through earlier verse romances—a name which emphasizes the most significant episode in the Arthurian saga and which commemorates that portion of Malory's work which has earned him enduring fame.

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MALPIGHI, MARCELLO (1628–1694), Italian physiologist, the founder of microscopic anatomy, was born on March 10, 1628, at Crevalcore near Bologna, where he graduated in medicine in 1653 and where he became lecturer in 1656. A few months later he was appointed to the chair of theoretical medicine at Pisa, but after four years he returned to Bologna. In 1662 he was appointed professor primarius at Messina. After a further four years he again returned to his native university, and spent the next 25 years there. In 1691 he moved to Rome as private physician to Innocent XII, and he died there on Nov. 30, 1694. Shortly before his death, he drew up a long account of his academic and scientific labours, correspondence and controversies, and committed it to the charge of the Royal Society of London, which published his autobiography in 1696.

Malpighi was one of the first to apply the microscope to the study of animal and vegetable structure, and his discoveries were of major importance. Although Harvey had correctly inferred the existence of the capillary circulation, he had never seen it; it was reserved for Malpighi in 1661 (four years after Harvey's death) to see for the first time the blood coursing through a network of small tubes on the surface of the lung and of the distended urinary bladder of the frog. This discovery was given to the world in two letters, *De pulmonibus*, published at Bologna in 1661 and often reprinted. These letters contained also the first account of the vesicular structure of the human lung, and they made a theory of respiration possible for the first time.

Malpighi's next achievement was a demonstration of the plan of structure of secreting glands. He maintained that the secretion was formed in terminal acini standing in open communication with the ducts. The name of Malpighi is still associated with his discovery of the mucous character of the lower stratum of the epidermis, of the vascular coils in the cortex of the kidney and of the follicular bodies in the spleen. He was the first to attempt the finer anatomy of the brain, and described the distribution of gray matter and of the fibre tracts in the cord, with their extensions to the cerebrum and cerebellum, with great accuracy, though from his microscopic study of the gray matter he concluded that it was of glandular structure and that it secreted the "vital spirits." At an early period he applied himself to vegetable histology, and became acquainted with the spiral vessels of plants in 1662. His *Anatomia plantarum*, published in 1672, included the *Observationes de ovo incubato*, which gave one of the best accounts (with good plates) of the development of the chick. His *Diss. epist. de bombyce* (1669) elaborately described the structure and metamorphosis of the silkworm.

Malpighi also wrote *Epistolae anatomicae Marc. Malpighii et Car. Fracassati* (1662), on the tongue, brain, skin, omentum, etc.; *De viscerum structura: exercitatio anatomica* (1669); *De structura glandularum conglobatarum* (1689). *Opera posthuma, et vita a seipso scripta* (1697) with preface and additions was published at Amsterdam in 1700. An edition containing all his works except the last two was published in London in 1686.

See Logan Clendening, *Source Book of Medical History*, pp. 209–217 (1942).

MALPLAQUET, BATTLE OF (1709), a marginal victory won near Malplaquet, a village 10 mi. S.E. of Mons in Hainaut (now on the French side of the Franco-Belgian frontier), by British forces under the duke of Marlborough and the Holy Roman emperor's forces under Prince Eugene of Savoy against French forces under Marshal de Villars and Marshal de Boufflers, on Sept. 11, 1709, during the War of the Spanish Succession (*q.v.*).

Proposed Anglo-imperial siege operations against the fortress of Mons were being threatened by a revitalized French army, about 90,000 strong, which moved to pass the natural wooded barrier separating it from Marlborough's army (also about 90,000) through the gap at Malplaquet. The operation was checked by Marlborough and both sides waited: the allies for reinforcements, and the French to fortify their naturally strong position.

Marlborough decided to attack the defended woodlands on either side of the gap, the heaviest blow to be delivered against the forest of Taisnière, north of Malplaquet on his right. Should the centre be weakened by these flank attacks, he intended to surge through it as he had at Blenheim (*q.v.*). These tactics were employed and were eventually successful. Each step toward victory, however, was bitterly contested. Only with difficulty and after tree-to-tree fighting was the wood of Taisnière cleared. On the allied left the containing activity, allotted to John William Friso, prince of Orange, and his Hollanders developed into an unsuccessful major action costing between 7,000 and 8,000 Dutch lives. When the flank pressures allowed the infantry to take the entrenchments in the Malplaquet gap the allied cavalry passed through, but repeated well-conceived counterattacks by the French cavalry, while they did not stop the advance, did prevent a French rout. Indeed, it is possible that had not Villars been carried wounded from the field the French might have at least held their ground. As it was, Boufflers conducted an orderly retreat and the allies were too exhausted to interfere with the withdrawal.

Strategically, the battle put an end to any idea the allies might have entertained of advancing on Paris, and it marked Villars as a general of stature. Tactically, it revealed, for the last time, the exceptional co-operation of Eugene and Marlborough in a pitched battle, and Marlborough's cool competence under difficult circumstances. Malplaquet was a battle worthy of particular note for its desperate and costly nature: the French lost about 11,000 men and the allies about 20,000. It was, as Marlborough wrote of it, "a very bloody battle." (D. M. Sc.)

MALRAUX, ANDRÉ (1901–), French writer and politician who, in all his writing—novels and studies of art—attempts "to give men a sense of the grandeur they fail to recognize in themselves." He was born in Paris on Nov. 3, 1901, of a well-to-do family, and showed an early interest in the arts and also a wish for a life of action and adventure. At the age of 21 he went to Indochina on an archaeological expedition. During this period, while he was excavating Khmer statues, he studied the problems of the colonial peoples and was involved in the activities of the Young Annam league. Later, he lived in Canton and Shanghai, saw the revolutionaries in action, probably worked with the Chinese Liberation movement and followed closely the work of the Kuomintang. On his way back to Europe, in 1927, he made important discoveries of Greco-Buddhist art in Afghanistan and Iran. He then flew over the Arabian desert and discovered what may have been the site of the queen of Sheba's legendary city. After his return he devoted himself to the fight against rising fascism, and participated in numerous anti-fascist activities. When the Spanish civil war broke out in 1936, he flew to Madrid and organized an international air corps for the Republicans. In 1939–40 he was an officer in the French regular army, was wounded and captured, escaped, was active in the *maquis*, was captured again, escaped and finished the war as an officer in Alsace. After the war he turned to politics and became one of the leaders of the Rassemblement du Peuple Français, the movement created by Gen. Charles de Gaulle. This failed, but when De Gaulle returned to power (1958) Malraux was appointed minister of cultural affairs in the first cabinet of the fifth republic.

Between the acts of this dramatic and absorbing life, Malraux, who had never lost his interest in art and literature, wrote several brilliant, powerful books and rose quickly to an eminent position among modern writers. His first important novel, *Les Conquérants* (1928), described insurrection in Hong Kong and an adventurer, Garine, who wanted "to give a meaning to life." Most of Malraux's heroes are men of action: through them the author explores the meaning of life, the moral and human implications of the struggles of a tragic era. *La Voie royale* (1930) has an Indochinese background; it is a tale of action, adventure and violence, and of man's efforts to achieve human dignity.

Malraux's best-known work, perhaps his masterpiece, *La Condition humaine* (1933), won him the Prix Goncourt and made him known to readers all over the world. Its background is Shanghai, during the crushing by Chiang Kai-shek of his former Communist allies (1927). Malraux was in Shanghai in those troubled times and poured his own experience into the book. But this is not a reporter's album of vignettes. The novel is powerfully constructed round the theme of revolution and its impact on a few well-chosen, magnificently drawn individuals. All the heroes of the novels share both a tragic fate and a pathetic solitude. But, unlike Garine, some of them discover the brotherhood created by common action. *Le Temps du mépris* (1935), a shorter novel, tells a story of the underground resistance against the Nazis in Hitler's Germany. In the important preface, Malraux defines his conception of fiction, which is akin to that of Greek tragedy (man, the crowd, human destiny) and emphasizes the need to understand and use art to "attempt to give men a consciousness of their own hidden greatness." From his experience in the Spanish civil war Malraux constructed the masterly fresco *L'Espoir* (1937).

His last novel, *Les Noyers de l'Altenburg* (1943), part of the unfinished *La Lutte avec l'Ange*, is a passionate, anxious interrogation on the concept of man. Malraux believes that man is what he makes. Man overcomes his tragic fate by "giving a meaning to human adventure." Revolution, love, art are ways of bringing the world into subjection. Man's dignity lies in not refusing his own greatness.

After 1945 Malraux as a novelist remained silent. Most of his time was devoted to politics and the history and criticism of art. He wrote, as well as a study on Goya (*Saturne*, 1950), the outstanding *Les Voix du silence* (1951), which was acclaimed as among the most important of modern works, although the art historians made reservations on Malraux's accuracy. It is a brilliant, well-documented synthesis of the history of art in all countries, at all epochs, and also a philosophical meditation and an attempt to redefine men and civilizations through the world of art. Malraux's wide culture, original style and faith in man make *Les Voix du silence* an eloquent statement of man's fate and greatness through active creation: "Civilization is not sweetness, but consciousness and mastery of man." This work was continued in *La Métamorphose des Dieux*, vol. i (1957).

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MALT is a food product prepared from cereal grain by allowing partial germination to modify the seeds' natural food substances. Except for wrinkling of the husk, malt has mostly the physical appearance of the grain from which it was prepared. Malt itself is seldom a constituent of human food. It is rather an extract or the result of an enzymatic digestion by malt that is found in "malted" foods. Hence the term is frequently but erroneously applied also to a concentrated sirupy aqueous extract of malt. The starch of malt is mellower and more soluble than that of the original grain. Its protein has become partially hydrolyzed. The enzymes (*q.v.*) developed during the malting process are responsible for its industrial importance.

Any cereal grain may be converted to malt by germination but barley (*q.v.*) is the favoured grain and has been hybridized to improve its malting quality wherever it is grown. Rye, wheat,

rice and, to an even lesser extent, corn are malted in some countries, usually as a result of tax complications or legal restrictions protecting native farm products.

Uses.—The largest bulk of malt is used in the manufacture of beer (*see* BREWING) and most of the extractives in beer are derived from malt. Hence the flavour of beer is predominantly the result of the malt from which it was made. From 30 to 50 lb. of malt are used to make a barrel of beer, depending upon its strength and the use of adjunct starches.

The next most important use of malt is in the production of distilled alcohol for both beverage and industrial purposes. It is used in this case almost entirely for its enzymatic ability and is hence specially prepared as a high-diastatic or distiller's malt. The diastase of malt converts starches, obtained from corn, potatoes or other economical sources, into sugars which are then fermented to alcohol and concentrated by distillation.

Distiller's malt is also used in the production by fermentation (*q.v.*) of other solvents such as acetone, butanol and other higher alcohols.

Malt extracts are either sirupy concentrates or dry powders resulting from the evaporation of strained mashes of malt and water, sometimes including added starchy materials. The malt contributes maltose (a sugar not as sweet as cane sugar), dextrins, soluble protein and vitamins, especially of the B complex, to these materials. The extracts are used to impart a "malted" flavour to confections and food mixtures. Many special baby foods are prepared in a similar manner. If milk is added before drying the resulting powder is the familiar malted milk. Frequently these products are made so as to retain diastatic activity and are offered as aids to digestion. Diastatically active malt extract is used by bakers to improve the fermentation of their dough, thereby influencing the texture of their products.

While malt contains enzymes other than those capable of hydrolyzing starch, it owes its importance primarily to this ability. Starch sizing applied in the processing of textiles may be removed by enzymatic solubilization utilizing a malt extract as the source of amylase.

Method of Manufacture.—Malt production is a controlled and limited germination initiated by adding moisture and arrested by removal of the moisture before the young plant grows out of the seed covering. Production thus depends upon the life processes inherent in a dormant seed. The first step after the barley has been cleaned and sorted as to kernel size is to steep it in water for about 24 hours until the kernel has absorbed from 40% to 45% moisture. This absorption awakens the embryo and causes the life processes to begin. The dampened grain is then moved to a germinating apparatus, which may be a revolving drum or a rectangular open tank equipped with slow-moving agitators. In the second half of the 20th century a few smaller establishments still spread the grain on a floor and turned it by shoveling.

In either system a means is devised to conduct cooled and moistened air through the mass of sprouting grain and a gentle method of moving the grains is provided so as to prevent matting of the roots. Carbon dioxide is thus removed along with heat developed during the process. Growth and modification of the starchy constituents of the original grain are controlled through manipulation of temperature and moisture within the "piece," as the batch of grain is called.

During germination, enzymes are activated particularly along the scutellum, a membrane separating the embryo, which is largely proteinaceous, from the endosperm or starchy portion of the kernel. These enzymes include cytase, phytase, amylases, phosphorylases, proteases and, in fact, all those which the embryo plant will use in breaking down the food material stored in the endosperm and building it into root and eventually stem structures. These enzymes permeate the endosperm, converting the contained flinty starch into a softer and more soluble form. Some of this starch is hydrolyzed to maltose and dextrose, which are phosphorylated and then pass through the scutellum where they are reconverted to starch in the rootlets that push out at the bottom of the kernel. An incipient stalk called the acrospire also grows upward from the embryo along the side of the kernel inside the hull and will eventually erupt from the top of the kernel to become the aboveground structure of a normal plant if the process is allowed to continue.

Since it is the enzymes and the partially converted starch that are desired, rather than a new growing plant, the growth or germination is stopped in malting when the acrospire has grown to or slightly beyond three-quarters of the kernel length. During this time the rootlets have generally attained a length of about an inch and the endosperm has been rendered entirely mellow. This change may take from four to nine days depending upon the temperatures permitted and the use for which the malt is intended.

When the desired amount of modification has been attained the biological processes are stopped by the simple expedient of removing the moisture necessary to sustain them. This cutoff is accomplished in a kiln, the floors of which are perforated to permit an upward current of dry, heated air to dry the grain. There are many kiln designs and many ways of operating them to control the rate of moisture removal and the amount of heating that is given. Timing and heat intensity govern the amount of caramelization and other changes that are associated with the development of both flavour and colour. Additional flavours are often imparted by the character of the fire used. For example, malt intended for Scotch whisky is dried over a fire to which peat is added. The ensuing smoke is taken up by the malt.

Distiller's malts and others retaining highest enzymatic activity are kilned at low temperatures, around 120° F., to preserve as much of the biological ability as possible. Consequently such malts are pale in colour and have little flavouring value. Some kernels retain the ability to grow. Those malts that are to be used primarily for flavouring or colouring qualities are kilned at temperatures in excess of 200° F. and retain little enzyme action. Malt intended for both enzymatic and flavouring purposes is finished off at intermediate temperatures.

Historical.—The processes of malting, brewing and baking have been closely entwined for a longer period of time than is covered by recorded history. Each was well known and developed into a triple industry or special activity in Egypt at the time of the Pharaohs. Records left by all of the ancient agricultural civilizations indicate that these arts had developed long before. Consequently the origin is resigned to the realm of Egyptian mythology. Osiris, the god of light, health and agriculture, taught man to malt as a preliminary step to brewing an alcoholic beverage that might allow him to escape the woes of the world. Man simultaneously discovered the leavening power of fermenting beer.

Since the sprouting of grain and fermentation will occur even without man's guidance, it may be safely assumed that early man sampled and liked a fermenting watery supernatant that he found over stored grain that had become drenched by rains. By observation, many deductions, experiments and, no doubt, a few temporary illnesses he learned to control the process of malting. Except for more accurate understanding of the biochemical changes involved, which led to better control, and for mechanical improvements, the malting process and its related processes of brewing and baking have remained unchanged.

In the period around 3000 B.C. spelt, wheat and barley were thrashed and winnowed by hand labour and stored in granaries for subsequent use. The biblical story of Ruth is a familiar reference to this though much more detailed and earlier information is contained in pyramid findings and in the Egyptian *Book of the Dead*. To prepare malt from this grain it was spread upon a flat surface in a pile perhaps about knee high and watered liberally until rootlets began to appear—after about two days. Water would then be added only to keep the pile moist and the grain would be turned by wooden shovels to keep the pile from overheating. Exact elements of control are unknown but it is possible that traditional tests of biting, kernel flexibility, buoyancy and the like may have had their origin this far back.

The first processes probably utilized green or undried malt for further processing, and earliest attempts at drying must have included spreading in relatively thin layers in the sun. Certainly the arid climate of Egypt at least contributed to very early adoption of dry air currents. Throughout ancient history and into the

middle ages few changes in even the methods of manipulation occurred. The European monasteries and the princely households continued to malt the available grain and, with the necessity of using heated kilns to dry the product in colder and more humid environments, the control of flavour was introduced.

As in other arts, control did not really improve until adequate means of measuring conditions developed. Uniformly scaled thermometers were introduced in the early 18th century. Other instruments followed and were adopted by the maltster-brewers. Barley became the favoured grain to malt and was ruled the only permissible grain for beer in Hamburg in the 12th century.

Not until 1873 was a satisfactory substitute for the hand labour of floor malting devised. In that year Nicholas Galland introduced a mechanical system termed the pneumatic method. While power-driven machinery had been put to use in many other industries before this, even including other brewery operations, no device had been gentle enough to both agitate and protect the grain during its germinating. Galland provided a rectangular compartment having a perforated false bottom that would allow passage of water or air but not of grain. A series of revolving augers reached into the grain to turn it as a rope drive supplied power which also enabled the entire agitator assembly to traverse the length of the compartment on a rack-and-pinion arrangement.

Shortly thereafter the rotating-drum system was introduced. From that time on further improvements were rapidly adopted; electric power, controlled speeds, oil- and gas-fired kilns, artificial refrigeration and volume handling were among the major innovations. None of these have, however, contributed new biological processes. The methods but not the process changed.

These improvements have altered the complexion of the industry substantially. At one time every brewer malted his own grain. Now the greater number of them buy malt from large separate maltsters, although a few of the larger breweries continue to malt much of their own requirements. This specialization has led to expansion in the use of malt for other purposes, to the more economical accomplishment of the changes, to the establishment of research laboratories devoted solely to malting problems and to greater support for barley-improvement programs of benefit to the barley growers.

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(R. I. T.)

MALTA (anc. MELITA). The Maltese Islands are situated between Europe and Africa, in the central channel which connects the eastern and western basins of the Mediterranean sea. The group is a parliamentary state, a member of the Commonwealth of Nations, and the site of a strategic British base. It consists of Malta (95 sq.mi.), Gozo (*q.v.*; 26 sq.mi.), Comino (1 sq.mi.) and the uninhabited rocks Cominotto and Filfla. Malta itself is about 60 mi. from the nearest point of Sicily, 140 mi. from the mainland of Europe and 180 mi. from Africa. Malta is about 17 mi. long by 9 mi. wide; Gozo is 9 by 4½ mi.; and the archipelago extends more than 29 mi. from northwest to southeast.

PHYSICAL GEOGRAPHY

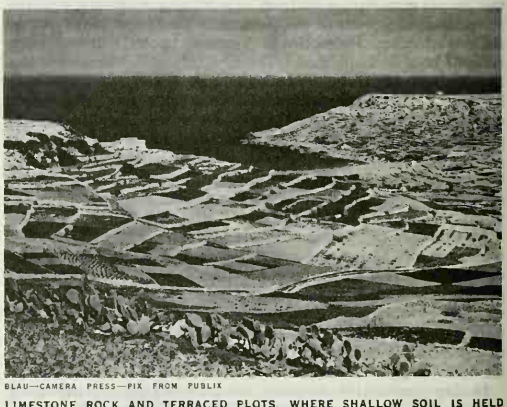
A fairly narrow submarine ridge extends southward from Sicily toward Malta, and thence continues southwestward on a broader scale toward Tunisia and Tripolitania. This ridge, lying at 50 fathoms in its northern part and deeper to the south, is a sunken land bridge which appears to have connected Europe and Africa during epochs of the later Tertiary and Pleistocene. Malta has abundant fossil evidence of this early interconnection, particularly in certain of the cave deposits.

The main island consists of a fractured and warped plateau, composed of Miocene rock series with a few superficial deposits of Pleistocene age. The higher parts, of somewhat irregular shape, occur mainly in the west central area and to some extent in the north; these are either residual features produced by erosion or ridges defined by fault scarps. The greatest height is 845 ft., in the irregular upland between Mdina (*q.v.*) and the southwestern coast. Thus, though small, Malta exhibits some variety in landscape and environment.

Structurally, the island can be regarded as made up of two somewhat differing component parts: the north, and the centre and south. The north is a region of horsts and downthrow zones controlled by imposing faults that mostly run from east-northeast to west-southwest. Downthrow is usually of the order of 200–400 ft., but the Victoria Lines fault, which runs across the island from Maddalena tower to Fromm ir Rih, appears to have nearly double this amount of displacement. Several nearly parallel horsts and ridges are discernible, separated by narrow lowlands, successively from the extreme north at Marfa, Mellieha, Bajda and Wardiya. Central and southern Malta consists of a shallow but complex anticline, aligned north-south. Faulting also occurs, but far less extensively than in the north.

Five rock series are usually distinguished. In order of formation they are Lower Coralline Limestone (the oldest), Globigerina Limestone, Blue Clay, Greensand and Upper Coralline Limestone. The Lower Coralline Limestone is a gray and relatively resistant formation which is exposed chiefly in a narrow coastal band in the extreme southwest, where it gives rise to a succession of imposing cliffs 200–400 ft. high; other exposures occur in the east—round Maddelena tower, north of Mosta and southeast of Valletta. Above it lies the distinctly softer Globigerina Limestone, which forms the principal outcropping series in Malta. Easily eroded, it produces a gently undulating topography but weathers to a soil of only moderate fertility which is nevertheless responsive to intensive and laborious cultivation. Of a characteristic golden or pale brown colour, it is an excellent building stone (it can be trimmed by hand adzes when newly quarried, but hardens on exposure) and many buildings on the island are made from it.

Next in succession comes an irregular layer of Blue Clay, which is a composite formation of blue and yellow clays and marls. Though absent in certain areas because of thinning out of the beds, this layer is extremely important to Malta in that the clays are impermeable and hence provide a water table between largely

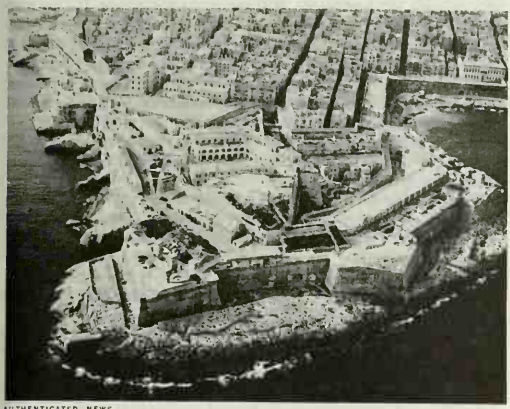


BLAU—CAMERA PRESS—PIX FROM PUBLIX

LIMESTONE ROCK AND TERRACED PLOTS, WHERE SHALLOW SOIL IS HELD TOGETHER BY RUBBLE WALLS, ON THE ISLAND OF MALTA

permeable limestones. The Blue Clay is also extremely fertile, and although its outcrops are greatly restricted they are usually marked by intensive terrace cultivation. The Greensand is a relatively narrow band (less than 50 ft. thick) of reddish-brown or green-brown limestone and, at its junction with the Blue Clay, landslips as well as springs are a feature. Lastly, the Upper Coralline Limestone occurs as a cap about 500 ft. thick upon the higher hills or where downthrow has occurred, and is thus exposed mainly in the west and north. It produces a classic karstic topography of bare rock pavement, eroded joints, solution hollows and irregular pinnacles and outlines.

There are thus marked differences between the eastern and western coasts of Malta. The western coast is high, bold and largely harbourless. On the east local downwarping has produced the remarkable double sea inlet of Grand Harbour and Marsamxett (Marsamuscetto) with nine associated creeks, including those of Sliema, Lazaretto, Msida and Marsa. Between them runs a central tongue of high ground, Mt. Sceberras, upon which the city of Valletta (*q.v.*) is built. The extreme north of Malta is mostly a craggy, bare region of coves and irregular hills separated by a few fertile lowlands. The centre and south is an area of gentler and



AUTHENTICATED NEWS

AERIAL VIEW OF VALLETTA WITH FORT ST. ELMO AT THE EXTREMITY OF THE PROMONTORY, FLANKED BY GRAND AND MARSAMXETT HARBOURS

more cultivated landscapes. The faults and warping movements are of very late geologic age, and the fact that certain Neolithic trackways disappear abruptly into the sea suggests earth movement in some localities even within the last few millenniums.

Gozo has a block structure, with a tilt toward the northeast, and local small-scale faulting and downwarping. There is the same rock succession as in the main island, Lower Coralline Limestone in the south and east producing cliffs rather similar to those in western Malta itself.

There are no perennial streams or permanent lakes in Malta, but because of the extent of bare rock pavement there can be considerable wash of rainfall, and this is important as a cause of soil erosion. Problems of water supply are acute. In most of Malta (especially in the south and east) porous limestone continues below sea level, so that deep wells are liable to contamination by rising salt water; this is a growing problem round Valletta.

Climate.—In general, Malta exhibits the normal Mediterranean pattern of mild, wet winters and hot dry summers. However, as an island in an extensive sea basin, it is windier than many adjacent mainland areas, and only one day in ten is calm. Nearly one day in three the *majjistral*, a relatively cool northwesterly wind, agreeable in summer but raw and damp in winter, prevails. Other winds are the gregale, a dry, sometimes violent and blustery northeaster; the *xlokk* (sirocco), hot and humid from the southeast; the *tramontana*, northerly and cold; and the *nofsinhar*, hot and intensely dry from the north African deserts. Because of the rapid changes of air mass over the central Mediterranean, wind and weather can vary considerably within a very short period.

Again because of Malta's maritime situation, the temperature is remarkably stable, although it occasionally exceeds 38° C. (100° F.) in summer. At Valletta monthly means range from 12° (53°) in January to 25° (77°) in July and August, with an average amplitude of 4.5° (8°) in winter and 6.7° (12°) in summer. Inland there are mean differences of up to 3.3° (6°), and patches of ground frost sometimes occur. There is no real thermal dormant season for plants, although growth can be checked briefly by abnormal cold spells and summer heat can cause wilting.

Nearly 70% of the annual rainfall (20.54 in. at Valletta) falls during October–March (50% during November–January). June and July account for only 2%, July usually being entirely rainless. Rainfall can vary considerably, however, both in overall amount and in onset. For short periods it can be extremely heavy, causing soil erosion and running off rapidly to be lost in the sea.

High humidity means that summer conditions, especially near the coast, can be oppressive. Moreover, conditions of wind, temperature and humidity together often have a markedly deleterious effect on plant growth. Thus, although the annual rainfall appears adequate for agriculture, its value is reduced by the summer drought, irregularity of fall, high evaporation and rapid runoff. Much attention has been given to methods of water conservation. There are ancient works still in existence, with several aqueducts, now only partly used. Great ingenuity is shown in trapping and storing rain water. Many programs were put forward in the 20th century, and important reports were made on the hydrology of Malta in 1952 and 1960. Small projects have been undertaken, but money has not been available for large-scale works.

Soils.—Because of high temperatures and the lack of regular drainage, soil formation in Malta has been slow; hence deposits are generally thin and immature. Moreover, most of the land in Malta and Gozo has been terraced, with high retaining walls and level patches cut from bedrock. When building takes place all soils must, by law, be removed from the site for use in agricultural areas; level stretches within quarries are often covered by such carted soil. Much organic town refuse is also spread on the surface. Consequently, soil in Malta has unusual characteristics; it is almost an exotic, partly manufactured medium. Soils of a *renzina* type tend to predominate, true terra rossas being much less widespread. (W. B. Fr.)

Vegetation.—The rocks and soils are mainly calcareous and the vegetation is typically Mediterranean. The largest element of the flora consists of species that also occur in Sicily and Italy, together with some found in the Iberian peninsula and north Africa. No forests are developed on the islands. The commonest tree is the carob, native to the islands; other native trees and shrubs include the fig and the chaste tree. Maritime and seashore vegetation is well developed; typical are golden samphire, rock samphire, saltwort, sea campion, spurge and marram grass. (V. H. H.)

Animal Life.—The mammals native to Malta are limited to the water shrew, white-toothed shrew, greater and lesser horseshoe bats, pipistrel, large and lesser mouse-eared bats and the least weasel. Rabbits, rats and mice are present as introduced animals. The few resident birds include the blue rock thrush, spectacled warbler, Manx shearwater, Cory's shearwater and jackdaw. Others breeding in Malta are several kinds of owls (including barn, tawny and little owls), linnets, buntings and the rock dove. Since the islands are on a migration route between Europe and Africa, there are numerous passage migrants, including bee eaters, rollers and hoopoes, osprey, vultures and eagles, swallows and cuckoos.

Because of the small size of the islands and the poorness of the vegetation the insect fauna is limited but includes cockroaches, beetles, plant bugs, grasshoppers, flies, dragonflies, moths, bees, wasps and ants. There are, however, several species of butterfly, notably the cabbage white which often arrives in swarms in spring and autumn from north Africa. Locusts also reach the island from Africa, and large numbers of ladybirds frequently arrive in spring from Sicily. (Ma. Bu.)

ARCHAEOLOGY

There is no conclusive evidence for Paleolithic man in Malta; the identification of two teeth from Ghar Dalam as those of Neanderthal man is doubtful and they do not seem to have been found associated with the rich Pleistocene fauna of hippopotamus and elephant in the cave. The same site, however, produced shards of pottery which represent the earliest Neolithic colonists of the island, related to those from the Mgarr temple (*see* below) and to the Stentinello type in Sicily. Similar pottery occurs in the earliest Neolithic levels of the Arene Candide cave in Liguria. But

the most notable evidence of prehistoric man in Malta is afforded by the monumental stone buildings usually known as temples and by the huge rock-cut collective tomb or hypogeum at Hal Saflieni. The best preserved of the temple structures are at Hal Tarxien, Hagar Qim, Mnajdra and Mgarr in Malta and at Ggantija on Gozo; less striking remains of similar buildings exist at Borg in Nadur, Kordin, Skorba and elsewhere.

The temples are built of the local limestone, though fine Globigerina Limestone was sometimes brought from several miles away, especially where fine-dressed surfaces or decorative carvings were desired. The plans of the buildings are based on the theme of apsidal chambers, usually in pairs, opening from an axial passage or central court, and the whole complex is enclosed in a massive stone revetment, roughly oval in plan, with a concave façade and forecourt at the entrance. The evidence implies that most of the apsidal chambers were roofed by first carrying several courses of corbeled vaulting above the slabs forming the walls and then laying large flat capstones across, but it is uncertain whether some of the very large chambers (*e.g.*, at Mnajdra) were in fact roofed in stone, as the large span presents great technical difficulties, and it is likely that the courts giving access to the chambers were always open to the sky, though in both instances temporary coverings of hides or textiles could have been used. The standard of building, with its fine dry jointing and carefully dressed surfaces, is of high technical quality, and in certain of the temples, probably relatively late in any sequence of construction, there is elaborate surface decoration of low-relief carving (either as naturalistic animal friezes or as spiral patterning) or of close-set pitting apparently made with a drill. Although all the freestanding temples are now ruined and roofless, the interior detail of the rock-cut chambers at Hal Saflieni and models of temples or their façades from Mgarr and Hal Tarxien give evidence for reconstructing the roofs on the lines suggested.

In addition to the low-relief carving, there is a large series of figures carved in the round, usually representing obese females and ranging from specimens a few inches high to a statue (of which the lower part alone survives) of a woman in a flounced skirt at Hal Tarxien which is well over life size; at Hal Tarxien too is an enormous bowl carved out of solid stone. There is evidence that much, if not all, of the carving and ornament was originally painted, and at Ggantija traces of interior wall plaster with red paint on it were recovered. In the Hal Saflieni hypogeum, elaborate spiral patterns are painted in red in certain of the chambers.

Although the hypogeum was certainly used for a vast series of collective burials, its function need not have been wholly or primarily sepulchral, and there is no evidence that the temples were used primarily for burial. However, their affinities in architecture and in planning are certainly with collective burial vaults, either rock cut or built above ground of large stones, which are known from many areas in the western Mediterranean and belong in the main to the 3rd millennium B.C. The Maltese temples have yielded a rich series of pottery finds, including the incised white-filled ware of Mgarr, allied to that of Stentinello. There also occur wares with fine ornamentation scratched on them and filled with red or white colouring matter in techniques characteristic of early southeast Italian, Ligurian and south French Neolithic pottery, and this style may in part be an imitation of Italian Neolithic painted pottery—shards of painted ware were indeed found at Mgarr and elsewhere. The latest Neolithic pottery includes volute or spiral patterns and these, especially the similar patterns in stone carving, seem likely to be related to the Minoan world shortly before 2000 B.C. The figure sculpture and animal reliefs again are features which suggest eastern Mediterranean origins. The use of the sling in Neolithic Malta (attested by slingstones) may imply Aegean contacts.

At Hal Tarxien, at a period when the original temple was deserted, a cremation cemetery with many burials was established within the precincts. With the burials was pottery of a style quite dissimilar from that of the earlier sites, and there were also bronze or copper flat and flanged axes and flat riveted knife daggers. The radiocarbon date for this cemetery is about 2000 B.C. This would seem to indicate that Hal Tarxien was deserted before this date, and this, taken in conjunction with other recent radiocarbon determinations, implies that the whole range of Maltese Neolithic temples and allied structures lies within the centuries *c.* 2750–*c.* 2000 B.C.

The Maltese Bronze Age is represented not only by the Hal Tarxien cemetery but also by pottery finds at Borg in Nadur, at Bahrija and at other sites in the island. The Borg in Nadur pottery, from a settlement site within a probably contemporary defensive wall across a promontory, is exactly paralleled by the Thapsos red ware of Sicily dated by Mycenaean imports to the 14th century B.C. and later. A shard of Late Helladic III pottery from Borg in Nadur confirms this dating. There are rock-cut tombs attributable to the Maltese Neolithic period at Attard, Busbisija (Mosta), Xemxija and Ta Trapna iz-Zghejra (Zebbug). The pottery relates these tombs to the earlier Neolithic phases. There is a blank in Maltese prehistory after the Bronze Age until the coming of Punic colonists in the earlier half of the 1st millennium B.C. Numerous Punic tombs show the island to have been an important colony; their range of date may extend to that of the Roman occupation.

A remarkable type of antiquity in the island is that of the so-called cart ruts, pairs of parallel grooves worn into the rock and having a span of about 4½ ft. It seems that these ruts could not have been made either by cart wheels or, because of the relatively sudden curves in many of them, by sledges; the best suggestion is that they were worn by a primitive form of "slide car" of a type still surviving in parts of Europe, in which the load is dragged on a pair of poles joined at their forward end (water carried in skins would be a likely burden). At one point the line of a pair of ruts crosses the mouth of a Punic tomb shaft in such a manner as to suggest that the tomb was the later feature; this is the only piece of dating evidence that can be adduced, except that at Birzebbuga another pair runs under a shallow inlet of the sea, showing that some marine transgression has occurred since its use. (S. Pt.)

HISTORY

At one time Malta's megalithic monuments were considered to be the best proof of Phoenician settlement in the islands. Although modern archaeology has established that these were built by prehistoric man, many historians still believe that the Phoenicians sought refuge or settled in Malta at some period of their travels through the Mediterranean. Old historiographers record the existence of scattered remains of alleged Phoenician origin, but these have since disappeared. Greek inscriptions, coins and works of art found in the island induced some authors to state that the Maltese Islands passed through Greek hands after the Phoenician period. This theory later found many adversaries who would only admit a strong Hellenic influence over the islands.

In the 6th century B.C. the Carthaginians landed at Malta and several Punic coins and inscriptions seem to belong to this period. Historians write that Carthaginian rule was very harsh and that oppressive tribute was levied. This would explain why, in 218 B.C., the Maltese gave up the garrison to the Roman general T. Sempronius. The Romans granted Malta and Gozo the privileges of a municipium. Cicero refers to the Maltese as socii; they coined their own money, had the right of sending ambassadors to Rome and of controlling their own domestic affairs. The islands' prosperity is attested by both Cicero and Diodorus Siculus. The latter writes of the beauty and ornamentation of Maltese houses, and remains of palaces and dwellings (notably the Roman villa at Mdina) indicate a high degree of civilization and wealth.

In A.D. 60 the apostle Paul was shipwrecked in the bay which now bears his name, and according to tradition and to St. Chrysostom he converted the inhabitants to Christianity. Publius was "chief of the island" and is said to have become the first Christian bishop of Malta. Outside the walls of Mdina are the Maltese catacombs (4th and 5th century A.D.) which are strikingly similar to those of Rome and which were used as places of burial. Malta was not affected by the Greek schism and remained steadfast in its allegiance to Rome.

Early Medieval History.—On the final division of the Roman

dominions in 395, Malta was assigned to the empire of Constantinople and it seems to have undergone the same fate as Sicily; some historians hold that it was conquered by the Vandals and Goths in the 5th century and reunited to the empire by Belisarius in 533. The Arabs made themselves masters of Malta in Aug. 870, massacred the Greek garrison and sold the Greek population to the native inhabitants. Unable to garrison the island with a large force, the Arabs cleared a zone between the central stronghold, Mdina, and the suburb called Rabat to restrict the fortified area. Many Arab coins, some Kufic inscriptions and several burial places were left by the Arabs; they did not establish their religion but they did give Malta its language, some place names and a few customs. (*See* MALTESE LANGUAGE.)

In 1091 Count Roger the Norman, then master of Sicily, came to Malta with a small retinue and was hailed as a deliverer by the inhabitants. According to tradition, Roger gave the Maltese their national colours, white and red. Under the Normans the dominion of the church was re-established and bishops were appointed. The Arabs were allowed to remain as vassals until 1245 or 1249 when they were expelled by the emperor Frederick II whose house, that of Hohenstaufen, had succeeded the Normans on the throne of Sicily. Gradually, feudal customs asserted themselves, and from 1192 the islands were granted as a fief to great officers of state or illegitimate descendants of the sovereign.

After the battle of Benevento (1266), Malta, with Sicily, passed to Charles of Anjou. In Ft. St. Angelo the revolt of the Sicilian Vespers (1282) was planned, and beneath the same fort the Angevin fleet was defeated (1283) by Peter III of Aragon, to whom the Maltese transferred their allegiance. The islands suffered under a succession of feudal lords who received Malta as a marquisate or countship, and in 1397, at the request of the Maltese, King Martin I incorporated the islands in perpetuity in the royal domains. However, when Alfonso V of Aragon was in urgent need of money, he broke Martin's charter by pledging the islands (1420) to a viceroy of Sicily, Antonio Cardona, for 30,000 gold florins. The Maltese paid the debt, but the islands were given to Gonsalvo di Monroy for the same sum in 1425. A revolt, organized and directed by the commune, against Monroy's rule (1427) led the king to incorporate Malta once more in the royal domains by a charter of June 20, 1428, and the Maltese were given authority to resist any intermediate lord that the sovereign might attempt to impose.

The Normans had improved considerably the political and economic condition of Malta and had raised it to municipal status. The political organization was similar to that of the large cities of Italy: the *università*, or commune, had a great deal of control over internal affairs. It was a representative body essentially constituted to defend the ancient laws and privileges of the Maltese. It had wide powers including the election of its officers, the appointment of judges and the sending of ambassadors to the foot of the throne to treat with the king, as was done in the revolt of 1427; it even taxed itself and its members. It was as liberal and democratic a body as any in Europe in the middle ages.

The Knights of St. John.—The Knights of St. John of Jerusalem, or Knights Hospitallers, having been driven from Rhodes by the Turks, obtained the grant of Malta, Gozo and Tripoli in 1530 from the emperor Charles V, subject to a reversion in favour of the emperor's successor in the kingdom of Aragon should the knights leave Malta, and to the annual tribute of a falcon in acknowledgment that Malta was under the suzerainty of Spain. The Maltese at first challenged the grant as a breach of the charter of King Alfonso, but eventually welcomed the knights. The grand master De l'Isle Adam, on entering the ancient capital of Mdina, swore for himself and his successors to maintain the rights and liberties of the Maltese. The order took up its abode on the promontory guarded by Ft. St. Angelo on the southern shore of Grand Harbour and, in expectation of attacks from the Turks, began to fortify the neighbouring town called Birgu (Vittoriosa). The knights lived apart from the Maltese, deriving their principal revenues from estates owned by the order in the richest countries of Europe and accumulating wealth by war or by privateering against the Turks and their allies. In 1551 the African Arabs ravaged Gozo after an unsuccessful attempt on Malta.

When Suleiman the Magnificent prepared to conquer Malta and exterminate the order, the knights and the Maltese were expecting the attack. The great siege of Malta, which checked the advance of Muslim power in southern and western Europe, began in May 1565. The defenders were outnumbered by about four to one. The sultan placed his troops under the veteran Mustafa and his galleys under his youthful relative Piali; he hesitated to make either supreme and ordered them to await the arrival of Dragut with his Algerian allies before deciding on their final plans. Against Mustafa's better judgment, Piali induced the council of war to attack Ft. St. Elmo, in order to open the way for his fleet to an anchorage, safe in all weathers, in Marsamxett harbour. This proved to be a strategic blunder. In the attack the Turks lost 8,000 killed, besides many wounded, before wiping out the 1,200 defenders. Meanwhile, Dragut was mortally wounded, the attack on Mdina was neglected, valuable time was lost and the main objective, Birgu, and St. Angelo were left intact. The subsequent siege of St. Angelo and its supporting fortifications was marked by great bravery on both sides. Finally, help was sent to the knights from Sicily and Mustafa abandoned the siege on Sept. 8. The order thus reached the pinnacle of its fame.

The grand master, Jean Parisot de la Valette, determined not to impair his independence, refused a cardinal's hat. He founded the city of Valletta with fortifications that were unrivaled.

Throughout the 16th and 18th centuries the knights harassed Turkish commerce and they took part as an allied Christian power in the battle of Lepanto (1571). However, with the growth of wealth and security the martial spirit of the order began to wane and so also did its friendly relations with the Maltese. The civil government became neglected and disorganized, licentiousness increased and riots threatened. In 1722 the Turkish prisoners and slaves, then very numerous, formed a conspiracy to seize the island, but the plot was discovered and promptly suppressed. In 1768 the Jesuits were expelled and their property was confiscated; Grand Master Emmanuel Pinto converted their university into one of general study. Ft. St. Angelo and the fort of St. James were, in 1775, surprised by rebels in a rising known as the Rebellion of the Priests. The last but one of the grand masters who reigned in Malta, Emanuel de Rohan, restored good government, abated abuses and promulgated a code of laws. On his death the French knights disagreed as to the selection of his successor, and a minority was able to elect, in 1797, a German of weak character, Ferdinand von Hompesch.

The rule of the knights ended when, in June 1798, Napoleon took possession of the island. He met with little resistance and after a stay of six days he proceeded with the bulk of his forces to Egypt, leaving Gen. Claude Henri Vaubois in command with 4,000 troops. (*See* also SAINT JOHN OF JERUSALEM, ORDER OF THE HOSPITAL OF.)

British Rule.—Toward the close of the rule of the knights in Malta feudal institutions had been shaken to their foundations, but the transition to republicanism was too sudden and extreme for the people to accept. Napoleon started despoiling the churches and he seriously interfered with the religion of the Maltese by enacting laws which invaded ecclesiastical and spiritual jurisdiction. Stoppage of trade and absence of work (in a population of which more than half had been living on the foreign revenues of the knights) followed the defeat of Napoleon at the Nile and the failure of his plans to make Malta a centre of French trade.

An attempt to seize church valuables at Mdina was forcibly resisted by the Maltese, and general discontent broke into open rebellion on Sept. 2, 1798. The French soon discovered to their dismay that, behind the rubble retaining walls that crisscrossed their fields, the Maltese were unassailable. The prospect of an English blockade of Malta encouraged the insurgents, of whom Canon Francesco Caruana became the most prominent leader. The Maltese formed a provisional government and an assembly. An appeal was made to Lord Nelson, who sent his Portuguese allies to blockade the island; later the British fleet took over and, after visiting the island, Nelson left Capt. (later Adm. Sir) Alexander Ball in command. On Feb. 9, 1799, the Maltese assembly

appointed Ball as its president and head of government and troops. The British flag was hoisted side by side with the Neapolitan, since Nelson upheld the contention that the king of Sicily (as successor to Charles V in that part of the former kingdom of Aragon) was the legitimate sovereign of Malta. After 14 months British troops were landed and suffered no casualties. Few Maltese lives were lost in actual combat, but famine and sickness killed thousands. Finally, after a siege of two years, the Maltese with the help of their British, Portuguese and Neapolitan allies forced the French to surrender. The treaty of Amiens (1802) provided for the restoration of the island to the Knights of St. John; the Maltese strongly protested against this, realizing that it meant the re-establishment of French influence. The assembly drew up a Declaration of Rights, in the first article of which the king of Great Britain was acknowledged as sovereign of Malta on certain conditions, such as that he should maintain the Roman Catholic religion and observe the constitution to be established by the assembly. Meanwhile, Sir Alexander Ball governed Malta as civil commissioner from 1802 until his death in 1809.

England's refusal to give up Malta was one of the causes of renewed war with France. In 1813 the British government accepted the offer made by the Maltese and acknowledged them as British subjects; the treaty of Paris (1814) ratified the compact. Sir Thomas Maitland was appointed governor and commander in chief in the Mediterranean with absolute powers and he introduced many important reforms. Trial by jury for criminal cases was established in 1829. An advisory council of government, composed of nominated members, was constituted by letters patent in 1835, but this measure only increased agitation for a representative legislature. Freedom of the press was introduced on the recommendations of John Austin and George Cornewall Lewis (later Sir George Lewis), royal commissioners, appointed in 1836. The chief government posts in the civil service were opened to the Maltese, sinecures were abolished, legal procedure was simplified and a police force established on the English model. Richard More O'Ferrall was appointed civil governor in 1847 and in June 1849 a legislative council was constituted with ten nominated and eight elected members. The practice of appointing military governors was reverted to in 1858, but the administration was largely confided to the chief secretary, with real power, at times, in the hands of the crown advocate.

Between 1854 and 1868 the criminal, commercial and civil laws were codified. Much of this work was carried out by the crown advocate, Sir Adrian Dingli (later chief justice and president of the court of appeal). An executive council was established in 1881 and the franchise extended in 1883.

In the 1880s an attempt to carry out measures prejudicing the privileged status of the Italian language in the island met with stiff opposition from Fortunato Mizzi, a lawyer, and his Nationalist party. Count Gerald (later Lord) Strickland joined forces with Mizzi and together they succeeded in obtaining the constitution of 1887, which established a legislative council consisting of 14 elected and only 6 official members. All those elected, including Strickland, were supporters of Mizzi's party. After a few months Strickland accepted a government post, and in 1889 he was made chief secretary. During the 1890s there was widespread agitation over the laws respecting mixed marriages, the Maltese relying on the Roman canon law, part of the law of Malta, and the English on the common law of England. The Holy See was consulted on the subject, but the question could not be settled to the satisfaction of both parties. In 1898, on opposite sides of the table, Mizzi and Strickland headed violent disputes in the legislative council on the language question, taxation and other subjects. The duel culminated in a council motion, passed by the elected majority, asking for the removal of Strickland from office. In 1902 he was made governor of the Leeward Islands. Mizzi would not yield on the language question and when the constitution was repealed in 1903, bureaucratic government with an official majority was again fully re-established for all local affairs.

During World War I the Maltese provided a garrison for the island and many naval seamen, as well as labour battalions for service at Gallipoli and Salonika. Postwar economic difficulties and agitation for constitutional reform led to violent rioting in Valletta on June 7, 1919. A national assembly was constituted similar to that set up in 1798, and a draft constitution was drawn up. In 1921 a constitution based upon the dyarchical principle was granted by letters patent. Members of the senate and house of assembly were to be elected by proportional representation; debates might be conducted in English, Italian or Maltese, but all official entries were to be in English or Italian. English was declared the official language of the administration and Italian the official language of record in the law courts. During the Nationalist administration the two sides of the dyarchy worked with little friction.

After the Strickland ministry took office in 1927, serious politico-religious trouble arose between government and church. The constitution was suspended in 1930, but restored in 1932. The Nationalists were elected to power, letters patent amending the constitution provoked an atmosphere of recrimination and in 1933 a second suspension followed. Then, by letters patent, Italian lost its position as an official language and as the language of the courts. In 1936 the constitution was revoked and full powers were vested in the governor until limited representation without responsibility was granted by the 1939 constitution. A council of government of 20 members was created, 10 being elected, 2 nominated and 8 official; the governor had a casting though not an original vote. The entire arrangement was much like that of 90 years earlier.

After Italy entered World War II in 1940 Malta was subjected to severe aerial attacks by German and Italian bombers based in Sicily. The island, 1,000 mi. from the nearest British position, became vitally important as a base of operations. For three years it was defended by the garrison and the people. At the height of the siege it was possible to send supplies of aviation gasoline and munitions to Malta only by submarine, while additional fighter aircraft of the Royal Air Force were flown to the island from the decks of distant carriers. Food became scarce. Despite the hardships, however, civilian morale remained high. On April 15, 1942, George VI awarded the George cross "to the Island Fortress of Malta to bear witness to a heroism and devotion that will long be famous in history." This was the first time that a medal had been conferred upon any part of the British Commonwealth. The siege ended in 1943: by June 30 of that year 1,436 civilians had been killed, 3,415 wounded or injured and about 37,000 buildings destroyed or damaged. The British government awarded more than £31,000,000 to Malta as compensation for war damage.

Government After World War II.—In 1947 self-government was once more granted to Malta. As in 1921 the constitution was based on the dyarchical system. It provided for a legislative assembly of 40 members elected by proportional representation; suffrage was extended to women; the official languages were to be English and Maltese.

In the first election under this constitution, Labour obtained 24 seats, but in 1949 the Labour party split and a Workers' party was formed. The island was administered between 1951 and 1954 by a coalition government drawn from the Nationalist and Workers' parties. The reunited Labour front was returned to power with 23 seats in 1955. The prime minister, Dom Mintoff, began negotiations looking toward Malta's integration with the United Kingdom; a round-table conference in London recommended Maltese representation in the house of commons but for three years Malta remained deeply divided on the issue. The Nationalist party under its leader, G. Borg Olivier, claimed ultimate dominion status; the Progressive Constitutional party led by Miss Mabel Strickland proposed quasi-dominion status. Following disagreement with Britain on economic and financial aid, Mintoff resigned in April 1958 and began to agitate for independence. Constitutional government broke down, a state of emergency was proclaimed and the 1947 constitution was revoked in 1959, being replaced by another which gave the governor full legislative and executive powers. Vigorous protests were raised and the political parties campaigned for an immediate return to self-government. A rift in the Nationalist party led to the formation of the Democratic Nationalist party (led by H. Ganado). A constitutional

commission was sent to Malta in Oct. 1960 to hear views on a future constitution. The Progressive Constitutional party proposed full internal self-government. The Democratic Nationalist party asserted its final aim of full autonomy within the Commonwealth but was prepared to consider, as an interim stage, a status similar to that of "internally self-governing state within the commonwealth" conferred on Singapore in 1958. The Nationalist party and the Malta Labour party boycotted the commission on the grounds that the terms of reference were too restricted.

The commission reported in March 1961 and met with a mixed reception. The new constitution was promulgated in Oct. 1961, and elections were held in Feb. 1962, with the Roman Catholic Church actively opposing the Labour party. The Christian Workers' party, which was hostile to Mintoff's anticlerical policies, won 4 seats; Mabel Strickland alone of her party was returned; the Democratic Nationalist party obtained 4 seats; the Labour party 16; and the Nationalist party 25. G. Borg Olivier formed a government and secured important constitutional amendments, but when he was refused additional aid by the U.K. government, he demanded independence. At a conference in London (July 1963) the Maltese parties failed to agree on an independence constitution. A referendum, upon which the British government was to have based its decision, was held in May 1964, but proved inconclusive. However, after further negotiations agreement was reached in July 1964 on the new constitution, and on defense and financial aid. On Sept. 21, 1964, Malta achieved independence within the commonwealth. (W. B. Pn.; A. G.)

POPULATION

The earliest recorded population estimates for Malta are those of an Arab amir of A.D. 991, giving a total of 21,000, and of 1240, showing 3,800 and 1,800 for Malta and Gozo, respectively. By about 1530 the total seems to have been about 20,000, of whom 5,000 were knights and their followers (of non-Maltese origin). Proper censuses began in 1842, when the total of 114,000 included 14,000 on Gozo. By 1957 the total had reached 319,620, with densities per square mile of 3,074 in Malta itself and 1,060 in Gozo. The population in 1962 was 328,989. The non-Maltese element (mainly servicemen and their families) fluctuates considerably and is not always clearly separable in census data.

Before the knights' arrival the inhabitants tended to cluster in small inland villages, with one major fortified town in the centre of each of the two main islands. When Valletta was built as a harbour and fortress on a hitherto barren peninsula, population was attracted to the city and its environs, with a parallel spread of settlement outside the old refuge towns. Valletta's population reached a maximum in the mid-19th century, after which it gradually declined. Twentieth-century trends were the establishment of new coastal settlements, the expansion of older ones and the peopling of the empty north round Mellieha bay and St. Paul's bay. In Gozo, however, there was less settlement on the coast.

The crude birth rate in the Maltese Islands, more than 40 per 1,000 in the 1840s, declined thereafter. There was a temporary increase in the 1880s and 1890s, but from the mid-19th century to the mid-20th century births averaged 30–35 per 1,000 in peacetime. In the 1950s there was a pronounced decline, the rate dropping to 26.1 in 1960. Indeed, from the early 1930s to the late 1950s the downward trend in births was more marked than in many other European countries. However, the death rate in Malta declined more rapidly than the birth rate. In the 19th century the figure fluctuated as a result of epidemics of cholera, smallpox and Malta (undulant) fever, and until World War II the death rate was generally between 20 and 30 per 1,000. From the late 1920s, as public health improved, there was a marked fall, the rate dropping to an average of less than 11 in the 1950s. By 1960 an excess of deaths over births (not uncommon a century earlier) had not occurred for nearly 20 years.

Thus, in the 1950s, because of the low death rate and relatively high birth rate, the natural increase was at its highest recorded level, the annual increment being about 5,000, or ten times that of a century earlier. Between 1842 and 1956 the natural increase of population was 267,000. Of this number about 70,000 emigrated, leaving a net increase of about 200,000. Although the proportion of Maltese who married was smaller than in Great Britain, for example, the average age of marriage was low and the fertility of married couples very high. Indeed some authorities concluded that in the 1950s the nuptial fertility rate was about 25% above that of the Republic of Ireland, long regarded as the highest in the world.

Because of the rapid growth of numbers and restricted natural resources, emigration played an important role. For a time in the 19th century many Maltese moved to the coastal zones of north Africa and the Levant, but in the 20th century America, Australia and Great Britain proved the more attractive. Emigration reached a peak in 1954, when more than 8,000 Maltese settled in Australia alone. In the late 1950s there were fewer outlets for migrants, and it became government policy to restrict emigration.

Language.—Among themselves the people speak the Maltese language. A significant but declining number also speak Italian, which was once the language of the church and administration, but in 1934 Maltese replaced Italian as one of the two official languages, the other continuing to be English.

Religion.—Malta has been described as one of the most devoutly Roman Catholic countries in the world; there are virtually no significant Protestant bodies other than those catering for non-Maltese. It is significant that the archbishop of Malta takes official precedence immediately after the governor. The educational system is inspired, patterned and partly maintained by the church, which also imposes a censorship on literature and films entering the island. After World War II, however, there was growing opposition to Roman Catholicism from left-wing trade unions and the Labour party, particularly in relation to the church's activities affecting the body politic.

Customs and Culture.—Malta's cultural pattern reflects its geographical situation, close to Europe but also not far from Semitic Africa. Family ties are extremely strong. Townsfolk often return temporarily to the family farm to help at harvest time, regarding themselves as part owners. Migrants overseas often hope to be joined by relations, and others return to Malta because of family connections. Café life is highly developed, and the main street of Valletta is closed to vehicles for a part of each evening in order to allow strolling and conversation. Women play a less prominent part in social life than men, but their role is by no means subordinate. Some women still wear the *faldetta*, a voluminous black hood and cape peculiar to Malta. There is an anglicized population, sometimes referred to as the Sliema group, as well as a Maltese order of nobility. (W. B. Fr.)

ADMINISTRATION AND SOCIAL CONDITIONS

Constitution and Government.—Malta is a constitutional monarchy and an independent member of the Commonwealth of Nations. The parliament of Malta consists of the governor-general, appointed by and representing the British sovereign, and a house of representatives of 50 members elected from ten electoral divisions by the single transferable vote system of proportional representation. The statutory life of parliament is five years. Executive authority is vested in the British sovereign but is normally exercised by the governor-general on the sovereign's behalf. The governor-general is usually required to act in accordance with the advice of the cabinet (the prime minister and other ministers). He appoints as prime minister the member of the house of representatives who is best able to command the support of a majority of the members of the house. The other ministers are appointed by the governor-general on the advice of the prime minister. The cabinet has the general direction and control of the government of Malta and is collectively responsible to parliament. The constitution contains a declaration of principles and a chapter on the fundamental rights and freedoms of the individual.

Taxation.—Before World War II indirect taxation on foodstuffs and other consumer goods accounted for about half of total revenue and constituted a heavy burden on the poorer classes.

After the war, although indirect taxation remained high, the burden was eased by the sharp rise in income per head. Bread and other foodstuffs were subsidized and high *ad valorem* duties were imposed on luxuries. Moreover, direct taxation was increased, income tax on a progressive scale being introduced in 1948. By the early 1960s, when less than two-thirds of the revenue was derived from taxation, about one-fifth of the tax revenue was accounted for by income tax and succession duty.

Living Conditions.—In the early 1960s, of about 90,000 gainfully occupied persons, three-quarters were wage and salary earners, mostly earning between £6 and £10 a week. Within ten years the average wage of employees had risen by nearly half, and in 1960 the minimum wage was raised by arbitration to £6 0*s*. 9*d*. a week. About 35 trade unions had a total membership of more than 20,000.

A social insurance program was introduced in 1956 covering employees over 14 years of age and providing cash benefits for marriage, unemployment, sickness, widowhood, orphanhood, industrial injury and old age. Under the National Assistance act, 1956, supplementary relief is given to households with limited means. A district medical service provides free treatment for the poor. In the early 1960s there were seven government hospitals in Malta itself and five in Gozo. Of about 75,000 households nearly one-fifth were officially described in 1957 as overcrowded. Most households lived in unfurnished accommodation, for which the rent averaged £7 a year for one room and £5 for each additional room, but about one-quarter were owner-occupiers.

Education.—In 1946 education became compulsory for children between 6 and 14, but full-time attendance for all was not achieved until ten years later. Primary education is mostly carried on at free government schools, the principal subjects taught being religion, arithmetic, English and Maltese. The grammar schools (also free) provide a course of studies fulfilling the requirements of either the general certificate of education or the Malta matriculation certificate. Students may then pass on to either the Royal University of Malta or one of the two teacher-training colleges. The university was founded in 1592 as the College of the Society of Jesus and became completely autonomous in 1961. Other educational facilities include evening classes for languages and commercial subjects, secondary technical schools, a technical school for craft training, a school for apprentices on the day-release (part-time) system, a small boarding school, a school of art and governmental industrial training centres.

Justice.—The main body of Maltese law was codified between 1854 and 1873. It is based mostly on French and Neapolitan law, but English principles have been followed in certain commercial and maritime matters and in procedural criminal law. Judicial precedent has no binding force. The chief justice and the seven other judges who preside in the superior courts are appointed by the governor on the advice of the prime minister. Professional magistrates sit in the inferior courts. Members of the bench, who are all Maltese, can be removed only in the event of proved misbehaviour or incapacity. The official language of the courts is Maltese, but an exception is made for English-speaking persons.

(A. G.)

ECONOMY

Malta has very few natural resources. There are no important minerals other than building stone, and even soil and water are in restricted supply. Malta's assets have been its geographical position—on an important intercontinental routeway and as a dominating strategic point for the central Mediterranean; a good deepwater harbour at Valletta (these are infrequent in the Mediterranean); a mild climate; and an abundant labour supply.

In the time of the knights income from outside (mainly from the estates owned by the order and by the knights personally) was an important element in the Maltese economy, perhaps exceeding £150,000 annually. There was also a valuable output of native cotton and cotton goods, both of which were exported, mainly to Spain. By the end of the 17th century this trade had reached an aggregate annual value of £500,000. About 1800, however, both sources of wealth were lost, the former by confiscation (most of the knights' estates were in France), the latter by an embargo on imports into Spain, following which the whole cotton industry, growing and manufacturing, gradually declined, becoming virtually extinct about 1860–80. During the Napoleonic Wars Malta was for a time an entrepôt for a large contraband trade with Europe and experienced a short-lived boom. Later in the century the island was important for bunkering, until, with the growth in size of ships, frequent intermediate coaling points were no longer needed, particularly as Malta had little commercial cargo justifying a call. Hence, more and more emphasis was placed on naval shipping, for which Maltese harbours were especially useful, and this function came to exert a predominant, almost overwhelming influence on Maltese economic life. Also, first army and then air force bases were gradually established. As a result, the whole economy of Malta became first influenced and then distorted by the British connection. The proportion of Maltese commerce based on indigenous resources and manufactures grew progressively smaller as service and governmental activities assumed greater significance. By the late 1950s, out of about 90,000 gainfully employed nearly 70,000 were employed either by the Maltese government, directly by the armed forces or in private industry and services supplying the armed forces. In the early 1960s, however, there was a decline in the armed forces stationed in Malta and some displaced workers were absorbed in new civilian industries.

Agriculture.—Because of the irregular nature of the surface and the easily eroded soil, cultivated areas occur mostly as strips or patches held by retaining walls that dominate the landscape. Outside the towns Malta appears to be a mass of low, irregular, stone walls, with tiny fields created and maintained by immense effort. Because of the size of the fields large agricultural machinery cannot be used, and most cultivation is either by hand, using light implements or, increasingly, by rotary cultivator. Rapid population growth has resulted in the subdivision of many holdings, and farms often consist of a number of small, scattered strips.

The main crops are wheat and barley, vegetables, fruit and fodder crops. These include green wheat and barley, and vetch, but the chief fodder crop is sulla (*Hedysarum coronarium*), a tall leguminous plant with a purple flower, covering about 10,000 ac. Because of the mild winters, a wide variety of plants can be grown; and in some parts enlightened methods are used with elaborate rotation of crops. Potatoes, tomatoes and some onions are grown for export, potatoes being especially important because, though small in quantity, they are very early and command a high price. Citrus and other fruit are grown mostly for home consumption, and the vine is also important in the west and north of the island. Wine is made, but it is of poor quality and suffers greatly from competition by foreign wine and from locally produced beer. The annual wine import averaging about £70,000 annually illustrates a remarkable paradox for a Mediterranean island. Again in sharp contrast to neighbouring areas, there is an almost complete absence of olives.

Animal husbandry is important. For long the goat was the chief supplier of milk, its tolerance of poor fodder and summer heat making it well suited to Maltese conditions. However, since goats' milk is the main carrier of undulant fever, the government began after World War II to follow, with some success, a policy of replacing goats by cows.

Fishing.—The fishing industry is comparatively unimportant because of the relative lack of fish in the Mediterranean, the deep sea bottom round most of the island and competition from foreigners. Fishing, being carried on from very small inshore boats, is affected by the weather, with frequent suspension of activity during December–April. In early summer lamps are used to attract the fish. In the late 1950s only about half the 600 fishermen were fully employed, but there were plans for improving the fishing harbour at Marsaxlokk, where about one-quarter of the 1,200 fishing boats were based.

Industry.—After World War II, and especially after 1959, efforts were made to attract industry, and a number of British and continental European firms established small plants. Brewing is a principal activity, and small consumer goods are also produced,

such as crown corks, buttons, clothing (including nylon stockings), foodstuffs and matches. Two traditional activities of Malta are lacemaking (still carried on in linen and cotton, especially in the Rabat-Mdina area) and silver filigree work (mostly in Valletta). In 1959 the naval dockyard, which then employed about 15% of the total working population of Malta, was transferred on a 99-year lease to a Welsh ship-repairing firm, the annual rent being fixed at £30,000 of which half would go to the Maltese government. A five-year capital development program was approved with the aim of attracting new industries, developing tourism and carrying out capital works. The Royal Navy agreed to continue major repairs in Malta for a short interim period, and in 1961 the British government undertook to lend most of the capital required for converting the dockyard to civilian use. Considerable hopes were raised by the growing oil traffic in the Mediterranean, especially following discoveries of oil in Libya, only 220 mi. away, which has few good harbours where extensive tanker maintenance and repairs might be undertaken. Between the late 1940s and early 1960s Malta's visible exports paid for only 5%–10% of its imports, and local agriculture supplied less than one-quarter of Malta's food requirements. The situation was being met by a grant-in-aid from the British government.

Trade and Communications.—Britain is the chief purchaser of Maltese products, as well as the chief supplier of goods, although Libya and countries of the northeastern Mediterranean also buy from Malta. The principal exports are potatoes, vegetables, hides and skins, buttons, hosiery and scrap metal, and the main imports foodstuffs, beverages, fuel oil, machinery and textiles.

Malta's road system was much developed and improved after World War II. Most parts of the island can be reached by bus services radiating from Valletta, and, subject to weather conditions, there are regular sailings from Valletta to Gozo. From a modern airfield at Luqa there are direct services to Britain, Italy, north Africa and the Levant. Fewer large passenger vessels call at Valletta than formerly, but there is much movement of cargo ships and the cruising traffic is growing in importance.

See also references under "Malta" in the Index. (W. B. Fr.)

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MALTA FEVER: *see* Brucellosis.

MALTE-BRUN, CONRAD (Malte Conrad Bruun) (1775–1826), one of the leading French geographers and the author and co-author of several extensive geographies, was born on Aug. 12, 1775, at Thisted, Den. A supporter of the French Revolution, he was banished from Copenhagen in 1800 for his political verses and pamphlets. Eventually he established himself as a journalist and geographical writer in Paris. His writings include volumes one through six of the *Précis de la géographie universelle* (1810–29). He originated the *Annales des voyages* in 1808. Malte-Brun took a broad view of geography, regarding it as complementary to natural history and as intimately related to the history, customs and institutions of mankind.

Malte-Brun was a founder of the Société de Géographie of Paris in 1822, the first modern geographical society. He died in Paris on Dec. 14, 1826.

His second son, Victor Adolphe Malte-Brun (1816–1889), followed his father's career of geographer. His special interest was the course of exploration, especially in Africa and the arctic. (G. R. Ce.)

MALTESE LANGUAGE, the only Semitic tongue officially written in the Latin alphabet, is a modern Arabic vernacular closely related to the western (Tripolitan, Algerian) Arabic dialects. In its phonetics, morphology, syntax and vocabulary it shows the strong influence of an earlier, later and continuing Sicilian (Latin) form of speech (cf. Maltese: *il-maktur,* "the handkerchief"; Sicilian: *maccaturu*). The contention that Maltese is descended from an ancient native Phoenician tongue current in the island at the time of the Roman occupation in 218 B.C. and continuing until A.D. 870, the date of the Saracen conquest, is completely untenable on cultural, historical and linguistic grounds. The Maltese of Gozo has interesting archaisms.

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MALTHUS, THOMAS ROBERT (1766–1834), English economist and demographer, best known for his theory that population increases faster than production, was born on Feb. 14, 1766, into a prosperous middle-class family dwelling near Dorking. His father's opinions and temperament are suggested by his friendship with David Hume and his devotion to the person and principles of Jean Jacques Rousseau. Before entering Jesus college, Cambridge, Malthus was educated largely at home. He was elected fellow of his college in 1793, took holy orders in 1797, married in 1804, and in the following year was appointed professor of history and political economy at the East India company's Haileybury college. He died near Bath on Dec. 23, 1834.

His opinions and teachings reflect largely a reaction—amiably conducted—to his father's views and the doctrines of the French Revolution. (Unlike Rousseau, who viewed human affairs from a theoretical standpoint, Malthus was an empiricist and began from the harsh realities of his time.) This reaction is developed in the tradition of British economics which would now be called sociological. In 1798 he published anonymously the first edition of *An Essay on the Principle of Population as it Affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and Other Writers.* He briefly, crudely, yet strikingly argued that infinite human hopes for social happiness must be vain, for population will always tend to outrun the growth of production. The increase of population will take place, if unchecked, in a geometrical progression, while the means of subsistence will increase at only an arithmetical progression. Population will always expand to the limit of subsistence and be held there by famine, war and ill-health. "Vice" (which included for Malthus contraception), "misery" and self-restraint alone would check this growth. Malthus was an economic pessimist, viewing poverty as man's inescapable lot. The argument in this first edition is essentially abstract and analytical. To subsequent editions which expanded the long pamphlet of 1798 into a massive book (6th ed. in 1826), Malthus added much factual material and illustration of his thesis, but at no point did he adequately set out his premises or examine their logical status. Nor did his handling of factual data reach any high level of sophistication. The American sociologist Kingsley Davis has remarked that Malthus' theories never had the empirical validity that he claimed for them but were nevertheless of great theoretical significance.

In biology it was Malthus who first set Charles Darwin and A. R. Wallace, quite independently, on the train of reasoning which led to the principle of natural selection. In economics the Malthusian theory of population was incorporated in the systems of Malthus' close friend David Ricardo (they met in 1811) and of subsequent economists. It acted as a brake on economic optimism, helped to justify a theory of wages that made the minimum cost of subsistence of the wage earner a standard of judgment, and discouraged charity. Demography is largely an increasingly statistical commentary on the first edition of the *Essay on Population.* The facts of industrial society, however, controvert the basic Malthusian theory: in industrial society national income tends to outpace population growth, and the size of the family in such societies has become a function of choice owing to the adequacy and prevalence of birth control. We do not yet understand much of the social psychology and sociology of fertility and of fluctuations in reproductive behaviour; we know that "misery and vice" do not explain them. In nonindustrial societies, however, the Malthusian model seems to possess a potentially threatening validity.

The influence of the theory of population on social policy was

great. It had been believed that fertility itself added to national wealth: the poor laws perhaps encouraged large families by their doles. If they had "never existed," wrote Malthus, "though there might have been a few more instances of severe distress, the aggregate mass of happiness among the common people would have been much greater than it is at present." The laws limited the mobility of labour, encouraged fecundity and should be abolished. For the most unfortunate it might be licit to establish workhouses, not "comfortable asylums," but places where "fare should be hard" and "severe distress . . . find some alleviation." These principles were to be enacted, were to enervate charity and cripple social reform for a century. Only by late marriage and "moral restraint" might, according to strict Malthusianism, the condition of mankind be, if briefly, relieved.

In 1800 Malthus published *An Investigation of the Cause of the Present High Price of Provisions.* He approached the problem of what determines price with a less rigorous analysis than Ricardo and with a bias to explanation in terms of an institutionally determined "effective demand," a phrase he invented. In 1820 in his *Principles of Political Economy Considered with a View to their Practical Application* he goes so far as to propose public works and private luxury investment—almost as Bernard de Mandeville did over a century earlier—as palliatives of economic distress which would increase effective demand. He went further and criticised thrift as a virtue knowing no limit; to the contrary, he argued, "the principles of saving, pushed to excess, would destroy the motive to production." To maximize wealth a nation must balance "the power to produce and the will to consume." In fact Malthus, as an economist, anticipated the economic discoveries of Lord Keynes in the 1930s and there is an unresolved discord between the economic consequences of his demography and the policy implications of his contribution to pure economics. For a century after his death the former was the dominant influence in economic thought and policy.

See also references under "Malthus, Thomas Robert" in the Index.

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(D. G. MACR.)

MALUS, ÉTIENNE LOUIS (1775–1812), French physicist, who made important discoveries concerning the polarization of light, was born at Paris on June 23, 1775. Dismissed without receiving a commission from the military engineering school at Mézières, because he was regarded as a suspected person (1793), Malus entered the French army as a private soldier. He was later sent to the newly established École Polytechnique in Paris, and after three years at the school was admitted into the corps of engineers. In 1798 he joined the Egyptian expedition, remaining in the east until 1801.

After his return, he held official posts successively at Antwerp, Strasbourg and Paris and did research in optics. He published a paper in 1809 covering his discovery of the polarization of light by reflection. The discovery gave impetus to the optical investigations of natural crystals by Sir David Brewster and others. In the following year Malus published a memoir on the theory of double refraction in crystals. He died in Paris on Feb. 23, 1812.

MALUS, a genus of the rose family (Rosaceae) including the apple (*q.v.*) and many ornamental and edible crab apples (*q.v.*).

MALVACEAE, the mallow family, a large group of flowering dicotyledonous plants, containing about 90 genera and over 1,500 species (sometimes arranged in fewer genera and species). Representatives occur in all except the coldest parts of the world but are most numerous in the tropics. Economically, the most important member of the family is cotton (*q.v., Gossypium*). Several *Hibiscus* (kenaf, roselle) produce fibres that are of lesser importance. The green fruits of okra (*q.v.; Hibiscus esculentus*) are cooked and eaten, and the mucilage secreted in tissues of some species has been used in certain confections (*see* MARSH MALLOW) and for other purposes. Thirty genera supply many species valued as ornamentals, among which are common mallow (*Malva*), hollyhock (*Althaea*), rose mallow or rose of Sharon (*Hibiscus*), Indian mallow (*Sida*), checkerbloom (*Sidalcea*), poppy mallow (*Callirhoë*), flowering maple (*Abutilon*), false mallow (*Malvastrum*), tree mallow (*Lavatera*), wax mallow (*Malvaviscus*), *Kitaibelia* and *Malope*. In the U.S. are 27 genera; additional ones occur from Mexico into South America. Only three genera (*Malva, Althaea, Lavatera*) are native in Great Britain, but the family is well represented in the Mediterranean region, Africa and Asia.

The Malvaceae includes annual and perennial herbs, shrubs and small trees. Their leaves, which alternate on the stem, are entire, toothed or palmately lobed or divided and mostly with deciduous stipules. Stellate hairs commonly cover some or most vegetative parts and even occur on the parts of petals exposed in bud in a few species. The flowers are regular, hermaphrodite (sometimes functionally either male or female) and often showy. They are borne alone or in loose clusters in the leaf-axils. A whorl of three or more bractlets is generally present below the calyx in many genera. Typically, there are five sepals and five petals with the petals tightly twisted in bud. The petals are fused to the staminal column at their bases and fall with the tube when the flower withers. A feature of the family is the central staminal column, surmounted by many kidney-shaped, one-celled anthers that open by terminal slits. The pollen grains are large, spherical and ornamented with spines.

ROCHE

MUSK MALLOW (HIBISCUS MOSCHATUS)

Pollination is by insects that seek the honey secreted in pits between the bases of the petals; self-pollination also occurs through the twisting of the stigmatic arms to touch the anthers. Carpels vary from two to many; when they number five the carpels are opposite the sepals (*Hibiscus*) or opposite the petals (*Abutilon*). In species having numerous carpels (*Malva, Lavatera, Sphaeralcea*) the carpels are arranged in a whorl around the top of the floral axis, with the stigmatic branches equaling or double the number of carpels and rising above the tip of the column. Each carpel produces one ovule (*Malva, Malvastrum*) to several ovules (*Sphaeralcea, Wissadula, Gossypium, Hibiscus*).

The fruit is a berry in *Malvaviscus,* a capsule in *Hibiscus* and *Gossypium* and a one- to several-seeded schizocarp in others. Marginal hooks or elastic strands on the schizocarps and mucilage or hairs on the seeds aid in dispersal.

Genera range in size from ten or fewer species (*Anoda, Iliamna*) to more than 200 (*Sphaeralcea, Hibiscus*). Several genera are exclusively American (*Sidalcea, Callirhoë*); others are almost worldwide in distribution (*Abutilon, Hibiscus, Malva*). A few species are troublesome weeds, *Malva rotundifolia* (called cheeses for the shape of its fruit) being the most pernicious. *See* also ABUTILON; HIBISCUS; HOLLYHOCK; MALLOW. (I. L. W.)

MALVERN, an urban district and spa resort of Worcestershire, Eng., lies 8 mi. S.W. of Worcester. Pop. (1961) 24,373. It is mainly on the eastern slopes of the Malvern hills, which run north and south for nine miles and rise from the Severn valley to a height of 1,395 ft. in the Worcestershire Beacon. The hills are administered by the Malvern Hills conservators and part of the southern end of the range is under the protection of the National Trust. Malvern chase, originally a crown land and forest, was granted to the earl of Gloucester by Edward I. The name Malvern is collectively applied to a number of former villages and hamlets.

The principal town is Great Malvern, lying beneath the Worcestershire Beacon. In early times Malvern was an ecclesiastical settlement and at Great Malvern was the Benedictine priory which

arose in 1085 out of a hermitage endowed by Edward the Confessor. The priory church of SS. Mary and Michael is a cruciform Perpendicular building, with a Norman nave and font. It is famous for its 15th-century glass and encaustic tiles; the great window in the north transept was presented by Henry VII in 1502.

Little Malvern, with remains of a Benedictine priory, now a parish church, lies at the foot of the Herefordshire Beacon, which is crowned by extensive and well-preserved hill fortresses of Iron Age date. Malvern Link, West and North Malvern and Malvern Wells are also in the district.

Malvern is now an educational and cultural centre, with Malvern college for boys (founded 1862), a further education college and school of art, a girl's college and a theatre (home of the Malvern Dramatic festival). Its mineral springs and pleasant surroundings have made it a favourite health and tourist centre. The large ballroom of the winter gardens is often used for conferences. The Royal Radar establishment, which is housed in Malvern, is the largest single employer in the town.

Jenny Lind, the Swedish singer, lies in the cemetery near the station, and Sir Edward Elgar, the composer, is buried in the Roman Catholic cemetery. (AL. C. C.)

MALVY, JEAN (1875–1949), French political figure whose tenure of the ministry of the interior led to his trial for treason during World War I, was born at Figeac, Lot, on Dec. 1, 1875. Inclined to the left in his sympathies, he entered the chamber of deputies as a Radical in 1906. He served as undersecretary under Ernest Monis (1911) and Joseph Caillaux (1911–12) and became minister of commerce under Gaston Doumergue (1913–14) and then minister of the interior under René Viviani. When World War I broke out he remained minister of the interior under Aristide Briand and Alexandre Ribot (1915–17); but on July 22, 1917, Georges Clemenceau charged him with lax administration in dealing with defeatists. Malvy resigned on Aug. 31, and the fall of the Ribot cabinet ensued. In October the royalist Léon Daudet brought against him a general accusation of high treason. At Malvy's own request the chamber of deputies decided that the senate, sitting as a high court, should try him on all the stated charges. On Aug. 6, 1918, he was acquitted of the charge of high treason but found guilty of *forfaiture* (culpable negligence in the performance of his duties) and sentenced to banishment for five years. He spent his exile in Spain.

Pardoned and returned to the chamber of deputies in 1924, Malvy represented France at the negotiations with Spain (Jan.–July 1925) for joint action against Abd-el-Krim. In Oct. 1925 he became chairman of the finance committee of the chamber. He entered the Briand cabinet of March 1926 as minister of the interior but this appointment roused bitter controversies and he resigned. He was again chairman of the finance committee in the chamber elected in 1928 and from 1932 to July 1940, when he retired from politics. He died in Paris on June 9, 1949. He had been a clever and able politician, but somewhat lacking in character.

See François-Albert, *Le Procès Malvy* (1920). (J. C. DE C.)

MALWA, a historic province of India, which gave its name to one of the political agencies into which Central India was divided under British rule. Strictly, the name is confined to the hilly tableland, bounded south by the Vindhya mountains, which drain north into the Chambal river; but it has been extended to include the Narmada valley farther south. From the Junagadh rock inscription it may be inferred that, in the 2nd century A.D., Rudradaman, the greatest of the western satraps, ruled over Avanti (*q.v.*); that is, both eastern and western Malwa. It formed part of the Gupta empire and was later annexed by Harsha. In the 9th century it was absorbed by the Gurjara-Pratiharas between whom and the Rashtrakutas of the Deccan the Narmada formed a fluctuating frontier. The first records of a local dynasty are those of the Paramaras, a Rajput clan, who ruled for about four centuries (800–1200) with their capital at Ujjain and afterward at Dhar.

The Muslims invaded Malwa in 1235 and in 1401 Dilawar Khan Ghori founded an independent kingdom, which lasted till 1531. In 1561 Malwa was annexed to the Mogul empire by Akbar. On the breakup of that empire, Malwa was one of the first provinces to be conquered by the Marathas, when it became a cockpit for fighting between the rival Maratha powers, and the headquarters of the Pindaris or irregular plunderers. The Pindaris were extirpated by the campaign of Lord Hastings in 1817, and the country was reduced to order by Sir John Malcolm.

Malwa is traditionally the land of plenty, in which sufferers from famine could take refuge. But in 1899–1900 it was visited by drought, followed by plague.

MALWA is also the name of a large tract in the Punjab, south of the Sutlej river, which is one of the two chief homes of the Sikhs, the other being known as Manjha. It includes the districts of Ferozepur and Ludhiana, together with the former cis-Sutlej states of Patiala, Jind, Nabha and Maler Kotla, all of them now in Punjab, India.

See R. Sinha, *Malwa in Transition* (1936). (C. C. D.)

MAMARONECK, a village in Westchester county, N.Y., U.S., is located on Long Island sound, about 5.5 mi. N.E. of the Bronx. Its name derives either from Mamaronock, a Wekquaeskeck (Mohican) chief, or from an Indian word meaning "where the fresh water meets the salt." Although part of a larger area acquired by the Dutch West India company in 1640, the site of Mamaroneck was resold by its Indian inhabitants on Sept. 21, 1661, to John Richbell, an English merchant from Massachusetts bay. In 1698 Caleb Heathcote, later mayor of New York city, purchased Mamaroneck from Richbell's widow. More than a century later James Fenimore Cooper resided in Heathcote Hill (De Lancey manor house) for several years and there wrote *The Spy*. Mamaroneck is a suburban community, with a fine marina and Harbor Island park. Major manufactures include metal-spraying equipment, electronic components, water heaters and tanks, lighting fixtures and metal stampings. It became an incorporated village in 1895 and adopted a mayor-village manager system of local government in 1931. For comparative population figures *see* table in NEW YORK: *Population*. (M. D. HH.)

MAMBERAMO, a river formed by the union of the Idenburg and Rouffaer rivers, is the lower portion of the largest drainage system of New Guinea. The system drains the Lakes plain, a depression parallel to the main axis of the island, and the surrounding mountains, the Idenburg and Rouffaer converging in a large wild sago swamp; from their junction the Mamberamo flows northward for approximately 130 mi. to the sea. Its first 20 mi. are placid, but the river then cuts through the Van Rees mountains in a series of rapids and gorges. Its lower course is navigable for large vessels, but the only settlements consist of native villages. (D. W. F.)

MAMBO, an offbeat rumba done to music in 4/4 time. It derives much of its excitement and colour from the use of brass and percussion instruments. In dancing the mambo, a step is taken on the fourth beat and held through the first beat, followed by a break (stepping forward, backward or sideward) on the second beat, and stepping in place on the third beat. Although the mambo foot patterns and breaks are essentially the same as in the more conservative rumba, the mambo is much freer in style.

The related cha-cha evolved from a rhythmical innovation done on the mambo offbeat to its present form as done on the downbeat. In dancing the cha-cha a step is taken forward or backward on the first beat, followed by a step in place on the second beat, followed by three steps (a ball change) forward, backward or sideward on the third and fourth beats. (B. WE.)

MAMELI, GOFFREDO (1827–1849), Italian poet and patriot of the Risorgimento, was born of a noble Sardinian family in Genoa on Sept. 5, 1827. A student of philosophy and law, he became an enthusiastic advocate of the ideas of Giuseppe Mazzini (one of his mother's admirers) and began to write patriotic poems. These included a hymn to the brothers Attilio and Emilio Bandiera (*q.v.*) and the poem "Fratelli d'Italia" (1847), which was set to music, sung throughout the wars of the Risorgimento and eventually made the Italian national anthem. He served with the volunteers against the Austrians in Lombardy in 1848 (*see* ITALIAN INDEPENDENCE, WARS OF) and met Mazzini in Milan. Having gone to Rome after Pope Pius IX's flight to Gaeta, Mameli on Feb. 9, 1849, sent the famous summons to Mazzini on the proc-

lamation of the Roman republic: "Roma! Repubblica! Venite!" Defending Rome with Garibaldi's forces (in which he refused a captaincy because of his lack of experience), he was wounded on April 30 and again on June 3 and died in the Pellegrini hospital on July 6, 1849. His writings were edited by A. Codignola in 1927.

MAMELUKE (Arabic *mamluk*, "owned"), the name given to white male slaves, chiefly Turks and Circassians, from Russia, the Caucasus and central Asia. Mobile and reliable soldiers, they were brought in by the caliphs of Baghdad to compensate for the military inadequacies of the Arabs and Persians. They progressively encroached upon the government until they became masters of the state and formed a military ruling caste.

The Fatimid sultans who governed Egypt from 969 to 1171 enlisted Mamelukes to free themselves from dependence upon north African and Sudanese troops. Saladin, who succeeded the last Fatimid, was himself a free Kurd, but he and his successors employed Mamelukes who were to form the spearhead of the Muslim resistance to the crusaders. Turanshah, the last free sultan, was followed by two Mameluke dynasties, the Bahri (1250–1382) and the Burji (1382–1517). The Mameluke sultans included Egypt, Cyrenaica, Syria, the Hejaz and northern Nubia within their dominions. Their politically chaotic, if culturally brilliant, regime, which endowed Cairo with some of its finest monuments, was overthrown by the Ottoman sultan Selim I in 1516–17. Under Ottoman governance the Mamelukes were retained as local governors, but by the 18th century they had recovered much of their former power and overawed the Ottoman governors general. They were finally destroyed by Mohammed Ali Pasha in a massacre in 1811. In Iraq the province of Baghdad was ruled by Circassian Mamelukes from 1749 until their elimination in 1831. *See* EGYPT: *History: Medieval Period; see* also references under "Mameluke" in the Index.

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MAMERTINI, so called from the Sabellian war god Mamers, were Campanian mercenaries hired from Italy by Agathocles (*q.v.*) of Syracuse. They seized the Greek colony of Messana (Messina) at the northeastern corner of Sicily (*c.* 288), settled there and plundered the surrounding country. Attacked by Hieron II of Syracuse (*c.* 265) they appealed to the Carthaginians, who sent a Punic garrison. Later they changed their minds and appealed to the Romans, thus providing the immediate cause for conflict between Rome and Carthage (264). On the Roman conquest of Sicily the town secured independence under treaty. The inhabitants were still called Mamertines in the time of Strabo, writing in the late 1st century B.C. (R. ME.)

MAMERTINUS, CLAUDIUS (fl. *c.* A.D. 360), Roman official, was the author of a panegyric on the emperor Julian delivered at Constantinople in A.D. 362 in the form of a *gratiarum actio* (thanksgiving) for the orator's elevation to the consulship. Mamertinus had already held high office under Julian's patronage, and later he was governor of Italy, Africa and Illyria under Valentinian I, but his career was terminated in A.D. 368 by a charge of embezzlement. Two earlier speeches in the collection of *Panegyrici Latini* (*see* below) are ascribed in certain manuscripts to a Mamertinus who cannot possibly be identified with Julian's Claudius Mamertinus. These were delivered, probably at Trier, in honour of the emperor Maximian; the first, probably in A.D. 289, on the anniversary of the foundation of Rome, the second, a birthday panegyric, in A.D. 291. All three speeches are important historical documents for their periods.

See W. Baehrens (ed.), *XII Panegyrici Latini* (1911); E. Galletier, *Panégyriques latins*, vol. iii (1955) and vol. i (1949) in which the two panegyrists are discussed respectively. (W. S. MS.)

MAMMAL, the name for any of the backboned animals in which the young are nourished with milk from special milk-secreting organs (mammae) of the mother. They constitute the vertebrate class Mammalia. Mammals are warm-blooded and typically have hair. The word "animal" is often used improperly as a synonym for "mammal," but animal (*q.v.*) properly refers to any living organism that is not a plant.

The following sections are included in this article:

I. General Features
II. Natural History
  1. Locomotion
  2. Social Life
III. Form and Function
  1. Skin and Hair
  2. Skeleton
  3. Dentition
  4. Musculature
  5. Nervous System
  6. Circulatory System
  7. Respiratory System
  8. Digestive System
  9. Urogenital System
IV. Reproduction and Development
  1. Courtship and Mating
  2. Gestation and Development
  3. Longevity
V. Distribution
VI. Evolution and Relationships
  1. Origin
  2. Adaptive Radiation
  3. Adaptations
VII. Classification and Survey
  1. Prototheria
  2. Allotheria
  3. Theria

I. GENERAL FEATURES

Mammals, about 3,500 known species of which are living, exhibit an extraordinary range in form, size and habits. Typical mammals, *i.e.*, those best exemplifying mammalian features, include man, dog, cow, rabbit and mouse. Among the less typical are the fishlike whale and seal, the birdlike bat, the plated armadillo and pangolin and the egg-laying duck-billed platypus. In size mammals range from a tiny bat or shrew scarcely larger than a bumblebee to the great blue whale, which reaches a length of 100 ft. and a weight of more than 175 tons. (The largest land mammal that ever lived was *Baluchitherium*, a gigantic hornless rhinoceros, from Oligocene and Early Miocene times, which stood 16–18 ft. high at the shoulders.)

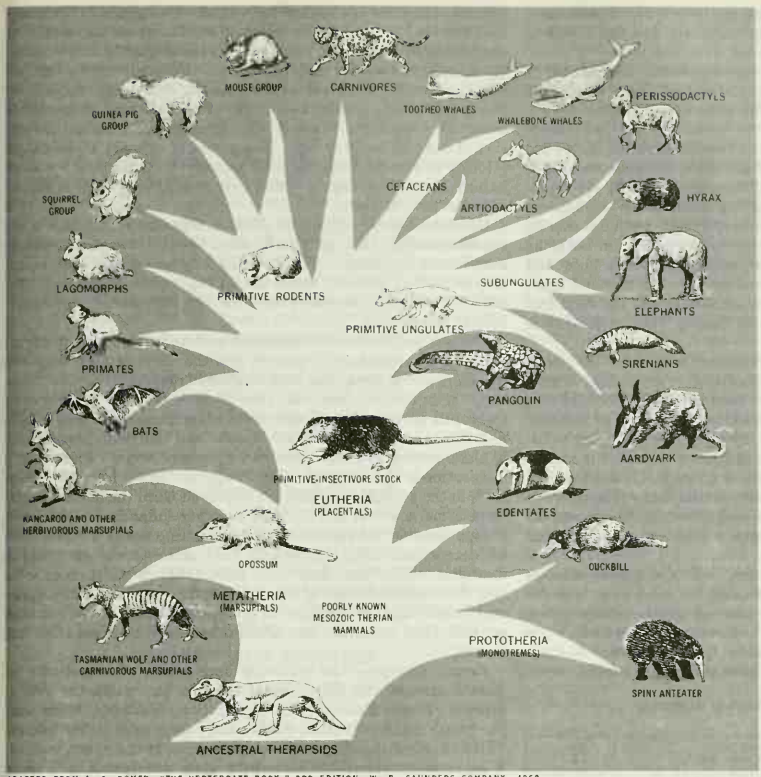
The class is world-wide in distribution, and its members have exploited a variety of ecological niches. It has been said that mammals have a wider distribution and are more adaptable than any other single class of animals, with the exception of certain lower forms such as the arachnids and insects. This versatility in exploiting the earth is attributed in large part to the ability of mammals to regulate their body temperatures and internal environment both in excessive heat and aridity and in severe cold.

Besides milk glands, many other features are diagnostic or characteristic of mammals. Hair (*q.v.*) is a typical mammalian feature, although in many whales it has secondarily disappeared except in the fetal stage. The lower jaw is hinged directly to the skull, instead of through a separate bone (the quadrate) as in all other vertebrates. A chain of three tiny bones (hammer or malleus, anvil or incus, and stirrup or stapes) transmits sound waves across the middle ear. A muscular diaphragm separates the heart and the lungs from the abdominal cavity. Only the left aortic arch of the primitive fourth pair persists; in birds the right arch persists, and in lower vertebrates (reptiles, amphibians and fishes) both arches are retained. Mature red blood cells in all mammals lack a nucleus; all other vertebrates have nucleated red blood cells.

Except for the echidna and the duck-billed platypus (*see* MONOTREME), which lay eggs, all mammals are viviparous: in man, the dog and the elephant, as examples of placental mammals (Eutheria), the young are carried to a high state of development before being born; in the pouched mammals (*see* MARSUPIAL), such as the kangaroo, opossum and wombat, the young are incompletely developed at birth and are afforded shelter and nourishment within the mother's pouch.

II. NATURAL HISTORY

1. Locomotion.—Mammals, like other tetrapods, are provided with two pairs of limbs used primarily for locomotion, although



ADAPTED FROM A. S. ROMER, "THE VERTEBRATE BODY," 3RD EDITION, W. B. SAUNDERS COMPANY, 1962

FIG. 1.—DIAGRAMMATIC FAMILY TREE SHOWING THE EVOLUTION AND RELATIONSHIP OF THE MAJOR GROUPS OF MAMMALS

they may secondarily become specialized for other purposes, as have the forelimbs of man, for example. Limbs may be lost, as happened to the hind limbs of whales and sirenians, but no mammal has ever had more than the typical two pairs of limbs.

In amphibians and reptiles the body is slung between the sprawled limbs (fig. 2). This is a relatively inefficient arrangement for locomotion on land, not much different from the position of the paired fins in fishes. Such animals habitually rest with the belly on the ground; they are incapable of sustained locomotion and move by crawling. In the extinct mammallike reptiles the limbs gradually shifted to a more favourable position beneath the body, the typical position for mammals. In this position the limbs can support the weight of the body with a minimum of fatigue, and can swing fore and aft in pendulum fashion, in walking or running.

The locomotor apparatus of mammals is typically adapted to walking or slow running on open ground. Generalized mammals still progress in this way—small rodents, many carnivores, most insectivores. But during the course of their evolution mammals have invaded all three of the major environments—land, water and air—and their limbs have undergone great adaptive radiation in each of these environments. Several distinct types of locomotion may be recognized, each of them being derived from the primitive walking type.

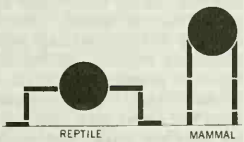


FIG. 2.—THE SPRAWLING POSITION OF THE LIMBS IN A REPTILE COMPARED WITH THE UPRIGHT POSITION IN A MAMMAL

Walking and Running-Walking.—This mode of locomotion is used by the hedgehog or the rat, in which the legs are of moderate length, well angulated at elbow and knee, and the hands and feet are each provided with five toes. The entire palm and sole are in contact with the ground (plantigrade posture). The legs are moved in an alternating sequence that leaves at least two feet in contact with the ground at all times; thus equilibrium is always stable.

Cursorial.—Sustained high-speed locomotion, as seen in horses and dogs for example, is associated with certain modifications in the limbs. The long, rodlike lower segments increase the length of stride and increase stability. The area of the foot that is in contact with the ground is reduced to a minimum to reduce friction, and the leg muscles are bunched toward the shoulders and hips in order to reduce the weight that must be swung as the leg is moved. Cursorial mammals stand and walk on their toes (digitigrade posture), and there is a strong tendency toward reduction of the number of toes. In the perissodactyls the middle (third) toe becomes dominant; in the horses finally it is the only functioning digit. In the artiodactyls the two middle (third and fourth) toes become dominant; in many artiodactyls, such as deer and cattle, they are the only functional digits. Cursorial mammals use various gaits when moving fast—the trot, the pace or the gallop.

Leaping.—Leaping locomotion occurs in several unrelated groups of mammals living on plains and open deserts: rabbits and hares, jerboas, kangaroo rats, kangaroos. The hind legs, particularly the lower segments, are much enlarged and strengthened. As in cursorial forms, the lateral toes tend to disappear. The hind legs move simultaneously to catapult the body through the air. In highly developed leapers the forelegs are no longer used for support, the animal resting on its hind legs with the tail forming the third leg of a tripod. During leaping the tail acts as a rudder to help maintain balance. From a mechanical standpoint this is a very inefficient and exhausting mode of locomotion.

Bipedal Walking.—This is the typical mode of locomotion in birds, but true bipedal walking, consistently employed, has been developed only once among mammals—in man. Gibbons are bipedal on the ground, but this is an unnatural form of locomotion because they never voluntarily descend to the ground. In bipedalism the whole body is held erect in the vertical position; consequently the structure of the entire body is profoundly affected by the new stresses and strains brought to bear. Most of the peculiarities of the human body can be attributed to man's upright posture. Bipedalism is not an efficient mode of locomotion; a great deal of energy is wasted in simply maintaining equilibrium.

Climbing.—Most small mammals with well-developed claws are able to climb trees and vines merely by digging their claws in, the typical mode of locomotion in squirrels. Larger, heavier mammals cannot rely solely on their claws, and either embrace the support (bears, porcupines) or have prehensile fingers for grasping it (primates). Extreme specialization for climbing leads to brachiation, as seen in certain monkeys, in gibbons and in the orangutan, where

the body is suspended from the arms and swung like a pendulum. In these forms the arms are greatly elongated, and the thumb is reduced so that the hand forms a hook.

Swimming.—Swimming types have evolved independently among several orders of mammals, and not all have solved the problems of aquatic locomotion in the same way. There is always a tendency for the legs to shorten, the hands and feet to broaden, the external ears to disappear and the nostrils to move up toward the top of the head. In whales and sirenians, the most aquatic of mammals, the tail is used for propulsion, the forelimbs are developed into flippers used for steering and maintaining equilibrium and the hind limbs have disappeared completely. Sea lions use the front flippers for propulsion, seals the hind flippers; in both the tail is vestigial. Otters swim by wriggling the whole body and tail in snake fashion; the legs are used only for steering and braking. Aquatic rodents (*e.g.*, beavers, muskrats) use the hind legs largely or exclusively for propulsion, folding the forelegs close against the body.

Aerial.—Two kinds of aerial locomotion have been developed among mammals: parachuting and true flight. Parachuting or gliding requires only a fold of skin stretched between front and rear legs on each side of the body. This simple device was evolved independently in the flying phalangers, flying lemurs and flying squirrels. True flapping flight demands much more extensive modification of not only the limbs but almost the entire body, and has been developed only once in the Mammalia—in the bats. The wings of bats are enormously enlarged hands and forearms, which support a thin membrane of skin; the hind legs are weak and cannot be used for walking.

Speed of Mammals.—Horses, racing dogs and human athletes can easily be timed over measured courses, but most records of the running speed of wild mammals are based on speedometer readings taken when an animal happened to be running parallel to an automobile. Scattered records, compiled by A. B. Howell in 1944, are the basis for the following table. Other sources may differ.

Maximum Running Speeds of Mammals
(m.p.h.)

Man (for 220 yd.)	22.5	Jack rabbit	40
Horse (for ¾ mi.)	42.3	African elephant	25
Dog (whippet)	34	Giraffe	28–32
Wolf	28	White-tailed deer	30
Coyote	40	Pronghorn	55–60
Cheetah	65–70	Bison	32

2. Social Life.—It is axiomatic that no species of mammal can lead a completely solitary existence, since contact between the sexes at mating, and between mother and young during the period of nursing, are unavoidable if the species is to survive. Such fleeting contacts between individuals are an elementary form of social life, and in some mammals this is the total of social existence—the sexes become antagonistic a few minutes after mating, and mother and young are associated only as long as they are together in the nest. From this rudimentary level, social structures of increasing complexity may be traced, through family, group and herd up to the involved composition of human societies.

Socialization.—If human societies are omitted from consideration, the social life of mammals appears extremely simple compared with that of the social insects (*q.v.*). Nowhere is there a caste system or any other division of labour except the most elementary one of group leader. Co-operation to build structures for common use, so general among the social insects, is singularly rare among mammals. Co-operation to ensure a common store of food is almost unknown. Socialization in mammals appears to be directed toward reducing the likelihood of disaster to the individual, rather than toward enhancing the effectiveness of the individual through co-operation within the group. Emphasis is on the welfare of the individual, whereas in the social insects the welfare of the group is paramount to that of the individual. The social life of mammals is far less stereotyped than that of social insects—or of other vertebrates, for that matter—depending to a much greater extent on individual intelligence and initiative. Such a system is therefore more adaptable to new or changing situations.

The bonds that hold a group together are not instinctive but are learned at an early age by each individual. This period of "primary socialization" is brief, after which it is difficult or impossible to change the pattern. The cues to which the animal becomes conditioned apparently involve all the senses. Normally during this period the young animal is integrated into its own group, but it may be experimentally conditioned to reject its own kind in favour of some other species to which it was exposed during the critical period of primary socialization. The period of primary socialization is longer in mammals than in other animals; it lasts only a few days in birds, whereas in dogs it occurs over several weeks and in higher primates several years.

Communication.—Any form of social organization depends upon communication of mutually understood signals between individuals constituting the group. These signals may be vocal, visual, olfactory or tactile. All four are in use among mammals, but their detailed significance, the extent to which they constitute "languages," is little understood.

Voice is the commonest means of communication among mammals. The vocabulary of sounds, and the effect of each on other members of the group, has been studied in detail for very few species. It is evident, however, that in such diverse forms as the California ground squirrel and the howling monkey there is a definite vocabulary of stereotyped sounds, and that individuals react to these sounds in predictable and consistent ways. Visual communication is less common. The "rump patches" of erectile white hairs in the pronghorn, which are displayed when the animal is disturbed, are a visual alarm signal to other individuals. In some groups, notably the carnivores and primates, there are repertories of stereotyped facial expressions that seem to convey specific meanings to other members of the group; these grimaces may indicate the emotional state of the individual. Scent is often important in individual recognition, in group recognition and in marking out individual territories into which other individuals are reluctant to trespass.

Family Groups.—The relatively long period of immaturity in most mammals, and the resultant need for protecting the young, make the family a natural unit of social organization. At its simplest, such a unit consists of mother and young, as in many rodents. This kind of relationship is dissolved as soon as the young mature. A permanent "marriage" between a male and female is a more stable social structure; such relationships are common among carnivores. Where the young mature very slowly, as in the higher primates, family groups may be quasi-permanent troops of a dozen or more individuals, from which the young are expelled as they mature. Such troops are usually sharply structured, with rigidly enforced systems of social hierarchy. There is rarely more than one mature male, who is the leader and defender of the troop, but there may be several mature females.

A beaver colony likewise consists of a family group, typically composed of one adult male, one adult female and the young of the present and the previous year. Only the colony occupies a pond, and the young are driven away as they mature. Beavers are unique among nonhuman mammals in showing co-operation for the common good in the construction and maintenance of dams and in the gathering of food.

Prairie dog "towns," on the contrary, are less organized than they appear to be. Although prairie dogs are gregarious, there appears to be little or no definite social organization or co-operative activity.

Breeding Aggregations and Herds.—Certain mammals, notably seals of various species, congregate in great numbers during the breeding season, when social organizations of considerable complexity may be formed. Where most elaborately developed, the breeding and nonbreeding animals separate and form separate temporary colonies. In the breeding colony each bull forms a harem of pregnant and virgin cows (numbering up to 30 in the elephant seal), which he jealously defends against other bulls. Each bull marks out a territory on the crowded beach, into which his cows are herded and which he defends fiercely. After the young conceived the preceding year are born and mating has again taken place, the harems break up.

Many plains animals tend to aggregate in herds that, in some

cases, reach vast proportions, which was formerly true of the American bison, for example. The composition of such herds varies in and out of the breeding season. During most of the year the males are either solitary or form loose bachelor herds and the females and young form separate herds, each under the domination of a female leader. During the breeding season the males join the female herds temporarily, each male usually forming a harem of several females.

Care-Dependency Relationships.—Unselfish or self-sacrificing actions, with no direct benefit to the individual, can be attributed only to the human species; it is given a high score on the scale of ethical values, but it may or may not be biologically justifiable as furthering species survival. Among all the other groups of mammals behaviour likened to the altruistic behaviour of man has always been traced to a purely biological motive, based on instinct or learning. Mutual care is commonly seen among monkeys and other primates that groom one another, examining the fur for parasites and other foreign matter; mice often exhibit a similar mutual grooming behaviour.

Among mammals, care-giving behaviour is commonly displayed by a mother providing for and defending her young. In highly socialized mammals, such as the higher primates, certain ungulates and canids, the males may participate in defense and may even take over the major responsibility. Among gregarious monkeys, the macaques and baboons, for example, an alarm cry from any member of the group brings an adult male promptly to the trouble spot. Instances of dogs remaining at the side of a wounded comrade or master are common, and there are authentic records of elephants assisting or transporting a mortally wounded comrade for some distance. Some mammals combine not only for mutual defense and care giving but also for aggression, as in the wolves and dogs and in certain primates. *See* ANIMAL BEHAVIOUR; PSYCHOLOGY, COMPARATIVE; SOCIOLOGY, ANIMAL.

III. FORM AND FUNCTION

In many ways mammals differ more from reptiles, their closest living relatives, than reptiles differ from the most primitive of living vertebrates, the fishes. (Even birds are more similar to fishes than they are to mammals.) The transition from reptile to mammal was, in fact, more of a revolution than an evolution. These revolutionary changes are especially evident in the structure of the head, but they can also be seen throughout the body. The anatomy of mammals is basically that of other vertebrates, but each of the anatomical systems shows features resulting from the "mammalian revolution."

1. Skin and Hair.—The most characteristic feature of the integument of mammals is hair, a structure found nowhere else in the animal kingdom. Hair serves the double function of insulating the body and protecting the skin against mechanical injury. Naked mammals such as whales and sirenians, which show only vestiges of hair, came from hair-covered ancestors. The skin of most mammals is well supplied with sweat glands (milk glands are modified sweat glands) and sebaceous or "hair sheath" glands that produce an oily substance. (*See* HAIR; SKIN.)

2. Skeleton.—*Skull.*—The skull, in particular, has been radically altered. Reduction in the number of elements making up the jaw and transformation of some of these into ear bones is mentioned below (see *Evolution and Relationships*). Several of the bones making up the brain case have also been eliminated in mammals: the tabulares, supratemporals, postorbital, postfrontal and prefrontals. A secondary bony palate has developed, separating the air passage from the food passage in the mouth and making it possible for mammals to chew and breathe at the same time. The bony elements surrounding the inner ear have been consolidated into a single bone, the periotic, which fuses with the squamosal. (*See* SKULL.)

Axial and Appendicular Skeletons.—In the vertebral column the most characteristic mammalian feature is the fact that mammals typically have seven neck vertebrae; the only exceptions are the manatee and certain sloths, in which changes in the first pairs of ribs have secondarily altered the apparent number of cervical vertebrae. The shoulder girdle of the majority of living mammals is much simpler than that of reptiles, some elements having been eliminated and others consolidated so that the mammalian girdle consists only of a scapula (shoulder blade) and clavicle (collarbone). In the monotremes, on the contrary, the shoulder girdle is essentially reptilian. The bones of the pelvis and limbs have undergone less conspicuous changes than has the shoulder girdle. (*See* SKELETON, VERTEBRATE.)

3. Dentition.—One of the most important characteristics of the Mammalia is the differentiation of the dentition into four kinds of teeth: incisors, canines, premolars and molars. This differentiation had already taken place in the more advanced mammallike reptiles, and was doubtless associated with the more efficient handling of food required by a higher rate of body metabolism. The incisor-canine-premolar-molar plan is a fixed pattern within the Mammalia, and is therefore a useful tool in classifying mammals.

The dentition of any species can be conveniently expressed by means of a formula. Since the two halves of each jaw are mirror images of each other, only one-half need be included in the formula; the total number of teeth is twice the total of the formula. For example, *Amphilestes*, a Middle Jurassic triconodont, had 4 incisors, 1 canine, 4 premolars and 5 molars in each half of each jaw (a total of 56 teeth). Its dental formula is written:

$$\mathrm{I}\frac{4}{4}\ \mathrm{C}\frac{1}{1}\ \mathrm{P}\frac{4}{4}\ \mathrm{M}\frac{5}{5}$$

In therian mammals (all extant mammals except monotremes) the pattern of differentiation has been carried still further. The full marsupial dentition, as seen in the opossum (*Didelphis*) is 5 incisors above and 4 below, 1 canine, 3 premolars and 4 molars—a total of 50 teeth. The full placental dentition, as seen in the European mole, for example, is 3 incisors, 1 canine, 4 premolars, and 3 molars; and since each tooth has a fixed position in the row, it may be assigned a number that identifies that particular tooth in all placental dentitions. The dental formula for the mole, and the primitive one for the Eutheria with the full complement of 44 teeth is then: $\mathrm{I}\frac{1\,2\,3}{1\,2\,3}\ \mathrm{C}\frac{1}{1}\ \mathrm{P}\frac{1\,2\,3\,4}{1\,2\,3\,4}\ \mathrm{M}\frac{1\,2\,3}{1\,2\,3}$

Very few placentals have the full placental dentition, various teeth having been lost during the adaptive radiation of mammals (*see* below). The formula may be written to show which teeth have been lost in a particular species. Such a formula for man, with 32 teeth, is: $\mathrm{I}\frac{1\,2\,.}{1\,2\,.}\ \mathrm{C}\frac{1}{1}\ \mathrm{P}\frac{.\,.\,3\,4}{.\,.\,3\,4}\ \mathrm{M}\frac{1\,2\,3}{1\,2\,3}$, the dots indicating that the third incisor and the first two premolars in each jaw have been lost. The corresponding formula for the rat, which like other rodents has a single huge chisellike incisor (the second of the original three incisors) followed by a toothless gap in each jaw, is: $\mathrm{I}\frac{\cdot\,2\,\cdot}{\cdot\,2\,\cdot}\ \mathrm{C}\frac{\cdot}{\cdot}\ \mathrm{P}\frac{\cdot}{\cdot}\ \mathrm{M}\frac{1\,2\,3}{1\,2\,3}$, totaling 16 teeth. On the basis of the primitive placental mammalian cusp pattern (three cusps arranged in a triangle) the American paleontologist E. D. Cope developed his "tritubercular theory" and H. F. Osborn proposed a system of naming the cusps for consistency in the study of dentition.

Each lower molar has, in addition to the primary triangle, a basin-like heel (called the talonid), into which the innermost cusp of the upper molar fits (fig. 3). In many of the more specialized mammalian dentitions a fourth cusp appears on the tongue side of the upper molars, in a new area called the talon, producing a square tooth. (*See* TEETH.)

The primitive type of therian dentition, as seen in the opossum and generalized insectivores, has undergone extensive change

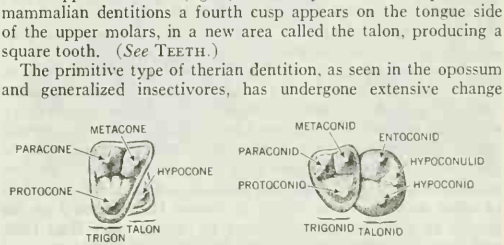


FIG. 3.—PRIMITIVE CUSP PATTERNS ON MAMMALIAN MOLAR TEETH: (LEFT) LEFT UPPER MOLAR; (RIGHT) LEFT LOWER MOLAR

among the various orders of mammals. At one extreme, the cheek teeth (premolars and molars) of certain rodents have become so complex that it is almost impossible to identify the cusps of the original tritubercular pattern. In the toothed whales the number of teeth tends to increase, some species having nearly 250. At the other extreme, the whole dentition has disappeared in the toothless whales and in the anteaters and pangolins. For the most part, modifications of the original tooth pattern are closely associated with food habits, for teeth are primarily tools for the seizing and mechanical processing of food. Man and most other omnivorous primates have the cheek teeth square and provided with rounded cusps for crushing. In strict flesh eaters, such as the cats, the functional cheek teeth are reduced to one in the upper jaw and one in the lower; on these teeth the cusps are in line and interconnected by sharp crests to form a pair of shears that can only cut. In herbivorous mammals, such as horses, cows and many rodents, the cheek teeth tend to become long, flat-crowned structures, provided with transverse enamel ridges on the chewing surface, that operate like millstones in grinding plant fibres. Mammals that habitually feed on grasses and other plants containing silica, which is extremely abrasive and wears teeth down rapidly, are faced with the problem of making the teeth last for the normal life span of the individual, since teeth normally do not grow once they have erupted. In some mammals, certain hoofed mammals and many rodents, for example, this problem is solved by having the teeth continuously grow up from the root, thus replacing what is worn off. In elephants the same problem is solved by having only one tooth in each jaw in function at a time, with new teeth erupting successively in the rear and moving forward to replace the one that is worn out. This is continued until the full complement of teeth has been used up, after which no more teeth are available and the animal may starve. Exclusively fish-eating mammals, such as certain whales, have the teeth reduced to a row of simple conical pegs in each jaw. Such teeth, which resemble the undifferentiated teeth of reptiles, actually are a secondary simplification of typical mammalian teeth, no closer to reptile teeth than are the teeth of any other mammal.

4. Musculature.—The muscular system in all lower vertebrates, including birds, is so similar that individual muscles can be homologized (compared as being derived from a common ancestral form) with certainty all the way down the scale to the sharks. In mammals this is no longer true; the plan and organization are the same as in other vertebrates, but details of the individual muscles are so different that it is often impossible to homologize them with their counterparts in reptiles. This is particularly true of the head, where the jaw muscles have been so revolutionized in mammals that they cannot be identified by the same names that are used for all other vertebrates. (*See* Muscle and Muscular System.)

5. Nervous System.—*Brain.*—The mammalian brain is characterized by great development of the outer layer, or cortex, of the cerebrum. The cerebral cortex is the seat of psychic or associative functions, as contrasted with the control functions of the more primitive parts of the brain. The cerebral cortex is often referred to as the neopallium, or new cortex, as opposed to the archipallium, or old part of the forebrain. In man, where it is best developed, the neopallium is larger than all the rest of the brain.

Information as to environmental conditions is continually being received by the numerous receptors of the body. In mammals all, or nearly all, of this information is fed along a widely ramifying nerve network into the cerebral cortex, which thus contains a continually changing picture of the environment. The cortex then acts like a vast computing system, relating input information to past experience in order to devise a response that is most likely to lead to the survival, or comfort and welfare, of the organism. Thus in mammals, in contrast to all other vertebrates, almost every act of the individual is influenced to some degree by the cerebral cortex. The individual mammal is able to profit by experience, to learn, to a far greater degree than other animals can. The behaviour of mammals is thus less instinctive than is the behaviour of other animals. The ability to reason (here defined as the faculty to solve complex problems by means other than trial-and-error procedure) appears sporadically and weakly in some lower mammals, is more highly developed in the primates and reaches its fullest flowering in man. The primates and man are also the most rapid learners.

The brain is relatively larger in mammals than in other vertebrates, but the actual size of the brain varies enormously among mammals (*see* table). The brains largest in actual size are found in whales and elephants; some of the small monkeys, however, have brains largest in relative size, many being relatively much larger than that in man.

Brain Weight in Mammals
(Ratio of brain weight to body weight)

Indian elephant	1 : 560	Dog	1 : 118
Dolphin	1 : 432	Macaque	1 : 71
Pilot whale	1 : 400	Man	1 : 50
Domestic sheep	1 : 254	Marmoset	1 : 28
Rat	1 : 208	Spider monkey	1 : 21
Leopard	1 : 168		

Casts of the brain cavity of the skull give an accurate picture of the size and shape of the brain. The brain casts of many fossil mammals show that in the more progressive stocks there was a steady increase in the size and level of development of the brain. In the horse line, for example, the brain of the earliest horse (*Hyracotherium*) was at about the level of development of the opossum. (*See* Brain; Nervous System; Neurology, Comparative.)

6. Circulatory System.—In reptiles and other lower tetrapods oxygenated blood coming from the lungs is more or less mixed in the heart with de-oxygenated blood coming from the body circulation. In mammals (as in birds) the heart is a four-chambered double pump, and there is no such mixing of blood: in mammals the left half of the heart handles only oxygenated blood, the right half only de-oxygenated blood. This complete separation of systemic and pulmonary circulations represents an enormous increase in metabolic efficiency, which is intimately associated with maintaining a high constant body temperature. This efficiency is further increased by the fact that the red blood cells are much smaller and more numerous in mammals and birds, which greatly increases the combined total surface available for gas exchange. The significance of nonnucleated red blood cells, which are found only in mammals, is unknown.

That the left aortic arch is retained in mammals, whereas in birds the right arch is retained, is no doubt a historical accident, but it emphasizes the deep-seated differences between mammals and birds, which arose from quite different reptilian stocks. There is no reason for believing that one arrangement of the arches is more efficient than the other. (*See* Blood; Circulation of Blood; Circulatory System.)

7. Respiratory System.—The respiratory system in mammals consists of paired lungs suspended in separate pleural compartments on either side of the heart. An adequate and rapid supply of air is required for the maintenance of high body temperature. Air is breathed into paired nasal cavities, partly separated from the digestive system, through openings on the snout called external nares. Nasal structures and lungs reach their greatest development in size and complexity in mammals. The turbinals, highly coiled and provided with olfactory receptors, and the sinuses associated with the nasopharyngeal region are also highly developed. A very efficient suction mechanism operates: a tendinous and muscular diaphragm, which separates the abdominal cavity from the thorax, is pulled down and the rib cage expanded, creating distension of the spongy lungs; air then rushes in through the branching system of cartilage-ringed tubes, the bronchi and bronchioles, to the finely subdivided cells called alveoli, wherein gaseous exchange takes place with the blood. (*See* Respiration; Respiratory System, Anatomy of.)

8. Digestive System.—The features along the gastrointestinal tract are merely further developments of the earlier originated structures in other higher vertebrates: esophagus, stomach, small and large intestines, rectum and anus. Among the many remarkable alterations are the specialized stomach types that appear, foremost among them being the ruminant (*q.v.*) stomach in cud-chewing mammals. A well-defined buccal cavity is framed by mobile lips; the tongue is the chief bearer of the taste buds. Sali-

Koalas, marsupials found in limited numbers in Queensland and Victoria, Australia, where they live in eucalyptus trees

So-called four-eyed opossum, order Marsupialia, found in Central and South American jungles

Cuscus, a slow-moving nocturnal marsupial found in the Australoid Indies

Gray kangaroo, marsupial of the plains of New South Wales and open forests of Queensland, Australia

Duck-billed platypus, a semiaquatic monotreme inhabiting the streams and rivers of southeastern Australia and Tasmania

Spiny anteater (*Tachyglossus*), order Monotremata, a native of Australia, Tasmania and New Guinea

MARSUPIALS AND MONOTREMES

BY COURTESY OF (BOTTOM RIGHT) AUSTRALIAN NEWS AND INFORMATION BUREAU; PHOTOGRAPHS, (TOP LEFT) PROF. GRZIMEK, FRANKFURT, (TOP RIGHT) POLLOCK—FPG, (CENTRE LEFT) JERRY COOKE—PHOTO RESEARCHERS, (CENTRE RIGHT) PROF. GRZIMEK, FRANKFURT, FROM PUBLIX, (BOTTOM LEFT) LINDGREN—PHOTO RESEARCHERS

MAMMAL

Common North American mole, order Insectivora. This species, one of the eastern moles, is found in the central plains and the east

INSECTIVORES AND BATS

Red bat, order Chiroptera, found in North and South America, the West Indies, Bermuda and the Galapagos Islands

Short-tailed shrew, an extremely active insectivore common in the eastern United States, lives in fields or among dead leaves on the forest floor

Flying "fox" or fox bat, largest of the bats, is native to Asia, Madagascar, Australia and the West Indies

Red elephant shrew, an insectivore, is a forest-dwelling species of the Congo and Kenya in Africa

Common hedgehog, an insectivore. Its homeland extends eastward from England and Ireland to maritime Siberia, Manchuria and Korea

PHOTOGRAPHS, (TOP LEFT) CHARLES E. MOHR FROM NATIONAL AUDUBON SOCIETY, (TOP RIGHT) AUSTING—PHOTO RESEARCHERS, (CENTRE LEFT) JOHN H. GERARD, (CENTRE RIGHT) PROF. GRZIMEK, FRANKFURT, (BOTTOM LEFT) DES BARTLETT—ARMAND DENIS PRODUCTIONS, (BOTTOM RIGHT) JOHN MARKHAM FROM PHOTO RESEARCHERS

Baboon mother and young from the plains of east Africa

Male mandrill. The mandrill inhabits dense forests of west Africa

PRIMATES

Langurs, graceful arboreal monkeys common in southeast Asia

Red-faced uakari from the rain forests of north central South America

Tarsier, found in the equatorial forests of Malaysia and the Philippines

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT) HOLTON—PHOTO RESEARCHERS, (TOP RIGHT) KINNE—PHOTO RESEARCHERS, (BOTTOM LEFT) CY LA TOUR AND SAN DIEGO ZOO, (BOTTOM RIGHT) CY LA TOUR

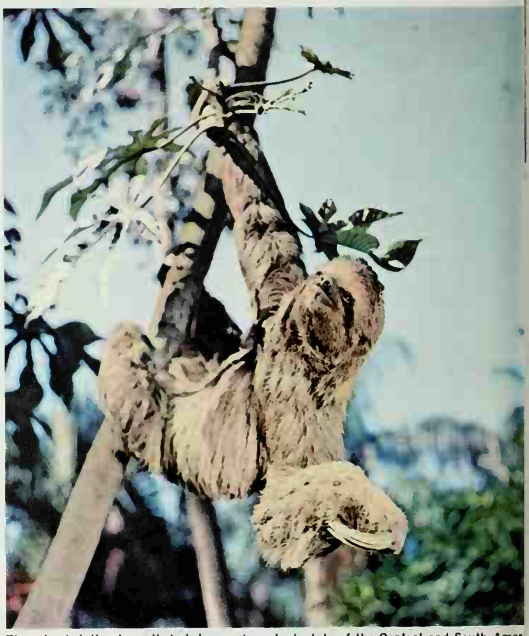
MAMMAL

Three-toed anteater, or tamandua, order Edentata. It lives in trees and is found from southern Mexico to Paraguay

Hairy armadillo, or peludo, an edentate. This species inhabits South America from Panama to the Argentine pampas

Pangolin, or scaly anteater, order Pholidota, is native to tropical Asia and Africa

EDENTATES AND RELATED ORDERS



Three-toed sloth, also called ai, is an arboreal edentate of the Central and South American tropics

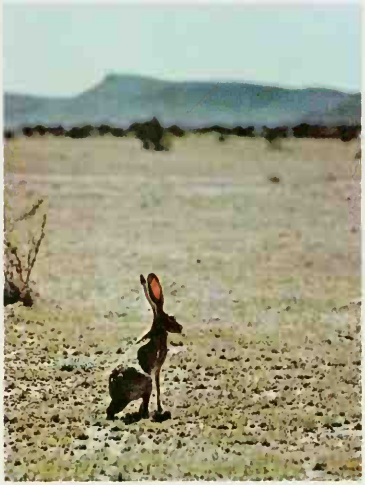
Aardvark belongs in an order of its own, Tubulidentata. It is found only in Africa, south of the Sahara

PHOTOGRAPHS, (TOP LEFT) HERMES—FPG, (TOP RIGHT) JOHN MARKHAM, (CENTRE LEFT) PROF. GRZIMEK, FRANKFURT, (BOTTOM LEFT) DES BARTLETT FROM PHOTO RESEARCHERS, (BOTTOM RIGHT) PARIS MATCH

Porcupine, order Rodentia, found in the woodlands of northern and western U.S. and most of Canada

Cottontail rabbit, order Lagomorpha. It lives in meadows and other open places near wooded areas throughout North America

White-footed mouse, or deer mouse, a rodent found throughout North America



Jack rabbit, a lagomorph. Technically a hare, it is a native of North America

RODENTS AND LAGOMORPHS

Golden-mantled ground squirrel, a rodent that lives in open woods or edges of meadows in western North America

Muskrat, a North American rodent whose habitat includes fresh-water and brackish marshes, lakes, ponds and watercourses

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MAMMAL

Short-tailed weasel, found in Europe and Asia. In the northern part of its habitat the weasel grows white fur in the winter

Striped skunk, found in Canada, the United States and as far south as northern Mexico

Raccoon; its habitats are watercourses, lakes and marshes throughout North America

Lesser panda, found in the mountain forests of Szechwan, China, and Tibet at altitudes ranging from 6,000 to 12,000 ft.

CARNIVORES

Common Eurasian otter found from northern Africa throughout Europe and Asia north to the arctic

Indian mongoose menacing a cobra. The mongoose, native to southern Asia, is noted as a natural snake killer

PHOTOGRAPHS, (TOP LEFT) JOHN MARKHAM, (TOP RIGHT) KARL MASLOWSKI FROM PHOTO RESEARCHERS, (CENTRE LEFT) LANKS—FPG, (CENTRE RIGHT) TOMSICH—PHOTO RESEARCHERS, (BOTTOM LEFT) KINNE—PHOTO RESEARCHERS, (BOTTOM RIGHT) YLLA FROM RAPHO GUILLUMETTE

Cape hunting dog of Africa; it is a predator of the brush country south and east of the Sahara desert

Leopard or panther, found in almost all parts of Africa except the Sahara and widely distributed in Asia

Black bear inhabits the wilderness forests of North America from Alaska to central Mexico

Young margay, one of the smaller South American cats that live in forests ranging from Paraguay to Texas

CARNIVORES

Cheetah, purported to be the swiftest animal on foot, lives in Africa south of the Sahara and in parts of Asia

Gray fox, found throughout the United States and ranging south to the northern part of South America

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MAMMAL

White rhinoceroses, order Perissodactyla, of east African plains (Mt. Kilimanjaro in the background)

Wart hog, a common species of swine (order Artiodactyla) on the plains of Africa

American bison, an artiodactyl once numerous on the western plains of North America, are now confined to government preserves

Grant's zebra and young, perissodactyls from the east African plains

PERISSODACTYLS AND ARTIODACTYLS

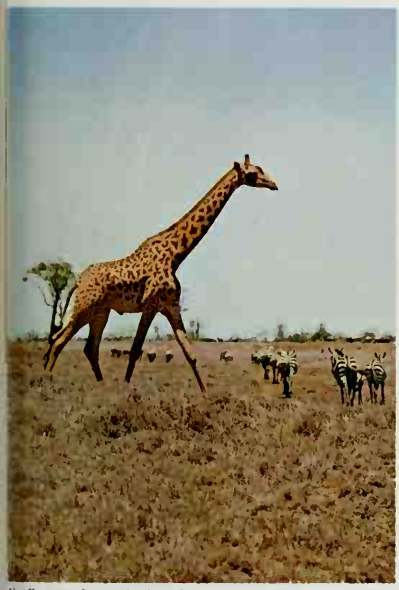
Hippopotamus, an artiodactyl now restricted to large rivers and swamps of west Africa

PHOTOGRAPHS (TOP LEFT) TREVOR—PHOTO RESEARCHERS, (TOP RIGHT) BOB CAMPBELL—ARMAND DENIS PRODUCTIONS, (CENTRE LEFT) CY LA TOUR, (CENTRE RIGHT) PROF. GRZIMEK, FRANKFURT, FROM PUBLIX (BOTTOM) PETERSON—PHOTO RESEARCHERS

Scimitar-horned oryx, an African antelope, ranges the arid steppes on the Sahara's southern fringe

Caribou, or reindeer, inhabiting the tundra of arctic Europe, Asia and America. The caribou is unique among deer in that both sexes have antlers

ARTIODACTYLS



Giraffe, one of several subspecies common throughout the African plains

Pronghorn, or "American antelope," found in open plains of western North America, is the only living member of the family Antilocapridae

One-humped camel, native to the near and middle east, is now an entirely domesticated animal

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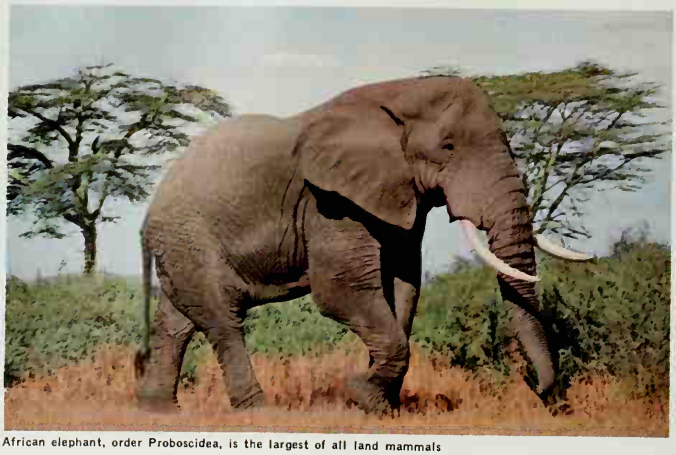
MAMMAL



African elephant, order Proboscidea, is the largest of all land mammals

ELEPHANT, HYRAX AND AQUATIC MAMMALS

California sea lions, fin-footed carnivores, among the smaller species of eared seals

Walrus, also a carnivore. This large arctic mammal is found in the northern circumpolar areas

Tree hyrax, in an order of its own, Hyracoidea, is native to forested regions of central and south Africa

White whale, or beluga, order Cetacea, of circumpolar arctic waters

PHOTOGRAPHS, (TOP) MYERS—FPG, (CENTRE LEFT) CY LA TOUR (CENTRE RIGHT) GOLD—FPG, (BOTTOM LEFT) JANE BURTON (COLEMAN & HAYWARD), (BOTTOM RIGHT) ALEXANDER—FPG

vary glands in the mouth initiate digestion of starches; completion of digestion occurs in the variously coiled intestines. A caecum (the appendix in man) is most highly developed in plant-eating mammals like rabbits and hares. (*See* Digestion; Gastrointestinal Tract; Nutrition.)

9. Urogenital System.—The most important excretory organs of mammals are the paired kidneys, highly efficient filters for removing nitrogenous waste products and excess water from the blood. But the skin, with its sweat glands, the lungs and digestive tract also serve important roles in excretion. (*See* Excretion [Kidney]; Perspiration; Urinary System.)

The reproductive organs are so intimately associated with the excretory (kidney) system that the two systems are often considered together as the urogenital system. In the monotremes there is a cloaca, a common reservoir or vestibule into which the digestive and urogenital systems release their products. Higher mammals have attained a separation of these systems. The external genitalia of marsupial and placental mammals are highly developed: the urethra (which also carries urine) courses through the penis of the male; the erect penis is introduced into the female vagina wherein sperm is ejaculated. Sperm may unite with an egg, and the resulting embryo, except in the monotremes, is nurtured in the uterus in close association with the maternal tissues. *See* Reproductive System.

IV. REPRODUCTION AND DEVELOPMENT

1. Courtship and Mating.—Formal ritualized courtship, as occurs for example in birds, is not found among most mammals. Instead, the cyclical periods of heat, or estrus, in the female create receptivity to copulation, thus ensuring mating and continuance of the species. But among the primates, and especially in man, periods of sexual receptivity are not clearly demarked, and courtship, a form of enticement by the male, assumes importance. Adornments and ritual, however, still appear in restrained form. (*See* Courtship, Animal; Sexual Behaviour; Reproduction.)

2. Gestation and Development.—One of the most characteristic features of placental (eutherian) mammals is the fact that the young develop to a relatively advanced state within the body of the mother. The most important benefit from this arrangement is that, with food supply assured, the development time of the young can be greatly extended. In egg-laying animals, by contrast, the development time is limited by the quantity of yolk that can be stored conveniently in the egg. Lengthened development time seems to be related to the large size and high degree of development of the mammalian brain at birth. The period of intrauterine development in mammals varies considerably: the shortest period, 12 to 16 days, occurs in the American opossum, a marsupial in which the incompletely developed newborn undergo further development in the mother's pouch; the longest period, about 22 months, is found in the Asiatic elephant. (*See* Gestation Period.)

There is, of course, a limit to the number of young that can be carried in the mother's body. Mammals typically produce a small number of young at a birth—one or two in the vast majority of species. The largest litter size among mammals occurs among the primitive Madagascan insectivores, where as many as 20 young may be produced at a single birth.

The developing embryo requires not only elaborate arrangements for protection but also for provision of food and oxygen and elimination of wastes. The embryo is sheltered within the uterus or womb, a typically mammalian modification of the vertebrate oviducts, and is further protected by the amnion, a fluid-filled sac within which the embryo floats (*see* Vertebrate Embryology). Nourishment reaches the embryo by way of the placenta, an elaborate structure made up of fetal membranes and the lining of the uterus. The placenta, which contains an intricate network of blood vessels from both the mother and the fetus, allows the interchange of food and waste between mother and fetus. The placenta is shed at birth (*see* Placenta).

In the monotremes the female reproductive system is typically reptilian. As in reptiles, the intestine and urogenital system open into a common chamber, the cloaca. The two oviducts open into the cloaca separately, without forming a uterus. The large egg, which receives a shell as it passes down the oviduct, is laid to develop outside the mother's body. (*See* also Embryology; Embryology, Human; Growth.)

3. Longevity.—Duration of life varies enormously among mammals. Large mammals, such as the elephant, lion, rhinoceros and horse, tend to be longer lived than small mammals, among which the mice and shrews are the shortest lived, but there is no consistent correlation between size and longevity. Man apparently has the greatest potential longevity of any known mammal.

It is important to distinguish between average length of life and potential longevity. Average length of life is the average age at death of all the individuals in a population, whereas potential longevity is the maximum age that an individual can attain. Since very few individuals of any species live as long as they are capable of living, dying from accident or disease rather than of old age, average length of life is always much lower than potential longevity. In man, for example, life expectancy in an American at birth is about 70 years, but potential longevity is thought to be about 115 years. In some species that are heavily preyed upon, such as wild mice, the discrepancy is probably much greater.

Potential longevity can be measured only in captivity, and even in captivity it is difficult to be sure that an animal has lived out its potential life span. Average length of life is much more difficult to determine. Data on zoo animals are almost meaningless, since these animals are carefully shielded against the mortality factors that operate in nature. *See* Life Span, Animal; Life Span, Human.

V. DISTRIBUTION

It is obvious that the various kinds of living mammals are not distributed uniformly over the earth's surface. Elephants are found only in Africa and Asia, anteaters only in South and Central America. There are no deer or bears in Africa south of the Sahara. These and many other examples indicate definite discontinuities in the distribution of mammals.

It is also known, from the fossil record, that mammals were not always distributed in the same way that they are today. Elephants were once abundant in North America, and indeed on all continents except Australia. At the beginning of the Tertiary period, horses were present in both North America and Eurasia, but they became extinct in Eurasia about the middle of the Tertiary and completed their evolution in North America, where in turn they became extinct late in the Tertiary. The living wild horses, zebras and asses invaded Asia and Africa only relatively recently, and wild horses in the Americas were brought in by the white man within historic times. On the other hand, the anteaters have always been American, and deer and bears apparently never did live in Africa south of the Atlas mountains. The fossil record shows that the distribution of mammals varied in time as well as in space. In other words, the present distribution of mammals is unintelligible except in the light of the past. For the broad geographical pattern of mammalian distribution, *see* Zoogeography; the ecological factors that influenced mammalian distribution in the past and continue to influence it, are discussed in Animals, Distribution of.

VI. EVOLUTION AND RELATIONSHIPS

Mammals underwent their major evolution, and became the dominant land animals, during the Cenozoic era of the earth's history, which extends in time from the present back to about 70,000,000 years ago. Thus the Cenozoic is popularly called the "Age of Mammals," although mammals actually appeared on the earth many millions of years earlier. The oldest known fossil mammals are from the Late Triassic period of the Mesozoic era about 175,000,000 years ago. Thus more than two thirds of the history of mammals took place before the beginning of the Age of Mammals, during a time when reptiles were dominant. Mammals remained small and insignificant throughout the Mesozoic, but this long early history is an important chapter in the story of mammals because it was during this time that the basic mammalian pattern was produced, the pattern on which depended all future evolution of the class.

1. Origin.—Mammals arose from the Therapsida, an order of reptiles that became extinct early in the Jurassic period. Several lines of therapsid reptiles became increasingly mammallike during the course of their evolution, and the group as a whole is popularly called the mammallike reptiles. The later members of one suborder of therapsid reptiles, the Ictidosauria, are in fact so mammallike that it is largely a matter of opinion whether they are to be regarded as reptiles or mammals.

Except in rare instances only bones and teeth are preserved as fossils; consequently the exact time during the transition from reptile to mammal, when many important mammalian characters—such as milk glands, hair, diaphragm or loss of the right aortic arch—first appeared, will probably never be known. It is highly unlikely that all these special features appeared at the same time, but rather they must have developed at various times during the evolution of the mammallike reptiles. The dramatic changes in the skeleton, on the other hand, are well documented in the fossil record. One of the most remarkable of these was the acquisition of a completely new joint between the skull and the lower jaw. The bones that form this joint in reptiles (articular and quadrate) were transformed into two of the mammalian auditory ossicles (the hammer and anvil), and a new joint, between the squamosal and dentary, was developed (fig. 4). The German anatomist Carl Reichert in 1837 concluded from a study of the embryology of this region in the skull of mammals that such a transformation had taken place during evolution. His theory was ridiculed by certain anatomists who insisted that such vital functions as chewing and hearing could not have been carried out during such revolutionary architectural changes. But nearly a century later the study of the fossil mammallike reptiles proved that Reichert's theory was correct. Fossil ictidosaurs (*e.g., Diarthrognathus broomi*), discovered in South Africa, have both reptilian and mammalian jaw articulations at the same time, the reptilian quadrate-articular joint not quite gone and the mammalian squamosal-dentary joint already in function. (*See* also PALEONTOLOGY.)

2. Adaptive Radiation.—In the history of all groups of animals there seem to be brief periods of very rapid evolution during which a number of new major types arise. The resulting major lines then evolve more slowly, most of them eventually becoming extinct, until one or more of the surviving lines again give rise to a new group of major types. The process of a parent stock breaking up into such groups is called adaptive radiation.

There have been four such periods of adaptive radiation in the history of mammals (fig. 5). The first was the radiation of the mammallike reptiles into a number of subclasses of mammals in the Late Triassic period; only two of these subclasses survive today. A second radiation, of marsupials in the Cretaceous period and Paleocene epoch, produced a great variety of pouched mammals, many of which are now extinct. At almost the same time the primitive placental mammals were radiating into a number of major types, most of which became extinct in the Early Tertiary period. Finally, in the Late Paleocene and Early Eocene epochs of the Cenozoic, there was a fourth radiation, that of placental mammals into the modern orders, most of which survive today. There is reason to believe that this last radiation had passed its peak and modern mammals had begun to decline even before the depredations of modern man began. There can be no doubt that mammals have been on the wane everywhere since the introduction of modern firearms and large-scale agriculture.

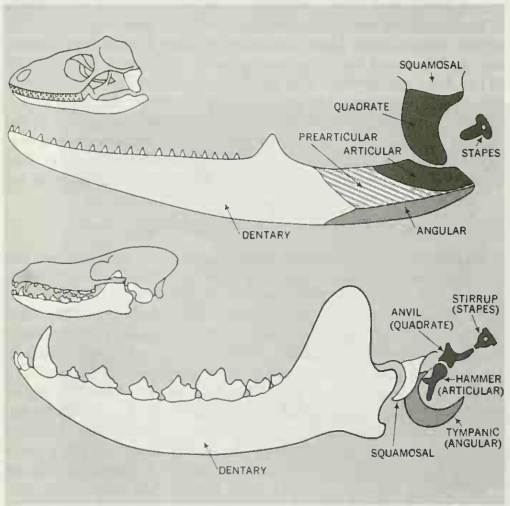


FIG. 4.—COMPARISON OF LOWER JAW AND EAR REGION IN THE SKULL OF A REPTILE (ABOVE) AND A MAMMAL (BELOW)

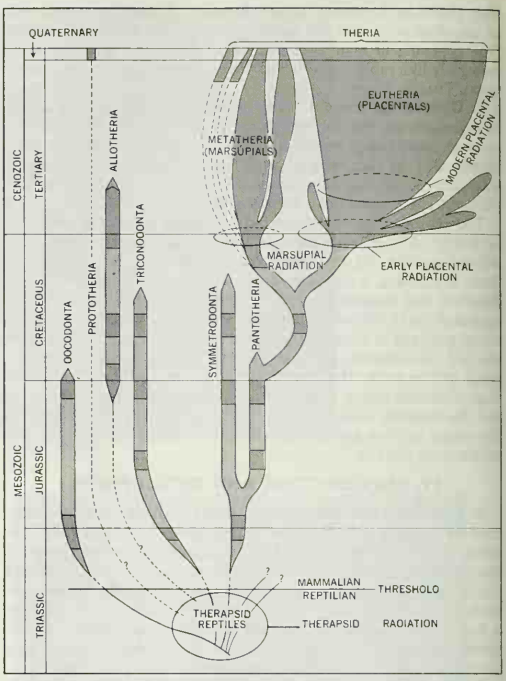


FIG. 5.—RELATIONSHIPS OF THE MAJOR GROUPS OF MAMMALS. KNOWN GEOLOGIC RANGES ARE SHOWN IN DARKER TONE, INFERRED RANGES IN LIGHTER TONE. THE FOUR MAJOR RADIATIONS OF MAMMALS ARE INDICATED BY CIRCLES

3. Adaptations.—The earliest mammals were small creatures, probably very similar to small opossums in appearance and behaviour (fig. 6), that occupied a very minor niche among the hordes of reptiles that dominated the land during the Late Mesozoic. They were omnivorous, perhaps largely insect-eating, animals that lived on the ground or climbed in the lower strata of the vegetation. Feet had five toes each, and there was a long and well-developed tail. Like the opossum, these early forms were not highly specialized for any particular way of life that demanded extensive modification of the structural system inherited from the mammallike reptiles.

Once the reign of the reptiles ended at the end of the Cretaceous, the therians began to move into the biological situations that had previously been occupied by the reptiles. Exploitation of these varied situations required modifications, often far-reaching, of the generalized body structure of the primitive mammals. Thus began the adaptive radiation of the Theria, and particularly of the Eu-

theria, into the orders of mammals that survive today.

With few exceptions, each of the mammalian orders represents an adaptation to a particular way of life, to exploiting some special ecological situation. The bats fly in the air, the toothed whales swim in the sea and eat animals, the sea cows live in the sea and eat plants. Rodents are typically quite unspecialized except for their remarkable chisellike gnawing teeth. Carnivores are equipped for preying on other animals. The hoofed animals are specialized for feeding on leaves and grass and for running at high speed. The scaly anteaters are "machines" for digging out and devouring termites. It is evident that the primary division of the Mammalia into orders involved specialization for particular kinds of feeding or locomotion, or both. The insectivores do not fit easily into this simple scheme because their structural pattern is still almost as generalized as the pattern of the original eutherian mammals. The ecological zone occupied by the primates is less obvious and less restricted than that of other orders; in general most primates are adapted to life in trees and to omnivorous feeding.

The Australian marsupials underwent an adaptive radiation independent of the radiation of eutherian mammals in other parts of the world. In filling the ecological niches of their environment these marsupials have produced counterparts of many of the eutherian types, and in some cases the parallel is astonishingly close.

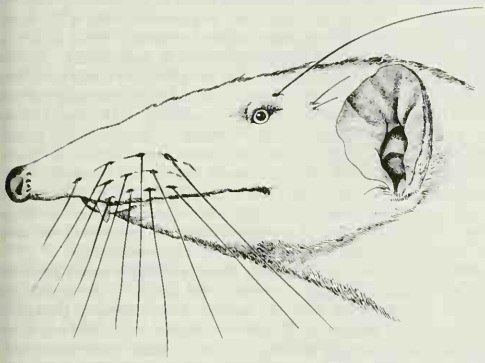


FIG. 6.—RESTORATION OF A CRETACEOUS INSECTIVORE, ZALAMBDALESTES LECHEI, ONE OF THE FIRST EUTHERIAN MAMMALS

The marsupial (Tasmanian) wolf is very similar to eutherian dogs and wolves; the marsupial "cats" resemble small cats, weasels and martens; the wombats, phalangers and marsupial "mice" are like woodchucks, squirrels and true mice in appearance and behaviour. There is even a marsupial "mole." The wallabies and kangaroos fill the role played by deer and antelopes in other parts of the world. *See* ANIMALS, PHYLOGENY OF.

VII. CLASSIFICATION AND SURVEY

The class Mammalia may be divided into three subclasses. Only one subclass, the Theria, is of great importance in the history of the Mammalia as a whole. It is probable that each of the subclasses arose from a separate line of mammallike reptiles, and that the Mammalia is therefore a polyphyletic group. Two poorly known groups of Mesozoic mammals, the triconodonts and docodonts, do not fit well into any of these three subclasses, and when better known may be found to represent separate subclasses of their own.

The major divisions of the Mammalia are as follows:

Subclass Prototheria, egg-laying mammals
  Order Monotremata, echidna and platypus
Subclass Allotheria (extinct)
  Order Multituberculata
Subclass Theria, live-bearing mammals
  Infraclass Pantotheria (extinct)
    Order Pantotheria
    " Symmetrodonta
  Infraclass Metatheria, all the pouched mammals
    Order Marsupialia, kangaroos, opossum, phalangers, koala, etc.
  Infraclass Eutheria, all the placental mammals
    Order Insectivora, shrews, moles, hedgehogs, etc.
    " Dermoptera, "flying lemur" or colugo
    " Chiroptera, bats
    " Primates, lemurs, monkeys, apes, man
    " Tillodontia (extinct)
    " Taeniodonta (extinct)
    " Edentata, sloths, anteaters, armadillos
    " Pholidota, pangolin or scaly anteater
    " Lagomorpha, rabbits and hares
    " Rodentia, all the rodents
    " Cetacea, whales, dolphins and porpoises
    " Carnivora, dogs, bears, weasels, cats, etc.
    " Condylarthra (extinct)
    " Litopterna (extinct)
    " Notoungulata (extinct)
    " Astrapotheria (extinct)
    " Tubulidentata, aardvark
    " Pantodonta (extinct)
    " Dinocerata (extinct)
    " Pyrotheria (extinct)
    " Proboscidea, elephants, mammoths and mastodons
    " Embrithopoda (extinct)
    " Hyracoidea, hyraxes
    " Sirenia, dugong and manatee
    " Perissodactyla, odd-toed ungulates including horses, tapirs, rhinoceroses, etc.
    " Artiodactyla, even-toed ungulates including pigs, cattle, deer, etc.

The extinct Triconodonta and Docodonta are of uncertain rank.

1. Prototheria.—No ancestral genera of monotremes are known, and the living forms (the echidnas and the platypus) are so specialized that many features, notably the dentition, that are useful indicators of relationships among other mammals are missing or extremely modified. Most modern mammalogists believe that the monotremes arose from a stock of therapsid reptiles entirely different from the stock that gave rise to therian mammals, and therefore that the histories of these two groups have been separate for at least 175,000,000 years. Some students have even denied that monotremes are true mammals.

2. Allotheria.—The multituberculates were small to medium-sized mammals with very peculiar and specialized teeth. The molars were elongate and had many cusps arranged in longitudinal rows; they often resembled miniature ears of corn. The multituberculates arose in the Late Jurassic and survived for about 100,000,000 years, longer than the recorded history of any other order of mammals. Representatives are known from North America, Europe and Asia. The largest multituberculate (*Taeniolabis*) was about the size of a beaver.

Triconodonta.—The Triconodonta were a small order of peculiar mammals that arose in the Late Triassic and survived into the Cretaceous. The relationship between the triconodonts and other mammals is unknown, and they cannot be assigned with certainty to any of the recognized subclasses of mammals. The cheek teeth were very characteristic, of a shearing type, with three main cusps arranged in a longitudinal row, an arrangement found in many therapsid reptiles. Triconodonts were carnivorous and ranged up to about the size of a mouse.

Docodonta.—Small mammals of Jurassic age, differing from all other mammals in that the articular (malleus) and quadrate (incus) bones still formed a subsidiary part of the jaw suspension. Only three genera are known: *Docodon*, from the Late Jurassic of North America, and *Morganucodon* and *Peraiocyndon* from the Late Triassic and Late Jurassic, respectively, of Europe. Some students believe the docodonts to be related to the monotremes.

3. Theria.—The therians include all living mammals except the monotremes. In the last great radiations of the class Mammalia, at the end of the Cretaceous and the beginning of the Cenozoic, the Theria diverged into the modern stocks that include the vast majority of marsupial and placental mammals populating the earth today, the three infraclasses Pantotheria, Metatheria and Eutheria.

Pantotheria.—A group of extinct mammals including two orders, the Symmetrodonta and Pantotheria proper. The symmetrodonts arose in the Late Triassic; they in turn gave rise to the pantotheres in the Early Jurassic. Both orders died out during the Cretaceous. In both symmetrodonts and pantotheres the teeth were basically similar to the teeth of later mammals. The pantotheres apparently

were ancestral to modern marsupial and placental stocks. Symmetrodonts differed from pantotheres and from all later mammals in lacking the heel (talonid) on the lower molars.

Metatheria.—This infraclass includes a single order, the Marsupialia, characterized by the presence of a pouch (marsupium) in the female, in which the young develop for some time after they are born. In a few marsupials the pouch is vestigial or has even disappeared completely. Typical marsupials are the opossum and the kangaroo. The marsupials arose in the Cretaceous at about the same time as eutherian mammals; these two groups underwent their early evolution side by side. The marsupials apparently were unable to compete with the more progressive eutherians, and died out except in Australia and South America, where they were isolated from most eutherian competitors by water barriers. At the present time marsupials are found only in the Australian region; in South and Central America; and in North America, where a single species, the American opossum, occurs. All but about a dozen genera are confined to Australia; nearly a hundred extinct genera are known.

Eutheria.—The vast majority of living mammals are eutherian, or placental, mammals that bear their young in a relatively advanced state of development and do not shelter them in a pouch. Man himself is a eutherian. Living eutherians are divided into 16 orders; 10 additional orders are extinct and known only as fossils.

Detailed information on the subgroups of mammals may be found under common and/or scientific names; ARTIODACTYL and ANTELOPE; CATTLE; DEER; CARNIVORE and BEAR, CAT, DOG; EDENTATA and ANTEATER; ARMADILLO; SLOTH; PROBOSCIDEA and ELEPHANT; MAMMOTH; MASTODON; SIRENIA and DUGONG; MANATEE; etc. *See* MARSUPIAL and KANGAROO; OPOSSUM; WOMBAT; PHALANGER; MONOTREME and ECHIDNA; PLATYPUS; *see* also references under "Mammal" in the Index.

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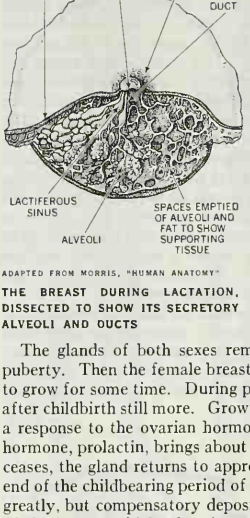
MAMMARY GLAND, the milk-secreting organ that, together with hair, furnishes the prime distinguishing characteristics of mammals. Such glands are present in both sexes, but in the male the organ is incompletely developed.

Anatomy.—In the human female the breast extends vertically from the second to the sixth rib, and transversely from the edge of the breastbone into the territory of the armpit. A little below the centre of the glandular swelling is the somewhat cylindrical nipple, whose rounded top bears minute pores where the milk ducts open; deep within is involuntary muscle that causes the nipple to erect in response to stimulation. Surrounding the nipple is a pigmented, circular patch called the areola, which is studded with slight nodules produced by from 10 to 15 underlying rudimentary milk glands (areolar glands). During the second or third month of pregnancy the areola darkens, but after lactation ceases, this added pigmentation fades. The glandular mass proper is composed of from 15 to 20 lobes, and these subdivide into smaller lobules that contain the secretory endpieces and lesser, branching ducts. Each lobe is drained by a single excretory lactiferous duct, which swells into a reservoir (lactiferous sinus) and then dwindles again and finds an outlet on the nipple. The endpieces (alveoli)



ADAPTED FROM MORRIS, "HUMAN ANATOMY"

THE BREAST DURING LACTATION, DISSECTED TO SHOW ITS SECRETORY ALVEOLI AND DUCTS

are scarcely recognizable as entities before pregnancy, and the entire gland has a blighted appearance. Connective tissue and fat comprise by far the greatest bulk of the inactive organ. During pregnancy the duct system extends and alveoli appear as minute vesicles, expanding the lobules. During lactation the alveoli become relatively prominent sacs, packed closely together. The secretory cells of the sac wall are cuboidal in shape, and the milk secreted by them collects in the relatively capacious cavity of the sac. The ending of lactation is accompanied by regressive changes that return the gland to the previous inactive state.

The glands of both sexes remain equal until the approach of puberty. Then the female breast increases suddenly and continues to grow for some time. During pregnancy it augments further and after childbirth still more. Growth is largely (and possibly wholly) a response to the ovarian hormone, estrogen, whereas a pituitary hormone, prolactin, brings about actual secretion. When lactation ceases, the gland returns to approximately its former size. At the end of the childbearing period of life, the glandular tissue atrophies greatly, but compensatory deposition of fat may maintain the size of the breast, which often becomes pendulous. The two breasts are seldom equal in size, the left tending to be somewhat larger. Suppression of a nipple or of the breast itself occurs at times. Supernumerary nipples or even small glands are relatively common; they usually lie along a line that corresponds to the position of the embryonic mammary ridge and represent extra developments from that tissue. Occasionally the male breast will simulate the female breast on one or both sides (gynecomastia).

Embryology.—The mammary glands are highly modified sweat glands; transitional stages are seen in the glands of the areola and armpit. In the sixth week of human development a thickened epidermal band appears in the pectoral region, much less extensive than the axilla-to-groin mammary ridge of many lower mammals. Each future gland begins as a local thickening on this ridge, the remainder of the ridge vanishing. This lens-shaped thickening becomes a globular mass from which 15 to 20 cords grow into the deeper regions of the skin; these cords are the primary ducts and they continue to grow and branch throughout fetal life. The exposed, free surface of the original thickening hollows into a pit, and at about the time of birth this area elevates as a nipple, bordered by an areola. The further history, following birth, has been summarized in the preceding paragraphs. Since these glands evolved late in the history of vertebrate animals, it is remarkable that they arise so early in the mammalian embryo.

Comparative Anatomy.—Both the number of glands developed in the different mammalian groups and their locations vary widely. In general, the number corresponds to the number of young ordinarily produced at one birth. This agreement is not always exact, as in evidence are the extra glands of sheep and cattle; moreover, since the glands occur in pairs, the minimal number of two is in excess of single human births. Actually, the number of glands is not entirely constant in individuals of the same species. The position of the glands seems to bear a relation to convenience of suckling. Mammals that have many young at birth, as the sow, most carnivores, many rodents, etc., have as many as 11 pairs of glands distributed along the wall of the underbody. In the pouched mammals (monotremes and marsupials) inguinal mammae are found, and the same is true in most ungulates as well as in the Cetacea. In sloths, elephants, Sirenia, Chiroptera and primates, on the other hand, they are confined to the pectoral region, and this is also the case in some rodents; *e.g.,* the jumping hare. The outcome depends on the development of glands along localized patches of the embryonic mammary ridges, while the

intervening parts of the ridges disappear.

In the monotremes a pair of pits within the longitudinal, pouch-like skin fold receive 100 or more separate mammary tubules. Milk is conducted from these openings along hairs, whereupon it is licked off or sucked up by the nursing young. In all other mammals the glands open in relation to nipples. The primary type is a pseudo nipple, as illustrated by the teat of cattle and other ruminants, in which the skin around the openings of the glandular ducts grows upward so as to surround a very deep pit; in the bottom of this canal the glandular ducts open. In the true nipple the gland surface itself is elevated into a papilla, and the ducts then open at its apex. In monotremes the glands are equally developed in both sexes, and it has been thought that among bats the male often assists in suckling the young. These facts, together with the occasional occurrence of functional activity of the organ in the human male, make it probable that among ancestral mammals both sexes participated in lactation and nursing. (L. B. Ay.)

Diseases.—The breast is the seat of various disturbances, all of which are worrisome and some of which are fraught with danger.

Mastodynia.—Mastodynia, or persistent pain in the breast, intensified before the menstrual period, is relatively common in mature women. The pain is often referred to a lump that is tender to the touch. These symptoms usually disappear spontaneously after months or years, but the possibility of infection or cancer must be considered.

Cysts of the Breast.—A galactocele is a tumour due to the locking up of milk in a greatly dilated duct. Other forms of cystic disease are usually special modifications of chronic mastitis. Such cysts are best treated by free incision, and by passing a gauze dressing into their depths. If the tissue is occupied by many cysts, it is well to remove the whole breast.

Acute Mastitis.—This is a temporary inflammatory condition of the breast. It is apt to occur in a woman who is suckling, and is due to the presence of septic microorganisms, which, as a rule, have found their way into the milk ducts, the lymphatics or the veins through a crack or other wound in a nipple that has been made sore by the infant's vigorous attempts to obtain food. Especially is this septic inflammation likely to occur if the nipple is depressed or so badly formed that the infant has difficulty in feeding from it. The inflamed breast is enlarged, tender and painful, and the skin over it is hot and perhaps reddened. The woman feels ill and feverish, and she may shiver or have a definite rigour if the inflammation is passing on to the formation of an abscess. The abscess may be above or beneath the breast, but it is usually within the breast itself. In the early stages, cold packs and the cessation of nursing may abort the infection. The response to sulfa drugs and penicillin therapy is excellent. If pus collects, applications of heat are administered to localize the abscess, followed by incision and drainage.

Chronic Mastitis.—This condition is not uncommon in women who are past middle age. The symptoms may have been present for months to many years. The part of the breast involved is enlarged, hard and more or less tender and painful. It is sometimes impossible clinically to distinguish this disease from cancer. True, the tumour is not so definite or so hard as a cancer, nor is it attached to the skin, nor to the muscles of the chest wall, and if there are any glands secondarily enlarged in the armpit they are not so hard as they may be in cancer. But all these are questions of degree, and the indications given for a diagnosis of cancer indicate also that the disease is so advanced as to have reduced the chance of successful operation to a minimum. Moreover, it is highly inadvisable to leave it to time to clear up the diagnosis, for a chronic mastitis, innocent at first, may become cancerous, while cancer and chronic mastitis often coexist in the same breast. Hence the only safe course is removal of the breast.

Fibroadenoma.—A simple fibroglandular tumour may be found in the breasts of younger women, who may possibly give an account of some blow or other injury; there may, however, be no history of injury. The tumour is smooth, rounded or oval, and lies loose in the midst of the breast; as a rule it is not tender. It is not associated with enlarged glands in the armpit. The tumour, though innocent, should be removed promptly, for such growths may enlarge rapidly and become cancerous later.

Cancer.—This is the commonest disease of the breast. It occurs chiefly among women between 40 and 60 years of age, but men are not entirely immune and women older or younger than the ages mentioned may suffer. The early symptoms are given elsewhere (*see* CANCER), and the later symptoms are those of cancer in general; viz., local spread, destruction of normal tissue, ulceration, early extension to the nearest group of lymphatic glands (in this case, axillary) and from these to neighbouring groups of glands (in this case, supraclavicular) and formation of secondary growths in skin, liver, bones, muscle, indeed in any tissue of the body. With the exception of melanotic sarcoma the secondary growths in cancer of the breast are more widely spread than in cancer affecting any other primary site. Probably this is in part due to the fact that the natural duration (*i.e.*, duration apart from all treatment) of breast cancer is relatively long, viz., about three and a quarter years. The pain and distress are usually great, particularly in the later stages when probably ulceration will have occurred and pressure of the cancerous mass in the armpit on the veins and lymphatics may have led to great swelling of the arm. Death may be brought about in various ways, the immediate cause often being some intercurrent disorder which the patient, enfeebled by absorption of toxic material from the ulcerated surface, anemia and pain, cannot resist; or by extension of the growth to the pleura and lung, with coincident pleurisy and pneumonia.

Cancer of the breast is usually spheroidal cell carcinoma, but the columnar cell type also occurs, notably in so-called "duct carcinoma," which is a less malignant variety. Sarcoma is also met with. Carcinoma is either hard and fibrous (scirrhous) or highly cellular (encephaloid), but many intermediate forms occur even in different parts of the same breast. A scirrhous growth is relatively smaller and runs, locally, a less rapid and extensive course than encephaloid, but as regards extension from the primary focus and the occurrence of secondary growths there is little difference between them. Sarcoma of the breast locally forms a large growth and the secondary growths have a somewhat different distribution. Speaking generally, scirrhous is associated with an atrophied and shriveled breast and retraction of the nipple.

It is often said that cancer runs a more rapid course in the young; statistical evidence does not support this view, though many cases in the very aged progress slowly. On the other hand during pregnancy a cancer of the breast participates in the rapid growth of the organ. But there is no evidence that suckling conduces to cancer; on the contrary, abeyance of the natural function seems to be related to the occurrence of chronic mastitis and consequently to local cancer after a longer or shorter interval.

The treatment of cancer of the breast depends to an overwhelming extent upon the stage at which the disease comes under full and proper treatment. If cancer of the breast is dealt with by the modern complete operation while the growth has not extended beyond the limits of the organ, approximately 90% of the patients are alive and well ten years later and their expectation of life is not materially different from that of women of the same age who have not suffered from cancer. But if the cancer has extended beyond the limits of the gland, a matter of a few weeks from the time when it first becomes recognizable, the case is very different. In spite of the same operative treatment, 90% of the patients will be dead by the end of ten years. No better evidence could be given for the paramount value of early and adequate operation, but the surgeon is dependent upon the patient and there is evidence that about half the number of patients dying with cancer of the breast do not seek medical treatment at all till the last days of life; of the remainder who seek advice, an average period of six months or more has elapsed between their first noticing that something was wrong and consulting a surgeon. There may be many explanations of this delay, but the fact remains that with each hour they have been throwing away a good chance of healthy life.

In cancer of the breast early and complete operation easily

holds the first place for success so far as present knowledge goes. Radium and X-ray treatment, though highly valuable in some other sites, are far inferior to surgery as curative agents in cancer of the breast with the present technique. Possibly it will remain so even with improved technique because of the special peculiarities appertaining to cancer of this organ. Upon this point no confident opinion can be given. When the disease is beyond operative treatment, radiation methods may afford palliative relief. (*See* CANCER; CANCER RESEARCH.)

Chronic Eczema.—Chronic eczema around the nipple of a woman late in life, with perhaps localized ulceration, is known as Paget's disease and has a sinister significance, for it indicates that the superficial layers of the fibrous dermis are in all probability infiltrated with cancer. Hence, when eczema about the nipple refuses to clear up in a few days under the influence of soothing treatment, the usual recommendation is the removal of the entire breast. The nipple is retracted in most of these cases, which, however, are not often met with.

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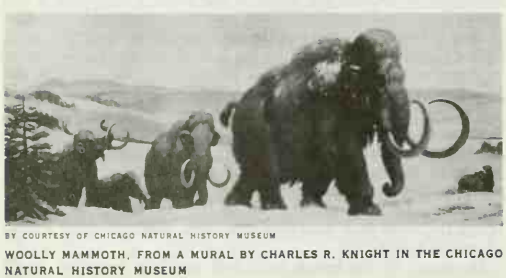
MAMMEE APPLE (MAMEY or ST. DOMINGO APRICOT), the fruit of *Mammea americana,* a large tree of the garcinia family (Guttiferae), with opposite, leathery, gland-dotted leaves; white, sweet-scented, short-stalked, solitary or clustered axillary flowers; and yellow or russet fruit, three to six inches in diameter. The bitter rind encloses a sweet aromatic flesh, which is eaten raw or with sugar, and is also used for preserves. There are one to four large rough seeds, which are bitter and resinous, used as anthelmintics. An aromatic liqueur distilled from the flowers is known as *eau de Créole* in the West Indies. The acrid resinous gum has been widely used locally for destroying skin-infesting chigoe fleas.

MAMMOTH, broadly speaking, any extinct member of the elephant subfamily (Elephantinae), representatives of which occur in Pleistocene deposits of every continent except Australia and, barring one dubious report, South America. Similar to living elephants (*q.v.*) in the body skeleton, mammoths differ from them and from each other in skull shape, tusk form and molar structure. So many are the differences in these body parts and so great is the variation within single species that there is little agreement on how many kinds of mammoths actually existed. There appear to be three major groups to which they may be consigned: one comprises relatives of the African elephants, of which the straight-tusked mammoth (*Loxodonta,* subgenus *Palaeoloxodon*) is the best known; another contains relatives of the Asiatic elephants; and a third, the genus *Mammuthus,* comprises a number of extinct species. The first two groups occur only in the old world; members of the third have been found in southern Africa as well as in southern North America. The North American imperial mammoth (*Mammuthus imperator*) attained a shoulder height of 14 ft. At the other extreme were certain dwarfed forms whose ancestors became isolated on various islands.

The woolly, Northern or Siberian mammoth (*Mammuthus primigenius*) is by far the best known of all mammoths. Knowledge of this animal is derived not only from skeletons but also from carcasses well-preserved in the permanently frozen ground in Siberia and from cave paintings, carvings, statuettes and incised drawings made by the Paleolithic men who hunted these beasts. Somewhat smaller than the Asiatic elephant, the woolly mammoth attained a shoulder height of about 9½ ft. The hind quarters were comparatively low, giving a downward slope to the back, and the tusks, larger and more complexly curved than those of living elephants, had the tips growing upward and inward in old individuals. Circumpolar in distribution, the species ranged from western Europe across northern Asia and Alaska to eastern North America, occurring very commonly within the Arctic circle. The tusks found in northern Siberia are so perfectly preserved that they have been used industrially; fossil ivory is so abundant that it has been exported from Siberia to China and Europe since medieval times.



BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

WOOLLY MAMMOTH, FROM A MURAL BY CHARLES R. KNIGHT IN THE CHICAGO NATURAL HISTORY MUSEUM

All available evidence indicates that the woolly mammoth, like the present-day reindeer and musk ox, was well adapted to the arctic climate. Paleolithic art depicts it as a shaggy animal, completely covered with hair. The frozen carcasses confirm the existence of a woolly, yellowish-brown undercoat, about an inch thick, beneath a coarser, outer covering of dark-brown hair, up to 20 in. long. The fur-covered ears were smaller than those of living elephants, and the short tail ended in a tuft of long, stiff bristles. Under the extremely thick skin was a layer of fat about half an inch deep over most of the body and, in at least one specimen, more than three inches deep on top of the skull. Paleolithic art shows some mammoths with and others without humps on top of their heads and above their shoulders. Very probably both kinds of representation are correct, the appearance of the humps perhaps having been seasonal phenomena, summer deposits of fat that helped sustain the animals through harsh winters. Remains of arctic plants have been found in the frozen carcasses. One of the most complete and most intensively studied mammoth carcasses was that unearthed in 1899 from the bed of the Berezovka river in Siberia. Several less complete remains have been discovered since that time.

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MAMMOTH CAVE NATIONAL PARK, established in 1941, provides protection to an extensive system of beautiful limestone caverns in west central Kentucky. These caverns were supposedly discovered in 1809 by a hunter following a wounded bear. They must have been known to exist earlier, however, since the entrance was designated in county records of 1799.

The main cave, entered through the natural Historic entrance about 7 mi. W. of Cave City, Ky., is from 20 to 140 ft. wide and averages about 40 ft. in height. It extends westward through various rooms and passages to its termination about 4 mi. from the entrance. Although the entire cavern spreads beneath an area only 10 mi. in diameter, the main cave and accessible passages, with their domes and chambers, aggregate a length of more than 150 mi. on five levels. One room, the Rotunda, is 139 ft. wide, 142 ft. long and 40 ft. high. In it are the remains of a crude processing plant which was used to extract saltpetre, an ingredient of gunpowder, from the bat guano of the cave. During the War of 1812 the cave was almost the only source of saltpetre for the blockaded and powder-poor U.S.

Mammoth cave shows great variety of formation and alteration (*see* CAVE). It includes extensive gypsum and travertine formations of great beauty to which names such as King Solomon's Temple, Pillars of Hercules, Giant's Coffin and Star Chamber have been given. In the Bridal Altar room, a majestic natural shrine, many weddings have taken place. Underground lakes and streams include Echo river, upon which boats are operated, the River Styx, Lake Lethe and the Dead sea. The Historic entrance to the cave has been supplemented by three man-made entrances. Five subterranean scenic routes have been laid out for the convenience of visitors, who are allowed in the cave only when accompanied by a park service guide.

The temperature of the cavern is fairly uniform at 54° F. (about 12° C.) throughout the year. Within the Historic entrance a draft sweeps outward for most of the year when the exterior air is the warmer; occasionally inward when the exterior air is the colder. The animal life of the cave includes cave crickets with very long antennae, the blind, colourless crayfish and the blindfish or cave fish, one to five inches long, which, through long evolutionary processes, have lost the use of their eyes completely. All the known forms of plant life in the caverns are either fungi or are related to them, many being microscopic. Mummified Indian bodies, possibly of pre-Columbian origin, have been found in Mammoth and other nearby caves.

The park's surface area is more than 51,000 ac. and, as with all U.S. national parks, is a nature sanctuary. Its hills are heavily grown with hardwoods and, although the forest is not primeval, there are numerous trees of great size along the Nolin and Green rivers, tributaries of the Ohio, which traverse the park through deep ravines.

Some of the more important trees are sycamore, tulip, American elm, white ash, sugar and red maple, black gum, shagbark hickory and various oaks. Trees that beautify the area with their blooms in early spring include the serviceberry, flowering dogwood and redbud. Abundant native wild flowers, mammals and birds are of species typical of eastern forests. A museum at park headquarters includes an illuminated map of the cave routes as well as exhibits showing the cave's formation, history, flora and fauna. The park encompasses the Flint Ridge Cave system (*q.v.*).

(Dx. B.)

MAMORÉ, a river of Bolivia formed by affluents rising on the slopes of the Cordillera Real and flowing northward to join the Guaporé river and subsequently the Madeira river. The Mamoré is the central and most significant river in the system of waterways which drain the northern plains region of eastern Bolivia and ultimately converge into the Madeira in the northeastern section of the country. Its complex of affluents includes the Chaparé, originating to the north of the city of Cochabamba, the Isiboro, the Ichilo, the Yapacani and its tributary the Piray and the Río Grande. The latter, also known as the Guapay, rises in the cordilleras of Cochabamba and Sucre. Starting out directly east, the Río Grande then sweeps northward, northwest, and after executing a semicircle for a distance of about 600 mi. unites with the Mamoré a few miles below the confluence of the latter with the Chaparé.

Most of the upper tributaries of the Mamoré are navigable by some type of craft, depending upon the season; consequently, the Mamoré is an important route from the north and east as it provides access to Cochabamba from both Trinidad and Santa Cruz. Fluvial travel from Cochabamba to the lowlands is accomplished by way of the Chaparé, Chimoré and Isiboro, utilizing rafts as far as the confluence of these rivers with the Mamoré, where larger craft are operative. The Mamoré can be descended without difficulty as far as Puerto Sucre, a point about 36 mi. from Villa Bella where the first rapids of the river are encountered. The Amazon river is reached by way of the Madeira and the Madeira-Mamoré railway via Pôrto Velho. The Guaporé river, or Iténez, the largest affluent of the Mamoré, is navigable along its course of 1,000 mi. at any season by vessels of light draft.

Starting from the edge of the mountains to its confluence with the Madeira, the Mamoré flows due north for about 1,000 mi. passing close by the town of Trinidad midway and absorbing several tributaries as it progresses. The downward slope to the north is so gradual in this section of the lowlands that the rivers are slow, shallow and irregular in their courses. This feature, together with the flatness of the land, results in the inundation of much of El Beni during the rainy season. The Mamoré is 1,118 mi. long and in part constitutes the northeast boundary of Bolivia and Brazil.

(J. L. Tr.)

MA'MUN, AL- (Abu-al-'Abbas 'Abdullah al-Ma'mun), (786–833), the seventh Abbasid caliph, who reigned from 813 to 833. Second son of the caliph Harun al-Rashid, he was assigned the government of Khurasan by his father (before his death in 809) together with the command of the Khurasanian guard. Differences over the guard and other matters led to war between al-Ma'mun and his brother al-Amin. With the help of the Iranian general Tahir, al-Ma'mun defeated his brother, who was killed as he fled from Baghdad, and became caliph, though his rule was opposed by his uncle Ibrahim ibn al-Mahdi until he was defeated in 819. Much of al-Ma'mun's caliphate was spent in an attempt to find a fresh balance of forces in which the social and political tensions underlying his personal struggle with his brother and uncle would be resolved. Such was his designation in 817 of Ali ar-Rida as successor in an attempt to gain Alid support; this plan was frustrated by the death of Ali in 818. Such also was the policy of the Inquisition (*mihna*), adopted in 833 a few months before his death but continued by his successors till about 848. Judges and other officials were required to profess publicly that they believed the Koran the created, not the uncreated, word of God. This was a doctrine held by the theological sect of the Mu'tazilites, a group of whom were close to the government. Though acceptable to the Shi'ites, it provoked opposition in other sections of the community. Linked with the support of the Mu'tazilites was the provision made by al-Ma'mun for translations from Greek of philosophical and scientific works, which greatly influenced the whole subsequent development of Islamic culture. He himself and the court showed great interest in this widening of intellectual horizons. The growing weakness of the central government is shown by several serious revolts after 819, and by the necessity under which al-Ma'mun found himself of continuing Tahir's family in the governorship of Khurasan—a premonition of the disintegration of the caliphate. His last years saw the renewal of war with the Byzantines. Al-Ma'mun died on a campaign in Anatolia in 833 and was buried at Tarsus. *See* also Caliphate.

(W. M. Wt.)

MAMVU, one of a cluster of closely related Sudanic-speaking peoples of the Orientale province of northeastern Republic of the Congo. They are also known as Momvu and call themselves Tengo. The main tribes of the cluster are the Mamvu (24,000 in the 1960s); Mangutu (often known as Mombutu—to be distinguished from the Mangbetu and Mangbele—and numbering 9,000); Balese (19,000) and Mvuba (a few thousand). There are many related smaller tribes in the area and the larger groups are divided into subtribes each with its own name; the nomenclature of groups in this region is extremely confused. It seems that the Mamvu are the parent group, the others having split off in past migrations. The whole region has been the scene of much migration and interspersal of small tribal groups, caused by the conquests of the Mangbetu and Azande (*qq.v.*) empires to the immediate north. The area also contains many Efe pygmy groups, speaking a language closely related to Mamvu.

These groups are agricultural, the most important crop being the oil palm; the extensive areas of palms were probably one of the chief objectives of the invasions from the north, as this palm does not grow north of Mamvu in this region.

The Mamvu lack any traditional, centralized, political authority, what political authority there is being exercised by the heads of patrilineal totemic clans. Before the Belgian administration (1908) they were largely under the authority of Mangbetu and Mangbele chiefs. The Mamvu are reputed to have been cannibals, but the evidence is not conclusive. *See* also Africa: *Ethnography (Anthropology)*: *West Central Africa.*

See H. van Geluwe, *Les Mamvu-Mangutu et Balese-Mvuba* (1957).

(J. F. M. M.)

MAN, EVOLUTION OF. From the point of view of the biologist, the problem of the evolutionary origin of man is only one of the many problems of mammalian evolution; for, in his physical structure and physiological functions, man falls within the biologists' definition of a mammal, and thus may be presumed to be the product of an evolutionary process similar to that which is now known from the fossil record to have occurred with other groups of mammals. At the time of the publication of Charles Darwin's *Origin of Species* (1859) there was considerable opposition to the conception of evolution as a whole, mainly because the idea of the fixity and immutability of the different species of animals and plants was very prevalent at that time. In part, this opposition was no doubt due to the influence of the biblical story

of the creation and to the fact that the teleological "argument from design" for the existence of a divine intelligence was superseded by the hypothesis of adaptation through natural selection, but it was also due to the purely scientific evidence adduced by taxonomists that species are clear-cut and sharply defined categories that are not linked by intergradations. As is well known, the cumulative evidence advanced by Darwin, reinforced by his exposition of the process of natural selection (a conception that had also occurred independently to the great naturalist Alfred Russel Wallace), eventually compelled acceptance of the main hypothesis of organic evolution. But general acceptance was certainly delayed by the circumstance that the hypothesis inevitably involved the consideration of man's relationship to lower animals, and the implied conclusion that man is also the product of an evolutionary process (and not a unique and special creation) dominated the minds of antievolutionists for a considerable time. It is possible that some of the more bitter controversies in the early days of evolutionary discussion might have been avoided if a clear distinction had been made between what may be termed "anatomical and physiological man" (*i.e.,* the biological species *Homo sapiens*) and the concept of *Man* in its wider philosophical context, for it is certain that misconceptions have arisen in the past, and even today still arise from time to time, from the use and misuse of the colloquial terms "man" and "human" in the discussion of evolutionary origins.

The difficulties involved in achieving a precise definition of these terms are discussed in HUMAN NATURE—an article that includes also an outline of the *Encyclopædia Britannica's* treatment of the efforts of scientists and philosophers to explore the nature of human nature.

Not even anthropologists always employ the terms "man" and "human" consistently, but the main difficulty is that they are terms that in ordinary usage are commonly taken to imply very much more than the meaning attached to them by anatomists and biologists when they are considering man only in a strictly anatomical or biological sense. It is, in fact, almost impossible to give a satisfactory definition of man that will satisfy all schools of philosophy. The anatomist is not qualified as an anatomist to define man as *Man;* he is competent only within his own special field of study to define man in anatomical terms as one of the species of the animal world—*Homo sapiens*. For this reason, it is a matter of importance that discussions of the evolutionary origin of our own species should as far as possible avoid the terms "man" and "human"—except when there can be no possible misunderstanding as to what is meant by them. Undoubtedly the whole problem can be approached with much greater objectivity if confined rather strictly to the scientific terms of zoology, such as *Homo* (meaning the generic group of which *H. sapiens* is the only surviving species) and the Hominidae (an inclusive term meaning the zoological family of which *Homo* is one of the genera). It has been suggested that, as a matter of convention, the terms "man" and "human" may reasonably be applied (and limited) to those representatives of the family Hominidae who acquired a level of intelligence enabling them to fabricate tools and implements.

As a broad generalization, such a definition is justifiable, for the ability to design and manufacture tools for different purposes, however simple the construction, involves powers of visualization and abstraction far beyond anything found in the rest of the animal world. But it is a definition that is not always applicable to extinct types of hominid, for evidence of toolmaking capacities in such cases may not always be forthcoming.

GENERAL EVIDENCE FOR EVOLUTION

There is no need to enter on a detailed discussion of the evidence for evolution as a whole, for this will be found in another article (*see* EVOLUTION, ORGANIC). But the different lines of evidence are summarized briefly below in order to see how far they are applicable to the special problem of the evolutionary origin of the Hominidae.

Comparative Anatomy of Living Types.—The unity of design shown in the anatomical structure of different animals (even when they appear superficially to be strongly contrasted) suggests a genetic relationship; *i.e.,* that the common structural pattern has been inherited from a common ancestry, and that the superimposed differences have been developed as the result of a gradual process of evolutionary diversification. On this hypothesis, degrees of relationship are indicated by degrees of resemblance in anatomical structure. Thus, if two types very closely resemble each other in a complex pattern of anatomical details, it is inferred that their genetic relationship is correspondingly close. Considerations such as these provide the basis for modern classificatory systems in zoology, and taxonomists aim at a natural classification of animals which expresses real evolutionary relationships. The fact that it is often possible, in the study of modern types, to arrange animals in a gradational series connecting those of simpler with those of more complex organization, or, in other words, to demonstrate what the older French naturalists called *l'échelle des êtres,* does indeed suggest that they are the products of an evolutionary process. For such a series demonstrates that there are links of an approximate kind in the animal kingdom even as it exists today, and such links may evidently represent the modified survivors of an actual evolutionary sequence in the past (*see* ANATOMY, COMPARATIVE).

Geographical Distribution.—The geographical distribution of different types of living creatures is most easily explained on an evolutionary basis. This argument is particularly convincing in the study of animal and plant communities isolated by geographical or other factors. In an island population, for example, the degree to which local varieties, subspecies or species differ from each other and from those on the adjacent mainland appears to be directly related to the length of geological time during which they have been isolated and thus prevented from interbreeding with parent groups (*see* POPULATION ECOLOGY).

Vestigial Structures.—Detailed anatomical study of an animal often reveals degenerate and useless relics of some organ or structure which are explicable only on the supposition that they were fully developed and of functional importance in a past ancestry. The remnants of eyes in naturally blind animals, of wings in flightless birds and of the limb skeleton in functionally limbless creatures are examples of such vestiges (*see* ANIMALS, PHYLOGENY OF).

Embryology.—The temporary appearance of certain structures during the development of the individual from a fertilized ovum (ontogeny) is difficult to explain unless it has reference to stages of evolutionary development in the past. For example, in embryos of those mammals in which, in the adult, certain elements of the skeleton or dentition have been lost, transitory traces of these elements may be found during embryonic development (*see* EMBRYOLOGY).

Genetics.—The study of the cytological basis of hereditary variations (mutations) demonstrates that such changes involve the hereditary units (genes), which are located in the chromosomes of the cell nucleus. Such variations may lead either to large and abrupt or small and closely graded changes in the structure of an organism, and, in either case, they provide a theoretically adequate basis for structural modifications which may be stabilized by the cumulative effect of selective processes (*see* HEREDITY: *Mutation*).

Potentialities of Selection.—The experience of animal breeders and plant cultivators makes it clear that a diversity of new varieties can be produced from common parent stocks by artificial selection, and field studies demonstrate by population surveys that the genetic make-up of a local group may undergo a gradual transformation under natural conditions of isolation and a changing environment; *i.e.,* natural selection, as well as artificial selection, is an effective agent in altering the distribution of gene frequencies in a local population. Further, statistical studies have shown that with a known mutation rate exposed to selective influences of a given intensity, natural selection is in fact adequate for the production of structural changes such as those that have been postulated to have occurred in evolution in a known period of geological time (*see* SELECTION).

Evidence of the Fossil Record (Paleontology).—The fossil record provides in a number of cases direct demonstration of a succession of closely graded intermediate types that form a tem-

poral sequence and thus provide concrete and objective evidence of the gradual transformations that have been postulated on the basis of indirect evidence to have led to the evolution of a whole series of types from a common ancestral stock (*see* PALEONTOLOGY: *Evolutionary Evidence*).

EVIDENCE THAT MAN IS THE PRODUCT OF AN EVOLUTIONARY PROCESS

These different lines of evidence for evolution, which have been briefly listed above, are applicable to man as well as to other types of mammal, and some of them may now be considered in this particular context.

Comparative Anatomy.—Anatomically speaking, *H. sapiens* belongs to the mammalian order Primates (*q.v.*). This classification carries the implication that, in common with other representatives of the order, he belongs to a natural group whose members, during the course of evolution, have become gradually diversified from a common ancestral stock. The living primates are characterized (and distinguished from other groups of mammals) in that they have avoided structural specializations of an extreme type. Rather, they have preserved a somewhat generalized structure, which confers on them a very considerable degree of functional plasticity. The order can be defined on the basis of the prevailing tendencies which have dominated its evolutionary development, and which include the following: the preservation of a generalized structure in the limbs associated with a free mobility of the digits (especially the thumb and big toe) and the replacement of sharp, compressed claws by flattened nails; the elaboration of the visual powers and a corresponding reduction in the apparatus of smell; and the progressive development of a large and complicated brain. In the Hominidae these same tendencies have manifested themselves and (particularly in the expansion of the brain and the reduction of the jaws) have advanced much further than in other primates; this zoological family also shows a unique specialization in the hind limbs, for the latter have become transformed into lower limbs for supporting the rest of the body in the erect position, while the mobility of the foot and toes (so characteristic of the primates in general) has become secondarily lost. The justification for the inclusion of the Hominidae in the order Primates is not only based on these general considerations, it is still further emphasized by a detailed antomical comparison with some of the other members of the order.

The primates that exist today comprise a rather remarkable gradational series which serves to link *Homo* anatomically with small mammals of a very primitive type. The most lowly representatives of the living primates are the tree shrews, small squirrel-like creatures, which have a wide distribution in southeast Asia. So primitive are the tree shrews that some authorities are reluctant to include them among the primates. But even these authorities would agree that they are at least very closely related to the ancestral stock from which the primates in general have been derived. In many of their anatomical characters the tree shrews show such a close resemblance to undoubted primates (*e.g.*, some of the lemurs) as to amount in certain details to an identity of structure. The lemurs, again, show in their more advanced anatomical structure a mixture of characters which indicate an intermediate position between tree shrews and monkeys. The curious little tarsier (which inhabits Borneo and the Philippines) is in some respects even more monkeylike. The various types of tailed monkeys represent a still higher grade of organization and, through the small gibbon, are linked with the large, tailless anthropoid apes—the chimpanzee, orangutan and gorilla. As their name implies, these anthropoid apes are very manlike in their anatomical structure. Their brain, although much smaller than a modern human brain, is relatively well developed as compared with lower primates. It also shows the same pattern of convolutions as a human brain (though in a simplified form), and the similarities in many details of its intrinsic structure (including the cerebral cortex) are astonishingly precise (*see* BRAIN). These anatomical resemblances in the brain have been found to be correlated with physiological similarities. Thus, the sensory and motor mechanisms fulfill functions that so closely reproduce those of the human brain that for experimental studies anthropoid apes have been found to be far more reliable than any other nonhuman mammal in their application to problems of cerebral function in man. Many features of the skull and skeleton of the large apes approximate very closely those of the Hominidae, particularly if account is taken of certain extinct primitive hominids. Some of the structural similarities in the skeleton of the trunk and limbs are in part related to posture, for the chimpanzee and gorilla are capable, at times, of balancing themselves on their hind limbs in a manner which suggests an approach (though a rather distant one) to the erect posture that is so characteristic of the Hominidae. In their dentition, particularly in the molar teeth, the anthropoid apes also show a close resemblance to the Hominidae. Indeed, it may sometimes be a matter of considerable difficulty to determine whether isolated fossil molar teeth belong to apes or hominids, for the distinctions that exist between the teeth of apes and of man are in general far less obtrusive when fossil types are considered.

Many of the muscles of the human body have the same disposition and attachments as those of the anthropoid apes. For example, in the sole of the human foot the same muscles are found that are used for the mobile functions of the ape foot, even though in man this mobility is not present. The disposition of the thoracic and abdominal viscera in apes corresponds quite closely with that of man, and even in their microscopic details some of the organs of the body show a remarkable resemblance. These examples of anatomical and physiological similarities between the large anthropoid apes and the Hominidae could well be multiplied. Their implications for a real phylogenetic relationship are further supported by reference to similarities in the serum precipitin reaction of the blood, the similarity of some of the blood groups, similarities in parasitic infestation, in susceptibility to certain diseases and so forth (*see* IMMUNITY AND IMMUNIZATION; BLOOD GROUPS).

As far as anatomical resemblances are concerned, it was stated many years ago by T. H. Huxley that "Whatever system of organs be studied, the comparison of their modifications in the Ape Series leads to one and the same result—that the structural differences which separate Man from the Gorilla and Chimpanzee are not so great as those which separate the Gorilla from the lower Apes" (by "lower Apes" Huxley was referring to the catarrhine monkeys). This proposition was subsequently labelled by E. H. Haeckel the "pithecometra thesis," an unfortunate term since it might have been taken to imply that the degrees of structural differences among man, anthropoid apes and lower primates can be expressed in strictly quantitative terms. While in certain of its dimensions, or in the degree of complexity of some of the cerebral convolutions, the anthropoid ape brain is morphologically closer to the human brain than it is to the brain of catarrhine monkeys, it is not feasible to state in quantitative terms just how much more closely the ape brain as a whole resembles the human brain. Still less is it possible to state in quantitative terms how much more closely in anatomical structure as a whole man resembles the large anthropoid apes than these apes resemble the catarrhine monkeys. Also, since soft structures of the body are not preserved in fossils, it is possible to compare only modern apes with modern man (*i.e.*, *H. sapiens*) in terms of soft tissue. But, with the data of comparative anatomy of living types and those so far available of extinct types (known from fossil remains), it can be affirmed that, by purely morphological criteria, the Hominidae show closer affinities with the anthropoid apes than with any other group of mammals; with increasing accessions to the fossil record the morphological boundary line between the two families is becoming more and more difficult to define.

Notwithstanding the numerous structural resemblances between the Hominidae and the large anthropoid apes, there are quite pronounced differences mainly related to the size of the brain and the adaptations to an erect posture and gait, as well as characteristic features of the dentition. Such differences have from time to time been stressed by those who claim a certain uniqueness for *H. sapiens* as a biological species and claim that he represents a terminal product of a phylogenetic sequence that must have had an extremely long history of evolutionary independence. Indeed, some have gone as far as to claim that most anatomical resem-

blances between man and apes are the result of evolutionary parallelism or convergence, and that the phylogenetic relationship between the two is far more remote than is commonly supposed. But there is little doubt that the significance of the differences has been grossly exaggerated since they are no greater than equivalent differences found in many other groups of mammals known from the fossil record to be by no means very distantly related. Anatomically speaking *H. sapiens* is unique among mammals only in the sense that every mammalian species has some features unique among mammals. It can be fairly stated that the Hominidae are not sharply separated from other primates by any major morphological feature of either a quantitative or qualitative kind, and it is reasonable that this zoological family is the product of an evolutionary process.

Embryology.—The evidence from comparative anatomy for the evolutionary origin of man receives further support from the study of ontogenetic development. As is well known, each person begins as a single fertilized cell, the ovum. This grows to a mass of cells that undergoes gradual differentiation to form tissues, and the tissues gradually become the definitive organs of the body. This process of ontogeny in some sense reflects the evolutionary history of the individual, and also has a very direct bearing on the conception of human evolution as a whole. For it may well be argued that if man as an individual can come into being as the result of the proliferation and differentiation of a single microscopic cell, there can be no objection to the thesis that mankind is the result of progressive evolutionary development initiated in a simple unicellular organism and passing through successive stages leading to organisms of increasing complexity. The suggestion that, in a modified form, ontogeny repeats phylogeny has been termed recapitulation. But it should be emphasized that this does not mean (as is sometimes popularly supposed) that the stages of embryonic development in any way represent the mature forms of successive stages of the evolutionary history of the individual. It means only that, broadly speaking, the human embryo passes through stages that reproduce the embryonic form of certain ancestral types. For example, in the early human embryo a foundation of gill arches is laid down in the neck region, precisely similar to that which finally leads to the establishment of functional gills in fishes. But in the human (as in other mammals) the elements of these gill arches do not become gills but quite different structures such as the skeleton of the larynx, muscles of the face and so forth. This transformation involves a most remarkable rearrangement of skeletal elements, muscles, nerves and blood vessels, and it seems impossible to explain such a profound modification unless it is supposed that the gill arches have been inherited from a remote ancestor of fishlike form. Some of the skeletal elements, for example, become displaced from their original position and rearranged to form the small ossicles of the middle ear (*see* EAR, ANATOMY OF) through which sound vibrations are conducted to the cochlea; it is particularly interesting that structural stages demonstrating this transformation have been followed in the fossil record of mammalian evolution. Examples of similar transformations in ontogenetic development are to be seen in other systems of the human embryo. For example, the muscles of the trunk are at first laid down in a regular segmental arrangement as they are in the adult form of primitive vertebrates, and subseqently become rearranged to form the definitive pattern of musculature characteristic of the human adult. The early human embryo shows a distinct, projecting tail, but this becomes withdrawn into the pelvic cavity to be represented finally by degenerate vertebral elements that form the coccyx. The heart is not laid down *de novo* with the four chambers characteristic of mammals; the partitioning takes place secondarily, so that for a time in the human embryo the heart is constructed on the same plan as that of lower vertebrates (*see* HEART, ANATOMY OF). The formation of the definitive kidney is preceded by the appearance of kidney tissue corresponding to that which becomes functionally mature in lower vertebrates; but in the human embryo this tissue only puts in a transitory appearance and in the course of development disappears. The arteries of the limbs at first are disposed in a pattern similar to that of lower vertebrates, but subsequently become rearranged in a new pattern which is functionally more suitable for limbs of human structure. This circuitous route through stages characteristic of lower forms of life, involving replacement of many temporary structures by structures of a very different pattern, provides strong additional evidence for the thesis of man's evolutionary origin from lower forms.

Vestiges.—The functionless remnants of vestigial structures normally found in the human body, or relics which appear occasionally in individuals as abnormalities, also are explicable on the assumption that *H. sapiens* has an evolutionary past. In the vestigial remains of a tail represented by the coccyx, even some of the caudal musculature has persisted in a rudimentary or modified form. The external human ear is attached to muscles whose function is very difficult to understand unless it is assumed that they are the relics of muscles that controlled ear movements in some ancestral stage of evolutionary development. The canine tooth in man is often sharply pointed and projects beyond the level of the adjacent teeth, and it is provided with an unusually strong root; this, again, is explicable if it is supposed that in some ancestral stock the canines were used for the special functions that they commonly have in lower mammals, for in modern man these teeth have no special functions to perform. In the human cadaver it is by no means uncommon to find the remains of muscles which are not normally present in the human body; but they may be normally found in lower primates in which they are required for activities such as those associated with arboreal life. An example of this is the dorsi-epitrochlearis muscle, which extends down the inner side of the arm and is normally present in the lower primates. The occasional reappearance in the human body of an anatomical structure which was presumably present in an ancestral form is termed an atavistic variation. Such morphological elements may persist genetically for millions of years after they have ceased to be of functional importance.

Human Genetics.—The analysis of pedigrees has demonstrated that the mechanism of hereditary transmission is the same in man as in other mammals and that the basis of mutational variations is similar in its genetic organization. In other words, these variations seem to arise as the result of alterations in the gene complex of the chromosomes precisely as they do in other animals, and in the same way they provide the raw material for evolutionary modifications under the influence of selection. Some of the characteristic differences among the races of mankind, such as skin pigmentation and hair form, are apparently based on genetic differences which depend on the interaction of a number of genes. It should be emphasized that the study of human genetics is difficult, and genetic analyses of racial traits are still very incomplete.

Geographical Distribution of Human Races and Adaptive Racial Characters.—*H. sapiens* is a polytypic species; that is to say, it comprises a number of different geographical varieties or subspecies which are commonly termed the races of mankind. As is well known, the races have a fairly well-defined geographical distribution—the Caucasoid peoples in the European area, the Mediterranean type extending from southern Europe and northern Africa through southwestern Asia into India, the Australoid peoples in Australasia, the Negroids in central and southern Africa, the Mongoloids in eastern Asia and the Americas, and so forth. This type of distribution is most easily explicable on the basis of an evolutionary diversification following the migration of representatives of a common ancestral stock to different parts of the world. Such migrations would lead to geographical segregation and genetic isolation which, in the course of time, have provided the opportunity for structural modifications in adaptation to different environments. For example, Australian aborigines have distinctive characters which presumably became stabilized during a long term of isolation in Australasia following a migration from southeast Asia, where peoples are still found (*e.g.*, the Vedda of Ceylon) who show similar characters but in a less extreme form. Again, the highly characteristic features of Negroids must have developed during a period of isolation—probably in central Africa. Natural selection seems to have played an important part in the evolutionary development of racial characters since some of these can be shown to be directly related to particular environments.

Thus, the dark pigmentation of some tropical peoples provides a protection against exposure to strong sunlight; the width of the nose is closely related to the prevailing temperature and humidity and almost certainly has an important physiological significance in respiratory functions; and the type of bodily physique (*e.g.*, the contrast between races of long, lanky physique and those of short, stocky build) also can be correlated with environmental differences. Such observations are consistent with the hypothesis that the races of mankind, as the different varieties of animal species generally, are the product of a gradual process of evolutionary diversification. *See* RACES OF MANKIND.

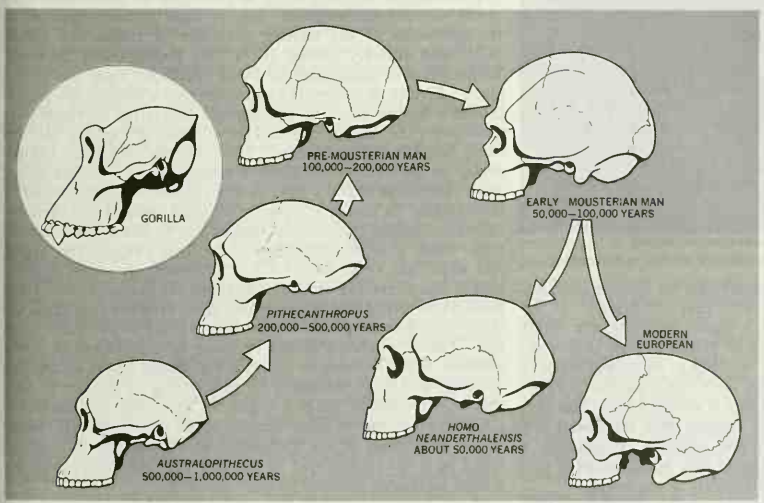
RELATIONSHIPS OF THE HOMINIDAE

Even the antievolutionary biologists of past days classified man as one of the Mammalia, but they emphasized his apartness by placing him in a separate order, or even a separate subclass, of mammals. This distinction was influenced by the view held generally at that time that man is the product of a special creation and unique in characters other than those of a purely anatomical or physiological kind. While modern man has such unique qualities, the problem of his zoological classification and phylogenetic relationships, as in the case of the Mammalia in general, is primarily morphological and must be approached on a morphological basis. The intensive studies of comparative anatomy after the beginning of the 20th century, together with the evidence of the fossil record that accumulated later, made it clear that the Hominidae (*i.e.*, the zoological family that includes not only *H. sapiens* but also his extinct precursors) are more closely related to the anthropoid ape family (Pongidae) than to any other group of primates. This view was expressed in the now generally accepted scheme of classification that includes both the Hominidae and the Pongidae in a common superfamily, Hominoidea, and thus contrasts them both with the catarrhine monkeys, which comprise the superfamily Cercopithecoidea. Some systematists would go even further by including the two groups in the same zoological family, but so far this view has found but few adherents.

If the taxonomic approximation of the Hominidae and the Pongidae in a common superfamily represents a natural classification, the assumption follows that these two families ultimately have been derived from a common ancestral stock by an evolutionary process of divergent modification. If this is so, it might be expected that, in tracing back the ancestry of the two groups in the fossil record, the morphological distinctions between the two would be found to become less and less obtrusive. This, indeed, is the case, for it is now known from fossil material that the geologically earlier representatives of the Hominidae approximated much more closely to a simian level of development than modern man, while the earlier representatives of the anthropoid ape family, in so far as they had not at that time developed all the specializations characteristic of the modern apes, showed a lesser degree of morphological divergence from the Hominidae.

PALEOANTHROPOLOGY

Paleontology, or the study of fossils, provides the really crucial evidence for the evolution of the Hominidae in the past. However extensive and compelling it may be, the evidence for evolution based on the study of creatures living today can be only indirect. Direct evidence must depend on actual demonstration from the fossil record of a succession of stages representing the transformation of an ancestral into a descendant type. The comparative anatomy of living forms, together with the geographical distribution of local species and varieties that exists today, suggests that evolution might have occurred. Study of the process of natural selection, experimental genetics, population statistics and so forth establishes quite clearly how evolution could have occurred. But that evolution did occur can be scientifically established only by fossilized representative samples of those intermediate types that have been postulated on the basis of indirect evidence. The field of paleontology which is related to the study of the origin of man is termed paleoanthropology. It is concerned not only with fossilized early representatives of the Hominidae and extinct primates from which this family may have been derived but also with relics of the cultural activities of ancient man and the nature of the environment in which he lived. Here, however, attention will be confined almost entirely to the evidence of skeletal remains. Broadly speaking, the main features of the evolutionary succession of the primates are now known from the fossil record, and they conform in a remarkable way with inferences already reached by a consideration of living primates. At the beginning of the geological era called the Tertiary period—about 70,000,000 years ago—there were in existence the most primitive of the primates, small treeshrewlike creatures called the Plesiadapidae. So primitive are their anatomical characters that it might be impossible to determine that they were primates but for the fact that they mark a gradation toward more highly organized creatures which definitely come within the category of primates. Early in the Tertiary period, during the Paleocene and Eocene, more advanced primates appeared which belong to the same zoological groups as the modern lemurs and tarsiers. Somewhat later, in the Oligocene (probably about 45,000,000 years ago), there came into existence primitive monkeys and exceedingly primitive anthropoid apes. In the succeeding Miocene (30,000,000 years ago or so), anthropoid apes of a generalized type appeared in great diversity in different parts of the world, and their remains have been found in considerable quantity in east Africa, Europe and India. Some of these early types, as far as can be ascertained from teeth and jaws and fragmentary limb bones, might possibly have provided the basis for the evolutionary origin



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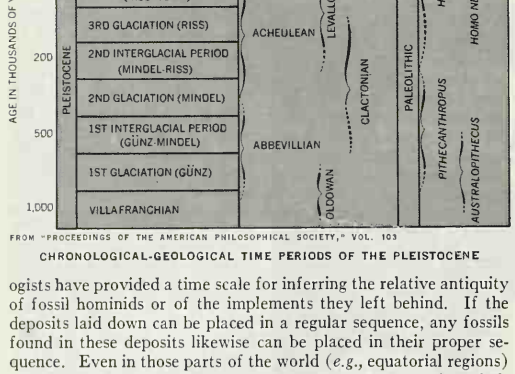
FOSSIL HOMINIDS ARRANGED IN AGE SEQUENCE: AUSTRALOPITHECUS BASED ON SKULL FROM STERKFONTEIN, S.AF.; PITHECANTHROPUS, ON SKULL CAP AND PORTIONS OF JAWS FROM JAVA; PRE-MOUSTERIAN MAN, ON THE STEINHEIM SKULL; EARLY MOUSTERIAN MAN, ON A MT. CARMEL, ISRAEL, SKULL; AND NEANDERTHAL MAN, ON SKULL FROM MONTE CIRCEO, ITALY. ADULT FEMALE GORILLA SHOWN FOR COMPARISON

of the Hominidae, but the fossil evidence is still too meagre to permit any positive conclusion. The earliest hominids known by 1950 date from near the beginning of the Pleistocene (about 1,000,000 years ago), and finds under study in the 1960s have been tentatively dated much earlier. For example, in 1964 hominid material from the Olduvai gorge in Tanganyika was estimated to be well over 1,000,000 years old and officially named *H. habilis*. Since these ancient types already were well advanced along the direction of hominid evolution, it seems that still earlier representatives of the Hominidae must have existed in the Pliocene period. Here there is a conspicuous gap in the fossil record which remains to be filled by careful study of recent and future discoveries.

ESTIMATION OF GEOLOGICAL ANTIQUITY

Before the evolutionary history of man in terms of fossil remains is traced in further detail, it is desirable to note the geological changes that marked the Pleistocene epoch. The date of the transition from the Pliocene to the Pleistocene is an arbitrary point in time, and geologists have not found it easy to agree on its definition. Broadly speaking, it was marked by the gradual onset of a cooler climate in many parts of the world, and the general lowering of the temperature finally led to the Great Ice Age during which, in modern temperate zones, icecaps and glaciers, originating on high levels, spread out for considerable distances over lowlands. This process of glaciation was recurrent and extended throughout most of the Pleistocene epoch; it is now generally agreed that there were four main glacial periods, of varying duration and severity, separated by interglacial periods during which the climate became warmer and in some cases (even in Europe) almost subtropical. Evidence of the successive glaciations can be detected in the characteristic geological deposits left by melting ice and also in the fossil remains of arctic or subarctic animals and plants from the glaciated regions. By the determination of the rhythmical succession of glacial and interglacial phases during the Pleistocene, geol-



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CHRONOLOGICAL-GEOLOGICAL TIME PERIODS OF THE PLEISTOCENE

ogists have provided a time scale for inferring the relative antiquity of fossil hominids or of the implements they left behind. If the deposits laid down can be placed in a regular sequence, any fossils found in these deposits likewise can be placed in their proper sequence. Even in those parts of the world (*e.g.*, equatorial regions) where there was no actual glaciation, there was a succession of alternating rainy and dry periods. There is evidence that these pluvial and interpluvial phases can be equated with the glacial and interglacial periods in the northern and southern hemispheres, a matter of importance for determining the time relationships of fossil hominids found in widely separated parts of the world.

The recurrent glaciations were accompanied by considerable falls in sea level, with a profound effect on the formation of river valleys. With the fall in sea level the erosive power of rivers increased and they cut their valleys deeper. With the rise in sea level during the interglacial periods the rivers flowed more sluggishly and laid down such stratified deposits as gravel and sand, over their alluvial plains. As a result, series of terraces were formed along the river banks, and it is in these terraces that some of the oldest remains of Paleolithic man and his stone implements have been found. The time relationship of the terraces to the glaciations has been worked out in some detail by geologists, and largely on this basis the relative antiquity of the fossils can be established.

In the case of skeletal remains embedded in sedimentary layers formed under the influence of agents such as running water or in stalagmitic formations in caves, the more ancient fossils are found in the deeper layers and vice versa. These deposits in some cases can be assigned to one of the glacial or interglacial periods, and a relative dating thus can be obtained. Another method depends on the fluorine content of fossil bones. The fluorine content increases with geological age by a process of ionic interchange as this element is slowly taken up from the soil and becomes fixed in bony tissue in the form of a very stable compound, fluorapatite. The amount of fluorine in a fossil bone thus increases with time and gives an indication of the period over which it has been in position in a particular deposit. However, this also depends on the amount of fluorine in the soil, and does not permit a comparison of bones from different deposits. But in a case of a hominid skull found with remains of extinct mammals of known antiquity, the fluorine test may be of utmost importance for determining whether they are all contemporaneous or whether the hominid remains may be the result of (say) an artificial interment at a much later time. The fluorine test first aroused suspicions about the authenticity of the Piltdown man (*q.v.*), whose remains were alleged to have been recovered from ancient deposits of an English river terrace. A detailed study of the skull and teeth exposed it as a most ingenious and unscrupulous forgery. Another method depends on the observation that fossil bones and teeth often show some degree of radioactivity by the gradual absorption of uranium from percolating ground water, and the degree of radioactivity of a fossil, therefore, depends partly on its geological age. But it also depends on the permeability of the deposit in which the fossil lies and on the uranium content of the water in past ages. Thus both the fluorine test and the radiometric assay are of value only for determining the relative age of fossils found in the same or strictly equivalent geological formations (*see* GEOCHRONOLOGY).

The absolute age of a fossil in years can be determined only rarely with present methods. One of these methods depends on the estimation of the relative quantities of radioactive carbon (C^{14}) and ordinary carbon (C^{12}) (*see* RADIOCARBON DATING). Radiocarbon is assimilated by living organisms from the atmosphere (directly or indirectly) and undergoes a gradual disintegration at a known rate. It is estimated that after approximately 5,600 years the ratio of radiocarbon will have dropped to half the value found in living material. With modern techniques the accuracy of the method is limited to estimations of a period of not more than about 60,000 years. A new potassium-argon method of determining the absolute antiquity of fossil remains has been developed. Ordinary potassium contains 0.01% of a radioactive isotope, which gradually disintegrates to form calcium and argon, and which has a half-life of 1.3×10^9 years. A recent application of this method to deposits containing the earliest known fossil hominids in east Africa has provided some evidence that these ancient types may have been in existence as much as 2,000,000 years ago. Lastly, reference should be made to the method of varve analysis, which depends on counting the annual layers of deposits (varves) laid down seasonally by the melting of glaciers as they gradually receded at the end of the Ice Age. But this method is applicable only for the determination of the rate of climatic change in the final stages of the Pleistocene epoch, and the estimations based on it are complicated by the fact that the varves may not always be strictly seasonal in their sequence.

ANTIQUITY OF HOMO SAPIENS

The biological species *H. sapiens* (of which the modern human races comprise a number of different subspecies or geographical varieties) is defined in terms of the anatomical characters shared

by its members. For historic representatives of the species the definition must be limited to skeletal characters, the only remains to be found. The definition of *H. sapiens* includes such features as a mean cranial capacity of about 1,350 cm.^{3}, an approximately vertical forehead, a rounded occipital skull with a relatively small area for the attachment of the neck musculature, jaws and teeth of reduced size, small canine teeth of spatulate form, the presence of a chin eminence, limb bones adapted to a fully erect posture and gait, and so forth. Any skeletal remains that conform to this pattern to an extent which precludes classification in other groups of higher primates must be assumed to be those of *H. sapiens*. In the past there was a most unfortunate tendency to create entirely new species of *Homo* on the basis of fragments of pre-historic human skeletons even though they showed no significant difference from modern man. This tendency was no doubt prompted by the supposed antiquity of the remains, or by a failure to realize how variable some features are even in modern *H. sapiens*. One of the best examples of this kind of fallacy is the famous Galley Hill skeleton, discovered in 1888 in the Thames valley and supposed to be of very great antiquity. Some anatomists thought they could recognize very primitive features in this specimen, particularly in the shape of the lower jaw. An apparently exhaustive study of the thighbone involving an elaborate statistical comparison of a number of measurements and indices even led to the conclusion that it was quite distinct from modern man. But in later years it was determined, largely as a result of the analysis of its fluorine content, that the skeleton was a burial of comparatively recent date—perhaps the remains of a Neolithic man or possibly even a later interment. How is this discrepancy to be explained? This is rather an important question, for statistical tables are apt to give an impression that conclusions based on them are final and indisputable. But it has come to be realized that the validity of statistical methods in the study of fossils depends on the actual number of measurements taken, on whether the measurements compared are really strictly equivalent in the morphological sense, on whether they are taxonomically relevant and so forth. It also has been demonstrated that if the individual characters of a bone or a tooth are compared independently, one by one, instead of as components of a total pattern (which can be done by the very complicated method of multivariate analysis), entirely different and sometimes very misleading conclusions may be reached. In the case of the Galley Hill thighbone, the statistical study was made with only a very limited sample of modern thighbones assumed to be representative of *H. sapiens* as a whole. Obviously the comparison must be made with adequate samples of all the main varieties of *H. sapiens* before it can be legitimately concluded that there is a distinction.

If the history of mankind is traced back beyond the ages of metal into the Neolithic period, which began about 9,000 years ago, it is found that numerous examples of skeletal remains show no significant differences from modern man. Indeed, much of the Neolithic population in Europe probably was indistinguishable from the modern types of European who inhabit the Mediterranean area. Earlier, from the latter part of the Paleolithic period, the human remains are also those of *H. sapiens*. This is the case, for example, with the Magdalenian period, which lasted during the terminal stages of the last glaciation of the Ice Age and which sometimes is referred to as the Reindeer period, since reindeer were characteristic of the local fauna at that time. The Magdalenian people were very skilful in the production of a great variety of beautifully made flint implements and also instruments of bone, ivory and reindeer antler. They are also noted for their mural art, represented in cave paintings of great artistic merit, which have been found chiefly in southern France and northern Spain. In some of the most famous of these caves, those at Lascaux in the Dordogne region of France, pieces of charcoal were found that are believed to be contemporary with the paintings, and a sample tested by the radiocarbon method gave a date of about 15,000 years ago. The Magdalenian period was preceded in Europe by the Aurignacian period of Paleolithic culture, and a number of skulls and skeletons of the Aurignacian people are also of modern type. Moreover, although in many respects they were culturally inferior to the succeeding Magdalenian people, they had already developed a fairly complex civilization. The evidence provided by the radiocarbon method indicates that the Aurignacian period dates from about 35,000 years ago, and if men of modern type had already developed an elaborate culture in Europe at this early date, the presumption is that *H. sapiens* must have been in existence as a species considerably earlier.

Several remains of early man from Africa, some unfortunately very fragmentary, with reasonable certainty can be assigned to a cultural stage equivalent to the Upper Paleolithic of Europe. In all cases these remains appear to be indistinguishable from modern varieties of *H. sapiens*. One skull, found at Florisbad in South Africa, is of particular interest, for it was embedded in deposits containing layers of peat, and a sample of the peat closely associated with the skull was used for radiocarbon dating. According to this estimate the peat was probably deposited at least 37,000 years ago, and it has been inferred that the skull is of like antiquity. Upper Paleolithic remains of *H. sapiens* were reported from cave deposits near Peking, associated with a stone culture corresponding to the Aurignacian or Magdalenian in Europe. In the Americas, remains of the species also were described from deposits dated on geological evidence to the terminal part of the last glaciation, and the antiquity of these was estimated at 10,000 years, more or less. One well-preserved skull found at Tepexpan in Mexico was assigned such an antiquity, and this may well prove to be justified, for the radiocarbon dating of organic material from an overlying deposit (which must have been laid down long after the skull was in position) gave an antiquity of certainly more than 4,000 years. There are two other relevant carbon datings that indicate an antiquity for *H. sapiens* in North America of at least 10,000 years; one of these was based on charred bison bones associated with stone implements of the Folsom type (in Texas) and the other on woven rope sandals found in Oregon buried beneath pumice deposited by a prehistoric eruption.

Evidently *H. sapiens* spread over most parts of the world at a very remote time, carrying with him types of Paleolithic culture that provide evidence of their common origin while showing local differentiations. It is unfortunate that the place of their origin is not yet certainly known, for this might give a useful clue to the geographical area of origin of the species. Claims have been put forward on behalf of one area or another, mainly on the basis of fossilized skeletal remains which have been assigned to an antiquity far greater than is known in other regions of the world. But the evidence for this supposed greater antiquity has not in all cases been sufficiently convincing. There is good evidence that precursors of *H. sapiens* were already in Europe before the last glaciation of the Ice Age—during the last (or third) interglacial period—and this could hardly have been less than 50,000 years ago. Examples of such early representatives of the species have been found at a number of different Paleolithic sites (*e.g.*, Fontéchevade, Ehringsdorf, Krapina, Saccopastore). Some of these skulls are very fragmentary, and although some show such primitive features as strongly developed brow ridges, this is not the case in all the specimens. The significance of these features tends to be overemphasized if comparisons are made only with modern European skulls, but they appear far less obtrusive when compared with the other varieties of modern *H. sapiens* such as the Australian aborigines; they are not sufficiently marked to warrant a taxonomic distinction from this species, though there may be some reason for allocating them to a different subspecies. There are at least two fossil specimens closely related to modern *H. sapiens* that date back to interglacial times—an almost complete skull from Steinheim, Ger., and a very fragmentary skull from Swanscombe, Kent, Eng. These have importance for determining the antiquity of the species. The Steinheim skull was discovered (1933) in interglacial gravels containing remains of extinct mammals such as *Elephas antiquus* and *Dicerorhinus merckii*. There had been some doubt whether these gravels were laid down in the second or third interglacial period, but later studies make it reasonably certain that they belong to the third. The skull has rather a low cranial capacity (1,100 cm.^{3}), which comes well within the range of modern man, however. The brow ridges are strongly developed, but it is doubt-

ful whether they exceed the size of those occasionally found in some modern races of mankind. The anatomical evidence of the skull as a whole, indeed, permits the inference that it may be attributed to a primitive type of *H. sapiens*. The Swanscombe skull consists of only three of the cranial bones, the two parietals and the occipital, all of which are exceptionally well preserved. They were discovered (1935 and 1936) 24 ft. below the surface in well-stratified gravels forming part of the 100-ft. terrace of the river Thames. These are definitely interglacial deposits, and the associated fauna includes *E. antiquus, Dicerorhinus megarhinus* and *Megaceros*. Also found with the skull bones were flint implements which can with certainty be assigned to the Middle Acheulean hand-ax industry. The geological, archaeological and faunal evidence is all consistent with the conclusion that the skull bones date to the second interglacial period. Finally, this received confirmation from an analysis of the fluorine content of the bones and of their radioactivity. A most detailed study of the bones (and of the endocranial cast) failed to justify a specific distinction from the corresponding bones of modern human skulls. It was inferred, therefore, that they provide unusually convincing evidence of the existence of the immediate precursors of modern *H. sapiens* in the second interglacial period, to which conservative estimates based on geological considerations give an antiquity of not less than 100,000 years or, according to potassium-argon evidence, probably at least 200,000 years. While this inference regarding the antiquity of the Swanscombe skull bones may be provisionally accepted, it should be regarded as no more than a provisional inference pending the accession of further and more complete material. But, taken with the evidence of the Steinheim skull, it does at least indicate a high probability that *H. sapiens* has an antiquity of this order.

NEANDERTHAL MAN AND NEANDERTHALOIDS

It is known from many fossilized remains discovered in different parts of Europe that there existed during the first phase of the last glaciation a rather peculiar type of the genus *Homo* commonly known as Neanderthal man (*q.v.*), and it is generally accepted that the type is referable to a distinct species, *H. neanderthalensis*. In the early days of paleoanthropological discovery, *H. neanderthalensis* was commonly assumed to represent the ancestral type from which *H. sapiens* derived in late Pleistocene times. This assumption was based partly on morphological arguments; in the flat and retreating forehead, the low height of the cranium, the massive brow ridges, the robust and chinless jaws, the large teeth and so forth, Neanderthal man certainly presents a somewhat simian appearance. The limb bones, also, are characterized by their relative thickness and unusual degree of curvature. But the accumulation of further discoveries made it clear that these apparently primitive features are secondary—the result of a retrogressive evolution from still earlier types which do not appear to be specifically distinguishable from *H. sapiens*. In some of the Neanderthal skulls from deposits which, on stratigraphical evidence, are of earlier date, the typical neanderthaloid features are developed to a less exaggerated degree than in those of a later date. Thus, the specialized Neanderthal type of *Homo* seems to have been preceded by a more generalized type. The brain of the specialized type was, surprisingly, rather large, for the mean cranial capacity actually exceeded that of modern human races. Neanderthal man was contemporaneous with the latter part of the Mousterian period of Paleolithic culture, and his remains have been found at various sites in Europe (*e.g.*, in France, Germany, Italy and the U.S.S.R.) as well as in north Africa and Palestine. Charcoal recovered from an upper level of the Mousterian culture in a cave at Gibraltar indicates a radiocarbon age of 49,000 years. The species evidently disappeared from Europe rather abruptly after the climax of the last glaciation, when it was replaced by an Upper Paleolithic population of completely modern type. It is probable that, with the first recession of the ice following the last glaciation, Europe was invaded (probably from the near east) by the more highly cultured Aurignacian people and that they displaced and exterminated *H. neanderthalensis* (*see* CRO-MAGNON MAN).

Remains of early man have been found in Java, Rhodesia and South Africa, which in the general appearance of the skull show a strong resemblance to *H. neanderthalensis,* and are regarded by many authorities as geographical variants of this species. However, they show differences in morphological details, so that their taxonomic relationships are somewhat doubtful. For this reason they are commonly referred to by the rather informal term Neanderthaloid. The remains from Java were found in terrace deposits related to the Solo river and are of Upper Pleistocene date (probably corresponding to the last glaciation). They consist of 11 skulls (all lacking the facial skeleton) and 2 shinbones. In the heavy brow ridges, the thick cranial walls and the flattened skull vault they closely approximate *H. neanderthalensis*. On the other hand, the cranial capacity was smaller, and the shinbones are similar to those of *H. sapiens*. The Rhodesian fossils were found in the course of open-cast mining of lead and zinc ores at Broken Hill in Northern Rhodesia and consist of a skull (almost complete except for the mandible), a maxillary fragment, a sacrum and portions of the pelvis and limb bones. The skull is of unusually massive appearance, with huge brow ridges, a strongly retreating forehead and a large palate. The sacrum, pelvis and limb bones, on the other hand, are not distinguishable from those of *H. sapiens* and show none of the features commonly regarded as characteristic of *H. neanderthalensis*. The artifacts found with these remains indicate an Upper Pleistocene date, estimated on indirect evidence to have been about 25,000 years ago. A second skull of the Rhodesian type (almost identical in its cranial features) was discovered later at Hopefield, S.Af., north of Cape Town, and from the geological evidence it probably somewhat antedates the Rhodesian skull. The significance of Solo man and Rhodesian man in the problem of human evolution is uncertain.

If these types represent variants of Neanderthal man, it must be assumed that the latter wandered widely. It also has been postulated that they represent local developments in the areas where their remains were found, and that they were either aberrant types that became extinct or that they provided the ancestral stock from which modern Australoid and Negroid peoples were derived. However, there is no convincing evidence for this last view, and it would appear that they existed too late in time.

Polygenetic theories of the origin of man hold that the racial varieties of modern *H. sapiens* have evolved independently from different stocks of earlier man. Although the idea may be valid, evidence for it is entirely negative; proponents of such theories do not seem to have taken account of the fact, now well established, that ancient types of *H. sapiens* spread widely over the earth at a very early date.

If it is accepted on the fossil evidence so far available that early varieties of *H. sapiens* certainly extended back to the third and almost certainly to the second interglacial period, the question now arises—is there any evidence that he existed anywhere on the earth at a still earlier date? In spite of reported discoveries for which a greater antiquity has been claimed, the answer to this question in the mid-1960s remained in doubt. If the term man is taken to connote toolmaking hominids, then man has been in existence since at least the early part of the Pleistocene period—that is to say (on the basis of indirect geological evidence and the potassium-argon method) 1,000,000 years ago or more—for his stone implements have been recovered from deposits going back to this remote time. The advanced culture of Aurignacian times was preceded by more primitive cultures termed the Mousterian and Levalloisian, and these again were preceded by populations responsible for the Acheulean hand-ax industry. The latter persisted into the last interglacial period in Europe, but extended back through the whole length of the prolonged second interglacial period, a matter of many thousands of years. Still earlier was the primitive Abbevillian industry, characterized mainly by large hand axes of a rough and unfinished type. Lastly, the very crude pebble-tool industry left its traces in deposits dating from the earliest part of the Pleistocene and found in many different parts of the old world. The only certain evidence of fossil man antedating the second interglacial period bears witness to hominids which, on morphological criteria, were very different from *H.*

sapiens, and they have been referred to as a separate genus altogether, *Pithecanthropus* (*q.v.*).

PITHECANTHROPUS

The first discovery of *Pithecanthropus*, made at Trinil in central Java in 1891, consisted of a skullcap and thighbone. These were found in alluvial deposits on the bank of the Solo river at a stratigraphic level that (it is now generally agreed) is of Middle Pleistocene age, and they were probably laid down at a time corresponding to the second glaciation of the Ice Age in other parts of the world. The skullcap is astonishingly small and presents a remarkably simian appearance. So much so that some anatomists at first refused to recognize it as hominid at all and supposed it to be from a giant gibbon. By contrast, the femur is entirely similar to that of *H. sapiens*, and some doubt was expressed that it really belonged to the same creature as that of the skull. However, portions of other thighbones of modern type also have been recovered from the same series of deposits, and that they are properly attributable to *Pithecanthropus* has been confirmed by fluorine tests and by the fact that thighbones of similar type also have been found with the remains of the same genus *Pithecanthropus* in China. That the skullcap belongs to a true hominid is shown by the cranial capacity, which exceeds considerably that of any known ape, and by further discoveries in Java. These later discoveries include the remains of three adult skulls and the cranium of an infant, an upper jaw and the adjacent part of the facial skeleton, some fragments of lower jaws and a number of teeth. One of the lower-jaw fragments, distinguished for its great size, has been referred to a new genus of extinct hominid, *Meganthropus*, but there is no convincing evidence that it is other than an unusually large jaw of *Pithecanthropus*. It should also be noted that some of these remains were found in deposits underlying the Trinil horizon, but, according to recent studies, these deposits are also no earlier than the Middle Pleistocene.

From all this fossil evidence it has been established that the Javanese type of *Pithecanthropus* shows very primitive characters in the skull and dentition. The mean cranial capacity was probably rather less than 1,000 cm.^{3}, the forehead region is flat and retreating, the brow ridges project forward as a shelf of bone overhanging the orbits, the cranium is extremely flattened and its general contour is very simian in appearance; the area on the back of the skull for the attachment of the neck musculature shows that the latter must have been powerfully developed, the nasal aperture is very broad, the palate and jaws are massive, there is no chin eminence, the molar teeth are exceptionally large, and in some individuals the upper canine tooth projects beyond the level of the adjacent teeth and interlocks to a slight degree with the lower canine tooth. The infant skull, found at Modjokerto in eastern Java, is of particular interest, for although it belonged to an individual perhaps not more than two or three years old, it shows the incipient development of some of the characteristic features of the adult *Pithecanthropus* skull; *e.g.*, the retreating forehead and the strong brow ridges. The cranial capacity of the skull is about 700 cm.^{3} and it has been estimated that in the fully grown individual it would not have exceeded 1,000 cm.^{3} The study of endocranial casts has emphasized the primitive character of this extinct hominid, for in its proportions and dimensions the cerebrum shows an approximation to that of the apes, as also in the convolutional pattern of the frontal lobe of the brain. Apart from the size of the canine tooth in some individuals, the dentition is entirely hominid in its general characters. No stone artifacts have been found in the strata from which remains of *Pithecanthropus* were recovered in Java, but stone chopping tools and primitive hand axes occur in deposits of a slightly later age; it is not improbable that such tools actually were made and used during the Middle Pleistocene by hominids of the *Pithecanthropus* type in that region. The thighbones indicate a height of about 5 ft. 8 in. and, since they are not distinguishable from those of *H. sapiens*, it may be inferred that *Pithecanthropus* already had developed erect posture and gait quite similar to those of modern man. Thus, the Javanese type has been called by the specific name *P. erectus*. Some authorities have interpreted the large mandibular fragments as evidence for the existence in Java during the Pleistocene of giant hominids. But this is a misapplication of the term giant, which is commonly taken to refer to stature. A large jaw does not necessarily imply a giant individual; on the contrary, as far as the available paleontological evidence goes, there is some reason for assuming a negative correlation between the size of the mandible and the total stature in primitive hominids. Certainly, as has been seen, the thighbones from the Trinil deposits provide no evidence of great height.

The Chinese representatives of *Pithecanthropus* (usually called *P. pekinensis*) are known from skeletal remains discovered at Chou-k'ou-tien, near Peking. The first find (1927) consisted of a lower molar tooth. Two years later, a well-preserved cranium of very primitive type was found at the same site. These remains were at first given a different generic name, *Sinanthropus* (*q.v.*), but their close relationship to the Javanese *Pithecanthropus* soon became evident, and the term *Sinanthropus* has been discarded by most scholars. *P. pekinensis* is now known from the remains of 14 skulls, as well as portions of the facial skeleton, several mandibles, many teeth and a few limb bones. The cranial capacity has a mean value of more than 1,000 cm.^{3}, but it seems to have been remarkably variable, for in four individuals it shows a range from 850 to 1,300 cm.^{3} The latter figure comes well within the range of variation of *H. sapiens*. All the skulls show a marked flattening of the cranial vault, heavily constructed brow ridges and thick bony walls. The facial skeleton is strongly built, the jaws and teeth are large, and the mandible lacks a chin eminence. The forehead region is better developed than in *P. erectus*, and, with the somewhat larger cranial capacity, has been taken to indicate that *P. pekinensis* was slightly more advanced. The teeth, in spite of their large size, conform in all essentials to the hominid pattern, and the canines, though in some individuals large and conical, do not project to any marked degree beyond the level of the adjacent teeth. The limb bones found at Chou-k'ou-tien comprise portions of seven thighbones, two upper arm bones, a collarbone and one of the small bones of the wrist. In no character has it been satisfactorily demonstrated that any of these are distinguishable from those of *H. sapiens*.

In the same deposits yielding remains of *P. pekinensis*, crude cores and trimmed flakes of quartz and silicified rocks were found, comprising a local Paleolithic industry of an archaic but fairly uniform character. Some bones of other animals, which evidently had been broken for their marrow content, also were found. Finally, the deposits contained the remains of hearths and quantities of charred bones, evidence that these ancient hominids were skilful hunters and had learned the use of fire for domestic purposes. It seems clear that, in spite of their very primitive morphological characters, the Chinese representatives of *Pithecanthropus* already had developed a very active communal life. The geological evidence makes it fairly certain that they lived during the Middle Pleistocene, probably at a time corresponding to the second interglacial period.

The question arises whether the geographical range of *Pithecanthropus* extended outside the far east. There is some evidence that it did, and reference may be made to the massive, chinless jaw found in 1907 in a sand pit at Mauer, Ger., near Heidelberg. The jaw is very simian in appearance, but the teeth, though large, are typically hominid. This specimen is usually referred to the species *H. heidelbergensis*, but it may equally well belong to the genus *Pithecanthropus* (*see* HEIDELBERG JAW).

The identification of the specimen is hardly possible in the absence of the skull. The fossil was found in association with *E. antiquus* and other extinct mammals characteristic of the early part of the Pleistocene; it probably dates from the commencement of the first interglacial period, which would give it an antiquity of several hundred thousand years. No stone implements were found at the site. Two lower jaws, quite similar to the Heidelberg fossil and possibly also belonging to a type of fossil hominid not taxonomically distinct from *Pithecanthropus*, were found in Algeria in 1954 in association with stone artifacts of an early hand-ax

industry ascribed to the early Acheulean phase of Paleolithic cultures. Although these jaws with the lower dentition appear to show no marked deviation from *Pithecanthropus,* they have been assigned, with no apparent justification, to yet another new genus, *Atlanthropus.* The geological and archaeological evidence suggests that these specimens date from a period of the Pleistocene slightly later than Heidelberg man. An incomplete cranium found at the Olduvai gorge in Tanganyika in deposits also containing stone tools of the Abbevillian culture appears to have a close resemblance to the cranium of *Pithecanthropus,* though in minor respects somewhat more advanced in its morphology. It thus appears that the genus *Pithecanthropus* may have extended its geographical distribution as far south as east Africa.

The paleontological evidence indicates that *Pithecanthropus* lived long before *H. sapiens* came into existence. He was, therefore, a precursor of *H. sapiens;* this naturally suggests that he was actually ancestral to this species. When it is suggested that *Pithecanthropus* may have been ancestral to *H. sapiens* (and the evidence of paleontology and comparative anatomy lends considerable support), it is not meant to be implied that the actual individuals whose remains have been found in the far east and elsewhere were themselves the ancestors, nor even that the local groups or species that they represent were so. It only means that the genus as a whole may have provided the ancestral basis from which modern types of man initially derived. Other representatives of *Pithecanthropus* than those already known, and perhaps a different specific group of the genus, may have provided the actual ancestors. This will be settled only when much more paleontological evidence has accrued.

The most that can be said without more evidence is that *Pithecanthropus,* primitive types of *H. sapiens* such as those known to have existed in pre-Mousterian times, and modern *H. sapiens* provide a gradational series and a temporal sequence; this strongly suggests that they represent an actual evolutionary lineage. Parenthetically, it should be noted that some authorities have doubted whether *Pithecanthropus* can properly be distinguished as a separate genus from *H. sapiens,* and they recognize the type as no more than a separate species, *H. erectus.*

Perhaps the most striking feature of the archaic *Pithecanthropus* is the combination of very primitive and almost simian characters of the skull, jaws and brain with a dentition that is fundamentally of the hominid type (contrasting very strongly with the dentition of all anthropoid apes, whether recent or extinct) and with limb bones which, known from rather fragmentary remains, are no different from those of modern man.

It seems clear, therefore, that in evolutionary development of the Hominidae, adaptation of limbs for erect posture and gait and acquisition of hominid dentition began earlier and proceeded more rapidly than the modification of the skull and jaws or the expansion of the brain to the form and proportions characteristic of *H. sapiens.* There is some reason to suppose that the expansion of the brain to modern proportions must have been a rather rapid process compared with evolutionary rates in general. Certainly there is no evidence that the brain had begun to approach modern dimensions before the Middle Pleistocene, and it is a matter of some importance that this should be recognized. For the consensus among paleoanthropologists was (in the early 1960s) that the Hominidae, as an evolutionary radiation distinct from that of the anthropoid apes, probably became segregated not later than the Miocene or the early Pliocene, several million years before the commencement of the Pleistocene. If this is so, it means that the earlier representatives of the Hominidae must have retained brains of simian proportions for a prolonged time.

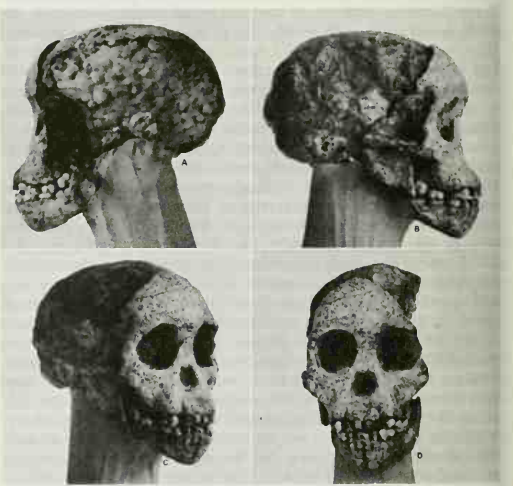
During this interval, however, they were presumably already differentiated from the ape family by modifications of the limbs for the erect posture (one of the outstanding diagnostic characters of the Hominidae) and by development of hominid dentition (both of which features were already well established in the Middle Pleistocene by the genus *Pithecanthropus*). From the anatomy of man and modern apes and from the paleontological evidence recounted above, the initial differentiation of the Hominidae and the anthropoid ape family from a common ancestral stock was related to divergent trends of evolution which, in the limbs and dentition, were rather strongly contrasted; there is some reason to suppose that, more than anything else, it was the divergent modification of the limbs for very different modes of life that determined the initial segregation.

If these inferences are correct, it must be presumed that the *Pithecanthropus* phase of hominid evolution was preceded by a phase characterized by a still smaller brain but in which limb structure and dentition might be expected to show at least some modification in the direction of evolution which has characterized the Hominidae. The interesting question now arises—is there any fossil evidence that such a type ever existed? The answer to this question is to be found in the remarkable discoveries made in South Africa and in east Africa of the remains of creatures to which (as a group) the name Australopithecinae has been given. It is difficult to give them a less pedantic name without misleading implications, though, because of the curious mixture of anatomical features that characterize these creatures, they are sometimes referred to as man apes or near men.

AUSTRALOPITHECINAE

The first fossil evidence of the existence of these creatures was obtained at Taungs in Bechuanaland in 1924—the skull and a natural endocranial cast of an immature individual (*see* AUSTRALOPITHECINE). This specimen shows a number of features (particularly in the milk dentition) in which it approximates much more closely to the Hominidae than do any of the known anthropoid apes. But, because the distinguishing characters of the skulls of adult apes and of the Hominidae are not so conspicuous in immature individuals, considerable doubt was then expressed regarding the significance of the apparently hominid features of the Taungs skull.

Later, from 1937 onward, considerably more remains of the same type were discovered in the stalagmitic deposits of ancient caves and fissures formed in dolomitic limestone at sites in the Transvaal. As the result of excavations extending over a number of years, a great quantity of important fossil material was collected, consisting of a number of skulls of immature and adult individuals, many upper and lower jaws, numerous examples of the permanent and deciduous dentition, several specimens of the limb skeleton, six examples of the bony pelvis and the greater part of a vertebral column, which was found still articulated.



BY COURTESY OF "THE STAR," JOHANNESBURG, SOUTH AFRICA

THE TAUNGS SKULL (A) LEFT SIDE SHOWING RECESSED FACE, HUMANOID TEETH, VERTICAL FOREHEAD AND CAST OF BRAIN PATTERN; (B) RIGHT SIDE; (C) SEMIPROFILE SHOWING HUMAN APPEARANCE; (D) FRONT SHOWING SMALL INCISORS AND CANINES, AND NASAL OPENING BEHIND EYE SOCKETS

With this material, more information is available about the anatomy of the Australopithecinae than about that of almost any other extinct group of higher primates. The outstanding characters are: (1) a small cranial capacity equivalent to that of the modern large apes (but in some examples probably exceeding it, at any rate in relation to body size); (2) massive projecting jaws; (3) large molar and premolar (or bicuspid) teeth but remarkably small incisors and canines; and (4) pelvis and limb bones constructed on the hominid plan (but showing significant differences from those of modern *H. sapiens*). The combination of a small brain case with large jaws gives the skull a most apelike appearance, and largely for this reason some authorities at first took the view that the creatures were really apes in the taxonomic sense.

However, a critical analysis of the cranial and dental characters, and especially the evidence of the pelvis and limb skeleton, makes it clear that the total morphological pattern conforms to the pattern diagnostic of hominid evolution and certainly not of anthropoid apes.

This remarkable combination of characters provoked rather acute controversies regarding their precise taxonomic position. Unfortunately, the discussions were at first somewhat confused by exaggerated claims on both sides. Thus, claims that the Australopithecinae were capable of fabricating bone tools and that they had even learned the use of fire were based on evidence that proved to be quite inadequate. On the other side, it was claimed (mainly on the basis of rather scanty earlier discoveries and partly from the application of inadequate statistical methods) that some of the skeletal and dental characters were no different from those of modern apes. The later accession of much more complete material showed that these latter claims had been put forward too hastily. For example, the dental morphology is now completely known, and it conforms in all fundamentals to hominid dentition.

The canine teeth are consistently small, of spatulate (instead of sharply conical) form, and they became worn flat from the tip so that (as in modern man) the biting surface at an early stage of attrition was brought level with the biting surface of all the other teeth. They never overlapped and interlocked in occlusion as they do in anthropoid apes. The front lower premolar tooth is consistently bicuspid as in *Pithecanthropus* and entirely different from the pointed sectorial type of tooth, which is characteristic of apes, recent and extinct. The molar teeth are not easily distinguishable in their cusp pattern from those of *Pithecanthropus* and, though large, in many individuals their size comes within the range of this genus of hominids. Lastly, the teeth are consistently arranged in an even arcade of elliptical or parabolic form, with no gap (or diastema) between the canines and adjacent teeth—a disposition that, once again, is hominid and in marked contrast with ape dentition. Application of careful statistical methods has demonstrated that the taxonomically relevant dimensions of the canine teeth lie far outside the range of variation of modern apes.

The skull presents a number of features which, taken in combination, are never found in apes but which are characteristic of hominids. These include the cranial height, the low position of the occipital protuberance, the detailed conformation of a number of features in the cranial base and the shape of the mandible. In a few of the largest australopithecine skulls, the vertex is marked by a low median crest which is related to the growth of large temporal muscles that moved the massive jaws. In one of the earliest of these skulls that was discovered, the occipital region was missing, and it was argued that the median crest must have extended back into a high transverse nuchal crest on the back of the skull just as it does in gorillas (implying an exceptionally powerful development of the neck musculature).

However, other skulls with a median crest on top and with the occipital region preserved show that there was no high nuchal crest of the gorilloid type—the muscular markings for the neck muscles are low in typical hominid fashion. This has an important bearing on the poise of the head, for the reduction of the neck musculature in the Hominidae is related to the fact that with the development of an erect posture the skull becomes more evenly balanced at the top of a vertical spine, and a powerful neck musculature no longer is required for holding up the head at the end of a forward-sloping spine. The contour of the back of the australopithecine skull, combined with details of the articular condyles on the cranial base, led to the inference that the Australopithecinae must have been adapted to an erect posture and gait approximating that of *Homo*. This inference received remarkable corroboration from the discovery of portions of thighbones and of the pelvic bones. The latter are of particular importance, for the total morphological pattern of the bony pelvis of the Hominidae is perhaps their most characteristic skeletal feature and, indeed, distinguishes them from all other primates (including the anthropoid apes). This pattern, moreover, represents in its major components an adaptation to the mechanical requirements of an upright or erect posture.

These components include the great breadth of the iliac blade, lengthening of the iliac crest for the more extensive attachment of powerful back muscles needed to support the trunk in the vertical position, backward displacement of the area of attachment of certain buttock muscles so they can be effective in upright walking, the rotation and downward shifting of the joint through which the weight of the body is transferred from spinal column to lower limbs, development of a very distinctive bony eminence marking the attachment of a powerful ligament required to stabilize the hip joint in the erect position and so forth. Not one of these features is found in the ape pelvis.

On the other hand, pelvic bones of the Australopithecinae all show every one of them consistently; the pelvis is constructed fundamentally on the hominid plan, and was adapted for erect, bipedal posture and gait. The anatomical evidence of bipedalism is entirely consistent with the geological evidence of the environment in which the creatures lived, for this shows quite positively that they were not forest dwellers but lived in open country very similar to the veld of the Transvaal today—an environment quite unsuitable for anthropoid apes of the modern type.

Until 1959 no indubitable australopithecine remains had been found outside South Africa. In that year an almost complete skull of the same group of primitive hominids was discovered in a stratum of deposits of early Pleistocene date at the Olduvai gorge. It is almost a replica of some of the more massive skulls from the Transvaal and the cranial roof is surmounted by a sagittal crest of the same type. Associated leg bones, the tibia and fibula, are remarkably hominid in appearance. Of more importance, these remains were resting on what was evidently a living site strewn with crude stone artifacts (and the flakes struck from them) of a recognized culture called the Oldowan. This outstanding discovery confirmed the evidence previously obtained in South Africa that the Australopithecinae were capable of fabricating stone tools. This skull was named *Zinjanthropus* but does not seem to be generically distinct from the South African fossils.

The latter also have been multiplied by some authorities into a number of different genera; *i.e.*, *Australopithecus, Plesianthropus, Paranthropus* and *Telanthropus*. But, in spite of conflicting opinion, there seems to be no valid reason for recognizing more than one genus (*Australopithecus*) and differences that *Zinjanthropus* may show are so minor as to merit a distinction equivalent to no more than a geographical variety, or at the very most a specific distinction. At a level in the Olduvai deposits below the remains of this individual a juvenile mandible has more recently come to light, with dentition also showing the characteristic features of *Australopithecus*. With the mandible were found the parietal bones of the skull and a number of limb bones, including an almost complete skeleton of the foot. This last discovery (*H. habilis*) is of particular importance regarding the extent to which the Australopithecinae had developed erect bipedalism (if *H. habilis* is regarded as truly australopithecine).

The taxonomic status of a previously unknown fossil—whether it is a primitive, small-brained hominid or a member of the anthropoid ape family—must depend on a recognition of the fundamentally different trends that have characterized the evolution of these two families and that are diagnostic of each of them as a

natural taxonomic group. The indirect evidence of comparative anatomy and the direct evidence of paleontology lead to the conclusion that the anthropoid ape family and the Hominidae represent divergent lines of evolution deriving from a common ancestry, and that only toward the terminal stages of the hominid line did the brain expand to the large size of the terminal species, *H. sapiens*.

The anthropoid ape sequence of evolution became adapted for a quite specialized arboreal life with accompanying specializations in the limbs, skull and dentition. The hominid sequence, by contrast, became adapted for terrestrial progression with profound modifications of the pelvic and limb skeleton (and also the skull) for erect bipedalism, and also was characterized by the replacement of sharp, interlocking canines by blunt spatulate teeth, and of pointed sectorial lower front premolars by bicuspid teeth, as well as numerous associated structural changes.

Careful appraisal of the anatomical structure of Australopithecinae makes it clear that, in spite of the primitive characters retained in the size of the brain and jaws, they already had advanced a considerable way in the direction of the hominid sequence and quite opposite to the direction that was followed by the anthropoid apes. For example, in those features in which the pelvic bone has undergone modification away from what must be presumed to have been the type of pelvis in the common ancestral stock, the modification has in every respect followed the direction of hominid evolution. Thus, by definition, the Australopithecinae must be classified zoologically in the family Hominidae. There is no evidence that they had the faculty of speech. But they were capable of fabricating stone tools; if toolmaking (and not merely tool using) is taken as a criterion of man in contradistinction to another animal, the Australopithecinae could be called primitive representatives of mankind.

The question arises whether the Australopithecinae could have been the ancestors of later hominids, including *Pithecanthropus* and *H. sapiens*. There appear to be no sound morphological arguments against such an inference; indeed, the Australopithecinae conform very closely to theoretical postulates for the phase of hominid evolution which, it must be presumed, preceded the *Pithecanthropus* phase. The australopithecine remains discovered in South Africa probably existed too late in time to be regarded as representatives of the ancestral stock; the geological evidence indicates that they probably lived in the Middle Pleistocene, more or less contemporaneously with *Pithecanthropus*. On the other hand, as already noted, the east African representatives of the Australopithecinae date at least from the early Pleistocene, and the potassium-argon method suggests that they have an antiquity of 1,000,000 years or more. In 1964 J. Napier was reported to have estimated the age of *H. habilis* at as much as 1,750,000 years. As far as the time factor is concerned, the group as a whole certainly could have provided the matrix from which more advanced types of hominid became differentiated by a process of evolutionary development.

In this brief survey a rather remarkable gradational series has been traced, leading from modern *H. sapiens* to primitive types of apparently the same species living many thousands of years ago in the Ice Age, from the latter to the archaic *Pithecanthropus*, which still preserved a number of anatomical characters approximating a simian level of development, and finally to the still more apelike Australopithecinae of east and South Africa. These simian characters do not necessarily indicate a very close relationship to modern anthropoid apes, for they are to be regarded rather as primitive characters derived in the distant past from a common ancestry, retained in the modern apes but subsequently lost in the later stages of hominid evolution.

Although it might appear that the primitive characters of the Australopithecinae emphasize the closeness of man to the apes in their evolutionary relationship, these extinct creatures were already very different from apes in many fundamental hominid characters of the skull, teeth and limbs. From what is known of the rates of evolutionary change in general, it is certain that the line of hominid evolution must have become a separate and independent line at a much more remote time.

ORIGIN OF THE HOMINIDAE

Exactly when the Hominidae, as a separate and independent line of evolution, became segregated from the anthropoid ape family is still not certainly known. No fossil hominid remains have been discovered that antedate *Australopithecus* and *Pithecanthropus;* indeed, in the 1960s it was the most serious gap in the fossil record of the Hominidae. Remains of several types of apes are known from Pliocene and Miocene deposits in Europe, Africa and Asia, but they consist almost entirely of teeth and fragments of jaws. Morphologically, most of these approximate quite closely those of the modern apes, but at least one of the genera, *Ramapithecus,* shows certain hominid traits.

The few remains of skeletons of Miocene apes from east Africa that have been found also indicate that the limbs had not developed the specialized modifications characteristic of modern apes; in many respects they were more like those of cercopithecoid monkeys. A Pliocene ape (*Oreopithecus*) from lignite deposits in Italy has been claimed as a primitive hominid rather than an ape, partly because of the small size of the canine tooth and the bicuspid character of the anterior lower premolar tooth. However, the dentition as a whole displays characters that suggest affinities with cercopithecoid rather than hominoid primates, while the skeleton shows the disproportionate length of the upper limb characteristic of more specialized brachiating apes. Such characters make it difficult to accept the proposition that *Oreopithecus* has an ancestral relationship (direct or indirect) to the Pleistocene hominids. Because of its unusual features, many authorities place this extinct type in a separate family of apes, *Oreopithecidae.*

The primitive characters of many of the Miocene and Pliocene apes are particularly relevant to the problem of the origin of the Hominidae. It has been seriously argued that hominids could hardly have an anthropoid ape ancestry because anthropoid apes are too specialized in limb structure and limb proportions. But there is a fallacy in the assumption that extinct anthropoid apes of earlier times must have shown the same degree of structural specialization as do the end products of the pongid sequence of evolution, which are represented today by the gorilla, chimpanzee and orangutan.

It later became known that this was certainly not always the case. Indeed, on the purely morphological evidence there is no improbability in the thesis that one of the known genera of Pliocene or Miocene apes may represent the common ancestral stock that gave rise, by different and contrasting kinds of adaptive modifications, to the divergent evolutionary sequences of the Pongidae and Hominidae. It has been proposed, and by some even taken for granted, that such features as the sharp, overlapping canines, the moderately sectorial first lower premolars and certain quite minor features of the cusp pattern of the molars constitute specializations which bar these early apes from any consideration as ancestors of the Hominidae. But this is to make assumptions on the irreversibility of evolution which are demonstrably untrue.

In genetic studies it has been shown that single mutations can be reversible in direction, and in phylogenetic studies there are many examples of what may be termed negative reversals; *i.e.,* the retrocession of characters previously well developed. There are strong morphological reasons for inferring that the hominid characters of the canines and premolars have been secondarily derived from those of the pongid type.

It may be noted that paleontologists frequently must consider whether certain extinct types had already attained such a degree of structural specialization that they must be regarded as divergent or aberrant groups with no ancestral relationship to modern types. The answer must depend on the assessment of the total morphological pattern in terms of its probable genetic constitution and the probable complexity of the selective influences that have determined its initial evolutionary development, and also on gauging the degree to which morphological changes have committed the group to a mode of life which has restricted too far the opportunities for selection in other evolutionary directions.

The morphological gap that separates the most primitive of the known hominids (*Australopithecus*) from the known fossil apes

of the Miocene and Pliocene has already been noted. The temporal gap is also large—a matter of at least several million years. From what is known of rates of evolutionary development in other mammals there is certainly no difficulty in postulating a transition from one to the other in this time period. But such a transition, the approximate period in geological time during which it took place and the region where it actually occurred can be demonstrated only by the discovery of the relevant fossil material.

See ANTHROPOLOGY: *Physical Anthropology; see* also references under "Man, Evolution of" in the Index.

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MAN, ISLE OF (Manx-Gaelic ELLAN VANNIN or MANNIN), one of the British Isles situated in the Irish sea, roughly equidistant from England, Ireland, Scotland and Wales. It is a lozenge-shaped island about 30 mi. long and 10 mi. wide, its main axis being southwest to northeast. Area 227 sq.mi. The capital is Douglas (*q.v.*). The island is not a part of the United Kingdom, nor is it a "foreign dominion" of the crown; it is a dependency, with a considerable degree of self-government, administered by the home office in a manner comparable with the Channel Islands. It is not exempt from the power of the English court to issue a habeas corpus.

Physical Features.—The island consists of a central mountain mass culminating in Snaefell (2,034 ft.) and extending north and south in low-lying agricultural land. There is fine cliff scenery along both sides of the central massif, whose grass-covered slate peaks are smooth and rounded, the result of ice action during the various glacial periods.

The landscape is treeless except in sheltered places; the many glens are not glacier formed. The island is almost bisected between Peel and Douglas by a narrow lowland tract which is in fact a double river valley, the rivers, all of which are small, running in opposite directions from the centre. The chief rivers are the Sulby, flowing north and east to enter the sea at Ramsey; the two-branched Dhoo-Glas at Douglas; the Santon at Cas-ny-haun; the Silverburn at Castletown; and the combined Neb-Rhenass at Peel.

There are no lakes, but the Douglas corporation constructed a large reservoir in the west Baldwin valley. To the southwest is a small islet, the Calf of Man, with precipitous cliffs, similar in structure to the main island, leased by the National trust of Great Britain to the Manx National trust, consisting of one farm and a strictly kept bird sanctuary.

Geology.—The central mass consists of Manx slates, flags, grits and conglomerates in which there is an almost complete absence of recognizable fossils. The slates, provisionally classed as Cambrian, have been much folded and crushed; they overlie the granite mass which has been denuded at Foxdale, the Dhoon and Oatlands (Kirk Santon).

Located in the south is a tract of about eight square miles of Carboniferous limestone which was formerly of great economic importance, providing building material for Rushen castle, the old houses of Castletown, King William's college and the quay walls of all the island ports. The quarries are no longer used for building stone, but there are extensive limekilns. Beneath the limestone is a basalt conglomerate, well exposed on Langness with some interesting "fault arches," and good examples of unconformable strata of conglomerate on the tilted slates. The Carboniferous limestone shows two main series: the lower, Castletown series, and the upper, Poylvaish, both rich in fossil forms. Flags overlying the upper series were formerly polished and known as Castletown "marble." At Peel an exposure of a dark red sandstone, attributed to the basement beds of the Carboniferous limestone series, provides picturesque building stone which gives the town, its cathedral and castle their rose-red coloration. The northern part of the island is a roughly triangular plain with its apex pointing northeast. This plain is based upon the limestone on which lies a thin band of Permian sandstone covered by a much wider band of Triassic sandstone, all deeply covered by a mass of glacial and alluvial material forming a marshland (curragh) formation of great floral and faunal interest. Toward the apex of the triangle (Point of Ayre) are the Bride hills, a mass of glacial drift, and beyond, along the northwestern coast, is a region of blown sand called the Ayre. The soil in the south is mainly of glacial gravel with local lacustrine and river deposits; from Derbyhaven to Port St. Mary there is blown sand upon which the airport and golf links are situated. To the south of Cregneish are signs of heavy earth movements in the faulting of the slate cliffs, which are rent by chasms and fissures running the whole height of the 200-ft. cliffs. To the southwest of Castletown stands the Stack of Scarlett, possibly a basaltic volcanic side cone, and around it for a considerable area are lava overlays, with basalt sills, and volcanic ash. There is a long history of mining activities —lead, zinc, copper and hematite having been worked—but all the mines are now derelict. They were centred around Laxey and Foxdale, with a few isolated mines in the south.

Climate.—The prevailing winds are from the southwest and the climate is equable. The mean annual temperature is 8.1° C. (46.6° F.), the average mean temperature in February is 4.9° C. (40.9° F.), and in August 14.3° C. (57.8° F.); the average annual mean daily sunshine is 4.31 hours; the average annual rainfall is 41.2 in. Fogs are common, snow and frosts are rare and of short duration. Thunderstorms are rare.

Vegetation and Animal Life.—The number of species of plants on the island is small, and the main interests of the vegetation lie in its varied associations and a comparison of its species with those of the surrounding countries. With the end of the glacial periods the land link was soon destroyed so that comparatively few plants were re-established. There is a profusion of ferns. Subtropical shrubs, such as the fuchsia, hydrangea, myrtle, *Escallonia* and *Clianthus,* flourish out-of-doors, while a prominent feature of the coastal landscape is the abundance of dragon palm (*Dracaena*).

There are no snakes or toads, few frogs and two species of lizards (common and sand). There are no badgers, foxes, moles, voles or squirrels. The mountain hare grows more and more

scarce; rabbits, formerly a pest, were very greatly reduced by myxomatosis. Hedgehogs, accidentally introduced from a wrecked ship at the beginning of the 19th century, are plentiful. The pygmy shrew (*Sorex arenaeus*) is abundant, as is the long-tailed field mouse (*Mus sylvaticus*); the black and the brown rat and the house mouse are too well-established; the stoat (*Mustela erminea*) is not common. The gray seal (*Phoca vitulina*) breeds on the Calf. There are three bats, the pipistrelle (*Vesperugo pipistrellus*), Natterer's bat (*Murina natteri*) and the long-eared bat (*Plecotus auritus*). Across the land bridge following the retreating ice came the giant Irish stag (*Cervus gigantaeus*), of which many skeletons have been found. There is only one species of fresh-water fish, the perch, much localized and probably introduced by the monks. The fish indifferent to salt and fresh water—salmon, brown trout, eel and stickleback—are present. The Manx cat, without a tail or with a greatly reduced tail, is common as a domestic pet in the island but is not indigenous. There is still one small flock of Manx *loghtan* sheep, a handsome four-horned breed. The main faunal interest is in the bird life, as the central position of the island makes it ideal for the study of both sea and land birds and their migrations. Birds not recorded are the jay and the woodpeckers. The chough is much less common than formerly; ravens are plentiful. The buzzard is a rare visitor, and the peregrine falcon is becoming rarer.

Archaeology and History.—All traces of Paleolithic inhabitants were destroyed during the glacial periods. There are many and varied evidences of Mesolithic civilizations, including Tardenoisian and the Bann type of northern Ireland. The Neolithic also has two aspects, one culture being associated with the megalithic monuments (*c.* 2000–1500 B.C.); the other, the highly individual Ronaldsway culture (named after a domestic site excavated in 1943), is apparently a Manx equivalent of the Late Neolithic of Orkney (Skara Brae). The three chief megalithic monuments are: Cashtal yn Ard, near Kirk Maughold, a gallery grave with a noble forecourt; King Orry's grave, near Laxey, a "double" long cairn cut in two by a road and further mutilated by 19th-century houses; and the Meayl (or Mull) circle, near Cregneish, a unique structure comprising six pairs of chambers disposed on the circumference of a circle.

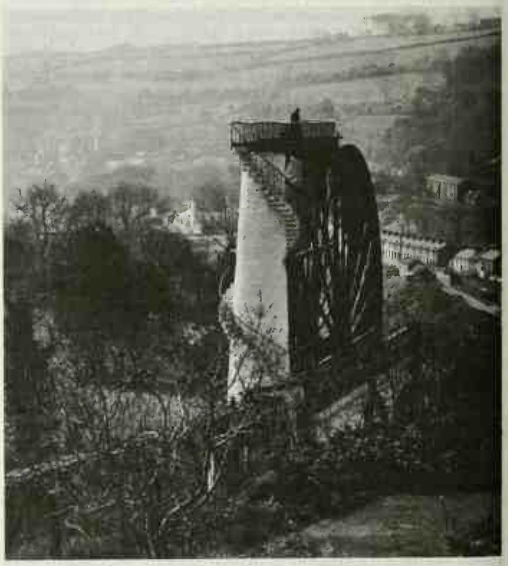
The Bronze Age is represented mainly by graves containing food vessels, several of Irish type, and the subsequent cinerary urns, and by surface finds of bronze tools and weapons. Groups of circular house foundations at Ronaldsway (excavated 1935–37, later destroyed) may belong to the Late Bronze Age.

The Early Iron Age is marked on the one hand by hilltop forts like some Celtic strongholds in Wales (South Barrule is the largest) and on the other by large, circular, wooden farmhouses, undefended and often sited in lowland meadows (notably Ballakeigan, excavated 1941–44 by G. Bersu), assigned to the 2nd century A.D. After 1956 the many mounds or "forts" on the coastal headlands were investigated by P. S. Gelling and were shown to be Celtic, modified by Norse occupation.

The island became the home of many Irish missionaries in the centuries succeeding the teaching of St. Patrick. This period was marked by the building of oratory chapels, or *keills*, and by gravestones with incised crosses of varying artistic merit, many of which are to be seen in the parish churches and in the museum. The Scandinavian invasions began about A.D. 800 and the first phase lasted till after the Norman Conquest of England, during which time the vikings came mainly for plunder but slowly began to settle. Already settlements had been made in the Nordreys (Orkney and Shetland) and the Sudreys (the Western Isles of Scotland). Such history of the period as is known is recorded in the sagas of the period. The second viking period began with the arrival of Godred Crovan in 1079 and lasted till 1266. Its history is recorded in the *Chronicon Manniae* (British museum), written by the monks of Rushen abbey (founded 1134). Fourteen kings and 15 bishops are recorded, and Godred Crovan appears to be the King Orry or Gorry of Manx legend. During this period the island was controlled by a Scandinavian system of government which has remained practically unchanged. Godred's son Olaf (1113–52) was the first king to style himself *Rex Manniae et insularum*. His son Godred II became the vassal of Henry II of England, and from that time the island became a pawn in the game of war between Scotland and England. Reginald I of Man paid homage to the king of England in 1187. Memorials of the Scandinavian age, apart from the ancient Tynwald parliament and many place names, are to be found in the remains of farm fortresses on the cliff edge, as well as in ship burial mounds at Balladoole (Arbory) and Knock-y-dooney (Andreas). In 1229 Bishop Simon of Argyll was sent from Nidaros (Trondheim) to be bishop of the Sudreys and Man. He began the building of the cathedral on the site of St. German's church on Peel Island by reconstructing the former church as the chancel of the future cathedral. He also built a fortress home, Bishopscourt, at Kirk Michael.

In 1266 the king of Norway sold his suzerainty of Man and the isles to Alexander III of Scotland. This suzerainty had long been repudiated by the kings of Man. Magnus, king of Man at the time, sent an army to assist an invasion of Scotland by the Norwegians. The battle of Largs found Alexander triumphant, and he demanded from Magnus the Sudreys, which were ceded, and from Magnus' son Godred he bought all Godred's claims as king of Man, thus becoming king of Man by purchase. With the rise of Edward I, Man changed hands and became an appanage of England. Edward II lost it to Bruce, who came to the island in person and conquered it, capturing King Orry's tower on the site of the present Rushen castle. But Edward III, by beating Scotland, won back Man, after which time all its kings were English. Edward III gave the kingship to William de Montagu, 1st earl of Salisbury, and from him the title passed to his son, who sold it and his "crowne" to Sir William le Scrope. (*See* MONTAGU.) During the kingship of the Montagus, Rushen castle, a typical castle of the period, was rebuilt round King Orry's tower at Castletown (*q.v.*). It became the home of the Manx kings and the seat of government. Scrope built a small castle beside the cathedral on St. Patrick's Isle at Peel (*q.v.*), but he was attainted and executed by Henry IV, who in 1406 granted the island to Sir John Stanley, his heirs and assigns to be called "kings of Mann." The Stanleys refused to be called "kings" but adopted the title of "lord of Mann," which still holds.

With the Stanley regime came a much more stable period of government. The lords rarely visited the island, but they appointed



AUTHENTICATED NEWS

THE "BIG WHEEL" (72½ FT. IN DIAMETER) OF THE OLD LEAD MINES AT LAXEY ON THE EAST COAST OF THE ISLE OF MAN

wise governors and sent strong garrisons from Lancashire. Thirteen members of the Stanley family were lords in succession, with two brief interludes. Queen Elizabeth I in 1594 took over the lordship when Fernando Stanley died leaving only daughters. It was retained by James I till 1607 when he gave it to the earls of Salisbury; but in 1609 it was returned again to the Stanleys. During the Commonwealth, James, the 7th earl, the "Great Stanley," left the island in charge of his countess, Charlotte de la Tremoille, whose military commandant, William Christian (Illiam Dhône), surrendered it to the Roundheads when the earl was executed after the battle of Worcester. Lord Fairfax was made lord of Man, but at the Restoration the young earl Charles resumed the lordship and undid a great amount of his father's good work, chiefly by disputing the permanent tenancies of the farmers, who held their lands under the Scandinavian system of permanent freehold upon payment of the lord's rent and not under the Norman feudal system as in England. As a result of a lasting quarrel with their lord, the farmers neglected the land and turned their attentions to fishing and the contraband trade. The island had no fiscal laws, and spirits, tobacco and silk could be legally imported into the island from which they were re-exported to Great Britain by a fleet of fast clippers with skilful crews. The land question was ultimately put right by the influence of Bishop Thomas Wilson in 1704 in an act of settlement, by which tenants received their lands in perpetuity on payment of a fixed rent, and a fine on succession or alienation. With the death of the 10th earl in 1736, without male heir, the lordship passed through the female line to James Murray, 2nd duke of Atholl, thence to his daughter Charlotte, Baroness Strange, and through her to her husband, John Murray, who also had a claim to the title.

The chief feature of the Atholl rule was the gigantic increase in the contraband trade, which became a serious menace to British revenue, and parliament resolved to suppress it. A Revesting act was passed in 1765 purchasing for the crown the sovereignty of Man for the sum of £70,000 together with an annuity to the duke and duchess of £2,000. The Atholls still retained their manorial rights and the patronage of the see. These were bought by the British parliament from the family in 1828 for the very high sum of £417,144. The 4th duke of Atholl, who built Castle Mona (now a hotel) at Douglas as the official residence of the lieutenant-governors of Man in 1804, remained as governor appointed by the crown. The Revesting act interfered to a considerable extent with the home rule of the island, but constant representations, especially in 1837, 1844 and 1853, produced alleviations, and in 1866 a good measure of home rule was restored to the island.

The People.—The earliest inhabitants in historic times were Celtic in speech, both British (Brythonic) and Gaelic (Goidelic) being spoken in the 6th century A.D. Gaelic (Manx) became dominant and remained the everyday speech of the majority until the first half of the 19th century. However, the number of Manx-speaking people fell from 4,657 in 1901 to 355 by 1951. In 1961 the population of the island was 48,150, that of Douglas 18,837.

The Church.—The first organized church was the Scandinavian Church, which was based on "treen" churches, or *keills*, in which a priest had charge of a tiny church and burial ground, living himself in a small cell usually beside a holy well. Later, 17 parishes were organized, each parish round one of the central *keill* churches, which were enlarged from time to time. But the church buildings maintained the constant type, a nave without transepts, side aisles or chancel, usually whitewashed and with a western bell turret and west door. In general they stood at some distance from the villages. The diocese was organized in Scandinavian times (*see* SODOR AND MAN). During the same age, too, were built the cathedral of St. German (now ruined and roofless); Rushen abbey (also in ruins), a branch of the abbey of Furness, which was the controlling factor of the religious life; and Bishopscourt, built as a fortress tower with a moat, and extended later. Of the nunnery near Douglas and the Franciscan friary at Bemaken, Kirk Arbory (founded in 1373 for 12 brethren), nothing remains except the chapels. Since the Reformation the church has retained its ancient organization and has formed a diocese of the York province of the Church of England, but it still carries marks of its "national" character in having its own canon law, convocation, and Tynwald control, the appointment of its bishop and archdeacon by the "lord," the retention of its vicar-general, its marriage laws and the appointment of churchwardens. In 1880, by act of Tynwald, four rural deaneries were formed and commissioners appointed to take charge of church endowments. In 1895 a cathedral chapter was authorized, consisting of the bishop (himself to be the dean of his cathedral), the archdeacon, four canons and the vicar-general.

The churchmanship of the island is traditionally evangelical. John Wesley, on his visits, won the affection of the Manx, and as a result the Wesleyan Church is very well established. There are Roman Catholic churches in all the larger towns.

For the language *see* CELTIC LANGUAGES; *see* also MANX LITERATURE.

Administration.—The government consists in a lieutenant governor, appointed by the monarch as lord of Man; a council, or upper house; and a house of keys, or lower house. The two houses sit separately as legislative bodies but come together to form a Tynwald court for certain business. The governor presides over the council and Tynwald; the house of keys elects a speaker. The Tynwald court and the house of keys constitute one of the most ancient legislative assemblies in the world. In the Tynwald court the two houses sit and vote separately but transact business and sign bills together. Tynwald controls revenue and appoints boards (education, agriculture and fisheries, local government, etc.). Customs duties are still controlled by parliament, but Tynwald can "impose, abolish or vary" customs duties, subject to parliamentary approval. The approval of the governor and the assent of the sovereign are necessary for every legislative enactment, and until lately such enactments were enforceable only after public proclamation from Tynwald hill in English and Manx. Acts of the Westminster parliament are enforceable in the island only if the island is directly named in them. The lieutenant governor is the supreme legislative authority, chancellor of the exchequer and commandant of military forces and police. An executive committee (constituted in 1946) acts as an advisory council on all matters of government and consists of the chairmen of spending boards and other members of Tynwald up to a total of seven members. The governor presides, and the government secretary, attorney general and clerk of Tynwald are in attendance. There is little trace of party government and no party "whips," and the majority of members are independent. The house of keys is elected for five years but may be dissolved by the governor; there is universal suffrage for men and women above the age of 21. The island is divided into six sheadings (administrative subdivisions), which return a total of 13 members to the house of keys. Douglas returns 7 members, Ramsey 2, and Castletown and Peel 1 each, thus maintaining the traditional 24 keys.

The annual reading of the laws passed during the year is carried out on old midsummer day, July 5, on the Tynwald hill at St. John's in the centre of the island. The day is a holiday and all inhabitants are bidden to attend. The Tynwald court assembles in the church of St. John for a short service after which it proceeds to the "hill," a mound of earth about 200 yd. distant, preceded by the coroners, captains of parishes, clergy and other dignitaries. Only the titles of the acts are now read, first in English, then in Manx.

Education.—Bishop Isaac Barrow in 1667 made education compulsory and founded a system of parish schools run by the clergy —the earliest scheme of compulsory education in the British Isles. In 1872, when the insular legislature passed the Elementary Education act establishing a board of education and local school committees, the state undertook direct responsibility for education. It became free in 1892 and a higher grade school was established in 1894. An act of 1907 established a system of secondary education. Parish boards were abolished in 1920 and one education authority took their place. The Education act of 1949 is based upon the English act of 1944. In the early 1960s there were 30 primary schools (one Church of England, two Roman Catholic). Secondary school reorganization was completed in 1948, there be-

ing separate secondary schools for boys and girls in Douglas and mixed secondary schools in Ramsey and Castletown. There is a small public school for girls (the Buchan school) at Castletown, and a public school for boys, King William's college, founded from the funds of Bishop Barrow's charity in 1832. Among its famous alumni have been Dean Farrar; Field Marshal Sir George White; J. Ellerton, the hymnologist; Sir W. H. Bragg; and T. E. Brown, the Manx poet.

Law.—Until 1920 the governor was president of the high (supreme) court of justice, but after that date he had no judiciary powers. There are now two judges of the high court, called "deemsters," and they have complete jurisdiction covered by the general jail delivery, queen's bench, chancery, admiralty, probate and divorce divisions. There is no regular assize; deemsters' courts are held every week of the legal term in one of the court towns of the island. The senior deemster is also clerk of the rolls; both deemsters can be called upon to act as judges of appeal in cases in which they have not been concerned, and another judge of appeal is appointed from the English bar. Magistrates (justices of the peace) sit in the four court towns, where also the high bailiff (stipendiary magistrate) holds courts; he also acts as coroner in the matter of inquests, etc. The Manx coroner, one in each sheading, holds a less exalted position; he is a court officer, empanels juries, serves summonses, collects fines and acts as a bailiff in cases of unpaid debt. The Manx bar differs from the English in that its members (advocates) act as solicitors and barristers.

There are peculiarities in the laws of real property, but otherwise the laws are practically identical with those in England.

The Shield of Arms.—The arms of the island are "Gules, three legs armed, conjoined in fesse at the upper part of the thighs, flexed in triangle, proper booted and spurred, or." The earliest appearances of the "three legs" of Man are on the village cross of Kirk Maughold, possibly 1375, on the shield of Sir William le Scrope, king of Man, 1395, and on the Manx sword of state *c.* 1450. The origin is uncertain. The motto *Quocunque jeceris stabit* ("It will stand wherever you throw it") first appears on the coinage of 1668, *jeceris* being misspelled as *gesseris.*

Economy.—The local fishing industry is almost dead, but a Scottish fleet lands herring in the summer at Peel, Port. St. Mary and Douglas, where large quantities are kippered or utilized as oil and fish manure. The Manx kipper is famous and is the most valuable export. There is a profitable scallop fishing (Manx *tanrogan*) off Bradda head. Sizable salmon run up the larger rivers, and there is a government salmon and trout hatchery at Kirk Michael. Liverpool university maintains a biological station at Port Erin which does scientific work in all phases of marine life.

The central massif is not cultivated but is used as grazing ground for sheep. The northern and southern plain lands and the central valley have mixed and dairy farms. Oats constitute the main crop and considerable quantities are exported, as are roots and potatoes. There is a rising export of cattle. Agriculture is well-organized. There are extensive market gardens but not enough to supply the demands during the holiday season. The aim of the island is to be self-supporting in agricultural produce and a great deal is exported.

By far the most important industry is the "holiday" trade; 500,000 persons, on an average, visit the island yearly from all parts of the British Isles. There are flourishing woolen mills producing Manx tweeds, modern flour mills and several well-established light industries.

Finance.—The finance of the island is based on a "common purse" agreement with Great Britain, by which duties imposed in Great Britain are also imposed in the island and amounts of duty paid for dutiable goods purchased in the island are credited to the insular exchequer from London on a basis calculated as the amount of consumption per head in Great Britain. There are no death duties, and income tax is lower than in the rest of Great Britain. In 1961 the Isle of Man government printed and issued its own bank notes for the first time.

Communications.—There is a civil airport (with modern buildings) at Ronaldsway, near Castletown, which handles many planes daily from all parts of the British Isles. Packet boats maintain a daily service to and from Liverpool all the year round. The railway has two narrow-gauge single-track lines running, one from Douglas to Port Erin via Castletown, the other to Peel and Ramsey via St. Johns. The electric railway has a wide-gauge double-track line from Douglas to Ramsey via Laxey, with a branch to the top of Snaefell. There are motorbus services from Douglas to all parts of the island.

Since 1904 the Isle of Man has contributed to the development of automotive engineering by passing an act annually in Tynwald closing the roads to ordinary traffic in order to allow the running of Tourist Trophy (T.T.) races over a 37-mi. course from Douglas to Ramsey and back over the mountain road. These races test the engines and mechanisms under very severe conditions. The car race began in 1904, the motorcycle in 1907. The motorcycle T.T. race, held in June, has been continuous except for the war years (*see* MOTORCYCLING) but the car race no longer takes place.

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(E. H. S.)

MANA is a term of Oceanic origin which, like tabu (*q.v.*), has attained a wider usage, though in this case not beyond scientific circles in the 1960s. Basically, the word refers to the idea of power beyond the ordinary—not just physical strength but power of a less tangible kind, though it must be demonstrated by physical results. It is believed that both persons and things can have this power. A chief whose prayers to avert drought from the crops are followed by rain, or a weapon which gives its wielder consistent victory over apparently stronger opponents, are both said to have mana—often translated as success, reputation.

Historically, the term was known from Polynesia in the first half of the 19th century, but it was R. H. Codrington who first provided Melanesian data which stimulated anthropologists and other students of comparative religion. Codrington wrote of "the belief in a supernatural power or influence" which "works to effect everything beyond the ordinary powers of men, outside the common processes of nature," which "is present in the atmosphere of life," and which "though itself impersonal, is always connected with some person who directs it . . ." The very general nature of such expressions promoted much theoretical speculation without leading to empirical research. It was argued variously that mana was an all-pervasive fluid power set in motion by ritual; that it was a mysterious, impersonal entity; that it was not so much entity as quality or attribute. R. R. Marett in England, and H. Hubert and Marcel Mauss in France argued that mana was the basis of magical belief and practice; Émile Durkheim identified it with the totemic principle. Comparatively, mana was linked with such American Indian concepts as *orenda* and *wakan.* In line with their interest in the origins and development of social institutions, many writers saw in mana a concept of force or power of a very primitive kind, anterior to ideas of personalized spiritual beings and even to religion itself.

Later interpretations have seen in mana and allied notions not a single evolutionary stage or prior component in religious thought but a set of complex, vaguely defined metaphysical concepts expressing the view that human efficacy is not explicable in physical terms alone. A social component is also seen in that a description in terms of mana often appears to be a symbolic way of expressing the special qualities attributed to persons of status and authority in a society, and of providing sanction for their actions. *See* also ANIMISM; MAGIC, PRIMITIVE.

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MANABÍ, a province in the coastal lowland and hilly belt of Ecuador, bounded west by the Pacific ocean, north by Esmeraldas, east by Pichincha and Guayas and south by Guayas. Area 7,306 sq.mi.; pop. (1962) 614,803. Its capital is Portoviejo, pop. (1962) 38,600. The province is occupied chiefly by lowland Indians, who have successfully withstood the advance of the Negroes from the north. The chief products are cotton, coffee, sugar cane, rice, beef cattle and goats. From the fibre of the *toquilla* palm, a plant that grows wild in the semiarid scrub woodland, the Indian women weave Panama hats. The forests also yield balsa wood, tagua nuts and fine cabinet woods.

Connections are by sea through Manta and Bahía de Caráquez or in dry weather by road from Quevedo. (P. E. J.)

MANAGEMENT SCIENCES is a phrase intended to represent a common and mutually accepted concern on the part of a number of scientific disciplines with the study and solution of the problems of management. World War II and the period after saw a great increase of interest on the part of the applied scientist in the management problems of the military and of industrial firms. Recognition of this common interest led to the formation of new societies in the United Kingdom, the United States, and throughout Europe, Asia and Australia, such as the Operational Research society (U.K.), the Operations Research Society of America, The Institute of Management Sciences and Société Française de Recherche Opérationelle. The phrase "operations research," which appears in some of these titles, was originally used by the military agencies in the U.K. and the U.S. to designate teams of scientists who studied military operations, but has since come to designate the application of science to any operations initiated and controlled by managers. Hence the phrases management science and operations research are often used interchangeably, although the latter sometimes refers to applied research conducted under contract. Similarly, because of a common interest in the process of decision making, decision theory and organization theory frequently have the same connotation as the management sciences. The scientists, in the typical fashion of such cases where the object under investigation is not easily susceptible to recognized methods of science, are groping for names that will adequately portray their interests.

Definition.—The management sciences are bound together by more than a common intellectual interest; they also share a common philosophy of method: namely, the need for more rigorous analysis of the complicated problems of management. This need can often be satisfied by the use of mathematics or of carefully controlled observation and experiment. Opinions about the importance of mathematics vary among those who recognize themselves to be management scientists, but most if not all would admit that science connotes among other things the attempt to become as precise as possible and that mathematics is one of the chief resources of the mind in this endeavour. Differences of opinion usually reflect different judgments about the possibility of reaching refinement of language in specific projects, and the relative importance of research problems. Sometimes the management scientists try to characterize their aims in terms of quantification of managerial activities, because they feel that this term connotes the refinement and rigour they aspire to, and not because they feel any importance attaches to numbers as such.

In order better to understand the goals that hold this community of scientists together and induce them to form associations, one has to examine the concept of management with some care. Any such scrutiny reveals the confusion that attaches to the word in the English language. Often management has a very special connotation; for example, the class of rulers in a society as opposed, say, to labour. Often the phrase is used in a very general way to connote rational behaviour, as when we say that a man manages his affairs very well. Neither connotation represents what the management scientist has in mind. For him, examples of managers are to be found among those who act as administrators or executives in firms, unions, city, state or federal governments, military agencies, churches and educational institutions.

Thus it is not too difficult to point to specific examples of managers. But it is clear that persons who are called managers do not always manage, and it is almost as obvious that many persons who are not called managers are really a part of the management process. Hence, there is a need to define management as a certain kind of activity, rather than a certain kind of person. Most management scientists would agree that this activity must take place within human organizations. Even this minimal agreement is at variance with some common usage; it precludes talking about the management of a bechive, for example, or the management of one man's affairs. But when scientists band together under a common name, this kind of opposition to common meanings is quite usual.

Next, the community of management scientists would also recognize that the activity or management in organizations includes at least the following: (a) discovering, developing, defining and evaluating the goals of the organization and the alternative policies that will lead toward the goals, (b) getting the organization to adopt the policies, (c) scrutinizing the effectiveness of the policies that are adopted, (d) initiating steps to change policies when they are judged to be less effective than they ought to be. Activity (a) is often called planning and is essentially a cognitive activity carried on by individuals or by committees, who use information collected for them by their staffs. It has become convenient to characterize planning as short range and long range. Long-range planning emphasizes the fact that management may be obliged to consider the survival and growth of the organization over many years, and hence may have to consider many social and intangible goals not usually relevant in short-range plans. Activity (b), the adoption of plans, is an extremely difficult one in large organizations. A paper-and-pencil plan, no matter how attractive to the manager, often cannot be put into action by a simple order. Elaborate communication systems may have to be designed to get a large body of persons moving in the planned direction, and the many subtleties of persuasion and motivation are involved as well. Activity (c), the continuing scrutiny of the effectiveness of adopted plans, is often called control, and is a function that in some instances is the responsibility of accounting staffs. Activity (d), the process of changing plans once they are deemed ineffective, requires not only a designed data processing system, but it also entails the search for the mean between the extremes of changing too often and not changing often enough.

If management is characterized in this manner, it is a term which is applicable to any organized, goal-seeking group of persons. Hence the phenomenon of management may occur in national governments, civic governments, labour unions, schools, universities, business firms and even in scientific research establishments. One should recognize that management does not connote rigid control; an organization may be managed best by permitting maximum freedom of decision among its members.

Further, it should be noted that management as defined above will often include the activities of staff as well as line personnel in an organization, and may in many cases include some aspect of the activities of every member of the organization. Indeed, as in the case of any teleologically defined activity, it is usually not possible to separate management behaviour from nonmanagement behaviour or managers from nonmanagers. A foreman of a shop may in the same act be serving the function of management and the function of production. On the other hand, it often happens that the owners of a firm, members of a union or the citizens of a country do not manage the organizations that supposedly serve their interests. The management of these organizations seeks to determine the goals of the interested parties and tries to make these goals a part or whole of the evaluation basis of their plans, but the interested parties themselves may contribute very little to the management of the enterprise.

The definition of management does not imply that all forms of management are good, but the community of management scien-

tists does have a strong interest in establishing criteria of good and bad management. In this sense, the management sciences are not primarily descriptive, although detailed descriptions of management processes may be quite important. Instead, they are predictive. But interest lies not only in predicting what a given management will do in a certain circumstance, but more fundamentally in predicting what would occur if certain activities were adopted. The outcomes of these predictions are then evaluated, and an attempt is made to rank management activities in terms of better and worse, and if possible to discern the best. Evidently, this evaluation is based on a decision as to whose interests are to be served by management or, more precisely, how various competing interests are to be weighted.

The community of management scientists is largely made up of persons from various disciplines; very few claim this field as their sole area of *expertise*. Interest in and conceptualization of management problems depends on the background of the scientist, so that the management sciences inevitably display radically different emphases. In true academic style, the more vocal management scientists are apt to argue that their own approach and emphasis is fundamental, thus giving rise to the healthy disputes that constitute intellectual growth.

One description of the composition of the community of management scientists follows a traditional classification of the sciences that leads from logic and mathematics through the physical and engineering sciences to biology, psychology and the social sciences, culminating in ethics. But it may be noted that this classification is at best arbitrary, reflecting as it does but one structure of the sciences. Indeed, the adequacy of a classification of the sciences is itself a problem of the management of science, so that members of the community might well be expected to differ on this score as well.

Logic.—Logicians find in the study of management a fertile field for axiomatic theory. The post-World War II trend in the management sciences emphasized both mathematical models and the development of precise measurements. In either case, there was a clear need for a rigorous formulation of the underlying language. This need was especially true in the case of measurement, a term with many historical meanings. The tradition in the management of firms has been that some aspects of the activity are measurable (*e.g.*, a cash balance) and some, called intangibles, are not (*e.g.*, good will). On the other hand, pure scientists observing the vagueness of discourse that surrounds business research often have been inclined to say that in this area nothing is ever really measured. The logicians' task has been to state in as unambiguous a manner as possible what measurement is, what kinds of measurement there are and what can be said in terms of each kind. Of particular importance to the management sciences has been the axiomatic treatment of utility and subjective probability. In the case of utility, an attempt has been made to state in unambiguous terms a theory of preferential choice in decision-making situations. Formal studies of subjective probability try to define precisely a decision maker's beliefs in the likelihood that a certain outcome will follow upon a choice; these studies are based on the observation that even the most carefully educated man does not behave in accordance with the principles of objective probabilities. For example, it has been found that in relatively simple gambling situations involving the toss of a coin, persons typically believe heads (or tails) will be more likely to occur. No doubt this bias in favour of certain kinds of events is also displayed in the attitudes of many managers as well. The scientific task is to measure the attitude in order to better understand the subtle ways in which subjective probabilities influence decisions.

Mathematics.—Interest in the mathematics of management increased tremendously after World War II, although a number of notable treatises had appeared before. This interest resulted in new fields of mathematical research, fields whose titles reflect the potential application to management problems: inventory theory, waiting line (queuing) theory, linear and nonlinear programing, dynamic programing, game theory. Many of the traditional fields of mathematics have been the bases of these developments, but maximization theory and probability theory are extremely important in this connection, because almost all criteria of evaluation are expressed in terms of maximizing some variable, and because almost all management decisions are based on probabilistic forecasts. The nature and diversity of the mathematics of management can be suggested by brief characterizations of some of the more important examples.

Inventory Theory.—This provides a language for describing the state of a system that is subject to a pattern of demand and has available resources for building up supplies. The demands may be probabilistic and may vary in kind. The replenishment may be subject to delays and uncertainties. The reservoir may be depleted by obsolescence and deterioration. Management costs include cost of shortages, cost of replenishment, cost of holding the supplies. Many studies have been made of inventory problems; it has been found possible to predict the demands on inventory within statistical limits and to estimate the net costs of adopting various inventory policies, even when there are many kinds of inventory, seasonal fluctuations and unpredictable demands. Mathematical language is not restricted to the original intent of its designer. Thus inventory theory may be applied to many problems where the term inventory would not normally be used, such as planning of personnel assignments, parking facilities and cash flows.

Waiting Line Theory (*Queuing Theory*).—The language of a system of service units, this describes how customers arrive for service, how service meets their requirements in terms of average service time and variation in service time, how long the customer may have to wait, how long the service unit may be idle.

Linear Programing.—A language of activities which describes how these activities utilize their resources in order to accomplish certain prescribed tasks; linear programing also describes how these activities operate within the limitations of time and space. The term linear reflects the fact that the basic descriptions must take the form of linear algebraic equations (or inequations). Nonlinear programing permits a relaxation of this requirement. The language of linear programing is astonishingly versatile. In addition to its obvious use in the planning of production schedules, it has been employed in such areas as military logistics, transportation and traffic, personnel assignments and salary levels.

Dynamic Programing.—This maximization theory, among other uses, permits one to maximize over a whole series of states where each state depends on decisions that have been made in earlier states. This language allows one to state in rigorous terms the period-by-period consequences of decisions and to calculate the desirability of incurring temporary losses, say, for the sake of long-run gains.

Game Theory.—A language for describing competitive strategies when the opponents can influence the probability of success of the other "players" under prescribed rules, and can form coalitions to thwart the activities of others. This language therefore is well adapted to the study of competition, but its application has not been extensive because in many realistic problems it is difficult to ascertain what the players really want and the rules that govern their plays. (*See* GAMES, THEORY OF.)

In addition to these languages, the following can also be mentioned: theories of search, replacement, communication, information and decision making.

All these languages enable the scientist to state in rigorous terms the nature of the problem as he sees it, and the consequences of alternative decisions even when the situation is extremely complicated. Many management problems continue to defy the best efforts of mathematicians to describe them, so that the management sciences devote a great deal of effort in searching for even richer languages than those developed thus far. The complexity and subtlety of many management problems have quite naturally led the unwary to force the problem to fit an existing mathematical model, a procedure that is certainly not unique to this field of science.

Mathematical Statistics.—From the 1920s and 1930s, this discipline has attempted to formulate its foundations in terms of the utilization of information for decision making under uncer-

tainty; it therefore shares a common concern with the management sciences, despite differences in terminology. In a sense, the manager of an organization is a statistician, since he gathers data and attempts to test hypotheses, while taking cognizance of the risks and losses associated with wrong decisions. Mathematical statisticians have tried to give a precise formulation of this process, and to determine optimal solutions in cases where the data can be assumed to come from some random source. Of course, in most management problems it is difficult to ascertain the random characteristics of the data, and it is not generally possible to set up experimental designs to test for randomness. But there can be little doubt about the usefulness of a number of statistical models in management studies, and especially models of control and stability.

The physical sciences would normally be expected to have only an indirect interest in management problems, although in the postwar period a number of physicists and chemists applied their research abilities in this area.

Engineering Sciences.—On the other hand, engineering shares many problems with management sciences. For example, the engineer is often concerned with systems in which human beings are links. These systems are goal directed and must include devices that enable one to adjust the activity when it deviates from the goals significantly. It is clear, therefore, that the manipulation and control of an engineered system (*e.g.*, a chemical plant or a guided missile) has many characteristics in common with the management of a human organization. The chief difference seems to be one of degree: the importance of motivation, status, persuasion may be less in the engineered system. But some engineers have quite naturally wanted to apply their knowledge to the area of management. This interest goes back at least as far as the "scientific management" movement, which, in its earlier development, seems to have been chiefly concerned with the control of procedures, especially those of the shop. This movement showed little inclination to develop mathematical models of these procedures, but rather tried to use careful observation and physical measurement to discern how improvements could be made. In this regard, the scientific management movement differs radically in its philosophy from the management science movement. Perhaps this difference can be clarified by saying that scientific management was not interested in trying to develop a model that would reveal all alternatives and provide a criterion for the selections of the optimal choice. Those who, like some "systems-and-procedures" or "time-and-motion" engineers, followed the scientific management movement have been somewhat apart from the community of management sciences, a segregation that may very well be a phase in the maturation of each group.

However, systems engineers who design electronic systems must construct models of the system and it is natural to associate themselves with the management sciences movement. Many industrial engineers have also approached the problems of the scientific management movement from a mathematical point of view.

One output of the systems engineer has been of great importance to all the management sciences: the development of high-speed computers. Evidently the problems of management may involve many variables, and the solutions thus require quite elaborate computations. Such has been especially the case with linear programing models, where several algorithms have been developed which can most economically be solved by computers. Furthermore, the management sciences have found the simulation of a system to be enormously helpful in understanding its complexities, and computers frequently provide the means for simulating. Finally, in the early 1960s there was considerable interest in "business games" and "military games." These games partially simulate an organization in a specially constructed competitive environment. The computer enables the researcher to structure the environment in rather complicated ways, and yet to derive the consequences of the managerial decisions of the teams in a short time. These simulations differ from simulations of a model in that they include human inputs which the experimenter does not control, whereas in model simulation every input is a decision of the experimenter. The games provide the management scientist with an opportunity of performing controlled experiments with more and more complicated structures.

Biology.—One might expect some coalition of biologists and management scientists, because (1) the analysis of the concepts of organism and organization clearly share a common ground and (2) the central nervous system seems to display a managerial activity. In the early 1960s, however, there were only a few instances of this mutual sharing of intellectual ideas.

Psychology.—Psychologists have studied management from several points of view. Some have concentrated on intense experimental studies of decision making, where the choices are relatively simple and the relevant variables can be controlled. These studies are intended to investigate the utilities of the decision maker and to relate these utilities to other personality variables or to his material or social environment. Some experimental studies have observed the effect of communication patterns, psychological variables and the social environment on the performance of groups who have been given specified tasks to perform. According to one viewpoint, these small group studies are a logical prelude to controlled observation of larger organizations.

Learning and problem solving are psychological concepts that are extremely important for management and hence for the management scientist. It would be unrealistic to picture the manager as a person who knows all the alternatives and merely tries to select the best from the available. Instead, the manager searches for new alternatives and for new goals. He is presumably engaged in a gigantic learning process by which he hopes to make his activities better. Thus the management scientist may try to understand not only what is optimal, but also how one may move most adequately in an optimal direction. Many management problems entail a fantastic number of discrete alternatives. In some of these situations the important problem may be the learning process and not the direct selection of the optimal choice. Hence management scientists share with some psychologists an interest in developing more rigorous models of learning.

Many psychologists have been willing to sacrifice precision in order to gain a broader view of management: *e.g.*, to study conscious and unconscious motivations, status or the "actual" way in which decisions are made. It must be admitted that the management scientists have not been in agreement about the importance of these studies, primarily because although their general value may be apparent, the manner in which they fit into more rigorous models of management is not clear. Similar remarks apply to social psychology and sociology. No doubt here too both the management sciences and the social sciences are in a period of transition; the one may tend to relinquish its rigid and often naïve insistence on precision, while the other will come to recognize the great research power provided by the mathematical languages.

Economics.—During the 20th century, economists have shown a divided opinion on the importance of rigour in economic studies. Some have felt that emphasis on rigour may sacrifice significance. But the econometrician and mathematical economist are clearly allied with the management scientist. Indeed, many such economists view the work of the management sciences in business firms as a logical development of micro-economics. It is true that much of the mathematics of management has come from economics; queuing, search and replacement theory being important exceptions. Although systems engineering and human motivation other than that expressible by utility functions have not been the concern of the traditional economists, some economists think that both these areas are of dubious importance at best to the development of the management sciences. In any case, in the years following World War II, the mathematical economist came to play a central role in the management sciences. Some economists have called themselves managerial economists, to emphasize the fact that the studies of management problems belong in a subclass of economic studies.

Business Administration.—Tending to regard itself as a profession prior to World War II, business administration's chief method of research and instruction depended on detailed descriptions of cases. As would be expected, the management scientist

does not look upon the case method as a scientific method, partly because the language of the case studies is not precise, but mainly because there appears to be no basis for relating the case to the population of which it is presumably a sample. After World War II, a number of business administration specialists joined the management sciences. In some instances, these researchers found it possible to develop mathematical models of marketing behaviour or financial policy making or production planning that satisfied the criteria of the scientific community and were at the same time useful to managers. In other instances (especially in accounting), the management sciences have presented new problems to an old profession. Although managerial accountants sometimes speak as though certain types of accounting data could be used for planning, a careful scrutiny often reveals that the data must be presented in an entirely different way, and that additional data have to be obtained, before an optimal decision can be made. Many accountants point out that accounting has other functions to perform besides that of aiding the manager in his decisions. But it is natural to expect that the growth of the management sciences will attract the interest of research minded accountants. The term administration has raised semantic problems for the management scientist. Many would prefer to use it instead of management because it is less apt to reflect the unintended connotations of rigid control or of management *v.* labour. Others feel that administration should be restricted to the execution of plans and not to their origination.

Organization Theory.—This sometimes refers to a set of principles that are intended to predict how effectively a social group will behave when given an organized structure of lines of authority, responsibility, control, etc. In the 1960s, many students of organization theory tried to develop rigorous models and to incorporate the findings of the behavioral sciences. Thus the intellectual objectives of the management sciences and organization theory are quite similar, especially because organization theorists emphasize the role of management in organization designs.

Other Disciplines.—Law, political science, anthropology, city planning, education and history have a research interest in the study of management, but few of their representatives believe strongly in the feasibility of developing rigorous models of and applying precise measurements to the phenomena they study. This condition seems to be true of ethics and epistemology as well. One would expect that a community of scientists whose chief interest lies in the study of optimal plans and procedures would inevitably find itself deeply concerned with ultimate values. But management scientists tend not to translate this concern into research activity, but rather to accept the value of an enterprise as "givens," no doubt because they are skeptical of the possibility of precise methodology in the area of ethics. Similarly, epistemology could be interpreted rather easily as the study of the management of groups whose aim is to acquire knowledge; *i.e.*, epistemology could be understood as the theory of the management of science, though the use of such terminology might be undesirable in view of the connotations of rigid control that are often associated with the concept of management. But if one keeps in mind the much more general characterization given above, then a plausible case can be made for the position that pragmatism is the philosophy of management (or more generally perhaps, of decision theory). But most pragmatists have not shown a strong interest in the management sciences.

As would be expected, it is not at all clear when a study should be regarded as belonging within the purview of management science. Perhaps the only operational criterion is whether or not the study would have been accepted in any of the existing journals that clearly publish in this field. But such a criterion would ignore the rather rapid changes that are taking place in the management sciences, changes which will bring about a recognition that many studies of the so-called less exact disciplines are really instances of management science.

Importance.—From this account of the sciences one can readily understand that the phenomenon of management is pervasive both in the engineering and the social sciences. Furthermore, few can deny the importance of management for the human race, especially in an age when almost all major social problems are studied and resolved within an administrative framework. But until the post-World War II period there was no strongly discernible trend to bring this common interest under one discipline. Thus management is sometimes viewed as the control of a system or as a set of interacting psychological forces or as an economically directed activity or as an activity directed toward the public welfare or as an ethical activity. Each discipline has looked at the phenomena through its own spectacles. The management scientists have tried to bring about a coalition which may eventually lead to an established discipline. They have often done this under the banner of a methodological adherence to the value of rigour and therefore at some risk to their entire efforts, for those who prefer not to march under this banner are bound to declare that one's choice in this area is to be precisely insignificant or vaguely significant. And those who prefer the foundations of their own disciplines are bound to find any proposed coalition both dangerous and needless, no matter how much they sympathize with the attempt to become precise. Like all movements, this one will have to develop with due regard to its dilemmas.

Nothing has been said so far about those who are called managers. The management sciences are unique in this respect: the subjects whom they investigate (1) are very vocal and critical, (2) maintain persistent pressure on the scientists to produce something "useful" and "intelligible" and (3) often support the research. These facts sometimes make it difficult for the management scientist to be "pure," even if he is so inclined. Furthermore, the dilemma of precision *v.* communication is especially acute when the scientist must talk to the manager. Also, the manager may try his best to influence the direction the field will take. All of which leads one to conclude that the management sciences in all likelihood will have to develop their own peculiar methodology, and will not be able in time to rely on the traditional successful means of other disciplines.

See PRODUCTION MANAGEMENT; MASS PRODUCTION; JOB EVALUATION; CYBERNETICS; COST ACCOUNTING; OFFICE MANAGEMENT; AUTOMATION; *see* also references under "Management Sciences" in the Index.

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MANAGUA, a small department in Nicaragua, bordering three sides of Lake Managua. Area 1,332 sq.mi.; pop. (1960 est.) 272,312. Population is 78.9% urban and is concentrated in the volcanic zone south of Lake Managua. With fertile volcanic soils, the department is important in producing coffee, dairy products, vegetables and fruits. Managua city, the departmental capital, is located on the southern shore of Lake Managua, in view of smoldering Mt. Masaya and the extinct volcanoes of Momotombo and Momotombito. (C. F. J.)

MANAGUA, capital of Nicaragua and of the department of Managua, is the largest city in the Central American republic. Pop. (1960 est.) 206,635. The city lies on the southern shore of Lake Managua (Xolotlán), which is 38 mi. long and 16 mi. wide, the lesser of the two great lakes which are one of the chief physical characteristics of the country. It is on the Pacific railroad, 87 mi. from the port of Corinto, and on the Pan-American highway. It is connected with the important cities of the world by airlines and has two airports, Las Mercedes (international) and

Xolatlán (local). Managua is the industrial and commercial centre of Nicaragua; its factories produce cotton fabrics, beer, cigarettes and matches. It is also the centre of an important agricultural region which produces cotton, rice and coffee; cattle are also raised and exported.

The city is located in beautiful surroundings between Lake Managua and the tiny lakes of Asososca, Nejapa and Tiscapa. Its climate is rather hot and humid during most of the year but many residents have built homes on the hills around the city, where the temperature is cooler. There are many new buildings of modern architecture, among them the communications palace and the social security building. The presidential palace and the U.S. embassy are on the southern outskirts of the city.

Managua's importance began in the late 1840s when it was used as a compromise capital in order to avoid the rivalry between Granada and León; it was established as the final site of the capital in 1855 after the war against William Walker (*q.v.*). The city was occupied almost continually between 1912 and 1933 by U.S. marines. In 1931, it was almost completely destroyed by earthquake and fire.

In addition to being the political capital of the country, Managua has been the religious capital since the beginning of the 20th century, when it was made the site of an archbishopric of the Roman Catholic Church. (M. F.-G.)

MANAKIN, any one of about 60 species of wren-sized birds, of the tropical forests from Mexico to Argentina, notable for the brilliant plumage of the males, often boldly patterned in combinations of red, yellow, blue, black or white. Manakins constitute the family Pipridae, which, with the closely related tyrant or New World flycatchers and the cotingas, form part of the more primitive section of perching birds (order Passeriformes). These short-billed, stout-bodied birds, most with very short tails, glean for insects among the leaves and twigs and also eat some fruit.

A. W. AMELER FROM NATIONAL AUDUBON SOCIETY

SOUTHERN LONG-TAILED MANAKIN (CHIROXIPHIA LINEARIS)

The males clear areas where they perform courtship displays. The dull-greenish females come to mate, then go their solitary way, each to make an open, cup-shaped nest in the fork of a branch, lay two spotted eggs in it and raise the young, which are hatched naked. (A. L. Rd.)

MANASSAS, a town and seat of Prince William county, Va., U.S., 25 mi. S.W. of Washington, D.C. The town, first known as Manassas Junction, came into being in 1853 when the Manassas Gap and the Alexandria, Orange and Midland railroads were joined. During the American Civil War this strategic junction afforded a direct connection between the Shenandoah valley and the railroad from Washington to Richmond. Confederate forces won the battles of First and Second Manassas (Bull Run, *q.v.*) nearby; the battlefields are preserved by the national park service. Manassas was incorporated as a town in 1873 and in 1892 it became the county seat, Prince William's fifth. It adopted a city-manager form of city government in 1927 and was rechartered in 1938.

Manassas with a population of about 3,500 is a trading centre for a general farming, dairying and stock raising area. Brushless generators are manufactured there. Many residents are government workers and skilled craftsmen who commute to Washington, the marine base at Quantico and other government installations. (G. M. Be.)

MANASSEH (in the Douai version of the Bible Manasses), king of Judah. He became co-regent *c.* 697 B.C. during the reign of his father, Hezekiah (*q.v.*), sole king 687/686, and reigned till 643/642. That he maintained his position so long is a tribute to his statesmanship, and probably his kingdom prospered materially. Very little is heard about him, however, because his recognition of alien cults was a grave offense in the eyes of those who edited the historical writings. He is, indeed, held responsible for the ultimate ruin of the kingdom. He was very much under the influence of Assyria, and documents from his reign unearthed at Gezer disclose the presence of Assyrians in his realm, the use of their language and method of dating. No doubt his introduction of the worship of the host of heaven and other Assyrian cults was dictated by political rather than religious motives. He may have been involved in the conspiracies of Shamash-shum-ukin, the rebellious brother of Ashurbanipal. If so, the account of his deportation to Babylon, and subsequent return (II Chron. xxxiii, 11–13) may be historical. Manasseh appears in inscriptions of Esarhaddon and Ashurbanipal as an Assyrian vassal. (W. L. W.)

MANASSEH (in the Douai version of the Bible Manasses), a tribe of Israel, one of the two (the other being Ephraim) into which the house of Joseph was divided. The territory occupied by the tribe cannot be defined with precision. Machir, the "son" of Manasseh, seems to represent sometimes that part of Manasseh dwelling in central Palestine, sometimes an element of that part of the tribe dwelling east of the Jordan, and sometimes the whole tribe. Machir appears in the ancient poem Judg. v as taking part in the struggle against Sisera, and seems to have as neighbours Zebulun on one side, Ephraim and Benjamin on the other. From I Chron. vii, 14 it may be deduced that the tribe contained some Aramaean elements. *See* Twelve Tribes of Israel.

MANASSEH (Menasseh) **BEN ISRAEL** (1604–1657), Jewish theologian and founder of the modern Jewish community in England, was born in Portugal, probably in Lisbon. His father was a marrano. The family later moved to Amsterdam, where Manasseh studied for the rabbinate under Isaac Uziel. Two years after the death of his master, Manasseh was chosen to succeed him as rabbi and teacher, though he was not yet 19 years of age. He acquired a reputation for his scholarship and theological argument, was one of the two principal teachers of Benedictus de Spinoza and numbered among his friends Isaac Vossius and Hugo Grotius. In 1627 he established the first Hebrew print shop in Amsterdam. He wrote prolifically, and many of his works were widely read.

Manasseh was convinced of an imminent return of the Jews to the Holy Land, according to messianic promise, but believed this depended first on a rescattering of the Jews into all countries. He was therefore interested in securing the readmission of Jews into England, where a ban on Jewish residence had existed since the edict of Edward I in 1290. Toward this end he wrote *Esperança de Israel* (1650; Eng. trans. *Hope of Israel*), which came to the notice of Oliver Cromwell and secured for Manasseh permission to visit England. There he pleaded his cause and eventually gained consent to end the debarment of Jews from living freely in England. In response to contemporary criticism, Manasseh wrote *Vindiciae Judaeorum* (*Vindication of the Jews*, 1656). After thus successfully concluding his mission in England, Manasseh returned to the Netherlands. He died in Middelburg, en route home, Nov. 20, 1657. A portrait etched by Rembrandt is extant.

MANASSES, CONSTANTINE (d. 1187), metropolitan of Naupactus, was an author of Byzantine "political" (*i.e.*, 15-syllable) verse and of prose works. At the request of Manuel I's sister-in-law, he wrote a verse chronicle (*Synopsis historike*) from the creation to 1081. His verse romance on Aristander and Callithea survives in fragments only. He wrote a variety of other poems, as well as descriptive pieces in prose (some on works of art), and a number of orations, including an address to Manuel I and a funeral eulogy of Nicephorus Comnenus. Much of his work is unedited.

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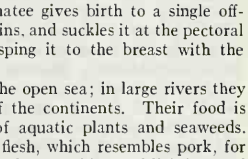
MANASSES (Manasseh), **PRAYER OF,** a short apocryphal book of the Old Testament. It purports to be the prayer of

Manasseh (*q.v.*), king of Judah, referred to in II Kings xxi, 1–18 and in II Chron. xxxiii, 1–20. This fine penitential prayer seems to have been modeled after the penitential psalms. It exhibits considerable unity of thought, and the style is, in the main, dignified and simple. The date of its writing is unknown. Some scholars assign it to the Maccabean period (2nd century B.C.), but its eschatology and doctrine of "divine forgiveness" may point to an earlier date; on the other hand, there are some indications of a doctrinal character which point to post-Maccabean times. The book was used in the early Christian Church, but was never included in the Vulgate Bible. *See* also APOCRYPHA, OLD TESTAMENT.

For the text, *see* H. B. Swete, *The Old Testament in Greek,* vol. iii (1894). *See* also H. E. Ryle in R. H. Charles (ed.), *The Apocrypha and Pseudepigrapha of the Old Testament,* vol. i (1913).

MANATEE (MANATI), aquatic mammals of the genus *Trichechus,* inhabiting the coasts and rivers of both sides of the tropical Atlantic and forming with the dugong (*q.v.*) the order Sirenia (*q.v.*). Although highly specialized in structure, the Sirenia have certain characters that indicate that they are perhaps distantly related to the elephants. The body of the manatee is fusiform in shape, rather flattened dorso-ventrally, with no externally visible neck. There are no hind limbs; the fore limbs are small flippers without separate fingers and the tail is expanded laterally to form a wide, rounded fluke, the principal organ of locomotion. The head is bluntly truncated at the front; the eyes are small and there is no external ear. The thick fleshy upper lip, beset with stiff bristles, is cleft vertically in the centre; the two halves can be separated or brought together and are used for seizing food and pushing it into the mouth. There are no canine teeth; the two-ridged molars may number as many as 20 pairs in each jaw, though few are in use at once, the posterior ones erupting as the anterior ones are worn out and lost. The body is covered with short, coarse, bristly hair, which is brownish or blackish according to the species; the total length usually ranges from 8 to 12 ft.

Manatees live singly or in small troops or family parties, swimming about slowly and grazing on aquatic plants. They are quite inoffensive creatures: where not habitually menaced they can be gently approached so closely that they have been described as very stupid animals. When alarmed they can remain submerged for as much as a half hour, though normally they surface to breathe about every 10 to 15 min. The extent of the territory of individual animals or troops is unknown but is probably extensive. Three species of manatee are known: *Trichechus senegalensis* inhabits the rivers and coasts of west Africa; *T. manatus* is found in the Caribbean from Florida to the West Indies; and *T. inunguis* ranges the coastal waters and rivers of the Guianas, the Amazon basin and farther south in Brazil. The female manatee gives birth to a single offspring each year, very rarely to twins, and suckles it at the pectoral mammary glands, sometimes clasping it to the breast with the flipper.



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AMAZONIAN MANATEE (TRICHECHUS INUNGUIS)

Manatees do not venture into the open sea; in large rivers they are found far into the interior of the continents. Their food is entirely vegetable and consists of aquatic plants and seaweeds. Locally they are valued for their flesh, which resembles pork, for their fat, from which oil is extracted for cooking and lighting, and for their hides. The manatee and dugong are said to have given rise to the legend of the mermaid. For an account of evolutionary relationships, *see* UNGULATA. (L. H. M.)

MANATÍ, a town and municipality of Puerto Rico, situated in the northern part of the island, about 3 mi. from the Atlantic ocean. Pop. (1960) 9,682 (mun. 29,354). Manatí is located in a beautiful valley drained by the Manatí river. The name is of Indian origin and refers to a sea mammal called manatee in English. The soil of the rural area around the town is very fertile. Sugar cane and pineapple are extensively cultivated; coffee, grapefruit, oranges and bananas are also produced. Several important industries, including a shoe factory, have been established in the town. (T. G. Ms.)

MANAUS (MANÁOS), a city and port of Brazil and capital of the state of Amazonas, is on the left bank of the Rio Negro, 12 mi. above its junction with the Amazon (Solimões) and 900 mi. above the mouth of the Amazon, in the heart of the Amazonian rain forest. Pop. (1960) 154,040. Manaus stands on a Tertiary terrace overlooking the river, 106 ft. above sea level, traversed by several *igarapés* ("canoe paths") or side channels that are spanned by bridges and divide the city into separate compartments. The climate is less oppressive than is commonly believed—the annual average temperature is 27.22° C. (81° F.), relative humidity 82% and average rainfall 75 in.

The National Institute for Amazon Research is located in Manaus. The majestic public buildings and homes, including the ornate opera house, where Caruso sang on opening night, date from the period 1890–1920 when the rubber boom brought wealth and luxury to Manaus. The port, which is the commercial hub of the entire upper Amazon region, was nothing but a river anchorage before 1902. In that year, an English corporation began improvements which included a stone river wall or quay, storehouses for merchandise and floating wharves or landing stages connected with the quay by floating bridges. The floating wharves and bridges are made necessary by the rise and fall of the river, the range between high and low waters reaching 50 ft. under extreme conditions. The principal exports are rubber, Brazil nuts, rosewood oil and jute; a host of minor forest products also move through the port. Cordage and coffee sacks are made in Manaus from locally grown jute. The city receives its beef from the savannas of the upper Rio Branco and from that region also come hides and horns for export.

Manaus is a regular stop on the shortest north-south air route between Miami, Fla., and eastern Brazil. It also serves as the hub of the well-developed air service of the Amazon valley. The port has direct steamship connections with New York and Great Britain and with all ports of the Amazon river system. A 5,000-bbl. refinery, built on a bluff below the city in 1956, refines crude oil barged down the Amazon from Peru. In 1955, oil was discovered at Nova Olinda, which is on the lower Madeira, about 110 mi. S.E. of Manaus.

The first European settlement on the site of Manaus was made in 1660, when a small fort was built there by Francisco da Motta Falcão and named São José do Rio Negro. The mission and village which followed were called Villa da Barra or Barra do Rio Negro ("barra" referring to the bar or mouth of the Negro). Manaus succeeded Barcellos as the capital of the old *capitania* of Rio Negro in 1809 and became the capital of Amazonas when that province was created in 1850, its name being then changed to Manaus after the principal tribe of Indians living on the Rio Negro at the time of its discovery. In 1892, Manaus became the see of the new bishopric of Amazonas. (Js. J. P.)

MANCE, SIR HENRY CHRISTOPHER (1840–1926), British scientist and engineer, inventor of the heliograph, was born in London in 1840. He joined the Persian gulf telegraph department of the government of India in 1863 and was employed on laying the first submarine telegraph cables in the Persian gulf. He was the originator of the Mance method for detecting and localizing faults on submarine cables and wrote several papers dealing with this subject. His heliograph was used successfully during the Second Afghan War and subsequently adopted for general use in the British army. Mance was made a companion of the order of the Indian empire in 1883 and was knighted on his retirement in 1885.

A member of professional and scientific bodies, Mance was president of the Institution of Electrical Engineers in 1897. He died at Oxford on April 21, 1926. (G. R. M. G.)

MANCHA, LA (Arabic AL MANSHA, "the dry land" or "wilderness"), in its widest sense denotes the bare and monotonous elevated plateau of central Spain that stretches between the mountains of Toledo and the western spurs of the hills of Cuenca, being bounded on the south by the Sierra Morena and on the

north by the Alcarria region. Altitude about 2,000 ft. It thus comprises portions of the modern provinces of Toledo, Albacete and Cuenca, and the greater part of Ciudad Real. Down to the 16th century the eastern portion was known as La Mancha de Montearagon or de Aragon, and the western simply as La Mancha; afterward the northeastern and southwestern sections respectively were distinguished by the epithets *Alta* and *Baja* (upper and lower). La Mancha remains almost exactly as Cervantes described it. Many villages, such as El Toboso and Argamasilla de Alba, both near Alcázar de San Juan, are connected by tradition with episodes in *Don Quixote*.

MANCHE, a coastal *département* of northern France, consisting largely of the westernmost districts of Normandy including the Cotentin peninsula and the Bocage Normand. The *département* is bounded west, north and northeast by the English channel (Fr. La Manche) from which it takes its name, east by the *département* of Calvados, southeast by Orne and south by Mayenne and Ille-et-Vilaine. Area 2,476 sq.mi. Pop. (1962) 446,878. Lying within the area of the Armorican massif, the *département* is composed of ancient folded rocks which weather to give poor, acid soils. The softer schist country of the Cotentin peninsula in the north is lower than the outcrops of granite and phyllade farther south in the Bocage Normand, but the highest parts in the southeast hardly reach 1,000 ft. Even so, the *département* is hilly and much dissected, the short streams flowing in deep-cut valleys. There are high cliffs along the coast, with offshore reefs making navigation dangerous. Farther to the west are the Channel Islands.

The climate is remarkably mild and damp, and the countryside is extremely verdant. Grain is unimportant and the *département* lies wholly north of the limit of viticulture. Although there are only fragments of woodland, trees are ubiquitous in the *bocage* countryside, a patchwork of little fields bounded by live hedges; apple orchards are widespread. Grass and fodder crops prevail and cattle are the mainstay of the farming, dairy produce being especially important. The sheltered low-lying ground of the Vire valley on the eastern margin of the Armorican massif is rich dairy-farming country. The rural population lives in hamlets and scattered farmsteads rather than in villages, and there are small market towns, such as St. Lô, Avranches, Valognes and Coutances.

Although granite is quarried at many places for road and building stone, and some iron-ore deposits occur in the extreme northwest at Diélette and in the southwest near Mortain, neither mining nor manufacturing is important. On the north coast the military port of Cherbourg has been developed as a *port de vitesse* for transatlantic passenger traffic, while Granville, on the west coast, beneath the fortified high town on a rocky promontory, is a seaside resort and fishing port with a trawling fleet. St. Vaast-la-Hougue in the northeast is a centre of oyster culture, and elsewhere there are fishing villages and small seaside resorts ranged round the rocky coast. Mont-Saint-Michel, with its picturesque Gothic abbey on a rocky islet attached to the shore by a long jetty, is a great tourist attraction. Although Cherbourg is by far the largest town, St. Lô in the Vire valley is the *préfecture* and Coutances is the centre of the bishopric, under the archiepiscopal jurisdiction of Rouen. For educational administration the *département* comes under the *académie* of Caen, and the court of appeal is also there. The *département* is divided into four *arrondissements,* centred upon Cherbourg, Coutances, St. Lô and Avranches. The towns of Manche suffered heavy damage in 1944 during the Allied invasion, but the 13th-century Gothic cathedral at Coutances largely escaped. At Lessay and St. Sauveur-le-Vicomte there are noteworthy remains of ancient Benedictine abbeys. (AR. E. S.)

MANCHESTER, EARLS AND DUKES OF. The Manchester title, in the English peerage, belongs to a branch of the family of Montagu. The first earl was SIR HENRY MONTAGU (*c.* 1563–1642), grandson of Sir Edward Montagu, chief justice of the king's bench 1539–45. He was born at Boughton, Northamptonshire, was educated at Christ's college, Cambridge, and was called to the bar. He was elected recorder of London in 1603 and was made chief justice of the king's bench in 1616, in which office he passed sentence on Sir Walter Raleigh in 1618. In 1620 Montagu was appointed lord high treasurer, being raised to the peerage as Baron Kimbolton and Viscount Mandeville. He became president of the council in 1621, and Charles I created him earl of Manchester in 1626. He became lord privy seal in 1628 and in 1635 a commissioner of the treasury. He was a judge of the Star Chamber, and one of the most trusted councilors of Charles I. In conjunction with Lord Coventry, the lord keeper, he pronounced in favour of the legality of ship money in 1634. He died on Nov. 7, 1642.

EDWARD MONTAGU (1602–1671), 2nd earl, eldest son of the 1st earl by his first wife, was educated at Sidney Sussex college, Cambridge. He was member of parliament for Huntingdonshire 1624–26, and in the latter year was raised to the peerage as Baron Kimbolton, but was known generally by his courtesy title of Viscount Mandeville. At the beginning of the Long parliament he was a leader of those opposed to the king in the upper house, his name being joined with those of the five members of the house of commons whom the king charged with treason in 1642. At the outbreak of the Civil War (*see* CIVIL WAR, ENGLISH), having succeeded his father in the earldom in Nov. 1642, Manchester commanded a regiment in the army of the earl of Essex, and in Aug. 1643 he was appointed major general of the parliamentary forces in the eastern counties, with Oliver Cromwell as his second in command. He became a member of the "committee of both kingdoms" in 1644, and was in supreme command at Marston Moor (July 2, 1644); but he later disagreed with Cromwell, and in Nov. 1644 strongly expressed his disapproval of continuing the war. Cromwell brought his shortcomings before parliament in 1644; and early in the following year Manchester, as a result of the Self-Denying ordinance, resigned his command. He took a leading part in the frequent negotiations for an arrangement with Charles and, with William Lenthall, was custodian of the great seal (1647–48). He opposed the trial of the king, and retired from public life during the Commonwealth; but after the Restoration, which he actively assisted, he was honoured by Charles II. In 1667 he was made a general. He died at Whitehall on May 7, 1671.

CHARLES MONTAGU (*c.* 1662–1722), 1st duke, grandson of the 2nd earl, was educated at St. Paul's school and Trinity college, Cambridge, and succeeded to his father's earldom in 1683. He fought under William III at the battle of the Boyne, became a privy councilor in 1698 and held various important diplomatic posts between that date and 1714, when he received an appointment in the household of George I, by whom in 1719 he was created duke of Manchester. He died on Jan. 20, 1722. GEORGE MONTAGU (1737–1788), 4th duke, grandson of the 1st duke, was a supporter of Lord Rockingham, and an active opponent in the house of lords of Lord North's American policy. In the Rockingham ministry of 1782 he became lord chamberlain. He died in Sept. 1788. WILLIAM MONTAGU (1771–1843), 5th duke, third son of the 4th duke, was educated at Harrow, and entered the army. He became a colonel in 1794 and was appointed governor of Jamaica in 1808. He remained there until 1827, doing much to prepare the way for the emancipation of the slaves. From 1827 to 1830 he was postmaster general in the cabinet of the duke of Wellington. ALEXANDER (1902–), 10th duke, succeeded to the title in 1947.

MANCHESTER, a cathedral city and county borough in Lancashire, Eng., lies 184 mi. N.W. of London and 35 mi. E. of Liverpool by road. The adjacent city of Salford (*q.v.*) is separated from Manchester by the river Irwell. Pop. (1961) 661,041.

The city of Manchester stands at the junction of the rivers Irwell, Irk and Medlock. Before the last Ice Age, a range of high mountains closed the approaches to Manchester's site on the north and east. Glacial action ground down and flattened them to a height of 1,000–2,000 ft. and glacial streams carved deep clefts and valleys, whose streams converge on the area that is now the Manchester district. There, where nature had laid down its own lines of communication, and where the high land gave way to the former estuarine marshes, making a natural defensive position, the settlement of Manchester first arose. The city varies from

100 ft. above sea level in the south to 400 ft. in the north, the height at the centre being 133 ft. Bordering the south of the city is the fertile Cheshire plain: to the east, north and west is the huge east Lancashire industrial area.

Manchester is built on Triassic, Permian and Carboniferous rocks, which often reach the surface, but which are usually overlaid with thick deposits of glacial drift-sands, gravel and boulder clay. Industrial water is obtained in part from wells in the Triassic rock, but the bulk is piped from Thirlmere in Cumberland, Haweswater in Westmorland, and the Longdendale valley in the Pennines. The whole region is seamed with coal, and one of England's largest coal mines lies within the city boundary. The city enjoys a temperate climate varying from 25° F. (−4° C.) to 72° F. (22° C.). It has an average rainfall of about 30 in. each year, but with sunshine somewhat reduced by the prevalent cloudy conditions. In 1952 the city centre was made the first effective smokeless zone in Great Britain; by the mid-1960s this had been extended to 9,500 ac.

History.—An early name for Manchester—Mancenion—is believed to have been taken from that of a Celtic settlement on the site, known as "the place of tents." One of the principal Roman roads from Chester northward passed through Manchester—a portion of it is still known as Watling street—and the Romans established in A.D. 79 a fort, small portions of which still remain, to safeguard military and trading traffic through the area. The Romans gave to Mancenion their own version of the name, Mancunium, and the inhabitants are still referred to as Mancunians. They were in occupation for about 350 years and from then onward there was little of note to relate until 870, when the Danes destroyed the town, except that the place was brought under the dominion of the Saxons early in the 7th century and named, in various forms, Mamecaster or Memcestre. Edward the Elder rebuilt Manchester in 920, and the right to coin money was granted to Manchester's citizens by King Canute. In the Domesday survey of 1086, Manchester is mentioned as an area poor and sparsely populated.

In 1229 the town was granted an annual fair by Henry III, and immigrant Flemish manufacturers chose the area for the establishment of their textile industry in 1330, thus giving the first evidence of the suitability of the area for textile production. The introduction about 1500 of vegetable cotton, known as cotton wool, must have been a stimulus to trade, for the antiquary, John Leland, reported to Henry VIII that Manchester was "the fairest, best builded, quikkest and most populous towne in all Lancashire." It is quite evident that Manchester's industry at the time was confined entirely to textiles, for a publication dated 1650 lists the town's manufactured products as "woolens, frizes, fustians, sackcloths, mingled stuffs, inkles, topes and prints," and in 1690 the art of calico printing was introduced from France. That event marked the beginning of Manchester's rise to importance.

Modern Manchester is one of the results of the Industrial Revolution which transformed the place, in a generation, from a market town to a thriving industrial centre. The discovery and exploitation in the late 1700s of steam power, and the opening up of road, river and, later, rail communications went hand in hand with the invention of devices for the mechanical manufacture of textiles. In 1761 the first English "navigation" or canal was opened to bring coal into Manchester from the duke of Bridgwater's estate at Worsley. In 1785 the culminating invention of the power loom for weaving was made, and in 1789 the first steam engine for spinning cotton was erected in Manchester. In St. Peter's fields, Manchester, occurred the famous "massacre" of Peterloo (*q.v.*) in 1819. The *Manchester Guardian* newspaper (now *The Guardian*), which began publication in 1821, became, under the editorship of Charles Prestwich Scott, one of the leading journals of the day, of Liberal views.

Manchester's attainment of municipal borough status in 1838 was mainly due to Richard Cobden. In 1837 he first emerged as a public figure when he led the struggle for Manchester's incorporation as a borough. His being summoned as a juror to the manorial court leet made him aware of the hopeless inadequacy of manorial rule in an industrial town. He then had a declaration drawn up, later signed by his fellow jurors, which criticized the existing system of local rule and was followed by his celebrated pamphlet, *Incorporate Your Borough*. This movement for incorporation resulted, at the beginning of 1838, in a public meeting at which Cobden was the principal speaker, to discuss the advisability of petitioning the queen for a charter of incorporation. Despite much opposition and the forgery of signatures to an anti-incorporation petition, the charter was eventually granted in Oct. 1838; Cobden was elected as a councilor for the St. Michael's ward and elevated to the aldermanic bench after one day's service as councilor. He remained on the borough council until 1844. After the incorporation of the borough Cobden became closely associated with John Bright, the son of a Lancashire cotton spinner, in the formation of the National Anti-Corn Law league. While Bright was famous as a national figure, his local connection with Manchester was confined to representing the borough in parliament in the 1847 and 1852 elections.

The so-called "Manchester school" of political and economic liberalism led by Cobden and Bright advocated free trade and unrestricted competition.

Other notable occasions in Manchester's history were the opening in 1851 of Owens college (later developed as the University of Manchester), the rise to city status in 1853 and to that of county borough in 1888, the bestowal of the title of lord mayor as the head of the city's government in 1893, the completion of the Manchester Ship canal in 1894, the commencement of the city's first satellite town at Wythenshawe in 1929 and the opening in 1938 of Manchester airport at Ringway.

In World War II the oldest part of the city—that round the original market place—together with the warehouse quarter near Piccadilly, the assize courts, the Royal exchange and the Free Trade hall, were badly damaged in air raids. Rebuilding and repair have since been completed.

Until the Reformation Manchester lay in the diocese of Lichfield, but in 1541 Henry VIII founded the diocese of Chester, which included the whole of Lancashire. Because of the increase in population caused by the Industrial Revolution, a new Anglican see of Manchester was formed in 1847. This diocese covered the greater part of Lancashire and the collegiate church became the cathedral. The northerly part was transferred in 1926 to the new diocese of Blackburn. Hulme and Middleton are bishoprics suffragan. From 1921 to 1929 William Temple, who was translated to York and later to Canterbury, was bishop of Manchester.

The Roman Catholic community is large, but its cathedral is in the neighbouring city of Salford, and the principal Roman Catholic church is that of the Holy Name. The city has long been a stronghold of nonconformity, and the Baptist, Christian Science, Congregationalist, Jewish, Methodist, Presbyterian, Unitarian and Free Christian congregations are considerable.

Architectural Features.—Few traces of medieval Manchester remain. Chetham's hospital and library occupy stone-built medieval buildings which were the ancestral home of the Grelle (Gresley, Grelley) and De la Warr (Warre) families, and were presented to the church of Manchester when it became collegiate in 1421; they were purchased by the Chetham trustees in 1653.

Manchester's cathedral is not externally imposing, but its history as parish church, college of priests and cathedral is long and interesting. An important church is thought to have stood there in the 10th century. There are no relics of Norman work, but there is evidence of a large Early English church. In 1421, chiefly through the efforts of Thomas de la Warr, who was rector and lord of the manor, a royal licence and charter was obtained, making the church collegiate and endowing it with extensive lands. Warden James Stanley, afterward bishop of Ely, built the present choir in 1485. During the 15th and 16th centuries nine chapels were built. The east end of the cathedral was severely damaged during World War II but repairs have been completed. The Manchester Regiment chapel, also bombed, was rededicated in 1951.

The Wellington inn in the market place, Wythenshawe hall at the southern edge of the city, Slade hall, Barlow hall and Hough End hall are among the few remaining early buildings. Of the Georgian period there are a number of notable individual build-

ings: Heaton hall, in Heaton park, is a splendid example of the work of James Wyatt and is furnished in the character of the time. Platt hall, Rusholme, was the home of the Carrill-Worsley family. St. Thomas' church, Ardwick, and St. Ann's church are outstanding examples of this style. The City Art gallery and the adjoining Manchester Athenaeum building are to the design of Sir Charles Barry, and the Portico library, the Friends' Meeting house, the District bank in King street and the Bank of England also belong to Georgian days. Notable Victorian buildings include the town hall, built in 1877 to the design of Alfred Waterhouse. In the fine great hall are frescoes by Ford Madox Brown of incidents in the history of, or connected with, Manchester. The university main buildings are by the same architect. The John Rylands library, designed by Basil Champneys, is in severe Gothic revival style. The Manchester Royal exchange, built in 1874, was extended in 1914–21; rebuilt after bomb damage, the great hall (the floor of which accommodated more than 12,000 members in the flourishing years of the cotton industry) was reduced in size and can now accommodate about 5,000 members on "high 'Change," the remaining space being occupied by offices.

Of Manchester's 20th-century buildings, among the finest are the town hall extension and Central library; the latter was opened in 1934. The Midland Bank building, to the design of Sir Edwin Lutyens, stands at the upper end of King street with the adjoining Ship Canal house. The modern concert hall, rebuilt in 1951 within the walls of the bombed Free Trade hall of 1856, was designed by Leonard C. Howitt.

Albert Bridge house is the home of several central government authorities, and Piccadilly centre has a shopping precinct, hotel, conference hall, roof gardens, and an office block nearly 350 ft. high. The new Co-operative Insurance building is 400 ft. high. The bombed assize courts have been rebuilt as the courts of justice on a new site near the city centre, while other notable new buildings are Peter house in St. Peter's square, the Domestic and Trades college in Fallowfield, and Granada house, headquarters of the Granada Television network.

Administration.—In 1301 the lord of the manor, Baron Thomas, Lord Grelle, yielded to the pressure of the burgesses a charter appointing town's officers, making rules for the management of the town and defining the functions of the courts. Even so, it was not until the late 18th century that centrally appointed town's commissioners took over the local government of the place. They failed to govern the town satisfactorily and when the Municipal Corporations act of 1835 offered opportunity, the movement led by Cobden and other notable reformers secured the incorporation of Manchester as a municipal borough.

The city council, responsible for the local administration of a densely populated area of about 43 sq.mi., has 152 members, 38 of whom are aldermen and 114 councilors. One of the councilors is usually chosen to be the lord mayor for a year. The municipal markets at Smithfield and elsewhere distribute foodstuffs throughout the northwest of Britain. The southerly suburb of Wythenshawe, transferred from Cheshire to Manchester in 1930, was planned as a "new town" with a projected population of 100,000, and with its own industrial areas and civic centre. The city's parks and open spaces have an acreage of 2,482 in which are included Heaton park of 638 ac. and Wythenshawe park of 251 ac. As the chief city of northwest England, Manchester houses the regional offices of 9 government ministries and the local offices of 38 other government departments; there are a court of assize and a district registry of the high court of justice, and six other courts of law. By the early 1960s 19 countries had consular representation in Manchester.

With the exception of the parliament of 1654, Manchester had no representation until the Reform bill of 1832 when it sent two representatives. In 1868 this was increased to three. In 1885 the city was divided into six divisions and in 1918 into ten divisions, each returning one member. By the Representation of the People act, 1948, the number was reduced to nine: Blackley, Clayton, Gorton, Ardwick, Withington, Moss Side, Exchange, Cheetham and Wythenshawe. In 1955 Openshaw replaced Clayton.

Cultural Life.—Manchester is famous for its many private, public and specialized libraries. The municipal libraries, with 26 branches, have as their focus the building in St. Peter's square opened in 1934. This central building is the home of a reference library which includes the Greenwood library for librarians, a commercial library and a technical library to serve the industrial and commercial interests of the region, a lending library, and the music library presented to the city by Henry Watson in 1902. The music library, which includes the Chapman collection of musical instruments, contains a comprehensive selection of rare and early music. Other libraries in the central building are the Arts library, Local History library, Jewish library, Special Collections library, American library, Patents and Microtext library.

The John Rylands library in Deansgate was built by the widow of John Rylands, a Manchester merchant, in memory of her husband. Opened to readers on Jan. 1, 1900, the library is a place of pilgrimage for scholars and bibliophiles. Its basis is the Althorp library collected by the 2nd Earl Spencer, and the earl of Crawford collection of manuscripts, together with incunabula, bibles from the Gutenberg Bible onward, works of the 16th-century scholar-printers and the de luxe printers of the 17th and 18th centuries and of modern times. It also contains historical pamphlets of the 17th and 18th centuries; records on clay, bark, bamboo, papyrus, parchment and other materials in 50 languages from the 3rd millennium B.C. onward; legal documents and family muniments from the 11th to the 20th centuries; medieval jeweled bindings; and extensive collections of historical, political and literary papers including 3,000 letters of the Johnsonian circle and of Charles Dickens, John Ruskin and other well-known figures.

The University of Manchester's library is located in various buildings; the science section is in the Christie building, and there is a special library for the education of the deaf. Chetham's library, at Chetham's hospital, Fennel street, founded in 1653 under the will of Humphrey Chetham, a Manchester merchant, was one of the first free public libraries in England, if not in Europe, and unlike the others is substantially in its original setting. At first the books were chained and the stools used by readers in those days are still preserved. Its great strength lies in the collections of printed books of the 16th, 17th and 18th centuries, and in both old and modern books on local history and related subjects. The Portico library in Mosley street was opened in 1806; the first secretary was Peter Mark Roget, the author of *Thesaurus of English Words and Phrases*. Among the members down the years were John Dalton, the physicist, and the Rev. William Gaskell, whose wife, Elizabeth, wrote *Cranford* and other novels of Victorian life. The library contains an unusual collection of rare historical treatises, ancient medical tracts and curiosities of many kinds.

The City Art gallery, formerly the Royal Manchester institution, was opened to the public in 1829 and presented to the corporation in 1882, together with the nucleus of the present art collection. Subsequent purchases have been supplemented by numerous gifts and bequests, notably that of contemporary works presented by Charles L. Rutherston in 1925 for use as a lending library from which pictures and sculpture could be borrowed by schools, colleges of art and galleries in the north of England. There are a number of branch galleries. The gallery of English costume at Platt hall, opened in 1947, is the first and largest institution in Britain to be solely concerned with that art and is based on the fine collection of English costume formed by C. Willett Cunnington. Heaton hall contains a display of Georgian painting, furniture, pottery, silver, porcelain and glass, as well as a fine Georgian two-manual organ. At Queens Park gallery a display of pictures, maps, models and other objects illustrates the past history of Manchester. The Manchester Whitworth institute, now the Whitworth Art gallery and part of Manchester university, was founded in Oct. 1889 under the will of Sir Joseph Whitworth. It contains early textiles and embroideries, and a collection of English water-colour drawings. The Manchester museum, which evolved from collections of the Manchester Society of Natural History (founded 1821), is now a university department and a public museum. It has special exhibits of Egyptian, ethnological

and Japanese objects as well as important natural history collections.

Upon the choral singing and brass bands of south Lancashire, which amount almost to a folk tradition, was superimposed, in the middle of the 19th century, a foreign musical culture arising from the immigration of German and central European merchants. From this period survives the Hallé Concerts society, formed in 1898, to keep in being the orchestra inaugurated in 1858 by Sir Charles Hallé. The Hallé orchestra, under its conductor, Sir John Barbirolli, has become an international orchestra. The B.B.C. Northern orchestra is another major symphony orchestra in the city. The Tuesday Mid-day Concerts society has given weekly concerts since 1916 at which many artists later to become world famous have been introduced to the public. The Manchester Royal College of Music is the only body in England outside London whose diplomas are recognized as qualifying the holder for a professional career in music.

Manchester has two theatres and a resident repertory company in a municipal "little theatre" at the central library. There is a wealth of private bodies for the furtherance of literature, art and kindred subjects, notable among which are the Ancient Monuments society, the Chetham (Printing) society, the Classical association, the Academy of Fine Arts, the Manchester Institute of Contemporary Arts and the Manchester Literary and Philosophical society (which has a long and notable history and among whose past members were John Dalton, who died in Manchester, and Thomas de Quincey, who was born there).

Cycling and other athletic events are promoted at the stadium in Fallowfield: there are two Association Football clubs (Manchester United and Manchester City) and at the ground of the Lancashire County Cricket club, Old Trafford, a test match is played against overseas cricket teams visiting Great Britain. At Belle Vue in West Gorton are large zoological gardens, an amusement park, exhibition halls and restaurants.

Education and Research.—The oldest educational institution in Manchester is the grammar school, founded in 1515 by Hugh Oldham, bishop of Exeter. Moved to new buildings at Rusholme in 1931, it now accommodates more than 1,200 boys. Another ancient educational foundation is that of Humphrey Chetham, whose Bluecoat school, founded in 1653, is housed in the building formerly occupied by the college of clergy and is now a grammar school. The educational charity of William Hulme (1631–91) is administered under a plan drawn up in 1881 and supports a grammar school. The College of Art has been redesignated the Regional College of Art. There are three recognized colleges of music. Schools for the deaf and dumb are situated at Old Trafford next to the blind asylum, to which Thomas Henshaw left a bequest of £20,000. There are also an adult deaf and dumb institution and a branch of the National Library for the Blind.

The University of Manchester, officially the Victoria University of Manchester, has developed from the college founded by John Owens, who in 1846 bequeathed nearly £100,000 to trustees for an institution in which should be taught "such branches of learning and science as are usually taught in the English universities." It was opened in 1851 in a former residence (now the Manchester county court) of Richard Cobden in Quay street, but such was the expansion of the college that a new building was erected in Oxford road and opened in 1873. In 1880 a university charter was granted and the Owens college was constituted a college of the university. In 1884 University college, Liverpool, was admitted and in 1887 the Yorkshire college, Leeds. The Federal institute thus created lasted until 1903, when a separate university was established in Liverpool. In 1904, when the Yorkshire college was raised to university rank, the Owens college was incorporated with the Victoria University of Manchester by act of parliament.

The chairs instituted since 1945 range from such subjects as radio astronomy, nuclear and other forms of engineering, various branches of chemistry and preventive medicine and dentistry, to the social sciences, music, ecclesiastical history and the study of foreign literatures and languages. University students number 8,500 including those who attend the College of Science and Technology which comprises the faculty of technology of Victoria university. The college was founded as a mechanics institute in 1824.

There are in Manchester a number of denominational colleges and many of the students preparing for the ministry receive their arts training at the university.

Manchester is a notable centre for research. It has played a major part in the development of atomic physics from 1803, when John Dalton propounded the atomic theory of matter (published in 1805 with a list of atomic weights) to the Manchester Literary and Philosophical society, onward. During 1908–19 Ernest Rutherford, later Lord Rutherford, was professor of atomic physics at Manchester university and there he first split the atom. Henry Gwyn-Jeffreys Moseley worked with Rutherford from 1910 to 1914 and Niels Bohr from 1912 to 1913. Sir James Chadwick was born in Manchester and Sir John Douglas Cockcroft was educated at the university. James Prescott Joule discovered in 1843 the mechanical equivalent of heat. A firm in Manchester, in co-operation with Manchester university, designed and now produces electronic computers.

The Shirley institute at Didsbury deals with the problems of cotton, silk and all man-made fibres, including synthetic fibres; the Cotton Board Colour, Design and Style centre in York street co-ordinates the many facets of the design of fabric patterns and of the styling of cotton materials into women's wear and household materials; the university and the College of Science and Technology co-operate in industrial research with the chamber of commerce. The research work of the Lancashire and Merseyside Industrial Development association makes known the potentialities of the area. The United Manchester hospitals, a group separate from the national scheme and centred round the Manchester Royal infirmary, join with the university in medical research; at the Christie cancer hospital and Holt Radium institute, Didsbury, is one of the largest centres of cancer research in the commonwealth; a research fellowship in poliomyelitis was set up by the university in 1954. At Jodrell Bank, Cheshire, the department of astrophysics of Manchester university has established a pioneer radio-astronomy observatory and has built one of the world's biggest steerable radio-telescopes, about 260 ft. across and on a movable track: it was the only one in the west able to track the earlier space satellites of the U.S.S.R. (1957) and of the United States (1958).

Industry, Commerce and Transport.—Manchester's importance arose primarily from the textile industry. In the 12th century locally produced wool was made up into cloth and garments until the introduction of cotton as a wool substitute, when the wool industry gradually moved into Yorkshire. The spinning, weaving, bleaching, dyeing, printing and finishing of the cloths is now carried out in the towns of south Lancashire, after which they come to Manchester for warehousing, packing and shipping, but this trade now engages only about 7% of the regional population.

Manchester, therefore, provides banking, insurance, marketing and shipping facilities for the whole of south Lancashire's industry based on the surrounding towns of Bolton, Oldham, Stockport, Ashton, Rochdale, Eccles, etc. On its own account it has extensive businesses of heavy and light engineering, factories for clothes, chemicals and dyestuffs, oil refining and food processing, plastics and electronics. The city is a centre of journalism second only to London. It is the north regional headquarters of the British Broadcasting corporation and Associated British Corporation Television, Ltd., and also the national headquarters of the Granada Television network.

The development of local industry was paralleled by the establishment of a network of road, rail and canal transport to bring in the raw materials and to take away the finished products. The Manchester-Liverpool line of 1830 (of which the Liverpool Road station still remains as the first and oldest railway station in the world) was followed by lines to Birmingham, London, Yorkshire and the north; Manchester now has four major mainline stations (Piccadilly, Central, Victoria and Exchange), two of which were entirely rebuilt in 1959–60. The canal system began in 1761 with the Bridgewater canal, designed by James Brindley, and was followed in 1767 by a second length dug from Stretford to Runcorn. A third section joined the canal with the Leeds-Liverpool canal

early in the 19th century. Since the opening of the Manchester Ship canal (*q.v.*) in 1894, the barge canals have fallen into disuse, but the access to Manchester, via the ship canal, of ocean-going vessels of up to 15,000 tons dead weight has laid the foundation of the region's continued prosperity.

The port of Manchester should be regarded as an elongated harbour, including as it does the whole of the 36-mi. Manchester Ship canal from the entrance locks at Eastham on the Mersey estuary to the terminal docks in Manchester. It is now the nearest port (54 mi. from the open sea) for an area containing the main mass of British industry and extending as far as Birmingham to the south and Wakefield in Yorkshire to the east. In that first year of 1894, the cargo entering the port amounted to 925,000 tons, it now exceeds 15,000,000 tons. With the coming of the oil industries to Stanlow in 1949 Manchester grew as an oil port. In 1896, Trafford park, a country estate adjoining the Manchester docks, was purchased to become the first and greatest planned industrial estate in Great Britain.

The first municipal airport in Great Britain was established at Wythenshawe in Manchester in 1929. The present Manchester airport at Ringway, 10 mi. S. of the city by road, is the largest municipally owned airport in England and is second to London in the amount of traffic, both passenger and freight, handled. More than 1,000,000 terminal passengers a year use the airport. Scheduled services operate to continental and domestic destinations. Inclusive holiday tours operate throughout the summer period. Ringway became a transatlantic airport in 1953 and by the 1960s there were regular passenger and freight services to the United States and Canada.

See also references under "Manchester" in the Index.

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MANCHESTER, largest city in New Hampshire, U.S., and one of the seats of Hillsborough county, is located in the centre of the state at Amoskeag falls on the Merrimack river, midway between Nashua and Concord, and 54 mi. N. of Boston. The Amoskeag falls, originally Namoskeag, Indian for "place of much fish," drop from a ledge 85 ft. high across the Merrimack river providing water power for industrial developments. Pop. (1960) 88,282. The standard metropolitan statistical area (SMSA), consisting of Manchester and Goffstown, had a population in 1960 of 95,512. In 1963 Bedford and Hooksett towns were added to the SMSA, making its population (according to the 1960 census) 102,861. For comparative population figures *see* table in NEW HAMPSHIRE: *Population.*

The first white settlers (Scotch-Irish) came in 1722–23. Through its early years the settlement was known for its fisheries. First called Old Harry'stown, it became Tyngstown after 1735 when it was granted to Capt. William Tyng's men by the Massachusetts Bay colony. In 1751 the settlement was incorporated as Derryfield. It was apparently renamed Manchester in 1810 at the suggestion of Samuel Blodget, who had seen the barge canals at Manchester, Eng., and who after 16 years of effort and aided by lotteries planned and constructed (1794–1807) the first canal around the falls, which together with the Middlesex canal in Massachusetts made navigation possible all the way to Boston.

It was chartered as a city in 1846. The Scotch-Irish community of potato and flax-raising farms emerged into a rapidly growing metropolis with riverside factories whose principal industry, the Amoskeag Manufacturing company with 18 mi. of water rights and numerous mills, employed 15,000 persons and reached a peak production of 360 mi. of cotton cloth a day, a prosperity augmented by the manufacture of shoes, cigars, locomotives and fire engines.

The downfall of Manchester's textile industry in 1935 caused by shrinking markets, foreign competition and the advent of silk and rayon, together with the disastrous floods of 1936 and the hurricane of 1938 awakened the city to the need for rehabilitation. In 20 years as a result of energetic action by civic leaders who bought the Amoskeag mills and leased many of them to small business enterprises, metropolitan Manchester was planned and rebuilt, and became an industrial and shopping centre for more than 106,000, with about 25% of the state's population residing within a radius of 20 mi. By the early 1960s Manchester had more than 200 industrial establishments manufacturing textiles, leather goods, rubber, automobile accessories, electrical instruments, confectionery, beverages and dairy products.

The city has 479 ac. of public parks, including Stark park, the burial place of Gen. John Stark, and within its limits is Massabesic lake, the source of its water supply. It is the home of the Manchester Institute of Arts and Sciences, the State Industrial school, Currier Gallery of Arts, Manchester Historic association, St. Anselm's college (Roman Catholic; 1889) and the John Stark homestead. (E. M. HU.)

MANCHESTER SHIP CANAL, an important artificial waterway affording passage for ocean-going vessels between the Mersey estuary (opening into the Irish sea) and the inland city of Manchester, Eng. The canal was begun on Nov. 11, 1887, to provide a port for Manchester's rapidly expanding textile industry and was opened to traffic on Jan. 1, 1894. It is 36½ mi. long and has a minimum depth of 28 ft. Extensive docks, dry docks, wharves and warehouses line the canal. *See* WATER TRANSPORT, INLAND.

MANCHOUKUO, a former state, created as nominally independent in 1932 by the Japanese out of old Manchuria and Jehol. Dissolved after World War II and subsequently divided by the Peking government into the provinces of Heilungkiang, Kirin, Liaoning and Jehol and the Inner Mongolian autonomous region. In 1955 Jehol was abolished and absorbed into Inner Mongolia, Liaoning and Hopeh.

See MANCHURIA; MONGOLIA, INNER; and articles on the political divisions.

MANCHU LANGUAGE. Manchu belongs to the southern group of the Tungusic languages (*see* URAL-ALTAIC LANGUAGES). Tungusic peoples probably inhabited the present Manchuria by the 3rd century B.C. The predecessors of the Manchus were the Nü-chên (Džürčen, Ju-Čen), who usurped the empire of the Liao dynasty in 1115 and ruled as the Chin dynasty until 1234, being overthrown in turn by the Mongols. The real founder of Manchu power was Nurhachi, who proclaimed himself emperor in 1616 and established his capital at Mukden in 1625. Under his reign the Manchus adopted for their own use the Mongolian alphabet which they inherited from the Uighurs. In the course of time changes were made in order to adapt this writing to the Manchu language, and in its final form it became far more elaborate and serviceable than its Mongolian prototype. Books had been printed in Manchu by 1647. The two emperors K'ang-hsi and Ch'ien-lung did most to establish and stereotype this somewhat artificial language by causing translations to be made of Chinese and Mongolian works and by the publication of numerous polyglot dictionaries. All officials had to pass an examination in Manchu. All imperial decrees and most official documents were issued in this language in addition to Chinese.

With the abdication of the young emperor P'u-i and the proclamation of the republic in 1912, Manchu may be said to have disappeared from China proper. It is, however, still spoken in parts of northern China, Manchuria and elsewhere. Regarded as a dead language, Manchu has received a considerable amount of attention from European scholars because the literal translations made into that language from the Chinese classics have simplified the interpretation of the latter.

The vocalic harmony is not so strictly observed in Manchu as in Mongolian, and in the case of grammatical suffixes there are in some instances no alternative hard or soft forms. The suffixes are as follows: accusative *be;* genitive instrumental *i* or *ni;* dative locative *de;* ablative *či.* The Manchu verb, like the Chinese, does not distinguish either person or number, the tenses are imperfectly expressed and general notions are conveyed by adverbial and participial forms. Manchu has no relative pronoun and ex-

presses a relative preposition as any other subordinate clause by means of participles.

Manchu, like the other Altaic languages, adds suffixes to the verbal theme to form derived verbs or gerunds expressing some extended meaning; thus the syllable *bu* added to *ara* ("to write") gives *arabu* ("to cause to write") and the syllable *na* added to *wa* ("to kill") gives *wana* ("to go to kill"), etc. A peculiarity of Manchu is the indication of masculine and feminine, or strong and weak, by the alternation of the vowels *a/e:* thus, *ama* ("father") and *eme* ("mother"). Even foreign words undergo this change: the Turkish *arsalan* ("lion") is modified into *erselen* ("lioness"); Sanskrit *garudai* ("male phoenix") becomes *gerudei* for the female phoenix; *ganggan* ("strong") becomes *genggen* ("weak"); and *wasime* ("to descend") becomes *wesime* ("to climb").

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MANCHURIA is the name given by westerners to northeastern China, historic homeland of the Manchus, rulers of China between 1644 and 1912. There is no direct Chinese equivalent for the word. The Chinese call the region either Tung-pei, the Northeast, or the Three Eastern provinces.

Manchuria has been the great frontier region of modern China. Only in the latter half of the 19th century were its eastern and northern boundaries firmly defined, and its western boundaries are still undergoing change. The southeastern political boundary is shared with Korea and has been stabilized since the late 14th century. It follows the Yalu river from its entry into the Yellow sea northward nearly to its source; it then crosses the mountainous water parting between the drainage basins of the Yalu and Tumen rivers, touching the famous Pai-t'ou shan (White Top mountain, 9,003 ft.); finally, it follows the Tumen river to within 20 mi. of the Sea of Japan. Manchuria, however, does not have direct access to the Sea of Japan, being separated from it by both Korea and the U.S.S.R. The northeastern boundary runs northward from the Tumen across the hilly grain of the country to Lake Hanka (Khanka), source of the Ussuri river, and then north along the Ussuri to its junction with the Amur river (Hei-lung chiang). This section of the boundary was established by the treaty of Peking (1860). Manchuria's northern frontier, as established by treaty in 1689 and 1858, follows the Amur from its junction with the Ussuri westward to the Argun river, which continues for most of its course as an international frontier between China and the Soviet Union. Southern Manchuria fronts upon the Po Hai (Gulf of Chihli).

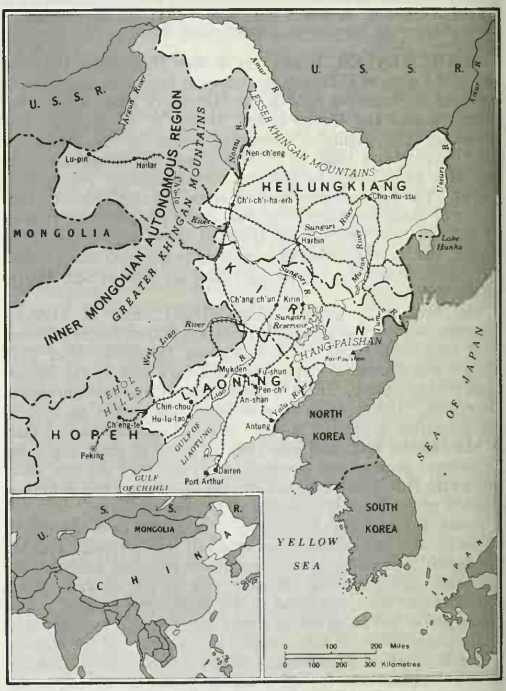
Under the Republic of China prior to 1928 the western frontier continued southward from the Argun river in the north across the eastern Mongolian plateau and then looped southeastward around the hills of Jehol. Manchuria at that time consisted of three provinces: Liaoning (until 1928 Feng-t'ien), Kirin (Chi-lin) and Heilungkiang (*qq.v.*). The total area thus included measured 463,320 sq.mi. In 1928 the province of Jehol was added, making a total of 502,000 sq.mi., and the region became known as the Four Northeastern provinces. Under the Japanese, the entire area later became the puppet state of Manchoukuo (Land of the Manchus). The Japanese eventually granted partial autonomy to the predominantly Mongol western areas. In 1947 the Chinese Communists incorporated these areas into the newly established Inner Mongolian autonomous region, and by 1954 the remaining area of 342,000 sq.mi. had been reconstituted as the Four Northeastern provinces, with three of the four truncated in the west. In 1956, after Jehol was divided among the Inner Mongolian autonomous region and Hopeh and Liaoning provinces, Manchuria once more was composed of three provinces, with an official total area of 309,498 sq.mi.—178,996 in Heilungkiang, 72,201 in Kirin and 58,301 in Liaoning. The western boundaries of the three provinces run roughly parallel to the north-south trending Khingan (Hsing-an-ling) mountains, except for an eastward salient (including T'ung-liao) along the valley of the Hsi-liao (West Liao) river and a southwestern panhandle down to the Great Wall. In all, the region extends through nearly 15 degrees of latitude, from approximately 38° 45′ N. to 53° 30′ N., or the equivalent of the distance between Washington, D.C., and Goose Bay, Labrador.

Manchuria is both an agricultural surplus producer and the most highly industrialized region of China. With a population estimated in 1961 at more than 53,000,000, about 7.5% of the national total, and the best regional transportation network in China, it continues to be the industrial but peripheral heartland of contemporary China, although other heavy industrial centres have been developed rapidly since 1952.

PHYSICAL GEOGRAPHY

Geographical Regions.—Manchuria may be divided into three subregions: the central lowland, the eastern highlands, and the western and northern highlands.

The Central Lowland.—Manchuria, as historically defined, forms a great quadrilateral, the heart of which is one of the great plains of China, the central Manchurian lowland. This plain is about 135,000 sq.mi. in area; all of it lies below 1,000 ft. elevation. It differs markedly from the north China plain, with which it often is compared, in that it is largely an erosional rather than a depositional plain. For this reason most of the surface of the plain is undulating rather than flat. Two major river systems drain the lowland—the Sungari (Sung-hua) and the Liao. The Sungari receives two major tributaries—the Nonni from the northwest and the Mu-tan from the south. The main stream rises in the eastern highlands of Manchuria and flows first northwest and then northeast through a broad floodplain to join the Amur. The Liao rises in the hills of Jehol as the West Liao and flows eastward and then southward to enter the Po Hai's northern arm, the Gulf of Liaotung. The 800-ft. divide between the two systems



MAJOR CITIES, RAILROADS AND PHYSICAL FEATURES OF MANCHURIA

occurs south of Ch'ang-ch'un, but is so little marked that it is scarcely discernible in the landscape. Most of Manchuria's hydroelectric potential is contained in the rivers of the Sungari system, together with the Yalu along the Korean border; the Liao, the drainage basin of which is largely semiarid, is much less significant, though it has built up a sizable alluvial plain along its lower course. Parts of the west Manchurian plain, moreover, are characterized by interior drainage with numerous ephemeral saline lakes and marshes.

The Eastern Highlands.—The central lowland is bounded on the east by the eastern Manchurian highlands which extend about 850 mi. in a northeasterly direction from the Liaotung peninsula almost to the junction of the Ussuri and Amur rivers. The most conspicuous range is the 5,000–9,000 ft. Ch'ang-pai shan (Long White mountains), of which the highest point is Pai-t'ou shan, containing the crater lake, T'ien Chih. The east Manchurian ranges are much higher in the south, where they provide a formidable barrier to communications between Manchuria and Korea, than in the north, where they dip toward the valley of the Amur and the lower Sungari rivers. These ranges are of complicated geological structure, with recent volcanic, igneous and metamorphosed rocks predominating; they are interspersed, however, with Paleozoic and more recent sedimentaries, many of which are carboniferous. The crystalline formations are highly metalliferous, and in them or at their margins are found a large proportion of Manchuria's metallic mineral wealth.

The Western and Northern Highlands.—West of the plain is the broken escarpment of the Greater Khingan mountains, now chiefly in the Inner Mongolian autonomous region, which extends from the broken hills of Jehol northward to the Amur. This range marks the boundary between the central lowland and the Mongolian plateau, which averages 4,000 ft. in elevation. Unlike the east Manchurian highlands, the Khingan are lower in the south than in the north, and in the vicinity of the West Liao river they decline to a series of low hills. Structurally, the Khingan mountains are the upturned edge of the Mongolian plateau, and they consist primarily of fairly recent sedimentary formations, some of which also are carboniferous. North of the plain and south of the Amur valley are the Lesser Khingan mountains, structurally related to the eastern highlands, which run southeastward for about 350 mi. from the northern Greater Khingan to the lower valley of the Sungari. The hills of Jehol, which bound the plain on the southwest, are an extension of the T'ai-hang shan of north China, though more complex in structure and with a higher proportion of igneous formations. They are characterized by high relief and denuded slopes, and resemble the highlands of Shantung province, themselves structurally related to the eastern Manchurian highlands. Between their eastern margins and the Gulf of Liaotung is the major entrance from north China into the central lowland, a narrow coastal plain which is crossed by the Great Wall at Lin-yü.

Climate.—Climatically, Manchuria reflects its northerly location on the eastern margins of Eurasia. Summers are hot and short; winters are long and severe. Winter temperatures decrease markedly from south to north; at Mukden, January mean temperatures are −13° C. (9° F.); at Harbin in northern Manchuria, they average about −16° C. (4° F.) The climatic analogue in North America for Harbin is Winnipeg, Man. In the north the rivers are frozen over until the end of April, and in the south until the beginning of April. Only the harbours at Dairen (Ta-lien), Port Arthur (Lü-shun) and Hu-lu-tao remain ice-free. On the plains the growing season is only 150–175 days; and in the highlands it is still shorter. The monsoon effect of eastern Asia is manifested in Manchuria's rainfall, which displays a marked summer concentration, with dry winters. At Ch'ang-ch'un three-fourths of an average year's rainfall occurs from June through September. Average annual rainfall on the plain is less than 25 in.; precipitation is greater in the east than in the semiarid west, where it may decline to 12 in. The rainiest areas are in the eastern mountains, where annual precipitation averages up to 40 in.

Vegetation and Soils.—The natural vegetation cover of most of Manchuria is grassland or mixed grassland and forest. In the northeast, marshes and poorly drained meadowlands follow the course of the lower Sungari. In the west lies an open steppe which blends into the grasslands of Mongolia and thence into the steppes that cross most of Eurasia. The eastern slopes of the northern Khingans are forested, but the gentler western slopes are sparsely forested and in the south the forests disappear, although it is assumed that the Jehol highlands were forested at one time. The forests of the Lesser Khingans and the eastern Manchurian highlands provide China with its largest forest reserves. Korean pine is the chief commercial tree, and with other conifers, of which spruce, larch and fir are most important, it occupies the higher elevations. Hardwood forests of deciduous species, including oak, elm, poplar and birch, occupy the lower elevations. Exploitation of these forests over a long period of time has resulted in the decimation of those most accessible, and the largest remaining stands of virgin timber are in the least accessible highlands. Under the Communist government some replanting has taken place, although the chief reported effort has been in the planting of meridionally trending tree shelter belts from Ch'i-ch'i-ha-erh (Tsitsihar) southward to the Great Wall. (*See* GREAT WALL OF CHINA.)

The soils of the Manchurian plain are among the best in China. In the south the soils of the lower Liao basin, the area of earliest Chinese settlement, are predominantly alluvial. The bulk of the lowland soils, however, consist of residual grassland soils—deep, dark and fertile. Some of these are classified as "degraded" chernozems, and are in appearance and productivity similar to the black prairie soils of the North American corn belt. The soils of the western plain range from dark chestnut soils to the lighter saline soils characteristic of semiarid regions. Soils in the northern and higher eastern uplands are podzolics formed under forest vegetation. In the eastern highlands and Jehol the predominant soil type is the Shantung brown soil, formed in part from materials of loessial origin.

POPULATION AND SETTLEMENT

There have been Chinese in Manchuria from ancient times, possibly from as early as 1000 B.C. Immigration and communication with China apparently were primarily by sea. The Chinese originally were localized almost entirely in a triangular area in southern Manchuria, centring about the alluvial basin of the lower Liao river and the uplands of the Liaotung peninsula. This so-called "Chinese Pale" was bounded on three sides, other than the south, by a wall known as the Willow Palisade. An extension of this frontier, the so-called Outer Willow Palisade, ran northeastward from a point north of Mukden to the Sungari river north of Ch'ang-ch'un (*q.v.*). The southeastern portion of the Willow Palisade formed a frontier between Chinese and Koreans; the Outer Willow Palisade separated what was predominantly Manchu territory in the east from the Mongol-occupied steppes of west-central and western Manchuria. Within the Pale patterns of occupance resembled those that characterized the north China plain —a relatively dense agricultural population, living in compact villages, and oriented around rectangular walled cities connected with their restricted hinterlands by poor roads and canalized streams.

Much of Manchuria was held until modern times by non-Chinese Tungus peoples, whose racial affinities are more with the Mongols than with the Chinese. On at least three occasions these peoples gained control of southern Manchuria and moved into northern China as barbarian conquerors, recruiting manpower from their homeland beyond the Willow Palisade and from the Chinese whom they had conquered within the Pale. According to some authorities, the Tungus originally dwelt in northeastern China but were forced to retreat into Manchuria in the second millennium B.C. by the Chinese advancing from the loess area of northwestern China. The tide of Chinese colonization then swung south into the Yangtze valley, and, while the northern branches of the Tungus spread into the northern forest, the southern groups remained in Manchuria. The Tungus of the forest retained their old hunting, nomadic life, but those of the central and southern plains in time acquired the arts of cultivation from their Chinese neighbours.

Although excellent horsemen, as befitted dwellers on the steppe, the Tungus of the plain, as evidenced by the Manchus, were ignorant of the art of milking and were essentially not pastoral nomads. On the other hand, the Mongols were true steppe nomads. They came to occupy most of western Manchuria after the upsurge of Mongol power which culminated in the late 13th century in the Yüan dynasty's rule over China, and until well into the 19th century they continued to control the grasslands of the central lowland eastward to Ch'ang-ch'un and nearly as far as Mukden itself.

The immigration of Chinese into Manchuria was long forbidden, but after 1776 this prohibition was relaxed in the case of Liaoning, the southern province, and in the third quarter of the 19th century the Manchus had to recognize colonization in Kirin (Chi-lin). The dense agricultural population of north China was beginning to spill over the border in considerable numbers into vacant lands whose settlement, always sparse, had been further depleted by recruitment for the Manchu garrisons in China. By the end of the 19th century the population of Manchuria, exclusive of Jehol province, is estimated to have been 14,000,000, of which 80% were Chinese. In comparison with what was to follow, however, this movement was no more than an infiltration and consisted mainly of males who intermixed with the Manchus and in time absorbed them. Pure Manchu groups remain only in northern Manchuria, chiefly in the Ai-hun (Aigun) district, and these are the descendants of soldier-colonists planted by the early Manchu emperors in the Amur valley. According to the national population registration of 1953, approximately 2,400,000 persons in all China were listed as Manchus, most of whom presumably lived in Manchuria. (*See* also MANCHUS.)

The rapid economic development of south Manchuria under Japanese auspices after 1905 set in motion a mass migration. Coming mainly from Hopeh and Shantung, the most densely peopled provinces of north China, from 300,000 to 400,000 agricultural labourers annually migrated to Manchuria, but of these half or two-thirds returned each year to China after the Manchurian harvest. In the 1920s this seasonal migration was accompanied by a permanent migration of families, and in 1927 net immigration reached a peak of 843,000. North Chinese farmers penetrated inland along the rapidly expanding railway systems in the north and west as well as the south.

By 1940 the total population of Manchuria as then constituted, including the former Kwantung leased territory and areas later transferred to the Inner Mongolian autonomous region, had reached 44,570,000. Of this total about 90% were ethnically Chinese, despite Japanese restrictions on Chinese immigration prior to 1938. At that time the Japanese, exclusive of troops, numbered about 1,000,000, settled almost entirely in cities in spite of Japanese attempts to encourage agricultural settlement. Mongols numbered about 2,000,000. Koreans totaled an estimated 3,000,000, concentrated chiefly in the southeastern Chien-tao region, an area long settled by Koreans and in which the Japanese officially encouraged Korean settlement after 1932. Many of these Koreans later became supporters of the Chinese Communists during the Chinese civil war and ultimately formed the trained core of the North Korean armies. When adjusted to 1961 boundaries, the 1940 population of Manchuria was about 38,000,000, exclusive of Japanese.

By 1957 the registered population of Manchuria within the 1961 boundaries had increased to 51,500,000, of which 47% was in Liaoning, 29% in Heilungkiang and 24% in Kirin. The rate of population increase had been considerably more rapid between 1940 and 1957 in Liaoning and Heilungkiang than in Kirin, possibly reflecting the expansion of agriculture and the development of new industries in northern Manchuria, and the expansion of a long-established industrial belt in the south. Population is most heavily concentrated in the central lowland, and chiefly in the southern part of it. The population density for the region in 1957 was 166 per square mile, considerably lower than in the rest of agricultural China. Densities were highest in Liaoning, with 413 per square mile; in Kirin they were 174 per square mile and in Heilungkiang, 83. With an estimated population of about 53,000,000 in 1961, the population density rose to 171 per square mile, although large areas continued to have densities of less than 25 per square mile.

Coincidental with the enormous increase in population was a rapid urbanization which caused Manchuria to become the most highly urbanized region in China. It is estimated that 30% of its population may be classified as "urban," as compared with about 13% for China as a whole. About 17% of the urban population of China is believed to reside in Manchurian cities. As compared with most cities in China, the larger Manchurian cities, with the notable exception of Mukden, are relatively modern creations. Officially, there are 24 municipalities, among which the 7 largest (with their estimated 1957 populations) are: Mukden (2,411,000), Lü-ta (Port Arthur-Dairen; 1,508,000), Harbin (1,552,000), Fushun (985,000), Ch'ang-ch'un (975,000), An-shan (805,000) and Pen-ch'i (1953) (449,000). With the exception of Harbin, the larger cities are in the southern half of the region, and these grew most rapidly during the Japanese period and the early part of the Communist period. However, there is evidence that cities in Heilungkiang, including Harbin, are growing at a more rapid rate as the economic development of the northern areas proceeds. Birth rates appear to be high in the largest cities (about 40–45 per 1,000), whereas death rates are low (7–10 per 1,000). Thus, since migration to Manchurian cities continues at a rapid rate and the rate of natural increase is high, both the absolute and relative growth potentials of Manchuria's cities are very large.

Illiteracy among the Manchurian population was high during the period of Japanese domination, and in the mid-1950s it still was estimated at 78%. However, by 1961 it was claimed that more than 90% of the school-age children in the region were receiving primary education and that illiteracy had been greatly reduced. Special attention was being given to technical education. Higher education was concentrated in colleges and universities at Mukden, Ch'ang-ch'un, Harbin and Lü-ta.

HISTORY

Until 1900 Manchuria remained in large part foreign to China. From earliest times Manchuria, except for the lower alluvial basin of the Liao river, had been sparsely populated by non-Chinese peoples. To the Chinese it was, historically, the easternmost part of the vast territory beyond the Great Wall within which lived nomadic barbarians who from time to time left their predominantly grassland "reservoir" region to invade China itself. Manchuria was an especially important part of the great "reservoir." From it the Liao (Khitan) dynasty extended its control over the north China plain in the 10th century; from it also the Jurchen (Chin) in the 12th century extended their control over China south to the Yangtze river. Later the Mongols spread over the region and descended upon China in the 13th century to form the Yüan dynasty. Finally the Manchus, a Tungus tribal group originally from eastern Manchuria, crossed the Great Wall and established the Ch'ing dynasty in the middle of the 17th century. Between these periods, Chinese control extended over much of the outlands, but most of Manchuria remained a preserve of the Manchus and their Mongol allies until very recent times. It was not until the latter half of the 19th century, when Chinese immigration into Manchuria began to increase rapidly, that Manchuria became "Chinese."

In the closing decades of the 19th century foreign powers began to eye the region as a fruitful field for imperialist expansion. For tsarist Russia, Manchuria was to be an eastern outpost and terminus of the Trans-Siberian railway which was to bind that empire together. Japan, with an apparently overflowing population and only limited resources, had a more vital interest than Russia in Manchuria. As a relatively undeveloped but potentially productive country, Manchuria promised to the Japanese not only an exportable surplus of both foodstuffs and industrial raw materials but also a field for colonization.

Russo-Japanese Conflict.—The conflict between Russia and Japan for the control of Manchuria first raged over the possession of the Liaotung peninsula, which is not only the southern gateway into Manchuria but commands the seaward approaches to Peking. The first move was taken by Japan. As the prize of its victory in the Chinese-Japanese War of 1894–95, Japan demanded the ces-

sion of the Liaotung peninsula from the mouth of the Yalu to the mouth of the Liao. But Russia, backed by France and Germany, forced Japan to abandon this claim. Then by means of intrigue and a show of force Russia acquired (1898) the lease for 25 years of the territory of Kwantung at the very tip of the peninsula, containing the naval station-to-be of Port Arthur and what has since become the great commercial entrepôt of Dairen. Japan returned to the attack and by the treaty of Portsmouth (1905), which registered its victory over Russia in the war of 1904–05, obtained the transfer of the Kwantung lease. Meanwhile Russia had been pushing forward its scheme of railway construction. It had already built the Chinese Eastern railway (C.E.R.) across northern Manchuria to Vladivostok and had completed construction of a branch from it through southern Manchuria to Port Arthur. Russia also had established an ethnically Russian centre of settlement, Harbin, on the banks of the Sungari river. By the treaty of Portsmouth Japan became heir not only to the lease of Kwantung but also to the Russian-built railway from Ch'ang-ch'un to Port Arthur. In 1906 it and the rights pertaining to it were vested in the semigovernmental South Manchurian Railway company (S.M.R.). Russian interests were thus pushed back into Manchuria north of Ch'ang-ch'un, into the provinces of Kirin and Heilungkiang. The properties of the C.E.R. and S.M.R. were held on leases, the S.M.R. on one of 99 years and the C.E.R. on one of 80 years. China had the option of purchasing the latter after 36 years. Investment in the S.M.R. was limited to Chinese and Japanese subjects and in the C.E.R. to Chinese and Russian; in effect the paramount interests were Japanese and Russian.

1915–1930.—By possession of the arterial railway through south Manchuria and of its seaward terminus in Dairen, Japan held the chief key to the economic penetration of south Manchuria. The famous 21 demands presented to China in 1915 affirmed "the predominant position of Japan in South Manchuria and Eastern (Inner) Mongolia." During the Chinese civil war Japan continued to exercise a controlling influence in south Manchuria with the support of the Kwantung army, organized in 1919 and destined to become Japan's most powerful military force on the Asian continent. As a result there had come to exist in effect an unstable condominium among Japanese, Russian and Chinese interests.

For a few years it appeared that the first power to be eliminated would be Russia. The Russian revolution of 1917 was followed by the breakdown of orderly Russian administration in the far east. The situation was complicated by the dispatch of troops to eastern Siberia by Great Britain, France, Japan, the United States and China. In numbers of troops Japan outdistanced the others, and for a time it appeared that Japan might supplant Russia in that region. Partly to prevent this development, the C.E.R. was placed under the control of an Allied commission with an American at its head. In 1919, after the Communists had gained control in Russia, they announced their renunciation of all special privileges acquired by the tsarist government in China. In the actual negotiations with China, however, by an agreement signed May 31, 1924, the Soviet Union, while surrendering extraterritoriality and the former Russian concessions and agreeing in principle to the eventual repurchase by China of the road, insisted upon retaining a share in the administration of the C.E.R. A somewhat similar agreement regarding the C.E.R. was signed between the U.S.S.R. and Chang Tso-lin, the ruler of Manchuria, Sept. 20, 1924. Friction followed, accentuated by the anti-Communist, anti-Soviet reaction in China after 1927. In 1929, under Chang Hsüeh-liang, the youthful successor of Chang Tso-lin, and impelled by the rising tide of nationalism, the Chinese attempted to oust the Soviet Union from its participation in the C.E.R. The U.S.S.R. struck back, and in a sharp, brief, undeclared war the *status quo* was restored.

The Japanese Period.—Not the U.S.S.R. but China was the first of the three powers to be eliminated from Manchuria, as mounting Chinese nationalism clashed with Japanese militarism. In various ways the Chinese attempted to restrict the Japanese. Friction, too, developed between Koreans and Chinese in Manchuria, the former being Japanese subjects. On the night of Sept. 18–19, 1931, the Japanese military forces struck, giving as the reason an allegedly Chinese bomb explosion on the South Manchurian railway near Mukden. In the following few weeks they occupied a number of strategic centres. At the time Chang Hsüeh-liang had most of his forces south of the Great Wall, and before the Japanese army his rule in Manchuria quickly collapsed. China appealed to the League of Nations. That body appointed a commission, headed by the earl of Lytton, which, after investigation, issued a report generally unfavourable to the Japanese, in the autumn of 1932. The League proved unable to implement its decision, but its action led to Japan's withdrawal from League membership.

In the meantime the Japanese were erecting a new administration. Local and provincial provisional governments were established mostly by resident Chinese (and, in some areas, Mongols) with Japanese advisers. Early in 1932 a Manchuria-wide government was organized, and on Feb. 18 of that year it declared the independence of the three eastern provinces under the name of Manchoukuo (the state of Manchu). To provide an air of legitimacy P'u-i, who with the title of Hsüan-t'ung had been the emperor of the Manchu dynasty when it abdicated its control of China in 1912 and who had since been living in retirement in Peking and Tientsin, became "chief executive." A step further was taken when, on March 1, 1934, P'u-i formally announced his ascent to the throne of newly named Manchoutikuo (the empire of Manchu) under the title of K'ang-te. His residence was established at Ch'ang-ch'un, renamed Hsin-ching, or Hsinking (the New Capital), where an extensive building program produced an impressive physical emblem of the new state. No attempt was made by the Japanese, however, to restore the Ch'ing dynasty throughout all China by linking the new state with the puppet regime of Wang Ching-wei in north China. The government of Manchoutikuo throughout its life was Japanese-controlled. The most important agency in the government was the so-called general affairs board, a kind of executive secretariat, the director-general of which was from the first a Japanese. Practical military control was exercised by the Kwantung army. Internationally, the new country was recognized only by Japan, Germany and Italy (its Axis partners) and El Salvador, although in the Soviet-Japanese treaty of 1941 the U.S.S.R. granted partial recognition. Soviet official interests were practically eliminated by the sale of the C.E.R. to the Hsin-ching government in 1935. However, the Soviet Union's continuing concern with the region was indicated by a series of border skirmishes between Soviet troops and military units (including Japanese) of the new government, which took place in 1937, 1938 and 1939, the last at No-men-k'an (Nomonhan).

After World War II.—On Aug. 9, 1945, after the Soviet Union's declaration of war against Japan, Soviet and Outer Mongolian troops invaded Manchuria from all directions except the south. Fighting was sharp and brief. The Japanese capitulated on Aug. 14, and within two weeks Soviet troops had occupied all the chief cities. Under the Yalta agreement the U.S.S.R. was granted use (with China) and practical control of the naval base at Port Arthur; Dairen was internationalized, although the harbour master was to be a Soviet national; and the C.E.R. and S.M.R. main lines, under the name of the Chinese Ch'ang-ch'un railway, were to be placed under joint Sino-Soviet control for a period of 30 years. These conditions were verified in the treaty between China and the U.S.S.R. of Aug. 14, 1945. As a result the U.S.S.R. regained essentially the same rights and privileges, other than extraterritoriality, which tsarist Russia had held in 1904. By the end of April 1946, however, the U.S.S.R. had evacuated its troops from almost all of Manchuria, though not before a systematic looting of Manchurian industrial equipment as war booty had taken place.

Meanwhile, Chinese Communist troops had begun to enter Manchuria in large numbers as "civilians" under orders from Communist leader Chu Teh and with the tacit consent of the Soviets. After the withdrawal of the Soviet troops, the Chinese Communists, allied with anti-Japanese Chinese and Korean guerrillas and with the later assistance of the Mongols of Manchuria, gained control of and politically organized all of northern Manchuria and

much of the countryside in the south. They armed themselves with captured Japanese military equipment, again with Soviet tacit consent. Nationalist troops landed at Ch'in-huang-tao in Nov. 1945, since Dairen was closed to them by the Soviets and other ports were in Chinese Communist hands, and marched northward along the Peking-Mukden railway. By May 1946 they had gained control of Ch'ang-ch'un, the former capital. The Nationalist and Communist armies fought over central Manchuria until Mukden fell to the Communists on Oct. 30, 1948; shortly thereafter the entire region passed into Chinese Communist hands.

Manchuria thus became the first major region of China to come wholly under Communist domination. On Aug. 27, 1949, the Northeast People's government was established at Mukden under Kao Kang, and Manchuria became the first of the six large administrative regions of China. On June 21, 1954, the major administrative regions were abolished in China, because of tendencies toward regional independence from Peking. Kao Kang was purged, and the powers of the Northeast People's government reverted to Peking, to the three reconstituted truncated provinces of Heilungkiang, Kirin and Liaoning, and to the Inner Mongolian autonomous region (originally established in May 1947). For a time Soviet influence remained strong in the region, but on Dec. 31, 1952, the Soviet Union transferred its rights in the Chinese Ch'ang-ch'un railway to the Chinese, and on May 24, 1955, the U.S.S.R. signed an agreement for the evacuation of troops and the transfer to China of all installations at Port Arthur without compensation. By June 1 the transfer was reported completed.

During the Korean War (1950–53) Manchuria was an important staging area for Chinese troops, which entered the war in Oct. 1950. Even prior to the war, Manchuria was a major supply base of the North Korean army both for personnel, from among the Korean population of the region, and matériel. Communications were facilitated by the three railway connections between Manchuria and North Korea.

ADMINISTRATION

Manchuria has been administered as a regional unit through most of its modern history, though after 1954 this was no longer the case. Under the Manchus it was formally separated from China south of the Great Wall as a Manchu reserve, despite the large Chinese population in the south and increasing Chinese immigration late in the 19th century. During most of the Republican period (1912–32) it was divided into three provinces—Liaoning (or Feng-t'ien), Kirin (or Chi-lin) and Heilungkiang, but until the Japanese period of domination after 1932, it was administered primarily as a single region under the war lord regimes of Chang Tso-lin and his son Chang Hsüeh-liang. During the Japanese period, Manchoukuo (or Manchoutikuo) consisted of 19 provinces, the boundaries of which followed earlier local administrative boundaries wherever possible. These provinces were Kirin, Lung-chiang, Hei-ho, San-chiang, Pin-chiang, Chien-tao, Ssu-ping, Antung, Liaoning, Chin-chou, Jehol, Mu-tan-chiang, T'ung-hua, Pei-an, Tung-an, West Hsing-an, South Hsing-an, East Hsing-an and North Hsing-an and one independent municipality Hsin-ching (Ch'ang-ch'un), the capital. The Japanese, however, granted partial autonomy to the heavily Mongol-populated Hsing-an provinces. After the end of World War II Manchuria was to have been divided into ten provinces by the Nationalist government: Liaoning, Liao-pei, Antung, Kirin, Sung-chiang, Ho-chiang, Heilungkiang, Nun-chiang, Hsing-an and Jehol; but this administrative division never was implemented.

On May 1, 1947, the Chinese Communists, who controlled most of Manchuria at that time, established the so-called Inner Mongolian autonomous region and included within it the western Hsing-an areas. The remainder of the region was divided among six provinces, again using previously established boundaries: Jehol, Liao-hsi, Liaotung, Kirin, Sung-chiang and Heilungkiang. In Aug. 1949 the Northeast became the first of the six so-called "large administrative regions" in China (*ta-hsing-cheng-ch'ü*). On June 19, 1954, the large administrative regions in China, including that of the Northeast, were abolished; the six provinces were reduced to four, Jehol, Liaoning, Kirin and Heilungkiang, and Manchuria ceased to exist as a formal regional unit. On Jan. 1, 1956, Jehol was abolished as a province, and 5 of its 16 *hsien* (counties) and 3 banners were transferred to Liaoning province, the remainder going to Hopeh province and the Inner Mongolian autonomous region. At the same time, five cities which had been defined as special municipalities at the provincial level were reduced to subprovincial rank, Mukden (Shen-yang), Fushun, Anshan, Pen-ch'i (Penki) (*qq.v.*), and Lü-ta (the twin cities of Port Arthur and Dairen), and several *hsien* were transferred from Liaoning to Kirin.

Thus, Manchuria consists of the three provinces, Liaoning, Kirin and Heilungkiang. At the subprovincial level, Liaoning is composed of five special districts (*chuan-ch'ü*). The special districts are divided into 42 counties (*hsien*); 2 autonomous counties (*tzu-chih-hsien*), the Fou-hsin Mongol autonomous *hsien* and the K'o-la-chin-tso-i Mongol autonomous *hsien;* and 11 municipalities (*shih*). Kirin province is divided into three special districts and one autonomous *chou,* the Yien-pien Korean autonomous *chou.* These in turn are subdivided into 41 counties; 2 autonomous counties, the Ch'ang-pai Korean autonomous *hsien* and the Ch'ien-kuo-erh-lo-ssu Mongol autonomous *hsien;* and 5 municipalities. Heilungkiang province is divided into five special districts. These are subdivided into 58 counties; 1 autonomous county, the Tu-erh-po-t'e Mongol autonomous *hsien;* and 8 municipalities. Most of the administrative municipalities in all provinces include not only the central city, but also a considerable nonurbanized hinterland.

At the subcounty level, the basic unit of administration has long been the township (*hsiang*) and the town (*chen*), but in 1958 a new unit of political and economic organization was established, the commune (*jen-min kung-she*), the area of which is most commonly coterminous with the *hsiang* or in some cases the *hsien.* The communes combine both administrative and economic functions, and thereby represent an attempt to better organize production and control political thought and activity. In the municipalities the administrative subdivision has been into wards (*ch'ü*), but urban communes also have been established in most cities to replace these.

Each of the three Manchurian provinces is governed by a provincial government elected by a provincial people's congress, which is composed of delegates elected by the county people's congresses. These, in turn, are elected by the township or commune people's congresses. Senior officials at the provincial level, however, are in fact appointed by the central government at Peking.

ECONOMY

Transportation.—Since 1900 Manchuria has witnessed a remarkable growth of population, agriculture and manufacturing. The framework about which this development has taken place is the railway system, virtually nonexistent at the turn of the century. The railways of Manchuria amount to more than 8,000 mi., about 42% of all the rail mileage in China. The main lines of the system are T-shaped and are the oldest in the region, having been completed by the Russians in 1904. The head of the "T" (the former main line of the so-called Chinese Eastern railway) runs from the northwestern border town of Lu-pin (Man-chou-li) southeastward through the rail junction at Harbin, a by-product of Russian railway construction, to the Soviet border at Sui-fen-ho, forming a chord across the Trans-Siberian railway's arc which follows the outer bend of the Amur river. Connections are made with the Trans-Siberian railway in Soviet territory at both ends of this line, and Vladivostok is its natural Pacific terminus. The base of the "T" runs from Harbin to Port Arthur. As of 1958, these key lines already had been supplemented by a connection from Peking to Mukden and a line built by the Japanese from Mukden to the Korean border at Antung. Railway expansion was rapid thereafter. The Chinese, with the Japanese anomalously supplying the capital, proceeded to build competitive railways parallel to the South Manchurian system in the south and cutting across the Chinese Eastern railway in the north, with connections leading into the central lowland. Chinese penetration into the Mongol country of the west and northwest over

these lines aroused Japanese fears of Chinese control over what had come to be regarded as an area of Japanese special interest. These fears were accentuated by Chinese development of the port of Hu-lu-tao, on the western shores of the Gulf of Liaotung, which was described by the Chinese as a potential rival to Japanese-held Dairen. They culminated in Japan's occupation of Manchuria in 1932.

From the basic network of 3,500 mi. of railways in 1932, the Japanese built an elaborate railway system which, together with the North Korean railway system, was run by the South Manchurian railway company. This company maintained an entirely self-sufficient rail network, producing its own coal and for a time steel, and manufacturing and repairing cars and equipment at shops near Dairen and in Mukden. In March 1935 the former C.E.R. was sold by the U.S.S.R. to Manchoutikuo. Within months its wide gauge had been narrowed to the standard gauge of all the major Manchurian lines, and branch lines were thrust out to the frontiers. A second connection was completed to Peking through southern Jehol province. Two major connections, in addition to that at Antung, were made with the North Korean railways. The most important of these was the eastward extension of the Ch'ang-ch'un–Kirin–Tun-hua line to Tumen at the Korean border and thence to three ports in northeastern Korea fronting on the Sea of Japan—Unggi, Najin and Ch'ongjin. This new railway provided a direct outlet for the produce of the central and northern Manchurian plain to the Sea of Japan, which was approximately 450 mi. closer to Japanese ports than Dairen. Other lines were pushed toward the Amur, some of them of relatively light construction, and all of them of strategic importance.

Manchuria's railways are single-tracked except for the Harbin–Lü-ta, Mukden–Antung and Mukden–Peking routes. Under the Peking regime, little railway construction has taken place in Manchuria. Until 1955 the Manchurian system provided the chief overland connections between China and the Soviet Union, but the completion of the Trans-Mongolian railway in that year provided a new connection which shortened the route between Moscow and Peking by 710 mi.

River and road traffic clearly has been secondary to the railways. Most of the 13,000 mi. of roads in Manchuria are unsurfaced, except for those connecting the largest cities. River traffic is restricted primarily to the Sungari and its lower tributaries, along which specially constructed river boats similar to the Mississippi river side- and stern-wheelers move for about seven months of the year until the rivers freeze in late fall. The rivers of southern Manchuria, though open somewhat longer, are shallow and little used above their lowest courses except by Chinese country boats. Plans exist to construct a series of canals which will connect the Sungari and Liao river systems with each other and An-shan with the lower Liao.

Agriculture.—The rapid expansion of the railways was accompanied by an equally rapid expansion of agricultural settlement, although not by an equally large increase in agricultural production. Between 1919 and 1930, when the amount of cultivated land reached an estimated 33,000,000 ac., the total area under cultivation doubled. By 1940 cultivated land amounted to about 44,000,000 ac., and total food crop production to about 19,000,000 metric tons. Since 1940 the acreage of cultivated land apparently has increased only slightly. It appears that the best agricultural lands in Manchuria, with few exceptions, were already occupied by 1940; those that remain are of poorer quality and present problems of drought, flood, poor soils or a short growing season. Land utilization, nevertheless, differs markedly from region to region. Whereas in the south up to 95% of the arable land has been put to use, in the north considerably less than 50% has been utilized. In the north, also, farm units traditionally have been relatively large, nearly half the farms being over 17 ac., whereas in the south about 60% of them are estimated to have been 10 ac. or less; even this size is large, however, as compared with the north China plain, where the average farm unit averaged about 5 ac. in size prior to communization.

Crop combinations in lowland Manchuria are similar to those in the north China plain, which it resembles climatically and culturally. Most of the crop acreage is devoted to drought-resistant cereals and soybeans. Kaoliang, a grain sorghum, is the most important cereal and occupies perhaps 25% of the total cropped acreage. It is cultivated chiefly in the southern portion of the central lowland. Small millets are almost equally important, and these also are concentrated in the south. In the north, soybeans are the most important crop, but they are widely grown and account also for about one-fourth of the total cropped acreage. Manchuria produces about 40% of China's total soybean production. Spring wheat, nearly one-third of China's acreage, also is a major northern crop; corn is concentrated in the southeast, chiefly in areas of Korean settlement; rice also is important, occupying about 1,000,000 ac., chiefly in southern Manchuria and the eastern uplands, although it is becoming increasingly important in the north as well. Other grains, such as barley and oats, also occupy significant acreages. Cotton is an important crop in the south, and flax and sugar beets are major crops in Heilungkiang. Lesser crops include oilseeds, tobacco, peanuts and hemp. Some crop rotation is practised, with grains alternating with legumes. The relatively short growing season of about 150 days in the central lowlands permits little double-cropping, and irrigated agriculture is restricted primarily to the rice-growing acreages. In general, yields are lower in Manchuria than in the north China plain, and efforts have been intensified, especially since 1957, to increase yields by more intensive cultivation practices, including deeper plowing, a greater use of fertilizers, drainage and water control, and the introduction of seed with a higher yield. Animal husbandry is subsidiary to crop production, as is the case in most of China, but the herding of sheep and goats is important in the dry western plains near the border with Inner Mongolia.

Manchuria has long been a surplus food producer in spite of its rapid growth in population. During the period of the Japanese occupation, agricultural products accounted for more than 60% of Manchuria's exports, chiefly in the form of soybeans and soybean products. Large quantities of millet also were exported to Korea to replace more valuable Korean rice, which then provided Japan with two-thirds of its rice imports. World War II disrupted agriculture, and it was not until 1952 that Manchurian food production reached its 1940–45 levels. In 1961 production may have reached 25,000,000 tons. An estimated 2,000,000 tons of foodstuffs are sent to other parts of China annually. In addition, soybeans, chiefly from Heilungkiang, are exported in large quantities to the U.S.S.R.

Agriculture in Manchuria was collectivized more rapidly than in any other part of China, primarily because the Communists controlled the region for a longer period of time. The commune system is the predominant form of agricultural organization. Manchuria also contains most of the large-scale state farms in China, of which about 100 are reported to be highly mechanized. Many of these had their origins in large reclamation colonies for Japanese soldiers and their families which were located in previously unsettled areas in the lower Sungari basin. Nevertheless, agricultural expansion apparently has been less rapid than had been anticipated, partly because of floods and other natural disasters in 1960 and 1961, though as early as 1959 several key Communist party officials were removed from their provincial posts as an indication of the central government's displeasure at the relatively slow progress in the agricultural sector.

Mining.—Although Manchuria has become the most important industrial region of China and its industries are based largely upon its own mineral resources, these resources are in general inferior to those of other parts of China. However, they have been relatively accessible, as compared with many other mineral deposits in China, and a number of them are conveniently located within a small area in the southern part of the region. Nevertheless, the relative importance of these resources is declining, as other discoveries are made elsewhere in China and new mineral deposits are being exploited.

The chief Manchurian mineral resource is coal. Reserves are estimated at about 20,000,000,000 tons, comparable in size to those of Japan but only a small fraction of China's total reserves, which are estimated at 1,000,000,000,000 tons. The chief Man-

PHOTO BY WILLIAM KINMOND

POWER PLANT AT FUSHUN, MANCHURIA, LARGE COAL MINING AREA. WORKERS' HOUSES ARE IN THE FOREGROUND

churian deposits are along the eastern and southwestern margins of the central lowland. The largest deposits are at Fushun, about 20 mi. E. of Mukden, where the coal measures are up to 400 ft. in thickness. Where the deposits reach the surface, opencast mining is practised in one of the largest open pits in the world. Other major deposits are exploited at Fou-hsin and Pei-p'iao in eastern Jehol, Pen-ch'i southeast of Mukden, Yen-t'ai south of Mukden, Liao-yüan (Hsi-an) east of Ssu-p'ing-chieh, Sui-tung (Hao-kang) in northeastern Manchuria, and in the Tung-pien-tao region in the east Manchurian highlands near the Korean border. Most of the Manchurian coals are noncoking bituminous, but good coking coals are found at Pen-ch'i, Pei-p'iao, Sui-tung and Tung-pien-tao. Production is estimated to be considerably above the peak pre-Communist total of 26,000,000 metric tons in 1943. The Fushun fields are associated with vast beds of oil shale (estimated at 7,628,000,000 metric tons) containing 3% to 7% petroleum. Production of more than 16,000,000 metric tons of shale in 1959 is reported to have yielded 1,000,000 tons of oil, or about one-third of China's oil production in that year. Large shale deposits also have been reported in Heilungkiang. Little liquid petroleum is known to exist in Manchuria, although there are favourable geological formations in the northwest near Dalainor.

Iron ore reserves are modest in terms of the needs for modern industry, but they account for at least half of all China's known reserves. The most reliable estimates of both measured and inferred reserves are 1,840,000,000 metric tons, of which only 115,000,000 tons are high-grade ores. The remainder are low-grade ores containing from 25% to 40% iron. The Manchurian ores also contain up to 40% silica and demand costly beneficiation. The major exploited deposits, in close areal association with coal deposits, are near An-shan about 60 mi. S.W. of Mukden, at Miao-erh-kou south of Pen-ch'i, and in the Tung-pien-tao region. In the first two cases, the ores are low-grade magnetites and hematites, with small deposits of higher-grade ores; at Tung-pien-tao the ores are hematites averaging 60% iron. In spite of their modest size, the Manchurian iron ores have become the basis for the largest iron and steel industry on the mainland of Asia. In large part this is a reflection of the localization of iron ore, coal and limestone within a few miles of each other in south-central Manchuria. Numerous other metallic minerals, including molybdenum, manganese, pyrites, copper, zinc and lead are mined in Manchuria; of these molybdenum and lead are important exports. Gold has long been an important product, particularly in the eastern and northern highlands. Huge deposits of magnesite are found east of Ying-k'ou in southern Manchuria, and alumina shales are mined south of Mukden. Limestone, talc, clays and mica are among the more important nonmetallic minerals. Salt is obtained from sea water along the coasts of the Liaotung peninsula.

Industry.—Manchuria continues to be the industrial heartland of China, despite the growth of major industrial areas elsewhere. Before 1932 Manchurian industry was small in size and highly localized in the Kwantung leased (to Japan) territory and along the main-line railways where the railway companies had developed collieries and manufacturing industries in addition to railway service facilities. After 1932 Japanese industrialization plans were implemented primarily under the direction of a congeries of semigovernmental corporations, including the South Manchurian railway. Estimates for 1943 indicate that under a war economy pig iron production, chiefly at An-shan and Pen-ch'i, rose to 2,000,000 tons and steel ingot production to more than 1,000,000 tons, with An-shan the only integrated iron and steel plant in the region. Although the iron and steel industry was large for Asia, it was small by American and European standards.

In association with the iron and steel industry a series of secondary manufactures were developed. Mukden, the centre of the heavy industry region, also was a centre for the machine tool and munitions industries. Dairen and Port Arthur formed a second industrial zone, with shipyards, railroad locomotive and car factories, and chemical, machinery and textile plants. At Harbin, light industries based in part upon processing of such agricultural produce as flax, soybeans, wheat and sugar beets were developed. Ch'ang-ch'un, Kirin, Chin-chou and Antung each possessed industrial establishments of size, all except Chin-chou dependent upon hydroelectric power from the great dams on the Sungari and Yalu rivers. The first of these dams was completed in 1941 at Sui-fong, 40 mi. up the Yalu from Antung, and is one of the largest in the world, being 525 ft. high and 2,800 ft. long. A second great dam and power plant was completed at Ta-feng-man (Feng-man), on the Sungari river about 15 mi. S.E. of Kirin city, to supply power for much of central and northern Manchuria. The total installed capacity of both hydroelectric and thermal power facilities in Manchuria in 1944 was estimated at 1,790,000 kw. as compared with 1,350,000 kw. in all of China proper. In addition, the oil shales associated with the coal measures of southern Manchuria were processed for oil extraction at a plant in Fushun which produced up to 300,000 tons per year, and coal distillation also was used to produce oil. Tied in with the expanding electrical generation program were new metallurgical and chemical industries. Local high-alumina shales and clays were used after 1938 to produce alumina and aluminum, and the rich deposits of magnesite near Ta-shih-ch'iao also were utilized. Chemical by-products of the iron and steel and oil shale extraction industries, such as ammonium sulfate fertilizer and carbon black, were produced at Fushun, An-shan and Pen-ch'i; ammonium sulfate plants were constructed at Dairen and Hu-lu-tao; and several plants producing soda ash and caustic soda were constructed. To satisfy labour requirements for the expanding industrial complex, the Japanese lifted restrictions on the immigration of north Chinese, allowing 595,000 to enter in the peak year of 1939; almost all of these entered the industrial rather than the agricultural labour market. For the most part, the industrial complex was developed as a potentially independent and substantially self-sufficient economic entity. Most of the manufactured products of Manchuria remained there; only a modest proportion was exported to Japan, and this represented only a fraction of the value of Manchurian agricultural exports to Japan. In fact, so much Japanese capital flowed into Manchuria that there is reason to believe that the region may well have been a drain upon, rather than an asset to, the Japanese economy.

As a result of World War II and the Chinese civil war, Manchurian industry suffered heavily. Soviet selective removals of machinery had an estimated replacement value of $2,000,000,000. Additional damage from civil war destruction, looting and neglect was enormous. By the time the Chinese Communists took over, the Manchurian industrial complex had substantially deteriorated. By 1952, however, considerable progress had been made in reconstructing the Japanese industrial complex, and by 1955 earlier peak loads of production for most industries had been equaled or

exceeded. Most of the 141 major industrial projects at the core of China's 1953–57 economic plan were located there; most were dependent upon technical assistance from the Soviet Union; and many represented rehabilitation and expansion of Japanese-founded installations.

In general, Manchurian industry continued to display the same basic locational characteristics that it did in the pre-Communist period, but it was characterized by an increasing diversification of products and some dispersion outside of the heavy-industry core-zone focusing on An-shan and Mukden. After the middle 1950s, established industries were further enlarged, and new ones established. The steel plant at An-shan and the Pen-ch'i iron and steel complex were expanded. Production in the oil shale refinery at Fushun was increased to 1,000,000 tons of oil annually, and the alumina-aluminum plant there achieved a capacity of about 100,000 tons of aluminum ingots per year. Coal mining was intensified at Fushun and at all the larger fields; the opencast operation at Fou-hsin in the southwest came to rival the output at Fushun, each producing about 10,000,000 tons annually. The large ammonium nitrate plant at Dairen achieved a yearly capacity of approximately 250,000 tons, its shipyards also greatly increased output, and the railway shops at Dairen and Ch'ang-ch'un were considerably enlarged. The hydroelectric facilities constructed by the Japanese were rehabilitated and expanded as well. The Yalu power plant, shared by North Korea and Manchuria, reached a capacity of about 700,000 kw. and the Ta-feng-man installation a capacity of nearly 600,000 kw.

In addition, scores of new industrial plants were opened. Harbin became a major machine tool centre, as well as a producer of steam turbines and electrical transformers. Aircraft were reported manufactured at Mukden, and fertilizer plants were constructed at Kirin and elsewhere. The power system was enlarged by the construction or expansion of thermoelectric plants in most of the larger cities, and the Manchurian power grid was tied in to that of northern China by a 220,000 kv. line between Chin-chou in Manchuria and T'ang-shan. In addition, a 290,000 kw. hydroelectric plant was under construction on the Hun river, a tributary of the Yalu. The most widely publicized new plant was the automobile factory constructed at Ch'ang-ch'un with Soviet help and opened in 1956; this plant mainly produced five-ton motor trucks, although some automobiles and tractors also were manufactured. The production goal for this plant originally was 30,000 units annually, and its capacity reportedly was increased to 60,000 in 1959, although production probably was less than half that in 1961. Within the Ch'ang-ch'un metropolitan area, a variety of smaller plants were developed to form an automotive industry complex. Numerous consumer goods industries also were established, especially in Kirin and Heilungkiang provinces, producing clothing, electrical appliances, and such items as fountain pens, paper products, wood products and some textiles.

See also references under "Manchuria" in the Index.

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MANCHUS. Manchu is the name given to a people who lived for many centuries in Manchuria and adjacent areas and who in the 17th century conquered China and ruled that country for more than 250 years. The term Manchu dates from the 16th century, but it is certain that the Manchus are the direct descendants of a people who under other names had lived in northeastern Manchuria long before the Christian era. In early Chinese records they are known as the Tung-i or Eastern Barbarians; in the 3rd century B.C. they were given the name of Sushen or Ilu; in the 10th century A.D. the Chinese historians speak of them as Nu-chi or Ju-chi, an attempt to transliterate the native word *Jurchen*. These Jurchen established a kingdom of some extent and importance in Manchuria and by 1115 A.D. had secured control over northeastern China. In Chinese records this is known as the Chin or Golden dynasty. The kingdom was annihilated by the Mongols in 1234 and the surviving Jurchen were driven back into northeastern Manchuria. Three centuries later the descendants of these Jurchen again came into prominence, but before long they dropped the name Jurchen for Manchu. The Manchus rapidly rose to power under Nurhachi, a tribal leader, who established military and political control over the whole of Manchuria and in 1616 proclaimed himself emperor. Nurhachi fought several successful battles against the Chinese, but died before he could carry out his lifelong ambition to invade China. However, in 1644 an attack took place; Peking, the Chinese capital, fell, and by 1680 the Manchus had complete control over all sections of the Chinese empire. The Manchus managed to maintain a brilliant and powerful government until about 1800 after which they rapidly decayed in energy and ability. It was not, however, until 1912 that the Manchu dynasty was overthrown.

In order to understand the origin and cultural development of the Jurchen-Manchus it is important to bear in mind that Manchuria is divided into two sections: one, to the south and west, is an open, rolling and almost treeless plain, ideally suited for pasturage; the other, to the north and east, is essentially mountainous and is covered with forests. In early times the south and west section was inhabited by the Tunghu tribes, the ancestors of the Mongols, who soon developed a nomadic horse culture; the north and east section served as the home of the Ilu and their descendants, the Jurchens and Manchus. Because of the difference in terrain the Manchus never fully adopted the Mongol culture pattern, even after they secured control over the whole of Manchuria.

Modern research shows that the Jurchen-Manchus are members of a widespread ethnic group known as the Tungus. At an early date, probably about the time of Christ, various Tungus tribes moved from their homeland in or near northeastern Manchuria to the north and west, and eventually occupied most of Siberia between the Yenisei river and the Pacific ocean. In so doing they absorbed some of the earlier inhabitants known as the Paleo-Asiatics. In some cases the latter were pushed farther back into northeastern Siberia where they still remain. With the advance of the Russian settlers in the 17th century, many of the Tungus tribes inhabiting Siberia disappeared, but some still remain, including the Tungus proper, the Lamuts and the Golds. Other Tungus tribes such as the Oroken are still to be found on Sakhalin Island. Basically the Manchus, like all the other Tungus peoples, are members of the Mongoloid race, but it is obvious that they have interbred widely with other peoples as there is wide variation in body type between different Manchu groups. It is almost certain that they have absorbed some of the Caucasoid races (Alpine and proto-Nordic) which inhabited parts of Siberia in prehistoric times. In general, the descendants of the Manchus living in China tend to be slightly taller and lighter in colour than the indigenous Chinese.

From inscriptions in the two languages it is clear that the old Jurchen language and modern Manchu are practically identical. Manchu is also closely related to the other Tungus languages. There is some doubt as to the relationship of Tungus to other languages, but because of similarity of structure, most scholars place Tungus along with Mongolian, Turkish, Hungarian and Finnish in a language group known as Ural-Altaic. In any case it is certain that Tungus is in no way related to Chinese. In writing the Manchus never adopted the Chinese ideographs but employed a phonetic alphabet developed by the Jurchen on the basis of the Mongolian alphabet. The ultimate source of this alphabet is to be found in Syria.

From the Chinese records it is evident that the Ilu, the ancestors of the Manchus, were on a rather low cultural level. Like many modern Tungus tribes in Siberia, they were essentially hunters, fishers and food gatherers, though in later times they and their descendants, the Jurchens and Manchus, developed a primitive form of agriculture. Unlike the Mongols and Turks, the Jurchen-Manchus were noted breeders and eaters of pigs. Pigs also played an important role in their religious myths and rites. It is probable

that the word Tungus is derived from an early Turkish word for pig. From very early times the Jurchen-Manchus were accustomed to braid their hair into a queue or "pigtail." When the Manchus conquered China they forced the Chinese to adopt this custom as a sign of loyalty to the new dynasty. Apart from this the Manchus made no attempt to impose their manners and customs upon the Chinese. After making an unsuccessful effort to abolish foot-binding, they permitted it to go on among the Chinese women, though the Manchu women never adopted this custom. Unlike the Chinese, who until very recent times have shown a marked dislike of dairy products, the Manchus were accustomed to drink milk. But they never attempted to impose milk or any other food upon their Chinese subjects.

After the conquest of China, the greater part of the Manchus migrated there and kept their ancestral estates only as hunting lodges for occasional vacations. Eventually these estates were broken up and sold to or occupied by Chinese immigrant farmers. By 1900 even in Manchuria the Chinese enormously outnumbered the Manchus. Many Manchus in the years following 1644 settled in and around Peking, where they obtained official positions. No effort was made to destroy or even seriously modify the traditional Chinese governmental structure, but in most cases the Manchus were given a good share of the higher administrative posts. Thus the grand council, the highest governmental organ, was usually half Chinese and half Manchu. A large number of Manchus were also incorporated into the mandarinate or administrative hierarchy scattered throughout the country. A great many Manchu males became hereditary soldiers, being incorporated in eight special banners or army divisions which were stationed at various strategic posts in order to maintain law and order and to prevent revolution.

Earlier Chinese emperors, such as the rulers of the Han and T'ang dynasties, secured some sort of control over the areas now known as Mongolia, Sinkiang (Chinese Turkestan) and Tibet, but in the 10th century this control was completely lost. The Manchus, after conquering China proper, sent military expeditions into these areas and brought all of them into some form of subjection. But the Mongols, the Turkestanis and the Tibetans believed that they had submitted to the Manchus, and not to the Chinese. Hence they made desperate efforts to regain their independence after the fall of the Manchu dynasty.

Prior to their conquests of China the Manchus were distinctly backward in cultural development, but they were quick to learn once they had gained military and political power. Several of the early rulers of the Manchu or Ch'ing dynasty (especially the emperors K'ang-hsi and Ch'ien-lung, who between them ruled for 120 years) were men of high intelligence and were among the most able and munificent patrons of literature and art that China had ever known. Under their stimulus a Manchu literature was created. Many of these Manchu works were subsequently translated into Chinese. In like manner, many important Chinese works were translated into Manchu and published at imperial expense. The emperor K'ang-hsi gathered together from all parts of the empire the best scholars and set them to work on literary and historical research. As the result of these efforts there appeared the *K'ang-hsi tzu-tien,* still the standard dictionary of the Chinese language, and the authoritative "imperial edition" of the Chinese classics. A little later the Manchu court fostered the publication of a gigantic encyclopaedia comprising more than 1,500 volumes. The Manchu rulers were also noted patrons of ceramic art, and the types of porcelain known as K'ang-hsi and Ch'ien-lung ware are still prized museum pieces.

The Manchu emperors, in spite of their patronage of Chinese culture, made strenuous efforts to prevent the Manchus from being absorbed by the Chinese. The Manchus were urged to retain their own language and to give their children a Manchu education. Attempts were made to prevent the intermarriage of Manchus and Chinese, so as to keep the Manchu strain racially pure. Too much social intercourse between the two peoples was frowned upon. All these efforts proved fruitless. During the 19th century, as the dynasty decayed, the efforts to preserve cultural and racial segregation gradually broke down. The Manchus began to adopt Chinese customs, to speak the Chinese language and to intermarry with the Chinese. When the dynasty was overthrown, and it became politically inexpedient to be known as a Manchu, the Manchus quietly disappeared into the main mass of the Chinese populace.

See also CHINA: *History;* CH'ING. (W. M. McG.)

MANCINI, PASQUALE STANISLAO (1817–1888), Italian jurist and statesman, a man of the Risorgimento and a liberal minister in the early years of the kingdom of Italy, was born on March 17, 1817, at Castel Baronia, in the kingdom of the Two Sicilies. A deputy in the Neapolitan parliament of 1848, he stood for genuine constitutionalism; and on the dissolution of the parliament in March 1849 he upheld the same cause, both as a journalist and as a lawyer for the defense of prosecuted liberals, till he was driven into exile in May. Going to Piedmont, he was appointed professor of international law at Turin in 1850. His first lectures, published as *La Nazionalità como fonte del diritto delle gente* (1851), were a notable contribution to the ideology of the Risorgimento. Elected to the parliament of Sardinia-Piedmont in 1860, he was sent in 1861 to be a member of the Sardinian council of lieutenancy over the newly conquered territory of the Two Sicilies, where he suppressed the religious orders, renounced the concordat with the papacy and proclaimed the state's right to church property. Returning to Turin, he sat with the centre in the first parliament of united Italy; and in March 1862 he was minister of education for 18 days under Urbano Rattazzi. In 1865 he won a great personal triumph by securing a considerable limitation of capital punishment. Finally identified with the left by 1867, he was minister of justice under Agostino Depretis from 1876 to 1878. As acting minister of public worship in 1878, he assured the cardinals that the Italian government would not interfere with the conclave for the election of Pope Pius IX's successor (the first held since Italy's occupation of Rome). Minister of foreign affairs under Depretis from 1881, he angered the irredentists by his *rapprochement* with Austria-Hungary and in May 1882 committed Italy to the Triple alliance with Austria-Hungary and Germany. In colonial policy he failed to promote any expansion of Italy's power in the Mediterranean area; and though he had to sponsor the occupation of Eritrea he could not prevent France's progress in Somaliland. Public discontent at his hesitant policies forced him to resign in June 1885. He died at Reggio di Capodimonte, Naples, on Dec. 26, 1888.

MANDAEANS, a Gnostic sect surviving in southern Iraq and Khuzistan, known to Arab and Iranian neighbours as SUBBA ("dippers"). They call themselves Mandaiia (literally "Gnostics"), though this now designates Mandaean laymen exclusively; priests are *tarmidia* ("disciples") and those priests initiated into secret doctrine are *Nazuraiia* (Nasoraeans). The religion as taught to the layman is syncretistic, and personifications of qualities, aspects and emanations of the Great Life, as they call the supreme Being, appear in a number of myths, which are often self-contradictory. The religion survives chiefly through its insistence on cult, baptism particularly, which is looked upon as necessary for all kinds of pollution and essential for salvation. Some personifications are saviour-figures, such as Manda-d-Hiia ("Knowledge of Life"), Hibil-Ziwa ("a light-bearer"), Yawar-Ziwa ("Awaking" or "Arousing Light") and *kushta* ("good faith," "truth," also a personification of the ritual handshake which symbolizes pact and alliance). Both beneficent spirits (*'utria*) and demons are innumerable. Illness is caused by possession by disease-demons, and the devout prefer exorcism to medicine. Baptism is followed by the administration of simple sacraments of water (*mambuha*) and bread (*pihta*), and this rite is one of a series of *razia* ("mysteries") of which the most important is the *masiqta,* a solemn ritual meal celebrated by priests only for the "raising up" (or resurrection) of the dead. Other ritual meals are *Lofani,* a lay meal eaten in commemoration of and for the benefit of the dead, and the Blessed Oblation at marriage and burial. As in other Gnostic religions, the body is called the "tomb of the soul" and death is looked upon as a release from prison.

Up to the beginning of the 20th century the Mandaeans wore only white, did not cut their hair and avoided pollution with others.

But modern education and the introduction of cars, radio and commercial enterprise tend to destroy their separatism, and the sect is fast disappearing.

The name "Christians of St. John" given to Mandaeans by medieval travelers originated because their priests claim John the Baptist as a member of their sect (the Nasoraeans), but Jesus is to them a false Messiah, and ascetic practices of Christians such as celibacy were and are abominable to worshipers of the Life. Mandaean tradition, supported by internal evidence and scholarly research, claims the west as the original home of the sect, although the language of their texts is an eastern dialect of Aramaic (*see* SEMITIC LANGUAGES: *Aramaic*). References in Mandaean literature to a flight from Judaea and persecution there point to connection with early Jewish Gnosticism. Libraries, consisting of scrolls and codices in Mandaic characters, are composed chiefly of fragments of pre-Muslim compositions, collected directly after the Muslim conquest (7th century A.D.). There are also post-Muslim writings and magical and astrological manuscripts of uncertain date. Most of the manuscripts are in the Bodleian library, Oxford (the Drower collection); others are in Berlin, Paris and London. *See* also GNOSTICISM.

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MANDALA (Sanskrit "circle"), in Hindu and Buddhist Tantrism, is a holy precinct prepared in honour of a Buddha or other divinity and sometimes used for the performance of a sacred rite. It is also a representation of the cosmos, a consecrated area in which the forces of the universe are collected. These forces are represented by images or signs of divinities, by ritual instruments or by other symbolic means.

In Tibet, China and Japan the *mandala* is commonly presented in graphic form on paper, silk or other material. Despite the basic meaning of the Sanskrit word, *mandalas* are commonly square or rectangular in shape and divided into various sections, or "courts." In Tantrism and in esoteric Buddhism the *mandala* is a "support for meditation"; that is, the adept uses the *mandala* as an object of meditation, progressively obtaining possession of the energies represented by the various images or symbols.

In Japan the *mandala* of the Shingon sect is twofold: the *taizōkai*, or "womb world," and the *kongōkai*, or "diamond world." These two *mandalas* represent the whole of the universe, being simply two differing aspects of it. In both *mandalas* the solar divinity Vairocana (Jap. Dainichi) occupies a central position; all surrounding divinities are but aspects of him. Vairocana and the other divinities may be represented by symbols, *e.g.*, by "seed letters" (Jap. *shuji*), which embody the essence, the energies, of the gods in question.

Movement in the diamond world tends to converge inward, to be centripetal, representing a reintegration of multiplicity to unity; in the womb world it is centrifugal, outward from the centre, from the unitary to the many.

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COURTESY, MUSEUM OF FINE ARTS, BOSTON; BIGELOW COLLECTION

CENTRE DETAIL OF JAPANESE TAIZŌKAI MANDALA, LATE 17TH CENTURY. IN THE MUSEUM OF FINE ARTS, BOSTON

MANDALAY, formerly capital (now chief town) of Upper Burma, headquarters of the Mandalay division and a district of the Union of Burma, stands on the Irrawaddy river. It was built mainly in 1857–59 by King Mindon to replace Amarapura (*q.v.*) as his capital. The population (185,867 in 1953) is mixed, but as Burmese Buddhists predominate Mandalay is far more Burmese than Rangoon. It is a great Buddhist religious centre and the abode of large numbers of monks (*Hpongyis*). Occupied by the Japanese during World War II the town was almost completely destroyed, sustaining the heaviest damage during the 12-day siege in March 1945 when it was retaken by the 14th army commanded by Gen. Sir William Slim.

The area inside the old walls of the royal palace (*Nandaw*) and environs is called Fort Dufferin. In the centre the palace itself (a group of wooden buildings, many of them highly carved and gilded, resting on a brick platform 900 by 500 ft. and 6 ft. high) stood until its destruction during the war. Mandalay hill (744 ft.) has innumerable monasteries, pagodas and monuments all of comparatively modern creation. It overlooks the *Kuthodaw* or "seven hundred and thirty pagodas" and the city. The city, west of the palace walls, was laid out on a gridiron plan and has little of interest apart from numerous bazaars (notably the large Zegyo bazaar) and some fine pagodas. Higher educational facilities are provided by the University of Mandalay (formerly University college affiliated to Rangoon university and raised to university status in 1958), a training college for teachers, a technical institute and a school of fine arts, music and drama. Trains run from Mandalay to Rangoon, to Myitkyina and to Lashio, the beginning of the Burma road to China. Steamers ply up and down the Irrawaddy.

MANDALAY DISTRICT has an area of 2,113 sq.mi. and a population (1962 est.) of 499,865. About 600 sq.mi. of land along the Irrawaddy are flat and nearly all cultivated. In the north and east there are hills and plateaus (1,500 sq.mi.) forming geographically a portion of the Shan plateau. This part of the district is well wooded and watered. The Maymyo (*q.v.*) subdivision has plateaus with an altitude of 3,000–3,600 ft. The Myitnge and Madaya drain from the Shan state, and are navigable for between 20 and 30 mi. of their plains course. Mingun, a village on the banks of the Irrawaddy about 7 mi. N. of Mandalay, has one of the world's largest ringing bells—weighing about 90 tons.

The Sagyin hills near Madaya are noted for their alabaster, which is carved into statues of Buddha in Mandalay. On the plains the climate is dry and healthful, the rainfall averaging about 30 in. Considerable areas are irrigated for agriculture. The hilly eastern tracts have a heavier rainfall—about 60 in.—and are forested. The extremes of temperature on the plains are considerable, ranging from 13° C. (55° F.) in December to 43° C. (110° F.) in July. The climate is typical of the centre of Burma's dry belt.

MANDALAY DIVISION in 1958 included the districts of Mandalay, Kyaukse, Meiktila, Myingyan and Yamethin, with an area of 13,225 sq.mi. and an estimated population in 1962 of 2,543,401. (L. D. S.)

MANDAMUS, WRIT OF, originally a formal order of high prerogative issued by the crown commanding an official to

perform a specific act within the duty of his office (Lat. *mandamus*, "we command"). It later became a judicial writ issuing from the court of king's bench in the name of the king at the request of individual suitors whose interests were alleged to be adversely affected by the failure of an official to act as his duty required.

It is not awarded as a matter of right but rather at the discretion of the court, and, although classified as a legal remedy, it is largely controlled by equitable principles. It is not ordinarily granted where an alternative remedy is available and, it is said, never where the official to whom it would be directed has legal discretion to perform the act demanded or to abstain from doing so.

In both England and the United States mandamus is used by courts of superior jurisdiction to compel the performance of a specific act refused by a lower court, such as the hearing of a case falling within the latter's authority. *See* PRACTICE AND PROCEDURE; APPEAL. (P. B. K.)

MANDAN, a Siouan tribe classified as village Indians along with the culturally and historically related Hidatsa and the Arikara (*qq.v.*) in the U.S. central plains. Said to number about 1,250 in 1804, they were reported reduced to less than 150 in 1837, largely due to smallpox. Because of loss of Mandan tribal identity among the Hidatsa, modern population estimates for them have varied; however, in the 1960s the total Indian population reported on the Fort Berthold, N.D., lands shared by Mandan, Arikara and Gros Ventres was 1,826. Their language allies the Mandan with the Winnebago, consistent with a vague tradition suggesting they once lived farther east. At one time theories were offered deriving them from the Ohio mound builders and even from the Welsh of the British Isles. Anthropologists have rejected these as fantastic.

In the 19th century the Mandan lived in dome-shaped, earth-covered lodges clustered in stockaded villages; they planted maize, beans, pumpkin and sunflower, hunted buffalo seasonally and made pottery. They had an origin myth of emergence from the lower world by climbing the roots of a grapevine; they treasured a sacred palladium in an ark and performed distinctive ceremonies that involved Plains elements. Mandan culture thus had eastern or southeastern affiliations; its drift in the historic period was upward along the Missouri river. They were called tattooed people in the sign language, and occasionally tattooed themselves on the left arm and chest. Traditionally, a Mandan man could practice polygamy, being entitled to marry his wife's younger sisters.

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(A. L. K.; X.)

MANDARIN, the common name for all public officials in imperial China, the Chinese name for whom is *kuan*. The word comes through the Portuguese from Malay *mantri*, a counselor or minister of state. With the passing of the old order in China the term, as applied to officials, went out of use.

The words "mandarin language" remained in use, though inappropriately so. Originally the term was used to describe the language as spoken in the capital city of Peking and, with local variations, in most parts of China away from the coast. The proper name is the national language, or *kuo-yü*, taught all over the country.

The mandarin duck (*yüan-yang*) is so described because of its bright, variegated plumage like the dress of the mandarins in imperial China.

The mandarin orange (*kan*) is so called because of its resemblance in colour, shape and size to the large button perched on the hat of those high officials, or very likely because of the similarity in colour to the brilliant yellow of their silk robes.
(L. M. L.)

MANDATE refers generally to an authorization to act, but the connotation is different according as the term is used in a political, administrative or legal context. Politically, a mandate is an instruction from a constituency to its elected representative in a legislative body or to a policy enjoined upon the legislature as a whole by the results of an election (*see* REPRESENTATION; ELECTORAL SYSTEMS). Administratively, a mandate is an authoritative command or order, especially an order from a superior to an inferior court, a papal ordinance dealing with an individual case, or an order from the Roman emperor to a provincial officer. In private law and, by analogy, in international law the term refers to an authorization by one person or one nation to act for another. In Roman law it is a contract constituted by one person (the *mandatarius*) promising to do something gratuitously at the request of another (the *mandator*), who undertakes to indemnify him against loss.

The essentials and the terminology of the contract are preserved in most modern systems; but in English law, mandate, under that name, can hardly be said to exist as a separate form of contract. To some extent the law of *mandatum* corresponds to the law of principal and agent. "Mandate" is retained to signify the contract more generally known as gratuitous bailment. It is restricted to personal property, and it implies the delivery of something to the bailee, both of which conditions are unknown in the *mandatum* of the civil law (*see* BAILMENT).

Mandate System of the League of Nations.—The treaty of Versailles set up various conditions for the administration of the former overseas possessions of Germany and Turkey, under which mandatory powers were selected by the supreme council of the Allies to administer the territories under mandate. This system was a novel experiment in the relations between a sovereign state and a country under its control, involving new departures in international law. It was created by art. 22 of the covenant of the League of Nations, which formed part of the treaty of Versailles, and thus gained the recognition of all states that were members of the League. Upon formation of the United Nations in 1945, the mandate system was superseded by the trusteeship system, and most of the mandated territories became trust territories. (*See* TRUSTEESHIP SYSTEM.)

In its origin the mandate system was in the nature of a compromise. After World War I the victorious Allies naturally wished to retain the German and Turkish colonies, in the conquest of which they had in most cases made great sacrifices. Pledges had been made to the native inhabitants, some of whom had taken part with the victors in the fighting, that they should not be handed over to the vengeance of their former masters; and finally, a misgiving existed lest, in case of rendition, Germany might use them as recruiting grounds for native armies, and their ports as bases for submarines in a future war. On the other hand, the Allies had declared (more particularly in the pre-Armistice statement of Nov. 5, 1918) that annexation of territory was not their aim in the war.

International control of some kind was the only alternative. Joint administration was believed to be impracticable and opposed to the interests of the people. Even as a condominium between two powers only, it had given rise to friction in Egypt, Samoa and the New Hebrides. The only other course lay in the appointment of an individual power in whom could be vested responsibility for the administration of each separate territory as an agent or mandatory of the League. For this course there were analogies in the delegation of quasi-sovereign powers to British and Dutch chartered companies and in the control of the Ionian Isles on behalf of the powers by Great Britain in 1815, and of Morocco by France under the Algeciras treaty of 1906. Individuals also had been appointed as mandatories of the powers, as when King Leopold II of Belgium undertook control of the International Free State of the Congo, and when Prince George of Greece was made governor of Crete in 1898.

The main defect of these delegations of sovereignty was that they provided no machinery to ensure the due execution of the trust, and it was the distinctive feature of the mandate system that it attempted to remedy this defect. The League of Nations afforded just such a supervisory authority as was needed, and its supervision was exercised through the medium of a standing com-

mittee known as the Permanent Mandates commission. The League did not assign the mandates or define their terms or the extent and boundaries of the territories. These were determined by the supreme council and confirmed by the League council, which had authority under the covenant to define "the degree of authority, control or administration to be exercised by the mandatory if not previously agreed on by the members of the League."

The United States, not being a member of the League, was no party to this arrangement, but it insisted that as an associated power its consent was necessary. The mandates therefore were submitted to the United States and approved on condition that "free and equal treatment in law and in fact was secured to the commerce of all nations." The United States negotiated separate treaties with most of the mandatories securing its interests.

Terms of the Mandates.—The mandates were framed to give expression in detail to the principles embodied in art. 22 of the covenant; and since that article prescribed that their character must vary with the varying conditions of each territory, they were divided into three classes to correspond with the three paragraphs of that article.

Class A included the former Turkish vilayets of Iraq, Palestine and Syria, whose independence was to be provisionally recognized until they were able to stand alone. The two former were assigned to Great Britain, the latter to France. These mandates came to an end through recognition of the independence of Iraq in 1932, of Syria and Lebanon in 1941, of Trans-Jordan in 1946, and of Israel in 1948. The last two comprised the Palestine mandate.

Class B comprised the former German central African colonies —Togoland, Cameroons, Tanganyika and Ruanda-Urundi—in which the mandatory was responsible for the administration and undertook to promote the moral and material welfare of the people. Tanganyika and a small part of the Cameroons and Togo fell to Great Britain, the major portions of the latter two being assigned to France, while Belgium became responsible for Ruanda-Urundi. These territories all became trusteeships under the United Nations, with the same administering powers. In 1956 British Togoland was, with approval of the United Nations following a plebiscite, joined to the Gold Coast, which soon became the independent state of Ghana. French Togoland became an autonomous republic within the French Union in 1956 and was proclaimed an independent republic in 1960. Tanganyika attained independence in 1961 and Ruanda-Urundi (as Rwanda and Burundi) in 1962.

Class C territories included those which could "best be administered under the laws of the mandatory as integral portions of its territories, subject to the safeguards in the interests of the indigenous population" which were laid down for class B. The territories were South West Africa, Samoa, New Guinea, the islands north of the equator in the west Pacific and the tiny island of Nauru. For these, respectively, the Union of South Africa, New Zealand, Australia, Japan and Great Britain accepted mandates. Western Samoa attained independence on Jan. 1, 1962.

In the case of Nauru, in July 1919 (before the issue of the mandate) Great Britain, Australia and New Zealand had by agreement jointly acquired control of the phosphate deposits, which constituted the sole value of the island, and they jointly undertook the execution of the mandate. Since, however, the British Commonwealth had no single code of laws, the administration was assigned to Australia.

These territories all became trusteeships under the United Nations except South West Africa. The International Court of Justice held in 1950 that the latter continue under the mandate of South Africa, with supervisory authority vested in the United Nations general assembly. The United States became trustee of the former Japanese mandated islands. The others retained the same administering authorities.

The "safeguards in the interests of the indigenous population" were: (1) freedom of conscience and religion, subject only to the maintenance of public order and morals; (2) prohibition of abuses, such as the arms and liquor traffic and the slave trade; and (3) prevention of fortifications, naval and military bases and the military training of natives except for police and the defense of the territory.

After acceptance by each mandatory, the mandates were confirmed by the League council, which was charged with seeing that their terms were in accord with the covenant and whose consent was required for any alteration. The A class could not be issued until the treaty of Lausanne came into force (Aug. 1924). The mandate was to be a "sacred trust of civilization" assumed by nations who (*inter alia*) "by reason of their resources can best undertake this responsibility and are willing to accept it." The altruistic nature of this pledge was confirmed in a reply to a German protest. "The Mandatory Powers," said the Allies, "in so far as they may be appointed trustees by the League of Nations, will derive no benefit from such trusteeship." A mandated territory differed from a protectorate in that the protecting power obtained rights over the population and against other powers, whereas a mandatory in its capacity as guardian assumed obligations both toward the population and the League.

League Supervision.—The system differed from such partial precedents as have been cited in that it set up machinery by which the proper execution of the mandate might be assured. This consisted in the unqualified right of supervision vested in the League, which imposed upon each mandatory the obligation to submit an annual report on its administration.

These reports were examined by a permanent mandates commission in the presence of an accredited representative of the mandatory concerned. The commission originally consisted of nine members of the following nationalities: Belgian, British, Dutch, French, Italian, Japanese, Portuguese, Spanish and Swedish. To these a Swiss and a German were later added, and a Norwegian superseded the Swede. The majority were nationals of nonmandatory states. The members were selected "for personal merit and competence" as private individuals, and not as representatives of their respective nations. They were nominated by their governments, but approved and appointed by the League council, and could not hold any office under their government. A representative of the International Labour office attended the sessions and took part in any discussions relative to labour. This international composition negatived any suspicion of bias and gave to the commission the aspect of an impartial tribunal of practical men whose object was to promote co-operation while fearlessly exposing any breach of the covenant. Its functions were purely advisory to the council.

In addition to the annual review of the reports of the mandatories, the commission received any petitions and memorials from inhabitants of the territories and others interested, and these, unless trivial or irrelevant, were forwarded to the mandatory concerned for comments before examination by the commission. The proceedings were conducted in French and English and were generally held in private to facilitate freedom of discussion. Full minutes were printed and given publicity. A permanent secretariat, under a director, collected and circulated all documents of interest concerning mandates and conducted the routine business. The commission met at least twice a year at Geneva; its procedure was governed by rules approved by the council.

The weak point in the system lay in the impossibility of independent verification of statements contained in the reports, which varied in completeness and accuracy. The League council refused to permit the permanent mandates commission to visit the mandated territories or to hear oral petitioners, but the International Court of Justice in 1956 authorized the general assembly committee on South West Africa to hear petitioners from that territory. After Japan's withdrawal from the League in 1933, the reports on its mandate were inadequate. For information not contained in the report, the commission had to rely on those public bodies or individuals who interested themselves in the welfare of native races and on such memorials and petitions as were presented to it. In order to obtain more accurate information, the actual administrators generally appeared as the mandatory's representatives. The only practical means at the disposal of the League for compelling the proper execution of the mandate was the force of public opinion, although in theory the League could transfer a

mandate if the mandatory grossly violated its obligations.

The French mandates in west Africa—unlike the British mandates for portions of the same territories (Cameroons and Togo)—contained a clause to the effect that "troops thus raised" (*i.e.*, for purposes of local defense and police) "may in the event of general war be utilized to repel an attack, or for defense of the territory outside that subject to the mandate." It was difficult to reconcile this clause with the words of the covenant. At the instance of the Mandates commission the British government was willing to go even further than the covenant prescribed, and agree to pledge itself not to enlist the natives of a mandated territory, even though they offered themselves for enlistment outside its frontiers, thus limiting its sovereign rights in adjacent territories not under mandate. The French government declared its willingness to accept the same restriction.

Prevention of Abuses.—The covenant enjoined the "prohibition of abuses such as the slave-trade, the arms traffic and the liquor traffic." Some urged that these words meant the enforcement of total prohibition alike for natives and nonnatives. The mandates, however, only prescribed a "strict *control* over the sale of spirituous liquors." The rights of the natives and the prevention of material advantages to the mandatory were major concerns of the League. To this end financial accounts were carefully scrutinized, as were administrative or customs unions of mandated territories with adjacent colonies of the mandatory.

In the matter of equal commercial opportunity for all nations, the covenant itself failed to fulfill the expectations raised by the pre-Armistice declarations of the Allies. No obligation in this regard was imposed in the C mandates, while in the B class it was restricted to states which were members of the League.

Boundaries.—Another cause of practical difficulty was presented by the fact that in some cases the boundaries of the territories assigned under mandate were not defined. In the case of Iraq this led to an acute dispute with Turkey in regard to the northern boundary. It was eventually settled by the council of the League, advised by a special commission sent to the area. The southern frontiers were the subject of an agreement with the sultan of Nejd, and an Anglo-French agreement determined the frontiers with Syria. The French in northern Syria had similar difficulties with Turkey, to which they ceded Cilicia and later Alexandretta (now Iskenderun). In the Cameroons a joint commission was set up to determine the precise boundaries, while with regard to Ruanda, the mandatory (Belgium) complained that the agreed boundary involved the loss to King Musinga of a considerable part of his territory. The British at once agreed that this area should be restored to him, and the consequent changes in the mandates were approved by the council. In South West Africa a neutral zone had long existed between the German and Portuguese colonies. This was replaced by a precise demarcation embodied in a treaty between the Union of South Africa and Portugal.

Sovereignty.—Wider issues were raised by such questions as the nature and extent of sovereignty exercised by a mandatory and the international status of the inhabitants of a mandated territory. The mandatory was authorized to make and enforce laws, to raise troops, to set up tribunals, to appoint officials and to raise and spend revenues. Sovereignty was not ceded by the treaty of Versailles to the League, but to the "principal allied and associated powers" who were obliged to place the territories under "mandatories on behalf of the League." The highest court in South Africa recorded the opinion that the territories were not ceded at all but placed by Germany at the disposal of the Allies, to be administered under mandate—a status new to international law. (*Rex* v. *Christian*, S.Af. L.R. [1924], App. Div. 101.)

The mandatory's powers were exercised "in its capacity as such." Any action on the part of the mandatory which had for its object (or would ultimately involve) annexation—as for instance the acquisition of large monopolistic rights, or of essential public services—was held to be contrary to the covenant and the mandate.

Juristic opinion differed as to the location of sovereignty in the sense of capacity to change the status of the territories. Arguments were made for the mandatory, the principal allied and associated powers, the mandated communities, the League of Nations and various combinations of these. Opinion tended, however, to accept the theory of ultimate League sovereignty; and practice gave support to this theory, particularly if the United Nations was to be regarded as the successor of the League. Art. 80 of the UN charter recognized that mandated territories remained in *status quo* until changed by appropriate action in accord with that instrument.

Status of Natives.—The status of the indigenous inhabitants of a class B or C mandate territory was the subject of special definition. Since the country was not annexed, its inhabitants did not become the subjects of the mandatory. The formula was therefore adopted by the council that "they should be designated by some form of descriptive title which would identify them as such," viz., as "persons administered or protected under mandate." Art. 327 of the treaty of Versailles stipulated that they should be entitled to the diplomatic protection of the mandatory when outside the mandated territory; individuals could, if they so desired, become naturalized subjects of the mandatory.

The application to mandated territories of special conventions, entered into by a mandatory power, was the subject of investigation and recommendation by the Mandates commission, in order to ensure that "persons protected under mandate" should not be in a less favourable position in regard to their persons and property and their economic interests than the inhabitants of a protectorate or colony. The terms of the covenant contemplated self-government as the natural fruition of the mandate and all of the A class territories achieved that status.

The mandate system for the first time in history accorded international sanction to the principles of "trusteeship," of "tutelage" and of "mandate." The annual report formed an effective means of inviting a popular verdict on the fulfillment of the trust and supervision by the League, constituted a fundamental distinction from annexation, whatever the degree of assimilation to other possessions of the mandatory.

The standards of the covenant came to be regarded as principles of general application and contributed both to the welfare and self-determination of dependent peoples. The mandate system was an acknowledgment of the international responsibility of powers that exercise control of "peoples not yet able to stand by themselves" and a contribution to the peaceful liquidation of "colonialism."

BIBLIOGRAPHY.—The mandates section of the League secretariat issued a *List of Books and Pamphlets Relating to the Mandates System and to Territories Under Mandate;* a bibliography was also prepared by the Royal Colonial Institute. *See* D. P. W. Van Rees, *Les Mandats internationaux* (1927); L. M. Palacios, *Los Mandatos internacionales de la Sociedad de naciones* (1927); Benjamin Gerig, *The Open Door and the Mandates System* (1930); Quincy Wright, *Mandates Under the League of Nations* (1930); H. D. Hall, *Mandates, Dependencies and Trusteeship* (1948). (LU.; Q. W.)

MANDAYA, a pagan Philippine group occupying the mountain area of southeast Mindanao. There was no traditional tribal organization but each district had its headman. To become a leader (*bagani*) and be allowed to wear distinctive red garments a man was required to kill a certain number of enemies. The Mandaya were once regarded as one of the most warlike groups in the Philippines; because of constant warfare, houses were built in trees or set on high piles. A clearing where scanty crops were grown surrounded each settlement. Hunting and the search for jungle products augmented the food supply. By the 1960s Muslim and Christian settlers had developed hemp plantations along the coast. These together with government control did away with most of the intertribal warfare. Both sexes traditionally wore embroidered jackets to which they attached silver disks. A breechcloth completed the male costume, while elaborate wrap-around hemp skirts were worn by women.

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MANDEL, GEORGES (1885–1944), French political leader noted for his hostility to Nazi Germany, was born at Chatou, near Paris, on June 5, 1885. His real name was LOUIS GEORGES ROTH-

SCHILD and he was a member of a prosperous Jewish family, although not connected with the bankers of the same name. In 1904 he became a contributor to Georges Clemenceau's journal *L'Aurore* and greatly impressed *"le Tigre"* who appointed him to his personal staff when he formed his first government (1906–09). Mandel continued to serve Clemenceau in office and opposition alike particularly with his journals, *L'Homme libre* and *L'Homme enchainé* and as the head of his personal staff during his second premiership (1917–20).

Mandel was elected a deputy in 1919, lost his seat in 1924, but served again from 1928 to 1940. He was a conservative, strongly opposed to the social and economic policies of the left but equally opposed to the pro-German policies of many conservatives in the period between World Wars I and II. He was minister of posts in four successive governments (1934–36) and minister of colonies from April 1938 to May 19, 1940, when Paul Reynaud transferred him to the ministry of the interior. The Germans were already advancing into France and Mandel's appointment came too late for him to deal vigorously with traitors. He strongly supported Reynaud's advocacy of continuing to fight from Africa. On becoming premier Marshal Philippe Pétain ordered the arrest of Mandel, but Mandel insisted on seeing Pétain and, in a stormy interview, browbeat him into signing an acknowledgment that he had been mistaken and that Mandel was a true patriot. Mandel was among the political leaders who sailed from Bordeaux on the "Massilia" (June 21) with a view to continuing the war. Arrested in Morocco, he was transported to France and imprisoned at the Château de Chazeron (Sept. 9, 1940). He was among the former ministers arraigned in the Riom trials (Oct. 1941–April 1942). Imprisoned at Le Portalet, he was delivered to the Germans in Nov. 1942. After a stay at the concentration camps of Oranienburg and Buchenwald he was sent back to Paris on July 4, 1944, and shot three days later in the forest of Fontainebleau by order of Joseph Darnand, head of police of the Vichy government.

See P. Coblentz, *Georges Mandel* (1946). (P. W. C.)

MANDELKERN, SOLOMON BEN SIMHAH DOB (1846–1902), Hebrew poet and grammarian best known for his Hebrew-Latin concordance to the Hebrew Bible, was born in Mlinov, Volhynia, Ukraine. He followed his rabbinical studies in Dubno and Wilna (Vilnius) by reading oriental languages at St. Petersburg university. An assistant rabbi at Odessa from 1873, he introduced the sermon in Russian before moving to Leipzig about 1880 where he worked as writer and teacher. He died in Vienna on March 24, 1902.

Although a prolific and gifted Hebrew poet with a vigorous and attractive style, Mandelkern was soon overshadowed by his younger and greater contemporaries. His best poems are contained in two volumes entitled *Shire Sefat 'Eber* (1882 and 1889) while his versions of Byron's *Hebrew Melodies* (published as *Shire Yeshurun*, 1890) are equally successful. He is the author of numerous satires, epigrams and translations from and into Hebrew, Russian and German, as well as a three-volume history of Russia written in Hebrew. His *Hekal ha-Kodesh* or *Veteris Testamenti Concordantiae* (1896), although not without shortcomings, excels all earlier attempts in method and completeness. It includes all verbs, adverbs, prepositions, conjunctions, pronouns and proper names, of which the last two categories as well as the Aramaic words are listed separately at the end. The lengthy note preceding each article or word makes this concordance a valuable contribution to Hebrew lexicography, grammar and syntax, as well as to biblical exegesis. An abridged edition appeared under the title *Tabnit Hekal* (1897). (D. PA.)

MANDER, KAREL VAN (1548–1606), Dutch painter, poet and biographer of painters, was born of a noble family at Meulebeke. He studied under Lucas de Heere, at Ghent, and in 1568–69 under Pieter Vlerick, at Courtrai and Tournai. The next five years he devoted to writing religious plays, for which he painted the scenery. In 1574–77 he studied in Rome, where he made the acquaintance of Bartholomaeus Spranger. On his return journey he passed through Vienna, where he collaborated with Spranger and the sculptor Hans Mont on the triumphal arch for the entry of the emperor Rudolf II. After much wandering he settled at Haarlem, where, with H. Goltzius and C. Cornelisz, he founded a successful academy of painting. His fame is principally based upon a biographical work on the painters of various epochs—a book that has become for the northern countries what G. Vasari's *Lives of the Painters* became for Italy. It was completed in 1603 and published in 1604, in which year Van Mander went to Amsterdam, where he died on Sept. 2, 1606. He translated Virgil's *Bucolics* and *Georgics*.

His *Het Schilderboeck* (1604) was translated into French by H. Hymans (1884) and into German by H. Floerke (1906). The poem in 14 chapters dealing with the technique of painting, which forms the introduction, was used as a source of information by Charles Eastlake in *Materials for a History of Oil Painting* (1847). (R. E. W. J.)

MANDEVILLE, BERNARD DE (1670–1733), the Dutch physician who made his name in England as a satirist and philosopher and won an international reputation with his paradoxical defense of the utility of "vices," was born at Rotterdam, the Netherlands, in Nov. 1670. He was graduated doctor of medicine from Leiden university in March 1691 and started to practise but soon went abroad. Arriving in England to learn the language, he "found the Country and the Manners of it agreeable" and settled in London. In Feb. 1699 he married Ruth Elizabeth Lawrence, by whom he had two children. A physician of repute, he enjoyed the friendship of Sir Hans Sloane and the patronage of Lord Chancellor Macclesfield. Benjamin Franklin found him "a most facetious, entertaining companion." He died at Hackney on Jan. 21, 1733.

Mandeville learned English quickly. His first English works, published in 1703 and 1704, were burlesque paraphrases from La Fontaine and Scarron. In April 1705 he published *The Grumbling Hive: or, Knaves Turn'd Honest*, a satirical allegory in verse, in which he maintained that, though men bewail the vices which render uneasy their prosperity and comfort, nevertheless material civilization is the product of vices gratified and not the work of virtue. He next elaborated this argument in *The Virgin Unmask'd* (1709), ten robust dialogues between two strongly characterized speakers on the manners of fashionable society. In *A Treatise of Hypochondriack and Hysterick Passions* (1711), on nervous and digestive medicine, Mandeville discounts the operations of pure reason in physics and treats scientific hypotheses as having a pragmatic, not an absolute, value. A collection of trifles followed in 1712 and a Whig tract in 1714.

In 1714 Mandeville published the first edition of the work for which he is best known, *The Fable of the Bees*, subtitled *Private Vices, Publick Benefits*. This edition consisted of a preface, the text of *The Grumbling Hive*, an "Enquiry into the Origin of Moral Virtue" and "Remarks" on the poem. An enlarged edition (1723), augmented with a strictly utilitarian essay on "Charity and Charity Schools" and an examination of "The Nature of Society," provoked a long controversy. In 1729, however, Mandeville published *Part II* of the *Fable*, in which he recast the entire argument. Without abandoning his original purpose of diverting his readers, he had discovered a philosophical commitment to his position.

Mandeville adopts a rigoristic definition of virtue, a motive totally selfless and completely rational, in no respect alloyed by passion. This enables him to categorize as equally vicious all human actions, which are all motivated by some self-interest, such as desire for comfort or praise, or pride. Yet while the motives must be vicious, the results of action are usually beneficial and agreeable to man, producing the comforts of civilization (apart from crimes, which Mandeville distinguished from beneficial vices). These comforts, however, are irreconcilable with the strict virtues of true Christianity. Extreme in his rigorism, discounting the efficacy of divine grace and assuming nothing in man's nature save the ability to survive in the world, Mandeville on the one hand challenged contemporary orthodoxy, which preached Christianity but practised politeness, and on the other developed a psychology related not to abstract ideas but to man's physical environment. More direct than Hobbes or Locke as a psychologist, he approached the utilitarian position more subtly than Bentham was later to do. His economics tended toward complete *laissez-faire* and seem to have had some influence on Adam Smith.

Mandeville's *Fable* went through many editions and had a European vogue. Before the second edition of the *Fable*, however, he had attracted attention in Europe with his *Free Thoughts on Religion, the Church and Natural Happiness* (1720). Later works included *A Modest Defence of Publick Stews* (1724), *An Enquiry into the Causes of the Frequent Executions at Tyburn* (1725), *An Enquiry into the Origin of Honour, and the Usefulness of Christianity in War* (1734) and *A Letter to Dion* (1732; on Berkeley's *Alciphron*).

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MANDEVILLE, GEOFFREY DE (d. 1144), earl of Essex, was easily the worst of a number of cruel and lawless barons whose conduct in Stephen's reign made men say openly, according to the Peterborough chronicler, that Christ and his saints slept. A great landowner in Essex and elsewhere, and hereditary constable of the Tower of London, he came to prominence in 1140 when Stephen, who could not dispense with his support against Matilda, made him hereditary earl of Essex, by the earliest charter granting an English earldom extant or even known. When Stephen was captured by Matilda's supporters (Feb. 1141), Geoffrey deserted to her and was granted virtually viceregal powers in Essex. Before the rout of Matilda's force at Winchester (Sept. 1141), Stephen's queen brought Geoffrey back to the royalist side by more concessions, possibly including the viceregal powers in London, Middlesex and Hertfordshire which were formally granted to him by Stephen in Dec. 1141. Arrested at St. Albans for treason against Stephen in 1143, he gave up his offices and castles in return for his freedom and went off to plunder the fenland, using Ramsey abbey, which he fortified, as headquarters. It was here that his atrocities became a byword. Stephen besieged him in vain, but in Aug. 1144 he was mortally wounded by a chance shot while laying siege to Burwell, and he died at Mildenhall, Suffolk, on Sept. 16. As he had died unabsolved and excommunicate, his body, at first removed to the Old Temple in Holborn, was given Christian burial only in 1163, in the graveyard of the New Temple.

See J. H. Round, *Geoffrey de Mandeville* (1892); R. H. C. Davis, "Geoffrey de Mandeville Reconsidered," *English Historical Review*, vol. lxxix (1964). (G. W. S. B.)

MANDEVILLE, SIR JOHN (fl. 1356), English writer of a fabulous travelers' guidebook, *The Voyage and Travels of Sir John Mandeville, Knight*, generally known as *Mandeville's Travels*. The first part is concerned with routes, and with wonders to be seen in Constantinople, Palestine and Egypt. The longer second part takes the reader "through many diverse lands . . . through Turkey, Armenia the little and the great; through Tartary, Persia, Syria, Arabia . . . through Lybia, Chaldea, and a great part of Ethiopia; through Amazonia, India the less and the more, a great part; and through many other Isles that be about India: where dwell many diverse folks, and of diverse manners and laws, and of diverse shapes of men." The lands described include not only Cathay (or China) but also the realm of Prester John (*q.v.*), the Land of Darkness, the Valley of Devils and the abode of the ten lost tribes of Israel imprisoned by Alexander the Great in the Caspian mountains.

During the Renaissance the author was famous as the greatest traveler of the middle ages, and also as the greatest liar. Whether he traveled at all is not certain, for he selected his materials almost entirely from the encyclopaedias and travel-books available to him. The first part follows the itinerary of William of Boldensele, a renegade German friar, who wrote in 1336. The second part follows that of Odoric of Pordenone, or Forli Julii, who wrote his *Itinerarius* or *De Rebus Incognitis* about 1330. These itineraries Mandeville prunes of the trivial and the dull, enriching them instead with accounts of the history, customs, religions and legends of the regions traversed, culled from his remarkably wide reading. A few details of names and distances in the first part may come from personal experience.

The tremendous popularity of this book about the wonders of strange lands caused many manuscript copies to be made (about 250 are extant), and many copyists tampered with the text. Wonders were added, numbers and unfamiliar names were misread, and reactions and translations multiplied. There are three French versions, two German, four English, four Latin, two Spanish, an Italian, a Dutch, a Danish, a Czech and a Gaelic translation. The earliest manuscript in English represents the author as saying that he wrote his book in three languages, Latin, French and English. This translation was made, however, from a slightly corrupt text which the translator followed blindly, making absurd blunders.

Authorship.—All that is known about Mandeville is that he states (in the Anglo-French current in England in the 14th century) that his name is "Johan Maundeville, chevaler," that he was born and educated in the town of St. Albans and that he began his travels on Michaelmas day (Sept. 29), 1322. Again, at the end of the book, he says that his name is "Johan Maundeville," that he set out in 1322 and passed through many lands and has now come home to rest, against his will, because of arthritic gout (*goutes artetikes*), and for solace in his enforced rest he has compiled and put in writing the account of his travels, as he remembers them, in the year 1356, the 34th year after he set out. "Mandeville" was a common surname in 14th-century England, especially in Essex and around St. Albans. Several John Mandevilles are recorded, any one of whom may have been the author.

The tradition that Sir John Mandeville became a doctor, practised at Liège as Jean de Bourgogne, wrote his *Travels* there and was buried there, is entirely fictitious; but it persisted from the 14th to the mid-20th century and so its refutation forms a necessary part of any account of the real author. Study of the French manuscripts, their distribution and corruption, shows that the most consistent and least corrupt is the Anglo-French version, which was clearly written in England where most of the surviving copies of this text have been preserved. The earliest manuscript of this version, although not the author's holograph, is the best text because in it the many names, especially of places and people, are least corrupt; and the simple, direct, modest style of the author is clear and consistent. A redaction of this original into the French of Paris was made before 1371, when it was copied for the library of Charles V. This redaction adds a long passage to the account of the Valley of Devils, and for Mandeville's explanation of the seven climates it substitutes a paragraph on the antipodes which rephrases what the original had already said. Spelling and word order are altered in the direction of Parisian French, and there are differences in details, including a change in the date of writing from 1356 to 1357. Sometime before 1396 a copy of this Paris redaction came into the hands of Jean d'Outremeuse (1338–1400) of Liège, a writer of verse romances, of a lapidary, and of a fictionized world chronicle, *Ly Myreur des Histors*. He used the *Travels* to create, in his *Myreur*, a series of eastern conquests for his favourite hero, Ogier le Danois (Ogier the Dane, *q.v.*). He also made a redaction of the *Travels* in the French of Liège, inserting into it a parallel set of references to the conquests of Ogier. He further enlarged his redaction by adding four "books": ii, of the shape of the earth; iii, of the heavens; iv, of herbs; and v, of precious stones. Besides many lesser additions to the text of the *Travels*, this version has a passage added at the end which represents Mandeville as saying that on the way home he was ill in Liège where he was visited by a venerable physician, Master Jean de Bourgogne, called à la Barbe, who recognized him because they had met previously at the court of the sultan of Egypt. The doctor persuaded Mandeville to write the *Travels*. The most complete exemplar of this version is manuscript No. 699 in the Musée Condé at Chantilly. A copy lacking the four additional books was made at Liège in 1396. The story of the meeting of the doctor and Mandeville at Liège was given wide currency and the authority of a learned language by a Latin abbreviation of this Liège redaction, which dates the meeting in Liège as 1355.

Not content with this attempt to claim the *Travels* for Liège,

Jean d'Outremeuse, in the fourth book of his *Myreur des Histors,* asserts that Jean de Bourgogne was really Sir John Mandeville. In a passage preserved in an excerpt, he says that the doctor, Jean de Bourgogne, died in 1372, and that on his deathbed he confessed to his friend and executor, Jean d'Outremeuse, that he was really Sir John Mandeville, knight, earl of Montfort in England, and lord of the isle of Campdi and of the château Pèrouse; that he had had the misfortune to kill a count in England, and had engaged himself to travel through three parts of the world, arriving at Liège in 1343. He was buried in the church of the Guillemins.

The château Pèrouse, near Rennes in Brittany, belonged to the French counts of Montfort about whom d'Outremeuse romances extensively, but no Mandeville was ever a count of Montfort. The "isle of Campdi" or "Comperdi" has not been definitely identified, but Jean de Bourgogne was a famous physician who owned property in Liège. In his *De Pestilentia* (1365) he states that he is a citizen of Liège and has practised medicine for 40 years. Since d'Outremeuse was a clerk and notary, he may well have been the executor of the doctor's estate and have written his epitaph. At any rate his story that Jean de Bourgogne was Sir John Mandeville was inscribed in stone in the church of the Guillemins. The stone has been destroyed but several visitors to the church, in the 15th and 16th centuries, report that it read, in Latin, to this effect: "Here lies the noble master John de Mandeville, knight, otherwise called ad Barbam, master of Comperdi, professor of medicine and most devout in prayer, and most liberal giver of his goods to the poor, who traveled over the whole world. He ended his life at Liège in 1372." This epitaph neatly combines what was known about the doctor with d'Outremeuse's fiction about Sir John Mandeville, but proof that this is fiction and not fact comes from examination of the manuscripts of the *Travels.* The Liège version is not the original text but the most corrupt of the three versions. Moreover, it was not made from the Anglo-French original but from the Paris redaction. It is therefore at two removes from the original. It is hardly possible to suppose that the Anglo-French text was written by a man who had been living at Liège for 30 years, or that it was written at Liège and yet was unknown there.

Spurious Works.—A lapidary in French was attributed to Sir John Mandeville in the 15th century. It is spurious and may be another fiction of d'Outremeuse, but it is not the same as the lapidary which he used to make book v of his version of the *Travels.* It does not correspond to any part of the huge *Trésorier de philosophie naturelle des pierres précieuses* compiled by d'Outremeuse and dated 1390. There are, however, in the *Trésorier* several quotations from a Latin lapidary which d'Outremeuse attributes to Sir John Mandeville. There also the author makes the claim that he has some precious stones which he bought from Sir John Mandeville. Other spurious works attributed to Mandeville in the 15th century include a life of St. Alban of Germany, a dedication to Edward III of England, a Latin letter purporting to be from the sultan of Egypt to the pope about the state of Christendom, all added to the *Travels* by Anglo-French copyists, and some medical and alchemical recipes probably attributed to Mandeville under the influence of the de Bourgogne legend.

Literary Genius and Reputation.—Mandeville was a literary genius who selected the best marvels from the narratives of genuine travelers and embellished them with additions from wide reading in the encyclopaedias, romances and legends of his day, transforming and vivifying them by his literary skill and genuine creative imagination. He wrote the first romance of travel in modern times.

He cast his materials in the mold of first person narrative and created for himself the character of a simple, honest, open-eyed observer who "would not have believed it if he had not seen it himself." He prefers natural explanations to miracles and gives a tone of modest matter-of-fact to the wildest tales, as when he says of the Fountain of Youth. "I have drunken thereof three or four times, and yet methinketh I fare the better." He knows how to select his materials to give sense impressions of taste, feel and smell. Like the later voyagers, he compares the strange with the familiar. He shows a sympathetic interest in strange peoples and attempts to understand their religious beliefs and customs. He is always tolerant, charitable and reasonable.

His explanation of the roundness of the earth and confident assertion that it could be sailed around, re-enforced by a story of a man who had actually done it twice, once in each direction, was known to Columbus and encouraged his companions. But in the age of exploration Mandeville lost his reputation as a truthful traveler and gained one as the greatest liar. However, when printing began in England an abbreviated English version of the *Travels* became a popular book, later adopted by children and remaining in print throughout the 17th century and beyond. Eighteenth-century interest in the history of the English language produced an edition (1725, often reprinted), of the oldest English translation of the *Travels* to which Dr. Johnson gave high praise in his *Dictionary* (1755). Today the work is chiefly of linguistic, literary and antiquarian interest, although it remains a delightfully readable book, valuable for its revelation of the mind and character of its author.

BIBLIOGRAPHY.—J. W. Bennett, *The Rediscovery of Sir John Mandeville* (1954) classifies the manuscripts (*c.* 250) and 15th- and 16th-century editions, and also discusses authorship, the Liège legend, the literary quality and the history and influence of the *Travels.*

The first English translation was edited by Paul Hamelius from British Museum Manuscript Cotton Titus C. XVI, for the Early English Text Society, original series 153, 154, as *Mandeville's Travels* (1919). *See* also *The Cotton Manuscript in Modern Spelling,* ed. by A. W. Pollard (1905). A second English translation in British Museum Manuscript Egerton 1982, was edited for the Roxburghe Club (1889) by G. F. Warner, who also prints the best Anglo-Norman text, from British Museum Manuscripts Harley 4383 and Royal 20 B X. The popular English version from the edition of Thomas East (1568) with woodcuts was edited by J. Ashton (1887); *see* J. W. Bennett, "The Woodcut Illustrations in the English Editions of *Mandeville's Travels,*" in *Papers of the Bibliographical Society of America,* 47, pp. 1–11 (1953). The Egerton text in modern spelling; the 1371 text of the Paris redaction; and the fourth translation into English, from Bodleian Manuscript Rawlinson D. 99, were edited by M. Letts for the Hakluyt Society, series II (1953).

For sources *see* Albert Bovenschen, *Die Quellen für die Reisebeschreibung des Johann von Mandeville* (1888), and the editions of Warner and Hamelius. (J. W. BE.)

MANDHATA, also called OMKARJI, a place of Shiva Hindu pilgrimage in the Nimar district of Madhya Pradesh, India, lies partly on the south bank of the Narmada river and partly on an island in the river. The Omkar temple contains one of the 12 great lingas of Shiva; another stands outside the Gauri Somnath temple. All the temples on the island are Shivite, but there are Vaishnava and Jain temples on the north bank, and one of the few Brahman temples on the south.

Mandhata's annual fair was formerly the scene of the self-immolation of devotees who threw themselves from the high cliffs (Birkhala rocks) into the river. The last sacrifice occurred in 1824. (J. B.-P.)

MANDI, a town and district of Himachal Pradesh, India. The town, headquarters of the district, lies 45 mi. N.N.W. of Simla and 2,991 ft. above sea level on the Beas, a mountain torrent crossed by a fine iron bridge. Pop. (1961) 13,034. It is a centre for transfrontier trade with Tibet and Yarkand. Motorable roads link it with Simla and the Kulu valley.

MANDI DISTRICT, before 1948 a princely state, is intersected by two great parallel ranges, with an average height of 5,000 to 7,000 ft. above sea level. Pop. (1961) 384,259. Area 1,523 sq.mi. The valleys are fertile and produce all ordinary grains, besides more valuable crops of rice, maize (corn), sugar cane and tobacco. Rock salt is found, annual production of which is about 4,000 tons. (S. GL.)

MANDINGO (MANDINKA, MANDE), a group of Negro peoples of the Republic of Mali and adjacent parts of western Africa, who speak a language of the Mande-tan group. They are also known as Manding, Mandinga or Mali; Arab historians called them Wangara. They formed the nucleus of the former empire of Mali (*see* MALI, REPUBLIC OF).

The Mandingo are divided into three groups according to their different dialects: the Malinke (*q.v.,* the Mandingo proper), who inhabit the upper reaches of the Niger, Senegal, Casamance and Gambia rivers; the Bambara (*q.v.*) who are found in places along the Niger around Bamako; the Diula (Dioula), who are a trading

people scattered in the southern regions. In the 1960s the groups numbered about 2,800,000, of which 1,500,000 were Malinke and 800,000–1,100,000 were Bambara. Linguistically the Mande-tan group also includes the Kasonke and the Soninke (Sarakole) in the north and the Koranko, the Kono and the Vai (*q.v.*) in the south. The Mande-fu group includes many tribes of Guinea, Sierra Leone and Ivory Coast (Susu, Mende, Kweni [*qq.v.*], Toma, Guerze, and Mano).

The Mandingo live mainly by cultivating millet, through burning and hoeing; cattle are used for sacrifices and in trade. Artisans (blacksmiths, potters, wood and leather workers) and *griots* (chroniclers and praisers) form separate castes which are little respected. Huts are usually round, with clay walls and straw roofs. An extended family, of paternal descent, occupies an enclosed area, under the leadership of the oldest member, villages and cantons having hereditary chiefs who are assisted by councils. Circumcision and excision are practised. Age groups and secret societies (Komo) extend throughout the whole society and "joking relationships" unite different groups. The Diula and a large number of the Malinke are Muslims. The pagans, in particular the Bambara, have a very rich cosmogony; feasts, the cult of the dead and divination are of great importance. By mid-20th century Islam had made considerable progress because of the splitting up of large families because of the monetary economy. *See* also AFRICA: *Ethnography (Anthropology)*: *West Africa;* AFRICAN LANGUAGES; GAMBIA; GUINEA, REPUBLIC OF; IVORY COAST, REPUBLIC OF; PORTUGUESE GUINEA; SENEGAL, REPUBLIC OF; SIERRA LEONE.

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MANDLA, a town and district of Madhya Pradesh, India. The town, formerly the capital of the Garh-Mandla Gond rajas and now the district headquarters, lies on the Narmada river, 45 mi. S.E. of Jabalpur. Pop. (1961) 19,416. The Rani Durgavati Mahavidyalaya (college) is affiliated to Saugar university. The town is notable for the manufacture of bell-metal vessels. It is the terminus of the branch railway line from Nainpur Junction (26 mi. S.W.), and main roads radiate in all directions.

MANDLA DISTRICT lies on the plateau of the central Satpura range. About 60% of the 1961 population of 684,503 were aboriginal tribes. The Narmada flows through the centre, receiving several tributaries which rise in the Maikal range, part of the great watershed between eastern and western India. The chief crops are wheat, rice and millet. The large forest area includes some sal forests and fine grazing land on the plateau. Big game is found in the Kanha National park. There is some export of food grains and oilseeds, and a larger export of timber and forest produce. The palace of the Gond rajas, built in 1633, is at Ramnagar, 10 mi. E. of Mandla town. (D. G. NA.)

MANDOLIN, a small stringed instrument, remotely derived from the lute (*q.v.*). The earlier "Milanese" mandolin was in effect a miniature, rather deep-bodied lute with either five or six courses of strings, played with a plectrum. It had the usual lute characteristics of a tension bridge glued to the flat table, the fingerboard flush with the front plane of the instrument and a violin-type pegbox and tuning pegs. The frets were fixed, however, and were either of ivory or metal.

The instrument as known and played in the 20th century owes its exact form and proportions to the maker Pasquale Vinaccia of Naples (1806–82). This "Neapolitan" mandolin has four pairs of steel strings tuned at violin pitch in fifths. The body is deeply vaulted and pear shaped. The fingerboard is slightly raised and is continued down from the neck to the border of the oval sound hole in the upper part of the belly, and carries 17 fixed metal frets. The table of the mandolin is reflexed downward at its widest part, forming an angle upon which the bridge is set. The strings pass over the bridge and are attached to a metal plate at the bottom of the instrument. Thus the cutaway table has the effect of increasing the pressure of the strings on the bridge, over which they pass at a marked angle, giving the instrument a brilliant soprano tone of great carrying power. Tuning is effected by a machine head.

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MODERN ROUND-BACKED NEAPOLITAN MANDOLIN

A characteristic feature of the plectrum technique of the mandolin is the tremolo, obtained by the rapid oscillation of the plectrum across a unison pair of strings for the duration of the written note. In expert hands this has almost the effect of a sustained sound. The table usually has a tortoiseshell plate below the striking position to protect it from damage by the plectrum. (E. HA.)

MANDRAKE (*Mandragora officinarum*), a plant of the potato family (Solanaceae) and a native of the Mediterranean region. It has a short stem bearing a tuft of ovate flowers, with a thick fleshy and often forked root. The flowers are solitary, with a purple, bell-shaped corolla; the fruit is a fleshy orange-coloured berry. The mandrake has been long known for its poisonous properties and supposed virtues. It acts as an emetic, purgative and narcotic, and was much esteemed in old times; but, except in Africa and the east, where it is used as a narcotic and antispasmodic, it has fallen into disrepute. In ancient times it was used as a narcotic to diminish sensibility under surgical operations and was believed to have certain magical powers. Its forked root, depicted as resembling the human form, was thought to be in the power of dark earth spirits. The plant could be safely uprooted only by moonlight, after appropriate prayer and ritual, by means of a black dog attached to the mandrake by a cord. Human hands were not to come in contact with the plant's destructive properties. In medieval times it was thought that as the mandrake was pulled from the ground it uttered a shriek that killed or made mad those who did not block their ears against it. (Shakespeare alludes to this belief in *Romeo and Juliet.*) Once the plant was freed from the earth it could be used for beneficent purposes such as healing, inducing love, facilitating pregnancy and providing soothing sleep. Mandrakes are twice mentioned in the Old Testament (Gen. xxx, 14–16, S. of Sol. vii, 13) and thus received allegorical treatment from the Church Fathers and in the *Physiologus.*

The North American May apple (*q.v.*) is known also as mandrake.

See H. Rahner, *Greek Myths and Christian Mystery*, pp. 233–277 (1963).

MANDRILL, one of the most grotesque and colourful of old world monkeys, is usually grouped with the related drill in the genus *Mandrillus* (sometimes grouped with the baboons in the genus *Papio*). It inhabits the forested country of western Africa. The mandrill (*M. sphinx*) is characterized by a short tail; stout body; prominent brow ridges; small, deeply sunken eyes placed close together; and coloured patches of bare skin (most vivid in the male) on the face and buttocks. The ribbed cheek prominences

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MANDRILL (MANDRILLUS SPHINX)

are bright blue to violet, the bridge and end of the nose being scarlet. The buttock pads, pink to crimson, shading to bluish at the sides, vary in intensity of colour. The long fur of the body is olive to brown tending to grayish on the underparts, but the small, pointed beard on the face and the wisps of fur about the neck are light yellow; the eyes are framed in black. The adult male is heavily built, about three feet long including the tail stub; the female, duller in colour, is considerably smaller and lacks the pronounced snout and facial features of the male. Young males have black faces and sombre coloration.

Mandrills feed on fruit, roots, insects, small reptiles and amphibians. They travel in companies or troops that assert territorial rights. Old males, who may become ferocious, are capable of inflicting severe wounds with their inch-long canine teeth; they do not, however, make unprovoked attacks on man or other larger animals. *See* also BABOON; MONKEY; PRIMATES.

MANDSAUR (MANDASOR), a town and district in the Indore division of Madhya Pradesh, India. Pop. (1961) 41,876. The town, formerly in Gwalior state, lies on the bank of the Siwana river, 52 mi. N. of Ratlam on the Khandwa-Ajmer section of the Western railway. It is of considerable antiquity and of historical and archaeological interest. One of the inscriptions on two monolithic sandstone pillars at Sondni near the town refers to the erection of a temple of the sun in A.D. 437. Mandsaur fort was built by Ala ud-din Khilji in the 14th century. The town is situated in the opium-producing area of Madhya Pradesh, and has a sugar factory, a cotton-textile mill and an arts and science college affiliated to the Vikram university.

MANDSAUR DISTRICT (area 3,966 sq.mi.; pop. [1961] 752,085) lies on the Malwa plateau and, except for a range which runs east and west to the north of Neemuch (Nimach), consists of a rich level plain producing jowar (millet), cotton, oilseeds and poppy seeds. On the northern border of the district power generation began from the Gandhi Sagar dam and power station (included in the Chambal valley development project) in 1960. The district is administratively divided into eight *tehsils*. (S. M. A.)

MANDU (MANDOGARH), a ruined city in Dhar district, Madhya Pradesh, India, the ancient capital of the Muslim kingdom of Malwa. The city is 38 mi. S.W. of Indore city, at an elevation of 2,079 ft., and extends for 8 mi. along the crest of the Vindhya mountains. It reached its greatest splendour in the 15th century under Hoshang Shah (1405–34). The circuit of the battlemented wall is nearly 23 mi., enclosing a large number of palaces, mosques and other buildings. The oldest mosque dates from 1405; the finest is the Jami Masjid (1454), a notable example of Pathan architecture, founded by Hoshang Shah. The marble-domed tomb of this ruler is also magnificent.

MANDYA, a town and district of Mysore, India. The town, headquarters of the district, lies about 26 mi. N. of Mysore on the Chamarajnagar-Bangalore railway line. Pop. (1961) 27,275. The Mysore-Bangalore railway also passes through the town. About 10,000 ac. in and around the town are given to sugar-cane cultivation to supply the Mysore sugar factory (established 1932) which has an annual capacity of 24,000 tons of crystal sugar. Alcohol is manufactured from molasses. There is an intermediate college affiliated to Mysore university.

MANDYA DISTRICT (area 1,924 sq.mi.; pop. [1961] 899,210), largely a plain with isolated hills, is drained by the Cauvery (Kaveri) river and its tributaries. A major part of the district is irrigated from the Irwin, now Visweswariah, canal which draws water from the Cauvery near Krishnaraja Sagar dam. Pandavapura in the south has a sugar factory. Srirangapatan (Seringapatam) is of great historic significance, containing the mausoleum of Haider Ali and his son Tipu Sultan. (G. K. GH.)

MANES, the collective name in Latin for the spirits of the dead. It was probably a euphemistic title, meaning "good people." As the ancestral ghosts of a family were respected as minor gods, the inscription *dis manibus,* "[sacred] to the gods below," was frequently placed on Roman tombstones. But this formula had so little religious significance, as there was no serious public cult of the dead, that it was used even on graves of Christians.

See Pauly-Wissowa, *Realencyclopädie,* vol. xiii, col. 1051–60 (1928).

MANET, ÉDOUARD (1832–1883), one of the greatest French painters and engravers, and precursor of the Impressionists, was born in Paris, the son of a magistrate, on Jan. 23, 1832. He studied at the Collège Rollin (1844–48), where he met his future biographer, A. Proust. He is alleged to have already preferred to make drawings from nature than from casts and to have subscribed to the realist doctrine, *il faut être de son temps* ("one must be of one's own day and age"). After seeking entrance to the naval college, he joined the training ship "Guadeloupe," bound for Rio de Janeiro, returning to Le Havre in June 1849. From 1850 to 1856 Manet was a pupil in the studio of T. Couture, where he seems to have been only an intermittent visitor since he made several visits, during these years, to Fontainebleau in France, and to Italy, Austria, Germany, Belgium and Holland. It was in 1859 that he made his first submission to the Salon, a painting, "Buveur d'absinthe" ("Absinthe Drinker"), in which, according to Proust, concessions had been made to the formulas of Couture. It was rejected but in 1861 his entries ("Portrait of the Artist's Parents," related to the style of Gustave Courbet, and "Guitarrero") were accepted, earned an honourable mention and were well received by the critics. In 1862 Manet became a member of the Société des Aquafortistes and in the same year was praised by Charles Baudelaire. In 1863 Manet exhibited at the Galerie Martinet 14 pictures including his latest and most personal work "La Musique aux Tuileries" ("Music in the Tuileries"), (1862); in the same year the Salon des Refusés was opened to all artists who had been rejected at the official Salon, and included three pictures by him, chief among them being "Le déjeuner sur l'herbe" ("Picnic on the Grass"). Both of these exhibitions aroused considerable hostile criticism, but also succeeded in making of Manet a rallying point for the younger painters who were to form the nucleus of the Impressionists. Despite the obvious allusions to traditional themes in the latter painting, it was the realism (the painting of the events and appearances of contemporary life), together with the rejection of customary relationships of colour and tone, that inspired both the hostile criticism and the enthusiasm of the younger painters.

In 1865 Manet exhibited at the Salon "Christ Mocked by Soldiers" and "Olympia," painted in 1863, the latter evoking another storm of abuse. This key work in his development is one in which, having assimilated the lessons to be gleaned from Japanese woodcuts, his preoccupation with the formal qualities of painting is perhaps for the first time clearly evident. In August of the same year he visited Spain primarily to study Velázquez, and one of the earliest pictures executed on his return, "Le Fifre" ("The Fife-Player," rejected at the Salon 1866), represents a combination of the renewed influence of Velázquez (the open atmospheric background), and the lessons of Japanese art (the simplification and intensification of colour and tone and the ornamental character of the silhouette).

On the occasion of the international exhibition in 1867, Manet organized his own exhibition, showing about 50 paintings, but these were hardly received any more favourably than before. During the later 1860s his work was varied in character, but in general it seems to represent a greater concern with close relations of tone, with complexities of illumination and atmosphere, and sometimes exhibits a freedom of handling comparable with that in "La Musique aux Tuileries." "The Execution of Maximilian," of 1867, and "The Folkestone Boat," of 1869, are representative of his work at this time.

During the Franco-German War of 1870 Manet served in the national guard under J. Meissonier, witnessing the siege of Paris and the Commune. In 1872, on a visit to Holland, he was impressed by the work of Frans Hals, and was much influenced by this artist when painting his "Bon Bock," which achieved considerable success when exhibited at the Salon of 1873.

At this time Manet was in intimate contact with all the members of the Impressionist group and during the course of 1874 spent some time at Argenteuil (near Paris) in the company of Monet and Renoir painting directly from the motif, a practice which he seems to have begun a few years earlier. An example of his work done at this time is "The Monet Family in Their Garden

PHOTOGRAPH BY COURTESY OF THE METROPOLITAN MUSEUM OF ART

"ARTIST'S GARDEN AT VERSAILLES," BY ÉDOUARD MANET. IN THE PRIVATE COLLECTION OF MRS. JOHN BARRY RYAN

at Argenteuil." Despite his intimacy with the Impressionists, and their influence upon his work at this time, he refused to participate in their independent exhibitions and continued to send to the Salon. "The Railway" (Salon, 1874) and one Argenteuil picture (Salon, 1875) were both badly received while two were rejected in 1876. At this time critics readily underlined the connection between Manet and the Impressionists even though the character of the works shown did not really justify it. Manet continued to submit to the Salon with very little success until 1880 when his portrait of Proust was fairly well received, but it was not until the following year that he obtained a second-class medal and became thereby free to exhibit as he liked. In 1882 the important "Bar at the Folies-Bergère" was exhibited with some success and in the same year, partly through the machinations of Proust, Manet was nominated *chevalier* of the Legion of Honour. By this time, however, he was seriously ill and he died at Paris on April 30, 1883. In 1884 a large retrospective exhibition was organized at the École des Beaux Arts and it was after this memorial show and after the Manet sale of the same year that the price of his pictures began to rise.

Manet's importance is due first to his insistence upon drawing his subjects from the events and appearances of his own time and upon representing them in attitudes, shapes and relationships of tone and colour which he had seen and considered to be "natural," and secondly, to the importance given to the appearance of the picture as an arrangement of paint areas on a canvas over and above its function as representation.

See PAINTING: *France: 19th Century; see* also references under "Manet, Édouard" in the Index.

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MANETHO (MANETHOS or MANETHON) (fl. *c.* 300 B.C.), an Egyptian priest born at Sebennytus (now Samannud) in the Nile delta, who wrote a history of Egypt in Greek, probably for Ptolemy I (305–282 B.C.). It has not survived except for some fragments of narrative in Josephus' treatise "Against Apion" and tables of dynasties, kings and lengths of reigns in the works of Julius Africanus, Eusebius and George Syncellus. Of these, Africanus' version is the most accurate and that of Syncellus the most complete, though his sources were not free from corruption. The fragments of Manetho's work thus preserved show that it was based on good native sources; these fragments have been of much service to scholars in confirming the succession of kings where the archaeological evidence is inconclusive, and Manetho's division of the rulers of Egypt into 30 dynasties is still accepted (*see* EGYPT: *History;* CHRONOLOGY: *Egyptian*). He also wrote on Egyptian religion and with the Greek Timotheus he advised Ptolemy I on the new cult of Serapis.

See edition of fragments with Eng. trans. by W. G. Waddell in F. E. Robbins, *Ptolemy: Tetrabiblos,* "Loeb Series" (1956), and bibliographies to EGYPT and CHRONOLOGY. (R. O. F.)

MANFALUTI, AL- (MUSTAPHA LUTFI AL-MANFALUTI) (1876–1924), Egyptian essayist and short-story writer and a pioneer of modern Arabic prose, was born in Cairo on Dec. 30, 1876, of a family claiming descent from Husain, grandson of the Prophet. He had the traditional Muslim education, including learning the entire Koran by heart, but he was fascinated by the new learning brought back from the universities of France. It is uncertain whether he learned French. More probably he engaged a translator, but what he read or heard he set to writing in Arabic in an easy flowing style, free from the then fashionable ornamentation of rhyming words, with a lustre not found in journalistic jargon. His collected essays (*Nazarat,* 3 vol., 1902–10; *Mukhtarat,* 1912) and short stories (*'Abarat,* 1946), adapted or translated from French and other sources, opened a new chapter in Arabic prose to which may be traced the more accomplished examples of modern Arabic narrative. He died in Cairo on July 25, 1924.

(A. EL-T.)

MANFRED (1232–1266), king of Sicily, was the natural son of the Holy Roman emperor Frederick II by Bianca Lancia. Frederick, who died in 1250, by his will appointed Manfred vicar for Conrad IV in Italy and Sicily. When Conrad arrived in the Sicilian kingdom (Jan. 1252), Manfred had crushed a rebellion but had also negotiated with Pope Innocent IV with a view to gaining the Sicilian crown for himself. On Conrad's death in 1254, a diet at San Germano deposed his son Conradin's representative, Berthold of Hohenburg, and elected Manfred instead. Excommunicated by the pope, Manfred at first submitted; then, having taken possession of Frederick's Saracen colony of Lucera, he headed a rising which led to the defeat of the papal army. Pope Alexander IV, however, after having excommunicated Manfred again, invested Edmund, son of Henry III of England, with the Sicilian kingdom in April 1255. A papal army entered the kingdom, but Manfred resisted successfully and, on rumours of Conradin's death, was crowned king of Sicily at Palermo on Aug. 10, 1258. As protector of the Italian Ghibellines, he asserted himself also in Lombardy and Tuscany; and he further strengthened his position by the betrothal, in 1260, of his daughter Constance to the infante Peter of Aragon. Negotiations with the new pope, Urban IV, came to nothing; and Urban, considering Alexander IV's agreement with England void, offered the Sicilian crown to Charles of Anjou, who sailed for Rome in May 1265. Manfred, having failed to prevent Charles's army from joining him, was defeated near Benevento on Feb. 26, 1266; he fell in battle.

In internal government, Manfred continued his father's policy, though he could not maintain the same measure of centralization. He shared Frederick's interest in philosophy and science: he revised, and commented on, Frederick's book on falconry and translated, or had translated, the pseudo-Aristotelian *De pomo.*

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MANFREDI, an Italian despotic family which during the later middle ages ruled the town of Faenza and also for a time the town of Imola. Their origin is to be sought among the landed gentry of 11th-century Faenza who subsequently formed the governing class of the early city commune. The Manfredi had risen by the 13th century to leadership of the Guelph faction in Faenza and by the early 14th century to effective leadership of the town, where from 1313 FRANCESCO MANFREDI (d. 1343) appears under the various titles of *capitano, podestà* and *dominus.* The lordship of the Manfredi, however, was neither uncontested nor continuous. In 1328 and 1368 they were dispossessed by the papal governors of Romagna; and, although Francesco's great-grandson ASTORGIO I (d. 1405) was invested with official power as papal vicar in 1379 and 1390, they were driven out again by the papal legate Baldas-

sare Cossa in 1405. Five years later Astorgio's son GIANGALEAZZO (d. 1417) recovered control of Faenza, which the family then continued to rule, despite domestic discord, for the rest of the 15th century. From 1439 to 1471 they also ruled Imola. The most distinguished in the politics and culture of his time was Giangaleazzo's grandson GALEOTTO DI ASTORGIO MANFREDI (1440–88), who patronized humanists and artists and formed a valuable library of books. He died a tragic victim to the jealousy of his wife, Francesca, and to the political ambition of her father, Giovanni II Bentivoglio, who together had him murdered on May 31, 1488. In the few remaining years of Manfredi domination Faenza passed increasingly under foreign influence. Galeotto's young son and heir ASTORGIO III (1485–1502) was thrown from power in 1501 by Cesare Borgia and murdered in Rome in 1502.

BIBLIOGRAPHY.—As well as general histories of Faenza, *see* A. Messeri, *Galeotto Manfredi signore di Faenza* (1904); G. Cencetti and G. Fasoli, "Gli studi storici sulle signorie romagnole," *Atti della Deputazione di storia patria per l'Emilia e la Romagna* (1938–39); G. Donati, *La fine della Signoria dei Manfredi in Faenza* (1938). (P. J. J.)

MANFREDONIA, a town of the province of Foggia, region of Apulia, southeast Italy, is situated at the head of the Gulf of Manfredonia, 38 km. (23 mi.) N.E. of Foggia by road. Pop. (1961) 36,553 (commune). Sheltered by the Gargano peninsula to the northwest, Manfredonia has an equable climate. There are a municipal library and a museum housing many remains from nearby Siponto, especially coins and an important collection of funerary stele. Manfredonia is the terminus of a branch line from Foggia. The chief occupations are agriculture, fishery and commerce. The early 1960s saw the expansion of the tourist industry and the development of a hydraulic works. The Romanesque cathedral of Sta. Maria Maggiore di Siponto (1117) lies 3 km. (2 mi.) S.W. and marks the site of the ancient Sipontum, the harbour of Arpi, conquered by the Romans in 217 B.C. and the site of a Roman colony founded in 195 B.C. The site was abandoned in the 13th century because it had become unhealthy as a result of the proximity of stagnant lagoons. The inhabitants moved to Manfredonia, founded in 1263 by Manfred. Although the town was destroyed by the Turks in 1620, the castle and part of the walls remain.

MANGABEY, a name applied to slender west African monkeys of the genus *Cercocebus,* characterized by their bare, whitish upper eyelids, large cheek pouches and the uniformly coloured hairs of the fur. *See* MONKEY; PRIMATES.

MANGALORE, a seaport on the Malabar coast and headquarters of the South Kanara district, Mysore, India, lies on the backwaters formed by the Netravati and Gurpur rivers, 190 mi. W. of Bangalore. It is the terminus of the west coast line of the Southern railway. Pop. (1961) 142,669. The town has the appearance of being a continuous coconut plantation and presents a remarkable rural picture. It is an important centre of Roman Catholicism and a good percentage of the population are Christians. It is also an educational centre having four colleges, three of which are managed by the Catholics. The Government college and St. Aloysius college (founded by the Jesuits in 1880) are affiliated to Madras university.

Although ships have to anchor three miles out, Mangalore is a seaport with considerable trade, especially for the export of cashew nuts, coffee and sandalwood brought down from Mysore and Coorg, and paddy, areca nuts (betel nuts), coir yarn, fish and cardamoms produced locally. Cotton weaving and tile manufacturing were introduced into the region by members of the German Basel mission in the 19th century, and the town has become an important centre for the manufacture of roofing tiles. Other industries include brick kilns, coffee curing, pottery manufacture, coir weaving and cashew nut peeling. (G. KN.)

MANGAN, JAMES CLARENCE (1803–1849), Irish lyrical poet, was born in Dublin on May 1, 1803, the son of an unsuccessful grocer. At the age of 15 he became a copying clerk in a scrivener's office and remained one for ten years, after which he lived as best he could as a contributor to magazines, though posts were found for him for brief periods in the library of Trinity college, Dublin, and the ordnance survey office. His natural melancholy was aggravated by years of ill-paid drudgery and an acute disappointment in love. He became an opium addict and a chronic drunkard, and the last years of his life were spent in extreme wretchedness. He died of cholera in Dublin on June 20, 1849. Two persons attended his funeral.

Many of his poems are translations from the Irish, from German and from eastern languages, often so free that Mangan is in effect using the original as a vehicle for his own emotions. Often also he described as translations poems that were in fact altogether his own. Much of his work has Irish history and legend for its theme, but in a few poems such as "The Nameless One" and "Twenty Golden Years Ago" he achieves an extraordinary modern note of personal realism and a tragic sincerity of tone.

BIBLIOGRAPHY.—*The Life and Writings of J. C. Mangan* (1897), by D. J. O'Donoghue, who also edited the *Poems* (1903) and *The Prose Writings* (1904). (A. CR.)

MANGANESE, symbol Mn, a hard, brittle metal melting at 1,245° C. (2,273° F.), was first recognized as an element by the great Swedish chemist C. W. Scheele in 1774 while working with pyrolusite, the manganese dioxide ore, and was isolated by his associate, J. G. Gahn, in the same year.

The addition of manganese in the Bessemer steelmaking process, initiated in 1856 by Robert Mushet, made that process a practical success (*see* MANGANESE STEEL). In 1882 Robert Hadfield discovered the high-manganese steels which bear his name. The use of manganese is essential in steel manufacture for deoxidation and the control of sulfur content, and this application accounts for over 90% of the manganese consumed in all forms in the United States. Somewhat less than 13 lb. of manganese, chiefly in the form of ferromanganese, is used for each ton of steel produced, and no substitute exists for it.

Manganese is vital to plant and animal life and is essential to reproduction in animals. While it has been known and commonly used in both alloy and compound form for a long time, it was only introduced to industry in pure form with the development of the electrolytic process for its recovery in the late 1930s. Relatively impure metal, made by aluminothermic (*see* THERMITE) or silicothermic reduction of the oxides, had previously been available, but only with the advent of the very pure electrolytic product was precise and extensive work on the potentialities of manganese made possible. (C. A. HL.)

OCCURRENCE

Manganese is found only in the combined state in the earth's crust, in which it ranks 12th in order of abundance. Its distribution is widespread. There are, for instance, very few if any iron ores that are manganese-free, but, since the majority of iron ores have a manganese content of less than 5%, they are not primary sources of this element.

The type formula and approximate manganese content of the more common minerals are given below. Of those mentioned, easily the most important is pyrolusite (*q.v.*). Wad, of which one variety is "bog manganese," is not strictly a mineral but an earthy mixture of oxides with 3%–25% combined H_2O.

Pyrolusite	MnO_2	63% Mn
Psilomelane	$BaMnMn_8O_{16}(OH)_4$	45%–60% Mn
Wad	Hydrous Mn oxides	Variable
Manganite	$Mn_2O_3{\cdot}H_2O$ (or MnO [OH])	62% Mn
Hausmannite	Mn_3O_4	72% Mn
Braunite	$3Mn_2O_3{\cdot}MnSiO_3$	62% Mn
Rhodochrosite	$MnCO_3$	47% Mn
Rhodonite	$MnSiO_3$	42% Mn

The major sources of ore supplies include the U.S.S.R., India, South Africa, Ghana, Morocco, the U.S. and Japan. Substantial quantities are also exported by Brazil, Cuba, Mexico and Egypt. On a smaller scale deposits are worked in Australia, China, Turkey and central Africa (Angola and the Republic of the [former Belgian] Congo). Western Europe is not completely dependent on imports from overseas, useful deposits existing in Italy, Sweden, Spain and Greece.

Reserves are known in Brazil and Morocco, while Indian production might be expanded if a market for lower grade ores came into being. When difficulties of geographical location and inadequacy of transport are overcome, ore bodies in Bolivia, Ecuador and Uruguay may be exploited.

Annual ore imports into the U.S. are about 2,000,000 tons despite production in several states, especially of rhodochrosite (*q.v.*), and the existence of very extensive low-grade deposits estimated to contain 75,000,000 tons of manganese. Under the direction of the U.S. bureau of mines, the American Iron and Steel institute and many private companies, a vigorous research program has been conducted in order to utilize these domestic reserves at least during periods of national emergency. Another potential source is slag from steel manufacture. On an average this yields 5%–10% manganese. Systematic investigation of the possibility of manganese recovery from such wastes has been pursued both in the U.S. and in Germany. Spiegeleisen, a pig iron containing 15%–30% manganese used in making steel, is produced from the residues left after the extraction of zinc from certain manganiferous zinc ores (*see* FRANKLINITE). (H. D. S.)

USES

Ferroalloys.—More than 95% of the manganese consumed is used in the form of ferroalloys by the metal industries, chiefly for steel manufacture. The predominant type, ferromanganese (78%–82% manganese, 12%–16% iron, 6%–8% carbon, 1% silicon), is made in blast furnaces and, to a lesser extent, in electric furnaces, by reduction of high-grade ores (48% or more manganese) with carbon. Low-carbon grades containing 0.07%–0.75% carbon are made by reduction of ores with ferrosilicon. Other types include spiegeleisen (15%–30% manganese, 6.5% carbon, 1%–3% silicon, balance iron) and silicomanganese (65%–70% manganese, 17%–20% silicon, 1.5% carbon, balance iron). These are used in steelmaking to a lesser extent than standard ferromanganese. In addition to their use in deoxidizing and desulfurizing steel, the ferroalloys are used in the preparation of manganese-containing alloy steels.

Pure Manganese.—The only source of pure manganese is the electrolytic process, and while the tonnage of metal produced is small compared with that used in the form of ferromanganese, it has grown steadily. Following the pioneering work done by S. M. Shelton and co-workers at the U.S. bureau of mines, production on a commercial scale was begun in the United States in 1941. Electrolytic manganese contains 99.9% manganese, and the greater portion, 60%–75%, goes into steel production as an alloying element and purifying agent, where it competes in cost with low-carbon ferromanganese. The balance is consumed in the preparation of nonferrous alloys of copper, aluminum, magnesium and the nickel-base alloys and of chemicals of high purity.

While methods in various plants differ in details, the electrolytic process uses a two-compartment diaphragm cell in which the anolyte contains manganous sulfate, ammonium sulfate and sulfuric acid to give a pH of about 1, and the catholyte is maintained at a pH of 7.2 to 7.6 in the presence of sulfur dioxide. The raw material is high-grade ore or high-manganese slag whose manganese content has been converted to manganous oxide, MnO, by roasting. This material is then leached with the anolyte from the cell, and the solution carefully purified to remove such impurities as iron, arsenic, antimony, tin, lead, nickel, cobalt, molybdenum, silica, aluminum, calcium and magnesium. The leach solution is returned to the cells as catholyte.

The compartmented cell operates with lead-base alloy anodes and stainless steel or Hastelloy C (trade name of Haynes Stellite Co. for alloy containing 14%–19% molybdenum, 4%–8% iron, 12%–16% chromium, 3%–5.5% tungsten, balance nickel) cathodes in the form of thin sheets. Manganese cathode deposits are removed periodically from these sheets by flexing and hammering and are recovered in the form of chips from $\frac{1}{16}$ to $\frac{1}{8}$ in. thick. An impure form of manganese metal, containing 95%–98% of the element, is made by the reduction of manganese oxide with aluminum or ferrosilicon.

Alloys.—Several alloys containing manganese are of commercial importance. One of the ferrous alloys is the iron-chromium-manganese stainless type, where manganese is substituted for nickel (*see* STAINLESS STEEL: *Austenitic Stainless Steels*). These contain 17%–19% chromium, 8%–10% manganese and about 0.1% carbon and have good structural strength and corrosion resistance. Practically all commercial alloys of aluminum and magnesium contain manganese to improve corrosion resistance and mechanical properties. The presence of manganese in titanium improves the strength and workability of this light metal. An extremely high ability to damp vibrations is possessed by binary copper-manganese alloys. The development of alloys of manganese has expanded with the increasing availability of electrolytic manganese (*see* also ALLOYS).

Chemical Applications.—About 50,000 tons per year of high-grade natural manganese dioxide are used in the preparation of dry cells, or primary batteries, where the MnO_2 acts as a depolarizer to react with the hydrogen liberated by the cell reaction. A special crystal structure in addition to chemical purity is required for this purpose. A satisfactory grade is made by electrolysis of manganous sulfate in a sulfuric acid solution. This battery use is the most important nonmetallurgical application of manganese.

Manganese compounds are used in glassmaking to counteract the green colour from iron and for pink and black colouring. Organic compounds, such as the naphthenate, as well as oxides and salts of manganese, are used in paints and varnishes as driers to promote the absorption of oxygen, which causes paints to set. Manganous sulfate, $MnSO_4$, is used alone and admixed with fertilizers to supply trace quantities of this element in agriculture, especially for citrus crops, to stimulate growth and to combat chlorosis in crops grown in certain calcareous and highly organic soils. Manganous chloride, $MnCl_2$, is added in some cases directly to the electrolytic cells producing magnesium in order to add the desired quantity of manganese for the alloying of the magnesium. The powerful oxidizing properties of potassium permanganate are utilized for disinfecting, deodorizing and decolorizing, and this compound is an important analytical reagent.

CHEMICAL AND PHYSICAL PROPERTIES

Chemical Properties.—Manganese, whose atomic number is 25 and atomic weight 54.938, is located in group VIIa of the periodic table, horizontally between chromium and iron. Although somewhat similar to iron in general chemical activity, it can exist in its compounds in the valence states of 1, 2, 3, 4, 6 and 7, the most stable salts being those of the divalent form, and the most stable oxide, the dioxide MnO_2. The lower oxides, MnO and Mn_2O_3, are basic; the higher oxides, acidic. The most stable compounds are those of valence 2, 6 and 7; exemplified, respectively, by the manganous salts, such as $MnCl_2$, $MnSO_4$ and $MnNO_3$; the manganates, such as K_2MnO_4; and the permanganates, such as $KMnO_4$. Divalent manganese is a reducing agent, tetravalent manganese is a good oxidizing agent and heptavalent manganese is a powerful oxidizing agent. The trivalent and hexavalent forms undergo autooxidation and reduction in acid solutions:

$$2Mn^{+3} + 2H_2O \longrightarrow MnO_2 + Mn^{+2} + 4H^+$$
$$3MnO_4^{-2} + 4H^+ \longrightarrow MnO_2 + 2MnO_4^- + 2H_2O$$

These factors make manganese compounds useful for analytical procedures and for a variety of industrial applications.

Manganese metal oxidizes superficially in air and rusts in moist air. It burns in air or oxygen at elevated temperatures, like iron; decomposes water slowly when cold and rapidly on heating, forming manganous hydroxide, $Mn(OH)_2$, with hydrogen evolution; and dissolves readily in dilute mineral acids, with hydrogen evolution and the formation of the corresponding divalent salts.

Fluorine, chlorine and bromine react with manganese when heated. At 1200° C. or over, nitrogen attacks the metal to form the nitride Mn_5N_2, and when heated with ammonia, manganese forms the nitride Mn_3N_2. Manganese reacts with sulfur.

Fused manganese dissolves carbon, as does iron, ultimately forming a carbide, and it reacts with carbon monoxide at temperatures above 330° C. and with carbon dioxide when strongly heated.

Because of its position in the electromotive series, the metal will displace arsenic, antimony, bismuth, tin, lead, copper, iron, nickel, cobalt, cadmium and zinc from solutions of salts of these elements. This property can be used to substitute manganese for zinc as a sacrificial electrode for cathodic protection and corrosion prevention in steel equipment. Boiling, concentrated solutions of potassium or sodium hydroxide have no action on manganese.

Physical Properties of Manganese

Atomic number	25
Atomic weight	54.938
Stable isotope	55

	Alpha	Beta	Gamma	Delta
Density				
Solid, g./cc. at 20° C.	7.44	7.29	7.18	
Liquid, g./cc.		6.54		
Atomic volume, cc./gram-atom		7.4		
Melting point, ° C.		1,244±3		
Boiling point, ° C.		2,097		
Specific heat				
Cal./g. at 25° C. or B.T.U./lb. at 77° F.	0.114	0.154	0.148	0.191
Linear coefficient of thermal expansion				
Per ° C. (0°–100° C.)	22 x 10^{-6}		14 x 10^{-6}	
Per ° F. (32°–212° F.)	12.2 x 10^{-6}		7.8 x 10^{-6}	
Electrical resistivity at 20° C., microhm-cm.	185	44	60	

Latent heat of fusion, cal./g.	63.7
Latent heat of vaporization, cal./g.	977.6
Magnetic susceptibility, 18° C. (cg. units)	9.9 x 10^{-6}
Hardness, Mohs' scale	5.0
Heat of transformation, cal./gram-atom	
Alpha to beta, 727° C.	535
Beta to gamma, 1,100° C.	545
Gamma to delta, 1,138° C.	430
Standard electrode potential, $Mn = Mn^{++} + 2e$	+1.1 volts

Allotropic transition points

From	To	Temperature, ° C.	Condition
Alpha	Beta	727±3	Heating
Beta	Alpha	700–665	Cooling
Beta	Gamma	1,079±3	Heating and cooling
Gamma	Delta	1,140±3	Heating and cooling
Delta	Liquid	1,244±3	Heating and cooling

Physical Properties.—Manganese exists in three, and possibly four, allotropic modifications, the alpha being the one stable at ordinary temperatures. Alpha and beta manganese are hard, brittle metals that will scratch glass. The pure metal cannot be fabricated. Gamma manganese, which changes to alpha at ordinary temperatures, is reported to be flexible and soft and can be bent and easily cut. The alpha form can be transformed to a ductile alloy by the addition of 2% copper and 1% nickel. The physical properties of manganese are listed in the accompanying table.

See also references under "Manganese" in the Index.

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MANGANESE STEEL. In the middle of the 19th century, when Sir Henry Bessemer (*q.v.*) was developing his pneumatic process for converting pig iron into steel, his experiments almost failed. He found that when he used Swedish pig iron, made from high-purity ore and reduced with charcoal, he could produce a usable steel; however, when he tried English pig irons, with higher contents of sulfur and phosphorus, the steel he produced could not be hot-rolled or forged without breaking up. It was hot-short. Fortunately, contemporary experiments by Robert Mushet showed that manganese, added to steel containing sulfur, would prevent this hot-shortness, and steelmaking on a large scale thus became successful. (*See* CONVERTER STEEL.) Since that time, manganese has been the one most essential additive to steels (iron-carbon alloys). In the absence of manganese, the iron sulfide in the steel melts at about 985° C., or 1,805° F., forming an intergranular liquid at hot-rolling temperatures. Manganese converts the sulfur to manganese sulfide, which has a much higher melting point and which remains a plastic solid during hot-rolling or forging and thus cures hot-shortness. When not added for alloying effects the normal manganese content of steel is 0.3% to 0.7%. In resulfurized steels, where sulfur is added to improve machinability, manganese may be increased to 1.5% with a sulfur content of 0.35%.

The term manganese steel often connotes Hadfield's austenitic manganese steel, which contains about 1.25% carbon and from 12% to 14% manganese. The carbon and manganese contents are high enough to cause the transformation from the high-temperature form of iron, austenite, to the low-temperature form, ferrite, to be very sluggish. As a consequence, when this steel is water quenched from a temperature of 1,000° C. (1,800° F.), it remains wholly austenitic at room temperature and is soft and ductile. The austenite is metastable, however, and when the steel is plastically deformed, as by cold working, it transforms rapidly to very hard martensite. (*See* STEELS, ALLOY.) Thus, for very rugged service, as in the rock crushers or railway frogs, it presents a hard, wear-resistant and self-renewing surface over a tough unbreakable core.

Manganese is fully the equivalent of nickel, chromium and molybdenum in promoting hardenability in steel, and it is cheaper. In low-alloy steels that are to be used in the normalized or hot-rolled condition, an increase in carbon will raise the strength, with a sacrifice in ductility, but an increase of manganese strengthens the steel, with no loss of ductility. Popular compositions contain 0.20% to 0.30% carbon and 1.25% to 1.75% manganese. Manganese is seldom used alone, however, because such steels tend to be coarse grained and notch sensitive. If not to be hardened, the grain size is usually refined with small additions of vanadium, titanium or aluminum. When they are to be hardened by water quenching, they often contain 0.2% molybdenum.

The so-called silicomanganese spring steel, containing 0.45% to 0.60% carbon, 1.8% to 2.2% silicon and 0.6% to 0.9% manganese, is really a silicon steel. Nondeforming steels for gauges, master tools, dies, etc., contain 0.80% to 0.90% carbon and 1.5% to 3% manganese and are characterized by their ability to maintain their shape and dimensions through a heat-treating cycle.

The high price and great scarcity of nickel and the production of carbon-free electrolytic manganese spurred the substitution of manganese for part of the nickel in austenitic stainless steels of the 18% chromium, 8% nickel type. Successful steels range from 16% chromium, 16% manganese, 1% nickel with 0.15% nitrogen to 18% chromium, 10% manganese, 4% nickel and 0.15% nitrogen, the latter being almost identical in properties with the 18% chromium, 8% nickel.

See also MANGANESE: *Uses;* IRON AND STEEL INDUSTRY.

(C. E. Ss.)

MANGANITE, a basic manganese oxide mineral, MnO(OH), is an ore of manganese, ranking after pyrolusite and psilomelane (*qq.v.*), to which it readily alters. The colour of manganite is dark steel gray to iron black, and the lustre brilliant and submetallic. The streak is dark reddish-brown, the hardness 4, and the specific gravity 4.33. It is a low-temperature hydrothermal vein mineral, and is chemically similar to lepidocrocite FeO(OH) and boehmite AlO(OH), but has a different structure. Manganite crystallizes in the monoclinic system, but with an angle β of 90°, and hence appears as orthorhombic. The crystals are prismatic and deeply striated parallel to their length; they are often grouped in bundles and in columnar or fibrous masses. There is a perfect cleavage parallel to the side pinacoid. Manganite contains 80.6% MnO; it dissolves in hydrochloric acid with evolution of chlorine. Fine crystals are found at Ilfeld, Harz mountains, Ger., with calcite and barite. It also occurs in England, in Nova Scotia and in the United States, in the Lake Superior iron district. (L. S. RL.)

MANGBETU (MONBUTTU), a Negroid, Sudanic-speaking people of central Africa living to the south of the Azande (*q.v.*) in the Uele district of the Republic of the Congo (formerly the Belgian Congo), where they cultivate chiefly bananas and manioc. They were reported to number more than 1,000,000 in the 1960s. The name Mangbetu refers strictly only to the aristocracy, which in the 19th century established a number of powerful kingdoms, though in looser usage it denotes the whole amalgam of peoples whom they rule. They impressed early travelers with their political institutions and their arts, especially with their remarkable skill as builders, potters and sculptors. Contemporary Mangbetu continue to attract artistic interest with their exquisitely carved knives, wooden containers for honey, statues, musical instruments and jars. They became renowned also for their cannibalism and for their practice of deforming the heads of babies by binding them tightly so that they retained through life a curiously elongated form. The elongation is gracefully shown in a celebrated Mangbetu pottery jar formed as a female head. *See* also AFRICA: *Ethnography (Anthropology): West Central Africa;* AFRICAN

LANGUAGES: *The Macro-Sudanic Family.*

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MANGEL (MANGOLD, MANGEL-WURZEL) is a large type of beet belonging to the species *Beta vulgaris*, which also includes vegetable and sugar beets and Swiss chard. These types interbreed freely. The species probably originated from the wild beet *Beta maritima* and had its principal developmental centre in the eastern Mediterranean region. Mangold, the original name, is German and it has been somewhat modified in use. In France mangels are known as disettes. The mangel root is a store of foodstuffs in the forms of sugar and other carbohydrates. The sugar percentage is approximately 7%–8%, being about half that of sugar beets. The principal use of the crop is to provide a high tonnage of a succulent, nutritious feed for use in livestock, including poultry feeding. As feed for cattle and sheep, mangel roots are highly regarded and being very palatable they are often utilized as a relish for stimulating milk production. They are also considered valuable in conditioning animals for show purposes. Pound for pound the dry matter of mangels is equivalent in feed value to grain. The crop is usually grown in regions too cool or seasons too short for corn and where other conditions, such as soil fertility, soil type and moisture supply, are particularly favourable. Corn as compared with mangels will produce nearly double the yields of dry matter in the regions of its adaptation. Mangels are grown chiefly in northern and coastal western Europe and on the Pacific coast of the United States and Canada.

The plant is a biennial. During the first year of growth the stem remains short and a rosette of large, crisp, prominent-veined leaves arises from it. The upper portion of the primary root becomes large during midsummer and autumn, attaining a diameter of from 4–10 in. and a length of from 6–30 in. The shape of the root is a varietal characteristic. If it remains in place and survives the winter, or if it is properly stored, and transplanted the following spring, tall, angular, branching stems grow to heights of three feet or more and produce inconspicuous flowers and seeds. The flowers are perfect and arranged in dense, sessile clusters, each subtended by a small bract, along an axis. The seeds are embedded in the flower parts and usually several flowers clustered together give rise to the seed ball, from which several seedlings may develop. Five groups of varieties are recognized based upon root shape and colour and leaf colour. Shapes recognized are globular, flattened, cylindrical and fusiform while colours may be white, yellow, orange or red. Zonal coloration may also occur within the root.

Culture.—Like other root plants, the mangel is a row crop. The seed is drilled about 1½ in. deep in rows 24–36 in. apart at a rate of 10–15 lb. per acre. After emergence of the seedlings, cultivation is begun and continued until late summer. When the plants reach the four-leaved stage, they are spaced about 10–14 in. apart in the rows by thinning. Hand hoeing is then begun and the crop is weeded as required. Harvesting is done by mechanically lifting the roots previous to heavy frosts in the fall and removing the tops by cutting. The roots may be stored in large heaps or in covered pits or root cellars. Successful storage is dependent upon careful handling to avoid severe bruising, and also upon good ventilation. The roots may be pulled and fed directly as needed without topping.

The best soils for mangels are rich, well drained and in good cultivation. On more shallow land varieties with shorter roots may be grown. The crop responds markedly to heavy applications of barnyard manure and to potash, phosphate and nitrogen fertilizers. Although mangels are sometimes grown for several years on the same land, they more commonly occupy a place in rotation with grain and forage crops. Requiring careful cultivation and weed control, they leave the soil in excellent condition for succeeding crops.

The principal values of the mangel are its productiveness, yields usually being 20–45 tons per acre, and its succulence. Very few crops will produce as much succulent feed per area. Mangels require much hand labour in thinning, cultivating, harvesting and storage. In corn regions the cost of producing corn ensilage for succulent feed is much less than with mangels or other root crops. Mangels are more drought- and heat-tolerant but more sensitive to frost than are turnips or rutabagas, often grown for similar uses. Also, they are less affected by root maggots and aphids. Important objectives sought in better varieties are high yield of sugar and dry matter, freedom from disease and premature seed-stalk formation (bolting) and smooth, well-shaped roots of good keeping quality. (D. C. SH.)

MANGO, one of the most important and widely cultivated fruits of the tropical world. Its origin is lost in antiquity; according to some authorities, horticultural forms are derived from *Mangifera indica*, of the cashew family (Anacardiaceae), considered indigenous to the region of eastern India, Burma and Assam; but other species, such as *M. laurina*, may have entered into the composition of some, particularly those of the Malayan region.

History.—Few fruits are so inextricably connected with the folklore and religious ceremonies of India as the mango. Buddha himself was presented with a mango grove, that he might find repose in its grateful shade. The economic importance of the mango in ancient times is attested by one of the Sanskrit names, *am*, which has an alternative meaning of provisions or victuals. The Chinese traveler Hwen T'sang, who visited Hindustan between A.D. 632 and 645, was the first person, so far as known, to bring the mango to the attention of the outside world. Friar Jordanus wrote of it in 1328, and Giovanni de Marignolli in 1349. Akbar, the Mogul emperor who reigned at Delhi from 1556 to 1605, planted near Darbhanga the Lakh Bagh, an orchard of 100,000 mango trees. Nothing better attests the esteem in which the fruit has long been held than this immense planting, made at a time when large orchards of fruit trees were almost unknown.

The name mango, by which the fruit is known in English- and Spanish-speaking countries, is derived from the Tamil *man-kay* or *man-gay*, which the Portuguese adopted as *manga* when they settled in western India. Probably because of the difficulty in trans-

BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

FLORIDA MANGO TREE IN FRUIT

porting seeds (they retain their viability a short time only), introduction of the tree into the western hemisphere did not take place until about 1700, when it was planted in Brazil; thence it reached the West Indies about 1740. It has taken on the appearance of a wild species in many parts of tropical America, trees springing up everywhere from seeds scattered by the roadside. During the ripening season, mangos are a major foodstuff wherever grown.

BY COURTESY OF THE SUBTROPICAL EXPERIMENT STATION, UNIVERSITY OF FLORIDA

CLUSTER OF MANGOS

Description.—The tree is evergreen, often reaching large size (50–60 ft.) and attaining great age. It is one of the favourite shade trees of the tropics. The leaves are lanceolate, up to 12 in. long; the flowers, which are small, pinkish and fragrant, are borne in large terminal panicles. They are polygamous, *i.e.*, some have both stamens and pistil, others stamens only. The fruit varies greatly in size and character, as would be expected of a species (or combination of species) that has been in cultivation for a long time. The smallest mangos are no larger than plums, while others may weigh four or even five pounds. The form is oval, round, heart-shaped, kidney-shaped or long and slender. Some varieties are beautifully coloured with shades of red and yellow, while others are dull green. The single large seed is flattened, the flesh that surrounds it yellow to orange in colour, juicy and of delicious spicy flavour. Fryer, writing of mangos in 1673, said "for Taste, the Nectarine, Peach and Apricot fall short." Hamilton, who wrote in 1727, went even further. "The Goa mango," he declared, "is reckoned the largest and most delicious to the taste of any in the world, and I may add, the wholesomest and best tasted of any Fruit in the World." There are ample grounds for considering the mango—as has been done by many writers—the "king of tropical fruits."

Most of the seedlings so abundant throughout the tropics do not represent this fruit at its best. While of good flavour, they are commonly characterized by coarse fibres throughout the flesh, which makes eating them disagreeable. In contrast, the fine grafted varieties that have originated in India and a few other regions, as well as seedlings of the race cultivated in the Philippines and other countries (known as Mangos de Manila in Mexico and Filipinos in Cuba), are almost devoid of fibre and are of excellent quality.

Distribution and Cultivation.—In 1889 the U.S. department of agriculture introduced into Florida the first of the grafted Indian varieties known in the United States—the variety Mulgoba, of superb quality but not highly productive. In subsequent years, mainly through the efforts of the Reasoner brothers and David Fairchild (*q.v.*), more than 50 other choice varieties were taken to the United States, whence the cultivation of several gradually spread to many parts of the American tropics. The British and French also introduced a number into the West Indies. Some of the best imported varieties are Pairi (known in Jamaica as Bombay), Borsha and Amini. In addition to these such varieties as Carabao from the Philippines and Saigon from Cambodia should be mentioned, as well as Julie, which first received horticultural attention in the French West Indies and later became popular in Jamaica.

Because of the failure of many varieties to produce regular and heavy crops of fruit, they have been replaced in commercial orchards by Haden (a seedling of Mulgoba that originated in Florida) and others that have been developed in that state.

Mango trees are injured by a few degrees of frost. They are grown commercially in southern Florida, but were not wholly successful in California, though numerous trees have fruited in that state. The mango is not particular as to soil, but the finer varieties yield good crops only where there is a well-marked dry season to stimulate fruit production rather than vegetative growth. There is another serious problem in rainy areas: a fungous disease known as anthracnose (*Colletotrichum*) which destroys the flowers and young fruits and is expensive to control.

Propagation is by means of grafting or budding. Inarching is widely practised in tropical Asia, but is tedious and relatively expensive. In Florida better methods have been developed and are used commercially. Chief among these are veneer grafting and chip budding. However, seedling trees of the Philippine race usually produce fruit like that of the parent and for this reason are extensively grown in Mexico. This race is polyembryonic, which means that trees usually do not develop from fertilized ovules, but from what are known as nucellar buds arising from the vegetative tissues surrounding the egg cell, hence they are in most respects similar to grafted plants. On the other hand, most of the Indian varieties are monoembryonic, which means that young plants develop only from fertilized ovules and therefore are subject to the variation that is characteristic of cultivated fruit trees in general.

Except with occasional dwarf varieties such as Julie, mangos in commercial plantings are spaced 35 to 45 ft. apart. The tree has a number of enemies, chief among which are the anthracnose disease mentioned above and certain scale insects (family Coccidae). In numerous tropical regions the fruits may be infested by the larvae of fruit flies (family Tephritidae), which render them unfit for human consumption and are difficult to combat.

See L. B. Singh, *The Mango* (1960); W. H. Chandler, *Evergreen Orchards,* 2nd ed., ch. 10 (1958). (W. Po.)

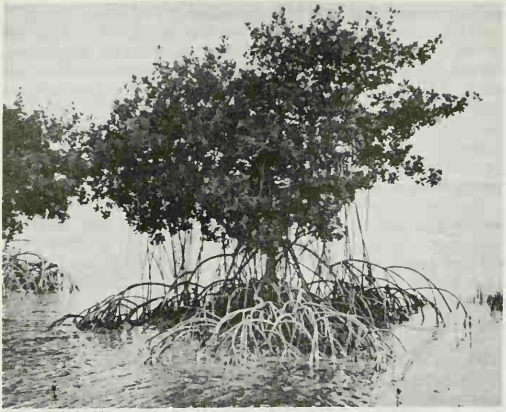
MANGOSTEEN, a beautiful, delicious fruit of tropical southeast Asia, produced by a handsome tree (*Garcinia mangostana*) of the family Guttiferae, which under favourable conditions reaches a height of about 35 ft. It has thick, dark-green, glossy leaves six to ten inches long; the flowers are large, polygamous; the fruits are about three inches in diameter, round to oblate in form, and dark purple in colour. They have thick hard rinds surrounding a large cavity in which lie several segments of snow-white flesh, resembling a mandarin orange; it is juicy, delicate in texture, and of delightful slightly tart flavour.

In spite of the fact that the mangosteen is so highly valued, and that its cultivation in such regions as Java, Sumatra, Indochina and the southern Philippines dates from very early times, the tree has nowhere been planted on an extensive scale, for mangosteens are difficult to ship very long distances. It was introduced into the western hemisphere in the 19th century, where it became established in several of the West Indian islands; it was later established on the mainland; *e.g.*, in Guatemala, Honduras, Panama and Ecuador. It did not prove well adapted to the climates of California and Florida, but has been grown successfully in Hawaii.

For best results the mangosteen needs a rich deep soil and a moist tropical climate, but it will grow under less ideal conditions, though not where temperatures often go below about 40° F. Propagation is by seeds, which do not long retain their viability. Grafting has been unsuccessful and not required, since the embryos develop from tissues surrounding the ovary; hence, being of vegetative origin they produce trees that are as much alike as grafted ones. Occasional trees may yield more than 1,000 fruits; there is a tendency to produce good crops only in alternate years.

See W. H. Chandler, *Evergreen Orchards,* 2nd ed., ch. 13 (1958). (W. Po.)

MANGROVE, generally, the name for tropical and subtropical vegetation forming dense thickets or forests along tidal estuaries, in salt marshes and on muddy coasts and being composed chiefly of shrubs or small trees that produce prop roots. Specifically, the term is applied to the most prominent trees of these floras, species of *Rhizophora* and *Avicennia*. The western man-



RUTHERFORD PLATT

COMMON MANGROVE (RHIZOPHORA MANGLE) SHOWING THE TANGLED ROOT FORMATION

grove flora, along the eastern coast of tropical America and along the Gulf coast to Florida, consists chiefly of the common or red mangrove (*Rhizophora mangle*) of the family Rhizophoraceae, and the black mangrove (*Avicennia nitida* or *marina*) of the Verbenaceae. The eastern mangrove formations of India and the Malay archipelago include also members of other families, such as *Sonneratia* (Lythraceae) and the acaulescent Nipa palm (Palmae).

The trunks and branches of the common mangrove are typical of the growth habit of all mangroves. They constantly produce adventitious roots, which, descending in arched fashion, strike at some distance from the parent stem, and send up new trunks, the forest thus spreading like a banyan (*q.v.*) grove. An advantage in dispersal, very characteristic of the myrtle order to which all families mentioned here belong, is afforded by the seeds, which have a striking peculiarity of germination. While the fruit is still attached to the parent branch the long embryonic root emerges from the seed and grows rapidly downward. When the seed falls the young root is in the right position to be driven into the mud; the plant being thus rooted, the shoot makes its appearance. The young root may grow to such a length that it becomes fixed in the mud before the fruit separates from the parent tree. An interesting feature of the mangrove is the appearance of air roots, erect or kneed branches of the roots, which project above the mud, and are provided with minute openings (lenticels), into which air diffuses; the air then passes through the soft spongy tissue to the roots beneath the mud. The wood of some species is hard and durable; the astringent bark yields a water-soluble tanning substance. The fruit of the common mangrove is sweet and wholesome.

MANHATTAN, a city of northeastern Kansas, U.S., the seat of Riley county, is located on the north fringe of the rolling Flint Hills, at the confluence of the Big Blue and Kansas (Kaw) rivers, 55 mi. W. of Topeka, and 10 mi. E. of Fort Riley, one of the state's beauty spots. The village was founded in 1854 when the settlements of Poleska and Canton were consolidated as Boston. It was renamed Manhattan in 1855 by mutual agreement between the Boston association and a party of colonists from Cincinnati. The city was incorporated in 1857 and adopted the commission-manager form of government in 1951. Manhattan, chiefly an educational centre, is the home of Kansas State University of Agriculture and Applied Science (formerly Bluemont Central college, chartered 1858), one of the first land-grant colleges in the U.S. The city supports a municipal airport, a zoo, several large parks and a recreational program. It is 5 mi. from Tuttle Creek dam. Commercial and industrial activities include insurance, wholesaling, food processing, farm machinery, cut stone and truck farming. For comparative population figures *see* table in KANSAS: *Population.* (A. B. SR.)

MANHATTAN, an island 14 mi. long and 2.3 mi. wide lying between the Hudson and East rivers in the southernmost part of New York state, U.S., is one of the five boroughs comprising New York city and also forms New York county. The borough of Manhattan includes, in addition to the island, a small area on the mainland known as Marble Hill and a number of small islands in the East river—Welfare, Governors, Randalls and Wards. Manhattan is the centre of much of the city's activities and is often mistaken as being synonymous with New York city.

The Dutch West India company founded Manhattan as a trading post and from the beginning finance was among its chief interests. In 1626 Peter Minuit, the first director-general of New Netherland province, is said to have purchased the island from the Brooklyn Indians (Canarsees) with trinkets and cloth valued at 60 guilders (then about $24). The island became the possession of the English in 1664, having already been incorporated as the city of New Amsterdam in 1653. Renamed New York city, it played a prominent role in the early history of the republic, both militarily and politically. It served as the meeting place for congress from 1785 to 1790 and George Washington was inaugurated there in 1789 as the country's first president. In the 19th century, particularly following the opening of the Erie canal in 1825, Manhattan developed rapidly and became the heart of a prosperous and expanding metropolis. In 1898 greater New York was formed when Manhattan was joined with the newly created boroughs of Brooklyn, Queens, Richmond and the Bronx (*qq.v.*).

Manhattan is renowned for its many attractions and points of interest. Among these are Broadway, one of the best-known streets in the world; Wall street, focal point of the financial district; the skyscrapers, such as the Empire State building; Greenwich Village; Central park, extending from 59th to 110th street; the United Nations Headquarters building; and cultural and educational institutions, including the Metropolitan Museum of Art, Metropolitan Opera house, American Museum of Natural History, Hayden planetarium, Columbia university including Barnard college, Hunter college and City College, both operated by the College of the City of New York, and New York university. *See* also NEW YORK (CITY). (D. L. D.)

MANI (MANES or MANICHAEUS) (215/216–274?), the Iranian founder of the Manichaean religion, was born in 215/216 in southern Babylonia, where his father, Patek, a native of Hamadan, had joined a religious community practising baptism and abstinence. Through his mother Mani was related to the Parthian royal family (overthrown in 224). Information about his life appears to derive from his own writings and the traditions of his church. He grew up at his birthplace, speaking a form of eastern Aramaic. Twice, as a boy and young man, he saw in vision an angel, the "Twin," who, the second time, called him to preach a new religion. He traveled to India (probably Sind and Turan) and made converts. Favourably received on his return by the newly crowned Persian king, Shapur I, he was permitted to preach his religion in the Persian empire during that long reign. There is little information about Mani's life in those years. He probably traveled widely in the western parts of the empire, but later traditions that he visited the northeast seem unsound. Under the reign of Bahram I he was attacked by Zoroastrian priests and imprisoned by the king at Gundeshapur (Belapet), where he died after 26 days in captivity in 274 or 277. *See* also MANICHAEISM.

BIBLIOGRAPHY.—H. C. Puech, *Le Manichéisme* (1949), an account of Mani's life, with full references; for the disputed dates of Mani's life, *see* W. B. Henning with G. Haloun, "The Compendium of the Doctrines and Styles of the Teaching of Mani," in *Asia Major,* new series, III, ii (1952), and with S. H. Taqizadeh, "The Dates of Mani's Life," *Asia Major,* VI/i (1957). (MA. B.)

MANIA, a psychiatric term used to designate any abnormal or unusual state of excitement, as in manic phase of manic-depressive psychoses. Normal individuals may from time to time exhibit increased excitement and are said to be mildly manic (hypomanic); if there is an accompanying feeling of well being the state is called euphoria. In popular usage as a suffix, the word

has been the subject of much misunderstanding. Such popular terms as dipsomania, nymphomania and pyromania merely serve as labels for groups of symptoms that may be related to a variety of psychiatric disorders. *See* also PSYCHOLOGY, ABNORMAL: *Abnormalities of Behaviour;* PSYCHOSES: *Psychogenic Psychoses;* EMOTION.

MANICHAEISM, a dualistic Gnostic religion first preached by Mani (*q.v.*) in the 3rd century A.D. Its early centre was Babylonia, then part of the Persian empire and a meeting place of faiths. Mani held that true religion had been taught by many prophets (among them Adam, Enoch, Buddha, Zoroaster, Jesus), but that all earlier religions were restricted in that they were local, taught in one language to one people; and that moreover each had been distorted in time by its adherents, who had lost sight of its original truth. He regarded himself as the "seal of the prophets," the last comer bringing a universal message; and by himself committing his teachings to writing he hoped to preserve them uncorrupted. He encouraged the translation of his writings into other languages and developed a missionary activity within his church which in time carried his teachings from the Atlantic to the Pacific, across the breadth of the ancient world.

History of the Manichaean Church.—Mani in his lifetime established his religion at many places in the Sasanian empire, sending missions within and beyond its borders, of which the following are specifically known: one to Egypt, between 244 and 261, led by Adda; one to Kirkuk (261–262), led by Adda and Abzakhya; and one to Margiana and Bactria, led by Ammo. The centre of the church was in Babylonia.

After Mani's death (274 or 277) the leadership of his church was disputed by Sisinnios and Gabriabos. The former triumphed, and led the community until his martyrdom in 291/292. His successor, Innaios, appears to have won tolerance for the Manichaeans, which lasted until new persecutions under Hormizd II. Little is known of the church in Persia during the remainder of Sasanian rule, except that it endured many bloody persecutions at the hands of the Zoroastrians, and that its main strength gradually became concentrated beyond the Oxus, across the northeastern Persian border. About A.D. 600 the trans-Oxian community claimed independence, under Shad-Ohrmizd, from the Babylonian Leader. Under the name of Denawars they preserved their autonomy until the early 8th century, when this administrative schism was healed, the rule of the Babylonian Leader Mihr (*c.* 710–740) being accepted in central Asia. Denawar literature survives in the Turfan fragments (*see* below).

Meantime, from the 3rd century onward Manichaeism had spread vigorously to the west, into the lands of the Roman empire. From Egypt it reached North Africa (where it was flourishing in the 4th century), and from Syria Asia Minor. It was known in Rome in the early 4th century, and spread to southern Gaul and Spain, where it probably attained its greatest extension in the 5th century. Christian persecution practically eradicated it from these lands in the course of the 6th century, but it survived in the eastern Mediterranean area until the 9th century, finally losing its identity in that of the so-called neo-Manichaean sects such as the Bogomils, Cathari (*qq.v.*) and Albigenses.

In the 7th century the Arab conquest of Persia and Iraq gave the Manichaean community there a brief respite from persecution, and some of the trans-Oxian community returned to their homelands. Under the Abbasids, however, cruel persecutions began again. Nevertheless, the community survived in Baghdad until the 10th century. It had sufficient vigour to maintain until *c.* 880 a schism which arose there in the early 8th century between the followers of Mihr and those of Miklas, concerning the community's way of life (no doctrinal disputes are recorded among Manichaeans). This dispute reached the central Asian communities. In the 10th century relentless Muslim persecution led to the seat of the Manichaean leader being transferred from Babylonia to Samarkand.

From early times the Sogdians of central Asia had been colonizing eastward, in small merchant communities, into what was to become East Turkistan. In 692 the Chinese reopened the great caravan routes, giving a new opportunity for Manichaean proselytizing among these communities. A Manichaean missionary reached the Chinese court in 694, and in 732 an imperial edict permitted its foreign adherents resident in China to practise this religion. As in the west Manichaeism had been reproached with using a cloak of Christianity, so in the east it was regarded as presenting itself as a form of Buddhism.

When East Turkistan was conquered in the 8th century by the Uighur Turks, one of their kaghans adopted Manichaeism (in 763), and it remained the state religion of the Uighur kingdom until its overthrow by the Kirghiz in 840. It probably survived in East Turkistan until the Mongol invasion in the 13th century, maintaining itself most strongly in and around Khoco (Turfan), which remained a petty Uighur principality. In China it was forbidden in 843, but although persecuted it survived there at least till the 14th century.

Doctrine.—Mani taught a strict dualism, affecting spirit and matter. According to him, good and evil are essentially, and originally existentially, separate and opposed principles, which have become mixed in the world through the act of the evil principle. Salvation lies in the release of goodness and a return to the original state of separation. This basic teaching is set out in an elaborate mythology, harmonized from many different elements, formally marshaled in triads, pentads and dodecads, with complex correspondences.

The Myth.—In the beginning the kingdom of Goodness, or Light, stretched unbounded upward and to left and right (or northward and to east and west); below, or southward, stretched endlessly the kingdom of Darkness. The kingdom of Light is ruled by the Father of Greatness, whose being is expressed in terms of the five powers of understanding: *nous, ennoia, phronesis, enthymesis, logismos.* It is inhabited by countless Aeons and Aeons of Aeons, anthropomorphically represented. Twelve Aeons, his "First-born," surround the Father, three to each quarter of the heavens; and a female divinity, the Great Spirit, is, as it were, his consort.

The kingdom of Darkness was divided into five realms, each made up of one of the five dark elements (smoke, devouring fire, tempest, salt water [or poison], darkness). From them grew five Trees, and from the five Trees came the five species of devils: two-legged, four-legged, winged, swimming and crawling. Each species, ruled by a king, was divided into two sexes, and lived in perpetual lust and strife. The lord of hell, the Devil, combines in his own person features of all five kings: demon, lion, eagle, fish and dragon. He is regarded sometimes as the personification of Hyle, the *formatrix corporum*, the *Enthymesis* of Death; sometimes as her highest manifestation. In the realms of hell were found also the five metals and the five tastes.

Mixture of the Two Principles.—The Devil, coming by chance to the boundary between the two realms, saw, desired and invaded the Light. The Father of Greatness, to protect the eternal calm of the Aeons, met the attack through his own emanations, hypostases of his actions, who are the individual gods of Manichaeism, distinguished from one another mainly by their functions. The divinities of his First Creation, "evoked" by his word, are the Mother of Life, the First Man and the five Light Elements (ether, air, light, water, fire), which are also the "limbs" or substance of the Light World. The Light Elements are represented as the "sons" of the First Man, as his armour and as a bait which he throws the demons. They swallow it, are appeased and cease their invasion; but a part of Light is thereby absorbed in Darkness. This Light becomes smothered by the Matter which engulfs it, suffers and loses awareness of its own nature. Matter grows dependent on the swallowed Light, which it is necessary for it to retain.

The First Man is left unconscious on the battlefield, after he has cut the roots of the five Trees of hell, that evil may grow no more. Recovering awareness, he cries for help to the Father, who evokes the Second Creation of gods to his aid: the Friend of the Lights (whose function is obscure), the Great Builder and the Living Spirit with his five sons (Splenditenens, King of Honour, Adamas of Light, King of Glory, Atlas). The Living Spirit utters a Call to the First Man, whose Answer comes back from the depths.

Call and Answer are hypostasized as gods, the sixth "sons" of these two gods respectively; together they form the *Enthymesis* of Life, a power strengthening the unconscious yearning of the lost Light Elements for their own home. The Mother of Life and the Living Spirit then lead the First Man back to the Light. His rescue is a symbol for the salvation of the Lost Light, and for individual redemption.

Creation of the World.—The Living Spirit then overwhelms the devils. From the bodies of those slain he makes eight earths, from their skins ten skies. Others he fastens, living, in the firmament. From that portion of the swallowed Light still undefiled he makes sun and moon, and, from slightly maculate Light, the stars. For the redemption of the Light retained by Matter he creates the three Wheels of Fire, Water and Wind, controlled by the King of Glory. The Splenditenens holds up the ten heavens, Atlas supports the three upper earths.

Process of Redemption.—The Father of Greatness then evokes the chief god of his Third Creation, the Third Messenger. He evokes the Maiden of Light (who in this part of the myth also appears as the 12 Maidens), and the two divinities show themselves naked to the devils fettered in the sky. Beholding them, the males ejaculate, and with their seed there falls to earth the Light in their bodies. Part of the seed, falling into water, becomes a huge sea monster, defeated by the Adamas of Light. Part, falling on land, becomes the five kinds of trees and plants. The female devils, pregnant from unions in hell, miscarry, and their abortions fall to earth and people it with the five kinds of living creations.

The Great Builder makes the New Paradise or New Aeon (consubstantial with the kingdom of Light but existing separately from it until the last day) as a home for the gods and the redeemed Light. Its ruler is the First Man. The Third Messenger evokes the "Column of Glory, the Complete Man" who is both a god and the path whereby redeemed souls ascend to the moon (at the time of its waxing). Thence they pass to the sun and to the New Paradise. Sun and moon are set in motion by the Third Messenger, and with the change of seasons begins the physical redemption of Light (through dew, rain, etc.).

Creation of Man.—To defeat the process of redemption, Hyle prompts the demons Ashaqlon and Namrael to devour the offspring of the other abortions. Having thus increased the Light in their own bodies, the pair mate and produce Adam and Eve, in the form of the gods seen by the parent-devils in the sky. The Light in the demons' bodies is transmitted to the first human pair as the Soul. Imprisoned with the Soul in the demon-born body is the Dark Spirit, made up of lust, greed, hate, etc. Lust ensures that humanity propagates itself, and so makes an enduring prison for part of the Light in the world.

The god Jesus the Splendour (evoked by the Maiden of Light) awakes Adam to knowledge of the Soul's origin. Adam resolves on chastity; but Eve is seduced by a demon. By him she bears Cain and Abel, and later, by Adam, Seth. The human bondage of Light is thus carried on. This part of Light cannot be physically redeemed. Its salvation depends on conscious effort by each individual.

Individual Salvation.—The Great Nous, evocation of Jesus the Splendour, sends prophets to mankind, to bring gnosis to Adam's descendants. With knowledge comes the will to redemption; and through the five virtues of love (*agape*), faith, perfection, patience and wisdom, with which gnosis clothes the Soul, men are able to withstand evil. Hyle seeks always to overwhelm the Soul with forgetfulness. Religion strives to keep it aware and resolute. Using Pauline imagery, Mani called the unawakened Soul the Old Man and the awakened Soul the New Man.

Being of Light, the Soul can be guilty of the sins of the Dark Spirit and the body only in so far as it is unconscious or fails, through forgetfulness or weakness, to check them. Punishment follows automatically, in a postponing of the return to Paradise. The only atonement is contrition and a renewal of awareness and resolve. Only those Souls which reject the teachings of the Nous commit deadly sin. They deteriorate and in time may become assimilated to Matter and hence damned eternally.

Fate of the Individual Soul at Death.—There exist two symbolizations of the fate of the soul at death: the soul goes before the Just Justice (an evocation of the Nous), and having been judged takes one of three paths: to "Life" (New Paradise), to "Mixture" (back to the world, that is, to a period of reincarnation) or to "Death" (hell); or, the soul of the righteous man, leaving its body, is met by a redeeming god accompanied by three angels, bearing insignia of victory, which they bestow upon it. It then ascends to the New Paradise by the Column of Glory, moon and sun.

End of the World.—The end of the world will be foreshadowed by the Great War, followed by the second coming of Jesus, who will establish his judgment seat and separate righteous from sinners. He will then withdraw to the New Paradise. Thereafter the gods supporting the cosmos will abandon their tasks, and heavens and earths will collapse in the Great Fire, lasting 1,468 years, in which the last particles of Light will escape from matter, ascending to Paradise as the Last Man.

Hyle will be imprisoned, and the prison sealed with a great stone. Finally the New Paradise with all its inhabitants will be joined again to the World of Light.

Mani and Jesus.—Mani recognized three Jesuses. The redeeming god "Jesus the Splendour," an integral figure in his mythology; the "Jesus patibilis," also called the Living Self, that is, the Light suffering or "crucified" in matter; and "Jesus Christ," prophet and "son of God," who had, as divinity, taken on the appearance of man and had seemed to suffer death on earth. As prophet, Jesus was regarded by Mani as his own immediate forerunner. As god, Jesus was by Mani's docetic interpretation made one of the "saved Saviours" of Manichaeism, in which all the redeeming Gods, as emanations of the Father, are seeking to save themselves, in that they are consubstantial with the Light suffering on earth. Mani, with his abhorrence of matter, rigidly opposed the doctrine of Christ's incarnation. Mani considered himself the Paraclete, identifying the Holy Ghost with the Nous, inspirer and being of all prophets. In Buddhist lands Mani is represented as the Maitreya (*q.v.*).

The Community.—Strict virtue for the Manichaean necessarily involved a life withdrawn from the world, since he must in every way avoid injury to the imprisoned Light. The community was accordingly divided into the elect, who felt able to embrace a rigorous rule, and the hearers, who supported the elect by works and alms. The elect could expect to attain paradise at death; the hearers (with rare exceptions) could hope for salvation only after a period of reincarnation.

At the head of the community was its leader, Mani's successor. Under him there were five grades: 12 teachers, 72 bishops, 360 elders, the general body of the elect (to which women were admitted) and the hearers. The elect were "sealed" with the three seals of mouth and hands and breast. They were bound to chastity, poverty and abstinence from flesh and wine. They might possess food only for a day, clothing only for a year. They ate only one meal of vegetables a day, after nightfall; but since they might not harm the Light elements by plowing or reaping, kneading or baking, this meal was prepared by hearers. Monasteries existed; but since Manichaeism was a missionary faith the individual elect was required to travel much, on foot, preaching. He was enjoined to be gentle, joyful and to mingle sociably with the hearers.

The chief religious duty of the hearers was to care for the elect. They also took full part in the religious observances. Otherwise they lived in the world and were allowed to marry (monogamously), have children, drink wine and eat meat (although they might not themselves take life).

Cult.—The Manichaeans appear to have had no sacramental rites (since knowledge and virtue alone could win salvation). The essentials of their cult lay in prayers, the singing of hymns, fasting and confession. Seven daily prayers were enjoined on the elect, four on the hearers (midday, midafternoon, just after nightfall and three hours after sunset). Prayers, with prostrations, were uttered facing the sun or moon; in them were invoked, with the gods, the fourfold Manichaean unity of God, Light, Power and Wisdom. The many hymns which survive appear designed for

communal singing, often in antiphony. Some are formal, others express deep feeling. They are very varied, some short, some immensely long, forming elaborate cycles.

Fasting was enjoined on the hearers each Sunday, on the elect each Monday. In addition there were five two-day fasts observed through the year (the times being calculated from solar, lunar and zodiacal data). The fourth of these fasts was followed by 26 fast days (probably representing the days of Mani's suffering in prison), during which the hearers, like the elect, ate only once a day, after nightfall. On the next days fell the fifth two-day fast (probably commemorating Mani's death), and this was followed by the feast of the Bema, the chief event of the Manichaean year, commemorating Mani's ascension. This fell always in the spring.

There was confession each Monday, of the elect to one another and of the hearers to the elect; and annual confession by the community at the feast of the Bema. A surviving confessionary for the elect shows that in Manichaeism it was accepted that even the elect might sin and lose salvation.

Manichaean Scriptures.—The Manichaean canon consisted of seven works composed by Mani in his mother tongue, an eastern Aramaic dialect: the *Great* (or *Living*) *Gospel;* the *Treasure of Life;* the *Pragmateia* or *Treatise;* the *Secrets;* the *Book of the Giants;* the *Epistles;* and *Psalms and Prayers.* These books were held, in part at least, to be inspired by the spirit Mani called his "Twin." In addition there were the *Shabuhragan,* in which he summarized his teachings in Middle Persian for Shapur I; the *Ardahang,* Mani's drawing of the cosmos, with commentary; and the *Kephalaia,* discourses by the prophet posthumously collected, which contain some apocryphal matter.

With the extinction of Manichaeism in the middle ages these books disappeared; but they have been recovered in part in the 20th century. The two main places of discovery have been Turfan (Chinese Turkistan) and Egypt. In Turfan, remains of manuscripts were excavated from ruined Manichaean monasteries. They are in Iranian languages (Middle Persian, Parthian, Sogdian, Bactrian, New Persian), central Asian Turkish and Chinese, and survive in fragments only, mostly beautifully and precisely written, chiefly in the characteristic "Manichaean" script, akin to Estrangelo. They include pages from the above-mentioned works, among them some sheets of the *Shabuhragan* in the original Middle Persian; and a wealth of secondary religious literature: hymns and prayers, confessionals, homilies, moralized tales, bits of a church history, calendar tables, etc. The tales show that the Manichaeans played a part in transmitting fables from east to west. From the caves of Tun-huang (Chinese Turkistan) came a Manichaean treatise summarizing the faith in Chinese for the emperor (731).

In Egypt damaged papyri were dug up to the southwest of Fayyum. Written in Subakhmimic Coptic, they include the *Kephalaia* and *Epistles,* a hymnbook and a collection of homilies. Neither the Egyptian nor the central Asian material is fully published.

A Latin Manichaean text, earlier than A.D. 400, was discovered in a cave southwest of Tebessa, Algeria. It concerns the elect and hearers. These different finds have shown that Manichaeism preserved its doctrinal unity, despite the wide areas over which it spread.

Indirect Documentation.—Excerpts from the Manichaean scriptures have been transmitted by non-Manichaeans. Among the chief sources are the 4th-century *Acta Archelai* by Hegemonius (of which the part extant in the Greek original is quoted by Epiphanius); the Syriac *Book of Scholia* of Theodore bar Konai (8th century); and, in Arabic, the *Fihrist* of Ibn an Nadim (10th century) and the works of al-Biruni (11th century), Shahrastani (12th century) and al-Murtada (14th/15th centuries).

Manichaean doctrines have long been known from polemical works (including some of those just mentioned). Chief among these are the writings of the Latin Church Father Augustine (354–430), himself for nine years a Manichaean hearer. The most important Greek writings are those of Alexander of Lycopolis (fl. *c.* 300?), Titus of Bostra (d. *c.* 370) and the philosopher Simplicius (fl. early 6th century). In Pahlavi there is the 9th-century *Shkand-gumanig Wizar.* Material is also supplied by the anti-Manichaean edicts of the Roman emperors, and two Greek formulas of abjuration for Manichaeans (6th and 9th centuries).

See also references under "Manichaeism" in the Index.

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MANIFEST DESTINY, a persistent and cherished tradition of U.S. history which, in its broadest conception, declared that Americans are a chosen people, blessed with free institutions and ordained by God to create a model society in the wilderness. In this sense Manifest Destiny may be said to have begun with the Puritan landings at Massachusetts bay in 1630. In its more restricted geographical sense, the phrase refers to the desire of American expansionists in the 1840s to extend the boundaries of the United States to the Pacific ocean. Connecting the two periods is a host of utterances in the 18th and early 19th centuries by geographers like Jedidiah Morse and statesmen like Thomas Jefferson on American rights to a continental empire.

First joined together in July 1845 in a magazine article by John L. O'Sullivan, the words "manifest" and "destiny" provided a ringing slogan for newspaper editors and politicians advocating territorial expansion. O'Sullivan, a New York lawyer and journalist, used the phrase in his own paper, *The United States Magazine and Democratic Review,* to prophesy "the fulfillment of our manifest destiny to overspread the continent allotted by Providence for the free development of our yearly multiplying millions." In Dec. 1845, O'Sullivan invoked Manifest Destiny in the *New York Morning News* to support the annexation of Texas. Congressmen speedily picked up the phrase in their debates on the three major territorial questions confronting the United States in 1845 and 1846—the annexation of Texas, the joint occupation of the Oregon territory with England and the prosecution of war with Mexico.

In resolving these questions James K. Polk, who on March 4, 1845, took office as 11th president of the United States, played a decisive role. Unlike O'Sullivan, who conceived of Manifest Destiny in long-range philosophical terms, Polk reflected the militant spirit of the "War Hawks" from the northwest, who sought immediate acquisition of land. Polk swiftly approved the long-pending annexation of Texas, endorsed the division of Oregon at the 49th parallel, and engineered a war with Mexico in order to acquire the present states of New Mexico and California. Since Texas had freely offered to join the United States, and since the Oregon dispute was settled at the conference table, the Mexican War presented the issue of Manifest Destiny in its plainest form. Should the American people undertake an expansionist war on the basis of a tenuous claim that the Texas boundary extended to the Rio Grande? Should the victorious Americans acquire all of Mexico?

The first question was answered when the Democratic and Whig parties closed their bitterly divided ranks and swallowed their misgivings to support a war already initiated. Yet, when the American public faced the consequences of their victory, they backed away from the full implications of Manifest Destiny. Southern Democrats feared the inclusion of mixed races in the U.S. population. Northern Whigs opposed the addition of a vast southern area which could extend the slave-owning territory of the nation. When a compromise solution was proffered, through the offices of a special commissioner, Nicholas Trist, the president and congress eagerly approved it, and public clamour for all of Mexico

speedily died. The proponents of Manifest Destiny were satisfied with the sparsely populated northern third of Mexico, for which a substantial purchase price was paid. The Pacific had been reached, but the rule of another people had been avoided.

In subsequent periods the spirit of Manifest Destiny reasserted itself, notably in the cases of Cuba in 1854 and the Philippines in 1898. Again the American people drew back from policies that would lead to colonialism. Today it can be seen that Manifest Destiny erupted in the 1840s as a product of sudden technological changes—the steamboat, the telegraph, the railroad—which brought the continent within manageable compass. The new industrialism cried for more land and more markets. In sober retrospect, Americans have become aware that militant Manifest Destiny runs counter to, and not in defense of, freedom and democracy.

See Albert K. Weinberg, *Manifest Destiny* (1935); Frederick Merk, *Manifest Destiny and Mission in American History: a Reinterpretation* (1963). (R. M. Dn.)

MANIFOLDS. A manifold in mathematics may be defined as a topological space equipped with a family of local co-ordinate systems that are related to each other by co-ordinate transformations belonging to a specified class. Manifolds occur in algebraic geometry, differential equations and classical dynamics. They are studied for their global properties by the methods of analysis and algebraic topology, and they form natural domains for the global analysis of differential equations, particularly equations that arise in the calculus of variations.

In the following account C^0 denotes the class of continuous functions, C^1 those with continuous derivatives, C^∞ those with derivatives of all orders and C^a those that are analytic. The discussion assumes some understanding of such topics as covered in Analysis; Analysis, Complex; Geometry; Point Sets; Set Theory (Theory of Aggregates); Solids, Geometric; Topology, Algebraic; Topology, General; Groups.

Let X be a topological space. An n-dimensional local co-ordinate system on X is a pair (U,θ) where U, called a co-ordinate patch, represents an open subset of X, and θ is a homeomorphic mapping of U onto an open subset of the real n-dimensional number space R^n. If P is a point of the patch U then $\theta(P)$ is an ordered set $(x_1, \ldots, x_n)$ of real numbers that are the co-ordinates of P in the local co-ordinate system (U,θ). If (U',θ') is a local co-ordinate system assigning local co-ordinates $y_1, \ldots, y_n$ to the points of U', then on the intersection of U and U', if it is not empty, the y values are related to the x values by an invertible co-ordinate transformation $y_h = F_h(x_1, \ldots, x_n)$ where $h = 1, \ldots, n$. An n-dimensional manifold M_n of class C^i (where i is $0,1,\infty$ or a) is a topological space X together with a family of local co-ordinate systems with patches that form a covering of X and with co-ordinate transformations of class C^i; that is, they are defined by functions of class C^i. The space X is called the underlying space of M and is denoted $|M|$. A C^i-manifold (that is, a manifold of class C^i) can equally be regarded as a C^j-manifold if j precedes i in the ordering $0<1<\infty<a$. The space R^n with a single local co-ordinate system (R,θ), where θ is the identity map of R onto itself, is the simplest example of an M_n of class C^a. A Euclidean n-sphere can be converted into an M_n of class C^a by means of two local co-ordinate systems, but not by one alone. Other examples of C^a-manifolds are: P_n (n-dimensional projective space) and $CP(n)$ (the complex projective space of complex dimension n); the real dimension of the latter, that is, the dimension as defined above, is $2n$. Manifolds of class C^0, C^1, C^∞ and C^a are also known respectively as topological, differentiable, smooth and analytic manifolds.

Let M,N be C^i-manifolds and f a mapping $|M| \to |N|$. In the neighbourhood of any given point of $|M|$, f can be represented in terms of local co-ordinates. The mapping f is of class C^i if each of its local representations is of class C^i; this mapping is an isomorphism if it also admits a C^i-inverse $|N| \to |M|$. A mapping $|M| \to |N|$ of class C^i where $i > 0$ is regular if the Jacobian matrix of its local representations is of largest possible rank. M is a submanifold of N if $|M|$ is a subset of $|N|$ and the identity mapping $|M| \to |N|$ is a regular C^i-mapping.

From now on only those manifolds with underlying spaces that are separable Hausdorff spaces shall be considered. Such terms as connected, compact (or closed), noncompact (or open), when applied to manifolds, refer to their underlying spaces.

Isomorphism Classes.—The n-dimensional C^i-manifolds fall into equivalence classes, two manifolds being regarded as equivalent if they are isomorphic. Let I_n^i be the totality of these equivalence classes. Since an isomorphism between two C^i-manifolds can clearly be regarded as an isomorphism between two C^j-manifolds if $j < i$, there is a natural mapping $I_n^i \to I_n^j$ ($j < i$) induced by inclusion. For each n the natural mappings $I_n^a \to I_n^1$ are surjective; this means that each element in I_n^1 has a pre-image in I_n^a. In fact, H. Whitney showed that if M is a differentiable manifold of dimension n, then its equivalence class contains an analytic manifold that is a submanifold of R^{2n}. It is also known that for $n = 0,1,2$ the mappings $I_n^a \to I_n^0$ are surjective. For small values of n the natural mappings $I_n^1 \to I_n^0$ are injective (*i.e.*, the images of distinct elements are distinct) but this is not true for every n. In fact J. Milnor constructed two nonisomorphic differentiable manifolds with underlying spaces that are homeomorphic so that they are isomorphic when regarded as topological manifolds. Certain cohomology invariants known as characteristic classes provide important tools for the analysis of equivalence.

A manifold can be triangulated if a homeomorphism can be established between $|M|$ and a simplical complex; such a homeomorphism is called a triangulation. E. E. Moise showed that topological manifolds of dimension three or less can be triangulated. S. S. Cairns showed that all differentiable manifolds can be triangulated, and J. H. C. Whitehead showed that there exist triangulations under which the images of the simplexes are representable in local co-ordinates by C^1-functions. The C^1-triangulations of a given differentiable manifold bear a relation to each other known as combinatorial equivalence.

If equivalent manifolds are regarded as identical then there are just two connected 1-dimensional topological manifolds: the line and the circle. There are an uncountable number of open 2-dimensional topological manifolds and a countable number of closed. The latter are given by $S_0, S_1, S_2, \ldots, S_1', S_2', \ldots$ where S_p is a sphere with p handles and S_p' a sphere with p cross-caps (a cross-cap being a circular hole on the edge of which diametrically opposite points are regarded as identical). Little was known in the 1960s concerning the topological classification of manifolds of dimension greater than two.

Tangent Vectors and Differential Forms.—To each point P of a differentiable manifold of dimension n there is associated an n-dimensional real vector space T_P called the space of tangent vectors at P. This association is such that each local co-ordinate system $(x_1, \ldots, x_n)$ covering P determines a canonical base for T_P. Moreover, if $(dx_1, \ldots, dx_n)$ denotes the dual base for the dual space T_P', then two dual bases (dx_h) and (dy_h) are related by the Jacobian matrix at P of the corresponding co-ordinate transformation, consistent with the differential notation for the dual bases. Forming tensor products of T_P and T_P' produces vector spaces with elements that are tensors at P. The totality of tangent vectors of a smooth manifold M can in a natural manner be given the structure of a smooth manifold of dimension $2n$ called the tangent bundle of M. Manifolds that occur in differential geometry have special structural features introduced through their tangent vector spaces or through the tangent vector spaces of their tangent bundles. In the Riemannian manifolds of differential geometry, for example, each tangent vector space carries a positive definite inner product.

Each system $(x_1, \ldots, x_n)$ of local co-ordinates determines a base $(dx_{i_1} \wedge \ldots \wedge dx_{i_p})$ where $i_1 < \ldots < i_p$ for the exterior algebra ΛT_P of T_P. A differential p-form on M is defined by assigning to each point P an element of ΛT_P of degree p. In a local co-ordinate system (x_h) a p-form has the representation $\Sigma a_{i_1}, \ldots, {}_{i_p}\, dx_{i_1} \wedge \ldots \wedge dx_{i_p}$ where the a's are functions of $x_1, \ldots, x_n$. The exterior algebra $\Lambda(M)$ of a smooth manifold M is the totality of differential forms that have local representations with coefficients of class C^∞. The exterior algebra ΛM admits a

natural endomorphism d, called exterior differentiation, that raises degrees one unit and satisfies $d^2 = 0$. The cohomology algebra $H^*(\Lambda(M))$ consists of the closed forms (those annulled by d) taken modulo the exact forms (those that are images under d).

Homology and Cohomology.—The homology and cohomology groups of a connected n-dimensional manifold M have the following special properties: (1) The cohomology group $H^n(M)$ based on cochains with compact supports and values in a coefficient field F is either 1-dimensional or 0-dimensional (as a vector space); M is called orientable over F in the first case and nonorientable in the second. (2) If M is orientable over F, there exist isomorphisms $H^k(M) = H_{n-k}(M)$ known as Poincaré duality relations where $k = 0,1, \ldots$ and where $H_{n-k}(M)$ is the $(n-k)$th homology group of M computed as the limit of the homology groups of the compact parts of M. The proof of (1) and (2) depends only on the fact that if P is any point of M, the cohomology groups of M "around P" (coefficients in F) are just what they would be if P were a point of R^n. A finite dimensional space having this property at each of its points was called by R. L. Wilder a generalized manifold over F.

If a manifold M is orientable over a field of characteristic other than 2, then its integral cohomology group H^n on compact supports is infinite cyclic and M becomes oriented when one of the two generators of H^n is chosen; the other generator determines the opposite orientation. A nonconnected manifold is oriented if each of its components is oriented. An isomorphism between two manifolds, one of which is oriented, determines a unique orientation for the other.

On any smooth manifold there exists a natural isomorphism between the cohomology algebra $H^*(M)$ over the real numbers, and the cohomology algebra $H^*(\Lambda(M))$ defined above (theorem of De Rham). The isomorphism holds equally well if both homologies are taken with compact supports.

The Cobordism Group.—Let M^1, M^2 be smooth oriented closed manifolds of dimension n. Let $-M^i$ be M^i with orientation reversed. The expression $\epsilon_1 M^1 + \epsilon_2 M^2$ where $\epsilon_i = \pm 1$ is called a cobordism if there exist isomorphisms of M^1, M^2 with disjoint oriented submanifolds K^1, K^2 of an open oriented $(n+1)$-dimensional manifold N such that $|K|^1 \cup |K|^2$ is the topological boundary of some relatively compact component of $|N| - (|K^1| \cup |K^2|)$ and such that the orientations of $\epsilon_1 K^1$, $\epsilon_2 K^2$ are those induced by that of N. (Unique orientations will in fact be induced in these circumstances.) The cobordism group Ω is the quotient A/B where A is the free abelian group generated by the closed oriented manifolds and B is the subgroup generated by the cobordisms and the elements $(M \cup N) - M - N$. Let Ω^n be the subgroup of Ω defined by the manifolds of dimension n. R. Thom showed that the n-dimensional manifolds that are Cartesian products of complex projective spaces with even complex dimensions are linearly independent in Ω^n and that the rank of the subgroup they generate equals the rank of Ω^n.

Complex Manifolds.—In a complex analytic manifold of complex dimension n, the local co-ordinates are defined by mappings into C^n, the points of C^n being ordered sets of n complex numbers, and the corresponding co-ordinate transformations given by complex analytic functions. Such a manifold M can be regarded as a real analytic manifold of $2n$ dimensions and as such is always orientable. The exterior algebra $\Lambda_c(M)$ of complex valued differential forms of class C^∞ is considered on M (regarded as real). Each local complex co-ordinate system determines a canonical base $dz_1, \ldots, dz_n, d\bar{z}_1, \ldots, d\bar{z}_n$ for the forms of degree 1 where $d\bar{z}_i$ is the complex conjugate of dz_i. Then $\Lambda_c(M) = \Sigma \Lambda^{p,q}_c(M)$ where $\Lambda^{p,q}_c$ is generated by the forms $\bar{\omega}_p \wedge \bar{\omega}_q$ where in each co-ordinate system ω_p and ω_q are homogeneous forms of degrees p and q in the dz's and degree zero in the $d\bar{z}$'s. In certain types of complex analytic manifolds, notably the so-called compact manifolds of Kählerian type, of which the complex projective spaces are examples, the (p,q)-decomposition of Λ_c extends to its cohomology algebra: $H^* = \Sigma H^{p,q}$ where $H^* = H^*(\Lambda_c(M))$. On such a manifold M, the Poincaré duality relations take the form $B^{p,q} = B^{n-p,n-q}$ where n is the complex dimension of M and $B^{p,q}$ the dimension of the vector space $H^{p,q}$ over the complex numbers.

See also references under "Manifolds" in the Index.

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MANIHIKI ISLANDS, a scattered archipelago forming part of the northern Cook Islands in the central Pacific ocean. It includes Suwarrow (Suvorov), Manihiki (Manahiki) or Humphrey, Rakahanga or Reirson, and Penrhyn or Tongareva. There is a good harbour at Penrhyn. Products include pearls, pearl shell and copra. The inhabitants are Polynesians. The islands were mostly discovered early in the 19th century and were annexed by Great Britain in 1888–89. They are administered by New Zealand. *See* COOK ISLANDS.

MANILA, the premier city of the Philippines in almost all respects. It is the chief port, the major trade centre, the leading manufacturing area and the focus of political and intellectual activity of the islands. Its northeastern suburb, Quezon City, is the official national capital but Manila handles many functions of government.

Manila has grown rapidly to a 1960 population of 1,145,723 (1948 census 983,906). About 80,000 Chinese, 4,000 U.S. citizens, 2,000 Spanish and a few hundred nationals from each of several other countries give the city an international aspect.

Geography and Topography.—Manila is about 1,500 mi. from Singapore and 1,400 mi. from Nagasaki. The city lies on the eastern shore of Manila bay (*q.v.*). To the north Mt. Arayat, a sacred mountain to the early Malays, is visible from the bay; to the west are the Mariveles mountains, and to the east the terrain rises to Laguna de Bay, a large lake from which the Pasig river issues to bisect the city. Various tidewater creeks find their way through Manila, connecting with the river or directly with the bay.

The modern Manila metropolitan area includes the chartered cities of Manila, Pasay City, Quezon City and 13 separate municipalities. Urban subdivisions reach out into Rizal province, overlapping a number of rural towns, villages and barrios in which truck gardening, poultry raising and a few rice fields still are found. Northeast of Manila is the suburb and national capital of Quezon City (*q.v.*) to which the University of the Philippines was moved. On the south is the smaller area of Pasay City.

Each of the 13 municipalities that serve as administrative centres for the political districts around Manila forms an older core of urban settlement around which new subdivisions in modern style were built. On the north, along the bay, lie Navotas and Malabon, with Caloocan inland. On the northeast, just beyond Quezon City, is San Mateo. To the east, south of Quezon City, are Marikina, San Juan del Monte and Mandaluyong. On the southeast lie San Pedro Makati, Pasig, Pateros and Tagig, and on the south, beyond Pasay City, are Parañaque and Las Pinas. Outward from the city core run main highways to the north, east and south; and thousands of persons who work daily in the urban area commute distances up to 20 mi.

Local names are applied to districts that are not formal political

units, such as Diliman district, where the University of the Philippines is located, Wack Wack, where a country club was established, and Santa Mesa, Grace Park, Rosario Heights and Balintawak, chiefly residential subdivisions.

As there are three Romes so there are three Manilas. There is the native Malay element indicated by pile-built houses of nipa palm thatch and bamboo thickly packed together along narrow streets and tidal creeks. There are the bits and pieces of Spanish medieval, reduced to remnants during World War II. Finally there is the Americanized modern element in the city (sometimes clearly of U.S. origin and sometimes a subtle blend of American, Malay and Spanish) indicated by public buildings, docks and warehouses, bridges, wide streets crammed with automobiles, the newer hotels, apartment houses, private houses built in contemporary U.S. styles, the country clubs and the airports.

The city of Manila proper is divided into 14 districts of unequal size, population and appearance. The most populous district is Tondo; north of the Pasig river and fronting the bay, it is still largely a native Malay zone. San Nicolás, Binondo, Santa Cruz, San Miguel and Quiapo, just north of the Pasig, are the heart of old Manila and of the business district, with Chinese stores, embroidery shops, banks, shipping offices, theatres and the Escolta—the famous business street—plus a tightly jammed residential zone.

Just out of the retail district, along the Pasig in San Miguel, is the Malacañan palace, formerly the residence of Spanish and U.S. governors and later the home of the Philippine president. To the east Sampaloc, the largest district and formerly a native residential area, gradually became largely a business section.

Four bridges cross the Pasig river within the main part of the city, offering access to the seven southern districts. On the bay front is the Port Area, a result of U.S. dredging of the harbour and construction of docks and warehouses. Although it was later dwarfed by a larger port district north of the Pasig, between San Nicolás, Tondo and the bay, most of the companies and government offices dealing in shipping services remained in the Port Area.

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SAINT AUGUSTINE CHURCH, BUILT IN THE 16TH CENTURY, WAS THE ONLY CHURCH INSIDE INTRAMUROS NOT DESTROYED DURING WORLD WAR II

Just inland from this is the old walled city of Spanish times, the Intramuros, with its 20-ft. walls stretching for two and one-half miles. About 1905 the old moat was filled and much of the space outside the wall was converted into gardens, playgrounds and a golf course. By the end of World War II only the church of St. Augustine was left intact within the Intramuros. South of the Port Area and the Intramuros lie Burnham Green, the Luneta and Wallace field, Manila's "common." Southward along the bay, Dewey boulevard and Taft avenue lead through the older residential zones, where many government bureaus, the general hospital and other institutions were established.

Ermita and Malate, the two districts involved, remained choice residential areas, and large houses and apartment houses were rebuilt there after World War II. Inland lie the chiefly middle-class residential areas of Paco, Pandacan and Santa Ana.

Climate.—The climate of Manila is similar to that of lowlands along the Philippine west coasts, having two pronounced seasons in rainfall but only mild seasonality in temperature. Weather is normally dry during January through April and rainy the rest of the year, particularly from June through October. July, normally the rainiest month, has high humidity and frequent thundershowers —24 rainy days as opposed to 3 rainy days in February. The annual total of 159 rainy days produces an average of 81.52 in., but annual variation is marked, ranging from 35.69 in. in 1885 to 154.35 in. in 1919. In temperature March through June is the warmest period, with May having a monthly mean of 28° C. (83° F.); November through February is the cooler period, January having a monthly mean of 24° (76°).

History.—The first European settlement at Manila was established by Miguel López de Legazpi in 1571. At that time a Mohammedan rajah (Lakandola) reigned over a native settlement within the district of Tondo. Manila became the capital and Legazpi the first governor of the Philippines. The islands were placed under the viceroy of New Spain in Mexico City, and official communication between the two widely separated areas was maintained by a galleon which plied annually between Acapulco and Manila. Trade of considerable proportions was developed.

Accompanying Legazpi to the islands was an Augustinian friar, Urdaneta, with others of that order, some of whom went on to Manila. In 1577 arrived Franciscans, who were followed by Dominicans, Jesuits and Augustinian Recollects. These orders founded convents, churches and schools and became very powerful in the government. In 1580 the first and only Roman Catholic bishop of Manila arrived in the person of Domingo de Salazar, a Dominican; but in 1595 the diocese was raised to a metropolitan see, and Ignacio Santibañez became the first of a long line of Spanish archbishops which ended with Nozaleda about 1900. In 1583 an *audiencia* (supreme court) was established. Abolished later, it was re-established in 1598 and continued as a Spanish institution for three centuries. The Spanish law was applied in those portions of the archipelago actually ruled by Spain; but the Spanish civil code came into force there only in 1889.

In the 17th century Spain warred with the Dutch and Moros, and Manila was menaced repeatedly. In 1762, the city was captured by British forces under Gen. William Draper and Adm. Samuel Cornish, who held it until 1764, the treaty of Paris (1763) having restored it to Spain. The 19th century was marked by some signs of progress. In 1825 Russell and Sturgis of Boston opened a branch of their Canton mercantile house—the first U.S. enterprise in the Philippines—and in 1837 the city was opened generally to foreign trade.

On the completion of the Suez canal a generation later, direct means of communication with Europe were provided and commerce accordingly was stimulated. The first Masonic lodge was founded at Cavite, near Manila, in 1856, and the Katipunan, a revolutionary society, borrowing some of its features from Masonry but never sanctioned by the Filipino nationalist leader José Rizal y Mercado, acquired a large following. The execution of Rizal on Dec. 30, 1896, was the signal for the outbreak of revolution, and the Spanish-American War brought Commodore George Dewey and his U.S. fleet, which destroyed the Spanish fleet at Cavite on May 1,

1898. Manila surrendered to the United States forces on Aug. 13, and for nearly 44 years the U.S. flag floated continuously over the city. The Japanese invasion in Dec. 1941 and Japanese occupation of the city on Jan. 2, 1942, was its fourth capture by a foreign power.

Liberation of greater Manila from Japanese control was accomplished by the end of Feb. 1945, and reconstruction began throughout the city, which had suffered greatly from war devastation. A significant change in the appearance of the city was brought about by its rapid industrialization. In order to accommodate the expanding population many private houses and older two-story constructions were replaced with apartment buildings. The historic Intramuros area was cleared of debris and a reconstruction scheme was proposed in the early 1960s. The rehabilitation program in Manila, as throughout the Philippines, was assisted by war damage payments by the U.S.; *see* PHILIPPINES, REPUBLIC OF THE.

(C. S. L.; J. E. SR.; R. E. HE.)

Educational and Religious Institutions.—Most of the early schools and churches in the islands were founded in Manila by religious orders. The Dominican order founded the University of Santo Tomas in 1619 and the Collegio de San Juan de Letran in 1640. As early as 1601 the Jesuit order founded the Collegio de San José, and in 1859, after the order returned to the islands, it established the Escuela Municipal, which later became the Ateneo de Manila. The Augustinians (the original order and the Augustinian Recollects) also have churches and convents.

The Protestant churches generally supported the public schools; a union theological school—Ellinwood seminary—was established for the training of Protestant ministers. The imposing Episcopal cathedral of St. Mary and St. John is located in Ermita, as is the Union (formerly Presbyterian) church.

There are a number of private technical schools, colleges and universities in greater Manila. Of these, the Far Eastern university was the largest in the second half of the 20th century. At the apex of the public school system are three national institutions, the Philippine Normal college, the Philippine College of Commerce and the University of the Philippines, in the Diliman district of Quezon City.

Administration.—Under Spain the city formed part of a province of the same name, which was abolished by the U.S. government after about three years of military rule. On July 31, 1901, by an act of the Philippine commission, Manila became the first of the Philippine chartered cities; other municipalities of the old province became part of the new province of Rizal. The so-called administrative code of 1917, amended in 1921, provided for a mayor appointed by the governor general (later by the commonwealth president) and confirmed by the senate, and a municipal board of ten members elected at large and serving for three years. Administrative departments were: engineering and public works, police, law, fire, finance, assessment, health and welfare.

On gaining independence in 1946, the Philippine government made the office of mayor in all chartered cities and municipalities elective, though the Philippine president exercised executive authority thereafter with regard to various of the chartered cities. There also are elective councils for each of the chartered cities. Because the national government's seat is in Manila and Quezon City, none of the cities and municipalities in greater Manila operates with complete autonomy; all are peculiarly subject to controls and influence from congress and the executive department.

Trade and Industry.—Greater Manila is by far the most important manufacturing center in the islands, having about one-half of the assets, one-quarter of the value of production, and one-third of the persons engaged in manufacturing in the country. Growth in and around Manila continued to be rapid after World War II. The highway around the circumference of the city was a particular focus of development during the late 1950s and 1960s. Manufacturing in the city includes textiles and clothing, food and beverage processing, fish canning, vegetable oil pressing, lumber veneer and plywood manufacture, production of chemicals and drugs, leather tanning and manufacturing, light metal fabrication and shipbuilding. Manila is the heart of most service facilities in the islands, the nerve centre of financial and political activity, and the centre of educational and medical facilities. About one-half of all professional persons in the country live in greater Manila. *See* also references under "Manila" in the Index.

(J. E. SR.; R. E. HE.)

MANILA BAY, an almost completely landlocked bay extending into the Philippine island of Luzon from the South China sea. Its widest diameter from northwest to southeast measures 36 mi. and from Corregidor Island to the piers in Manila harbour is 30 mi. The bay has two entrances, one on either side of Corregidor (*q.v.*); the seldom used South channel is 6 mi. wide while the busy and safer North channel between Corregidor and Bataan peninsula is only 2 mi. wide. The north and northeast shore of Manila bay adjoins the central plain of Luzon. In this section the bay is shallow and lined by mud flats and mangrove; here are located the most extensive commercial fish ponds in the Philippines. The major part of the bay is between 30 and 120 ft. in depth; it has only a moderate tidal range and provides good to excellent anchorage. Manila harbour at the easternmost part of the bay is divided into two sections, North harbour for interisland ships and South harbour for international shipping; both have excellent docking facilities. Sangley Point, a U.S. naval reservation near Cavite city on the southeast shore, provides servicing for naval vessels. Bolanga on the western shore is home base for a small fishing fleet. In 1574 the Chinese pirate Lim-Ah-Hong sailed into Manila bay but was repulsed by Spanish forces. The bay was the western terminus of the Manila-Acapulco "galleon trade" between 1593 and 1815. The Spanish fleet was destroyed in the bay by a U.S. squadron under the command of Commodore George Dewey on May 1, 1898. During World War II many Philippine, American and Japanese ships were sunk at Manila, Cavite, Corregidor and several other locations by aerial bombardment. *See* WORLD WAR II: *The War in the Pacific.*

(R. E. HE.)

MANILA HEMP: *see* ABACÁ FIBRE.

MANILIUS, MARCUS (fl. early 1st century A.D.), Roman didactic poet, was the author of *Astronomica,* an unfinished poem on astronomy and astrology, of which five books remain. The poem consists of over 4,000 hexameters and was composed in the reigns of Augustus and Tiberius. To the reader unversed in astrological calculations the interest chiefly resides in the attractive prefaces to each book and the mythological or moralizing digressions. Manilius, writing as a Stoic, stresses the providential government of the world and the operation of divine reason. His style shows indebtedness to Lucretius, Virgil and Ovid. He abuses his unparalleled facility for versifying astronomical computations and habitually substitutes the complex for the simple. Rarely read *in toto* even by Latinists, he has been given unexpected publicity by the five brilliant volumes of A. E. Housman.

BIBLIOGRAPHY.—For text with an introduction, apparatus criticus, review of Manilian scholarship, full discussion of textual and paleographical problems, elucidation of difficulties, etc., *see* A. E. Housman, *M. Manilii Astronomicon,* 5 vol., 2nd ed. (1937). *See* also G. P. Goold, "De fonte codicum Manilianorum," *Rheinisches Museum,* vol. xcvii (1954).

(H. H. HY.)

MANIN, DANIELE (1804–1857), Venetian leader of the Italian Risorgimento, was born in Venice on May 13, 1804, the son of a converted Jewish lawyer who had taken the historic name of his sponsors' family at baptism. Daniele studied law at Padua until his strikingly early graduation in 1821 and then began to practise. This work absorbed his energies, and for some years he showed no great concern with public or patriotic issues, unless the discussion of possible routes for a railway between Milan and Venice can be counted as such. He disapproved of the conspiratorial activities of the extreme patriots and it was only after the election of Pope Pius IX in 1846 that it became clear that his views had changed. In association with Niccolò Tommasseo he then began to express the grievances of the Venetian people by whatever means were legally available to him. In Sept. 1847 he took part in a congress of Italian scientists which was the excuse for much political propaganda. After this he presented to the Congregation (the only quasi-representative body in the Austrian province) a petition for home rule. This was too much for the Austrian authorities, and Manin's first period of political activity ended with his and Tommasseo's imprisonment in Jan. 1848.

A popular rising on March 17, 1848, forced the Austrian governor to release Manin, and after a few days of uncertainty and another rising he was made president of the newly liberated republic (March 22). He announced the willingness of Venice to join a confederation of Italian states and then set to work to organize the defense of the republic against an Austrian recovery. In June the Austrians reoccupied the Venetian mainland, and on July 4 it was agreed that the republic should be fused with the kingdom of Sardinia-Piedmont in order to maintain the cause of Italian independence. Manin regretted the necessity of the decision, but accepted it. The defeat of the Piedmontese armies a month later meant the end of this fusion; and the Piedmontese commissioners who had come to Venice to negotiate the union were lucky to escape with their lives from a crowd enraged by the armistice. Manin now reassumed office (Aug. 11) virtually as dictator, but limited himself to proclaiming a provisional government without specifying the nature of the regime eventually to emerge. A heroic defense was maintained against siege by the Austrians; and hope revived once more when Sardinia-Piedmont re-entered the war in March 1849. Unhappily, the news of the defeat of Novara came almost at once. The siege was continued until August, but the combination of cholera and naval bombardment after the withdrawal of the Sardinian fleet from the Adriatic then made further resistance useless. The city capitulated on honourable terms (Aug. 22, 1849), and only Manin and a few others were excepted from amnesty. (*See* ITALIAN INDEPENDENCE, WARS OF; ITALY: *History*.)

Manin went into exile in France and his wife died almost as soon as he arrived in Marseilles. He went to Paris, where he suffered over the lingering death of a daughter. Neither this nor his penury kept him from politics. He strove to enlist French sympathy for Italy, helped to organize the Società Nazionale Italiana and urged the exiles to adopt the leadership of the house of Savoy. When Sardinia-Piedmont had entered the Crimean War, Manin made the famous pronouncement which expressed his conversion to the monarchist cause: "If you make Italy, I am with you; if you do not, I am not" (*Fate l'Italia e sono con voi; se no, no*). He died in Paris on Sept. 22, 1857; in 1868 his body was brought to Venice and buried there in state. Manin's political correspondence with Giorgio Pallavicino is edited by M. Maineri (1878); other documents were printed by M. Brunetti *et al., Daniele Manin intimo* (1936).

See G. M. Trevelyan, *Manin and the Venetian Revolution of 1848* (1923); A. Levi, *La politica di Daniele Manin* (1933).

(J. M. Rs.)

MANING, FREDERICK EDWARD (1811–1883), New Zealand author and land court judge, was born on July 5, 1811, in County Dublin in Ireland. His family emigrated to Van Diemen's Land (Tasmania) in 1824, but Maning, attracted by the freedom of life in New Zealand, went to Hokianga in 1833 as a trader. Tall, strong, full of fight and good humour, he was successful with the Maoris, who needed such Europeans among them to bring in trade goods and muskets. Maning married the daughter of a Ngapuhi chief and paid a lavish £222 for 200 ac. of land at Onoke, Hokianga. He advised the Maoris against the treaty of Waitangi which established British sovereignty in 1840 but thereafter he accepted colonization as inevitable. At the Bay of Islands a Maori chief, Hone Heke, began a war against the British in 1845. At first he was successful against British regular troops, but in 1846 he was defeated, largely by Maoris under Waka Nene and Maning, who thoroughly enjoyed the fight. Although he had chosen to live among Maoris and knew them so well, Maning was often angry and disgusted with them and at the same time was very impatient of all officialdom. As a judge of the native land court from 1865 to 1876, he used his great knowledge of the Maoris' language, customs and traditions to serve them honestly, while berating them frequently with both humour and fury in private letters. Maning died in London on July 25, 1883.

He wrote *The History of the War in the North Against the Chief Heke* (1862), an account through Maori eyes, exposing the follies of both Europeans and Maoris; and *Old New Zealand* (1863), an ironical, semi-autobiographical account of the good old days which has remained in print.

(N. M. TA.)

MANIOC, a native South American plant commonly called cassava (*q.v.*) and the raw product of its starchy tuberous root, from which tapioca (*q.v.*) is processed.

MANIPLE, a eucharistic vestment of the Roman Catholic Church, proper to all orders from the subdeacon upward, worn on the left forearm. *See* VESTMENTS, ECCLESIASTICAL.

MANIPUR, a Union territory and former feudatory state of northeast India, adjoins the frontier of Upper Burma. Area 8,628 sq.mi. Pop. (1961) 780,037. Its western districts project into Assam and are bounded on the north by Nagaland (*q.v.*) and the hills overlooking the Assam valley, on the west by Cachar district and on the south by the Lushai hills. The capital is Imphal (*q.v.*). The territory consists of the wide valley of the Manipur river, a tributary of the Chindwin, with an area of about 650 sq.mi., and a large surrounding tract of mountainous country. The valley is 2,500 ft. above sea level. The hill ranges generally run north and south, with occasional connecting spurs and ridges of lower elevation between. Their greatest altitude is in the north, where they reach to more than 8,000 ft. above sea level. The principal geographical feature in the valley is the reedy Loktak lake, more than 25 sq.mi. in area, but said to be gradually growing smaller. The Manipur river flows southward from the lake and turning eastward joins the Chindwin in Upper Burma. The territory is watered by many other rivers, the Barak in the west being the most important. The climate is temperate and rainfall in the valley is moderate. The hills are densely clothed with tree jungle and large forest timber. Elephants are found there, also tigers, leopards, rhinoceros and wild buffaloes.

Although their general facial characteristics are Mongolian, there is a great diversity of feature among the inhabitants of Manipur, some of them showing a regularity approaching the Aryan type. In the valley the people are chiefly Hindus, that religion being of recent introduction. Their own name for themselves is Meithei (*q.v.*), and their language is a branch of the Kuki-Chin family. One of their peculiarities is the high position enjoyed by women, who conduct most of the trade of the valley. The aboriginal hillmen belong to one of the two great divisions of Nagas (*q.v.*) and Kukis (*see* CHIN) and are subdivided into innumerable clans and sections. The Nagas are found mainly in the north and the Kukis in the south. About 60% of the population speak Manipuri, while rather less than one-fifth speak Naga and Kuki dialects respectively. Polo and hockey are favourite games of the people.

Manipur has virtually no history before 1762. Very little is known of its archaeology although ground stone hoes are reported to have been found there. The first relations of the British with Manipur date from 1762, when the raja solicited British aid to repel a Burmese invasion and a treaty was concluded. Little further communication took place until 1824 on the outbreak of the first Burmese War. British assistance was again invoked by the raja, and the Burmese were finally expelled from both the Assam and the Manipur valleys. Disputed successions became a continuous cause of trouble, and, in 1891 after a disturbance, Chura Chand, a five-year-old child of the ruling family, was nominated raja. During his minority the administration was conducted under British supervision. The opportunity was seized to abolish slavery and unpaid forced labour, to open up the state by roads and to introduce other reforms. In 1907 the government of the state was handed over to the raja and durbar, or council, with a member of the Indian civil service as vice-president. Subsequently the administration of the state was transferred to the raja from the durbar, of which the vice-president became president. After the Kuki rising in 1917 a new system of administration was adopted, three subdivisions being established, each under an officer lent by the Assam government. Manipur was invaded by the Japanese in World War II and was the scene of fierce fighting. After the accession of the state to India (Aug. 15, 1947) the political agency exercised by Assam was abolished; on Oct. 15, 1949, the administration was taken over by the Indian government and effected through a chief commissioner, with an elected territorial council.

The state is divided into two districts: Manipur Hills (pop.

[1951] 175,368) and Manipur Plains (402,267). There are three colleges at Imphal affiliated to Gauhati university.

Agriculture and forest produce are the main sources of income. The soil is rich, and rice, sugar cane and pulses flourish. The state is noted for the excellence of its ponies. Several cottage industries are also well established, notably handloom weaving, and to a lesser degree soapmaking, carpentry and tanning. Communications in the whole state are poor. From Imphal there is a road northward to the North-Eastern railway at Manipur Road (Dimapur), Assam, and southeast to Tamu on the Burmese border.

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MANIPURI, one of the major classical dance styles of India (*see* also KATHAKALI; KATHAK). Indigenous to the somewhat isolated territory of Manipur in northeastern India, Manipuri is quite dissimilar in style from the other classical dance arts of India, though it is based on the *Natya Shastra*. Dance in Manipur is communal and a part of religious life, being performed out-of-doors on numerous festivals. Themes are generally taken from episodes in the life of Krishna, the pastoral god. Dance dramas are interpreted during the action by a narrator who chants dialogue and descriptive action.

Long isolated in its native soil, Manipuri was made popular in India when, in 1917, the poet Rabindranath Tagore visited Sylhet. He saw demonstrations of the art and brought back teachers to serve in his University of the Arts in Santiniketan.

Manipuri is smooth and graceful, and technically easier and more limited than the other classic styles. Hand poses are used decoratively rather than as pantomime. Although bells are worn on the ankles, the movement of the dance does not accentuate their presence, the steps being light and close to the floor. It is the flowing sway of the body and the liquid quality of the arms and hands that give this dance style its beauty. Stronger and more primitive movements are used by men in the communal dances; sometimes the dancer plays a two-headed drum which is lashed to his waist. (R. M. Hs.)

MANISA, the chief town of Manisa *il* (province), Turkey, situated in the valley of the Gediz Nehri (Hermus river), at the foot of Manisa Dagi (Mt. Sipylus), and connected by railway with Izmir (Smyrna) and Afyonkarahisar. Pop. (1960) 59,675, Manisa is an important agricultural and commercial centre, and contains interesting buildings dating from the times of the Seljuk and early Osmanli sultans, including mosques built by Murad II and III and a Mevlevi *tekke* (Dervish convent) second only to that at Konya.

The area was inhabited in early times, as attested by the nearby ruins of the ancient Greek Magnesia ad Sipylum (*see* MAGNESIA). In 1204 Manisa was secured by John Ducas, who when he became emperor made it the Byzantine seat of government. In 1305, Roger de Flor besieged it unsuccessfully. In 1313 the town was taken by Saru Khan and became the capital of the Turkmen amirate of that name. In 1398 it submitted to the Osmanli sultan Bayazid I, and in 1402 was made a treasure city by Timur. In 1419 it was the scene of the insurrection of Bedr ed-Din, which was crushed by Murad II. In the 17th century Manisa became the residence of the greatest of the Dere Bey families, Kara Osman Oglu, which was Turkmen in origin, and was possibly connected with the amirs of Sarukhan.

The *liwa* of Sarukhan was one of the 22 districts in the Ottoman empire leased on a life tenure up to the time of Mahmud II. In the 18th century the Kara Osman Oglu (or Karaosman) ruled *de facto* all west central Anatolia, one member being lord of Bergama and another of Aydin, while the head of the house held Manisa with all the Hermus valley and had greater power in Smyrna than the representative of the kaptan pasha in whose province that city nominally lay. The last of its great beys was Haji Hussain Zade, who was frequently called into Smyrna on the petition of his friends, the European merchants, to assure tranquility in the troublous times consequent on Napoleon's invasion of Egypt and the British and Russian attacks on the Porte early in the 19th century. He always acquitted himself well; but, since he refused to bring his contingent to the grand vizier when on the march to Egypt in 1798 and aroused the resentment of the kaptan pasha, he was in continual danger. Exiled in 1812, he was subsequently restored to Manisa, and died there in 1821. His son succeeded after sanguinary tumults; but Mahmud II, who had long marked the family for destruction, was so hostile toward it after he had disposed of the janizaries that it had lost all but the shadow of power by 1830. Descendants survived in Manisa who retained a special right of granting title deeds within the district, independent of the local administration.

MANISA IL (area 5,315 sq.mi.) had a population of 657,104 in 1960. There are scattered mineral deposits (magnesite, mercury, zinc) and grapes, olives, tobacco, sesame and cotton are grown on the fertile plain of Gediz. (X.; N. TU.; S. ER.; E. TU.)

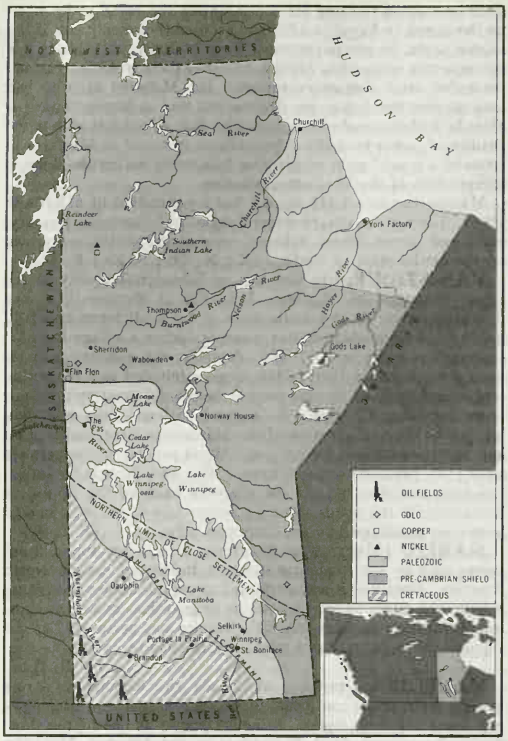
MANISTIQUE, city and seat of Schoolcraft county in the Upper Peninsula of Michigan, U.S., lies at the mouth of the Manistique river on the north shore of Lake Michigan about 40 mi. N.E. of Escanaba. It was incorporated as a village in 1885, chartered as a city in 1901, and adopted a city-manager form of local government in 1926. Manistique originated as a lumbering centre, and much of its pine went to help build many midwestern cities, including Chicago. Its natural harbour, kept relatively ice free by the swift current of the Manistique river, makes it an important commercial fishing port. Wood and paper products are among its principal manufactures. The area is rich in Indian folk-lore, and sites include the allegedly haunted Big Spring or Kitchitikipi in the woods adjoining Indian lake (5 mi. W.), said to have been worshipped by the Chippewa tribe. (B. L. F.)

MANITO (MANITOU or MANITU), a term for supernatural power used by the Algonkian-speaking Indians of eastern North America. Generally it was attributed to various deities and nature spirits, who might become protectors or guardians as well as causing ill-fortune. In some tribes the manito was personified as the supreme deity, perhaps as a result of Christian teachings. (F. R. E.)

MANITOBA, a province of Canada, situated midway across the North American continent. Area 251,000 sq.mi., of which 39,225 sq.mi. are fresh water. Although known as one of the three "prairie" provinces (with Saskatchewan and Alberta), Manitoba possesses great diversity and only a small portion is treeless prairie. The remainder consists of parkland, forest interspersed with lakes, and subarctic tundra, and the province has 400 mi. of coast on Hudson bay. It is bounded by the U.S. on the south, Saskatchewan on the west, Mackenzie on the north, and Ontario on the east. The whole of the province falls within the central time zone. The capital is Winnipeg (*q.v.*).

Geology and Physiography.—The Pre-Cambrian shield (*see* map), covering three-fifths of the province, is made up of ancient rocks (gneisses, granites, etc.); it forms hilly broken ice-worn country with numerous lakes, and is drained northeast to Hudson bay by the Seal, Churchill and Nelson rivers. The Hudson bay lowland, the land sloping down from the shield to the sea, is built of horizontal Paleozoic limestones. The Manitoba lowland, southwest of the shield, is a basin that once held the great glacial lake known as Lake Agassiz. The several large lakes found in this lowland today are its remains and include some of the largest lakes in Canada: Lake Winnipeg (9,465 sq.mi.), Lake Winnipegosis (2,103 sq.mi.), Lake Manitoba (*qq.v.*) (1,817 sq.mi.), Cedar lake (537 sq.mi.) and Moose lake (525 sq.mi.). The Red river valley forms the southern part of the lowland and its fertile soils derive from the lacustrine clays deposited there by Lake Agassiz. The Manitoba escarpment (or cuesta) terminates the lowland on its southwest side; this feature has been broken up by rivers (of which the Assiniboine is the chief) into hilly areas known as the Porcupine, Duck and Riding mountains. The Saskatchewan plain, composed of Cretaceous shales with a covering of glacial boulder clays and lacustrine clays, extends westward from the escarpment into Saskatchewan.

Climate.—The climate is extreme or continental, with very cold winters and warm summers. In winter the temperature may fall to −40° F. (−40° C.) and below in all parts of the province. The average minimum in January is −13° F. (−25° C.) at Winnipeg



GENERALIZED GEOLOGIC STRUCTURE AND TOPOGRAPHY AND MAIN MINERAL DEPOSITS OF MANITOBA

and −27° at Churchill. The average maximum January temperature is 7° at Winnipeg and −11° at Churchill. Sudden changes of temperature of up to 40° may occur within 24 hours in winter. Spring is a brief season in which temperatures rise rapidly in May after the April thaw. June, on the average, is about 25° warmer than April.

Summer temperatures often exceed 90° F. (about 32° C.) and occasionally reach 100° in the south, but nights are relatively cool. The average minimum July temperature at Winnipeg is 55°, at Churchill 43°; the average maximum July temperature is 79° at Winnipeg and 64° at Churchill. Violent electrical storms accompanied by heavy rain and often hail occur in summer. Autumn often has prolonged periods of dry sunny weather with mild days and frosty nights. Annual precipitation, occurring mostly in the summer months, ranges from 15 in. in the north and west to 20 in. in the south and east. Most of the province receives over 2,000 hours of sunshine a year.

Vegetation and Animal Life.—Except for a belt of barren tundra along the Hudson bay shore and a small area of prairie along the U.S. border in the south, the natural vegetation of Manitoba is forest. North of the prairie comes an open parkland with such trees as the aspen, Manitoba maple, elm and bur oak. This gives way to a mixed forest, where coniferous species are found along with deciduous trees. Next, beginning at the southern edge of the Canadian shield, comes the full development of northern coniferous forest with spruce, larch, pine and fir. This degenerates northward into subarctic forest where the trees become smaller and fewer until open tundra is reached.

The bison, antelope and elk, which flourished on the prairie before the white man came, have vanished. The principal prairie animals are gophers, badgers, coyotes and jack rabbits, and among the birds are prairie chicken, grouse, gull, and mallard and black duck. In the forests, the black bear, moose, timber wolf, fox, otter, skunk, marten, mink and weasel may be found, along with such rodents as the squirrel and beaver. A variety of fish inhabit the lakes (see *Fishing*, below).

History.—Southern Manitoba was inhabited by Blackfoot, Sarcee, Assiniboin and Ojibwa (Chippewa) Indians, with Eskimos farther north along the shores of Hudson bay. The first European to enter the territory was probably Sir Thomas Button, who entered the Nelson river in 1612; seven years later two Danish ships wintered at the mouth of the Churchill. After its foundation in 1670, the Hudson's Bay company began to build forts in the area, the chief of which was York Factory at the mouth of the Nelson. From here, in 1691–92 Henry Kelsey explored parts of the province in the direction of the Saskatchewan river. In 1717 a wooden fort, Fort Prince of Wales, was built at the mouth of the Churchill; this was rebuilt in stone (1731–76).

Throughout the 18th century the area was affected by the Anglo-French feud. The Hudson bay region was recognized as British by the treaty of Utrecht in 1713, but the French entered Manitoba from the east. In 1731 La Vérendrye crossed southern Manitoba and in 1738 the French built Fort Rouge at the future site of Winnipeg. After the British conquest of Canada this rivalry was continued by the Hudson's Bay company, operating southward from York Factory, and the North West company of Montreal, the successor of the French fur traders. The routes from the north and the east met at "the Forks" or junction of the Red and Assiniboine rivers (Winnipeg). There the North West company built Fort Gibraltar (1804). It was in this disputed area that Lord Selkirk, in 1812, began the first agricultural settlement on the Red river (*see* Red River Settlement). A struggle ensued in which the North West company destroyed the colony and the Hudson's Bay company destroyed Fort Gibraltar. Yet colonists still arrived, despite the harsh journey by way of Hudson bay. Numerous half-breeds (métis) swarmed around the colony and trading post. In 1821 the rival companies amalgamated and a new fort, Fort Garry, was built, first of wood, but in 1836–39 of stone. The whole territory was then under the jurisdiction of the Hudson's Bay company.

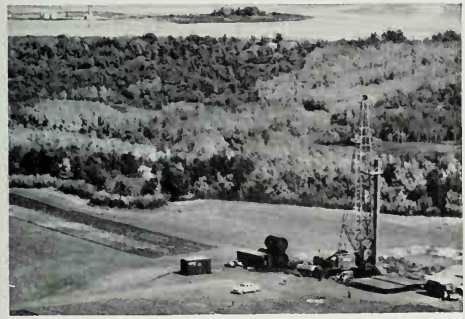
In 1867 the Red river colonies became linked by steam navigation with the westward development of settlement and railways in the United States, and settlers began to pour into the region from the south; they came from eastern Canada, the British Isles and continental Europe. In 1869 the newly formed Dominion of Canada acquired the territory from the Hudson's Bay company, and in the unsuccessful Riel rebellion of that year the métis took up arms against the new order. In 1870 the province of Manitoba was set up and entered the federation. The town of Winnipeg grew rapidly around Fort Garry after 1870 and was linked by rail with the U.S. in 1878 and with eastern Canada in 1881. Immigrants came in still larger numbers by rail to Winnipeg and spread over the province to the west, breaking up the virgin land; wheat flowed eastward in increasing quantities. To provide an additional outlet for this growing agricultural production, a railway to Hudson bay was begun in 1910, but work had to be abandoned with the outbreak of World War I; it was resumed again in 1926 and completed to the port of Churchill in 1929. The population of Manitoba, which was 25,000 in 1871, had passed 250,000 by 1901 and reached 700,000 in 1931. The boundaries of the province were extended in 1881 and again in 1912.

The 1930s were years of depression and drought. After World War II there was a greater diversification of agriculture, increased industrial expansion and mining activity.

Government and Public Finance.—The constitution of the province is derived from the British North America acts of the imperial parliament (1867 and 1871); the Manitoba act of the Canadian parliament (1870); such laws and institutions of the North-west Territory as have not been abolished or amended; and British common law and constitutional conventions. Power is divided between the federal government at Ottawa and the provincial government seated in Winnipeg, the capital. The crown is represented in the province by the lieutenant governor. The provincial premier and his ministers are normally selected from the largest party in

Harvesting wheat near Portage la Prairie. Grown chiefly in the southern part of the province, wheat is Manitoba's most important field crop

Commercial fishermen netting a catch from one of Manitoba's many lakes. Only Ontario outranks Manitoba in the development and value of its inland fisheries



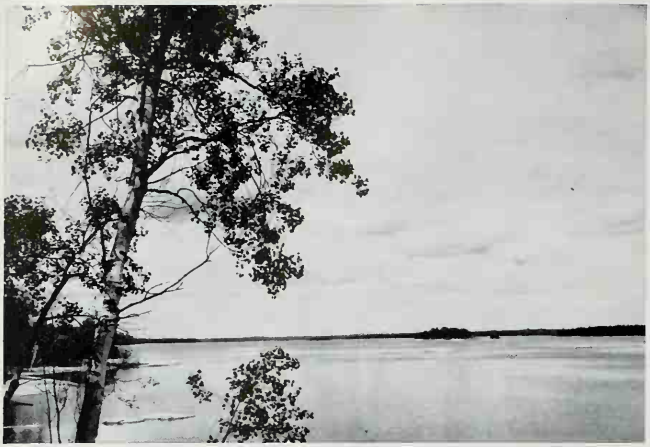
Oil derrick in the plains region of southwestern Manitoba. Although not commercially produced there until after World War II, petroleum became one of the most important minerals of the province

View of the business district of Winnipeg, capital of Manitoba and fourth largest city of Canada. In foreground is the Red river

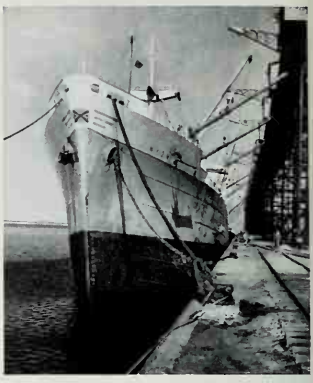
SCENES IN MANITOBA

BY COURTESY OF (CENTRE LEFT, BOTTOM LEFT, BOTTOM RIGHT) PROVINCE OF MANITOBA, DEPARTMENT OF INDUSTRY AND COMMERCE; PHOTOGRAPH, (TOP) HUNTING SURVEY CORP., LTD.

MANITOBA



View along the Winnipeg river in the Whiteshell forest and game reserve near the Ontario border. Once a route used by explorers and trappers, the river now supplies most of the hydroelectric power of Manitoba



Ocean-going freighter tied up at Churchill, chief seaport of Manitoba, on Hudson bay. Wheat is the major item of export

Freight yards at Winnipeg, among the largest in the world. Its central location made Winnipeg the principal rail and air centre of western Canada

Miners preparing to drill into ore face in one of the pits at Flin Flon, the chief mining and smelting centre of Manitoba

Highway through the forest region of northern Manitoba. Only small sections in the east have been cut over for paper and pulp. The remainder is virgin timber, and the area is largely unpopulated

TRANSPORTATION AND INDUSTRY

BY COURTESY OF (TOP LEFT) MANITOBA TRAVEL AND PUBLICITY BUREAU, (TOP RIGHT, BOTTOM) PROVINCE OF MANITOBA, DEPARTMENT OF INDUSTRY AND COMMERCE, (CENTRE RIGHT) CANADIAN CONSULATE GENERAL, CHICAGO; PHOTOGRAPH, (CENTRE LEFT) KARSH OF OTTAWA FROM PUBLIX

the single-chamber legislature, which consists of 57 members and is elected for a maximum period of five years. Local government is under provincial control. There are 6 incorporated cities, 35 towns, 37 villages and 112 rural municipalities which vary greatly in size and which are divided into land units called townships (each 6 miles square). There are 14 local government districts in newly developed areas which before 1945 had no organization. There are no counties but 16 census divisions. Manitoba is represented in the federal parliament at Ottawa by 6 senators and 14 members of the house of commons. Annual revenue of about $100,000,000 is derived from corporate income taxes (44%), gasoline tax (17%), liquor control (13%), licences (8%) and mining (5%). Major expenditures are for highways (34%), education (22%), health and public welfare (18%).

Population.—With a population of 850,040 in 1956, and 921,686 in 1961, Manitoba was sixth among the Canadian provinces. The rate of growth was very slow during the economically difficult period from 1931 to 1946, when immigration almost ceased and there was much migration from the province. After 1946 the increase was marked; it amounted to 123,117 in the intercensal period 1946–56, compared with 26,784 in the preceding 15 years. Urban population increased rapidly while rural inhabitants became less numerous; between 1941 and 1951 the urban population increased from 49% to 56%, and in 1961 more than one-half the population lived in greater Winnipeg. The chief towns of the province are Winnipeg (*q.v.*), St. Boniface (*q.v.*), St. James, Brandon (*q.v.*), East Kildonan, Portage la Prairie, Transcona and Flin Flon. All except Brandon, Flin Flon and Portage form part of greater Winnipeg (pop. [1961] 475,989).

Incorporated Places of 5,000 or More Population (1961 census)

Place	Population				
	1961	1956	1951	1941	1921
Total province	921,686	850,040	776,541	729,744	610,118
Brandon	28,166	24,796	20,598	17,383	15,397
Dauphin	7,374	6,190	6,007	4,662	3,885
East Kildonan*	27,305	18,718	13,144	8,350	6,379
Flin Flon	11,104	10,234	9,899	—	—
Portage la Prairie	12,388	10,525	8,511	7,187	6,766
St. Boniface	37,600	28,851	26,342	18,157	12,821
St. James†	33,977	26,502	19,561	13,892	11,745
Selkirk	8,576	7,413	6,218	4,915	3,726
Transcona	14,248	8,312	6,752	5,495	4,185
West Kildonan‡	20,077	15,256	10,754	6,110	4,641
Winnipeg	265,429	255,093	235,710	221,960	179,087

*Previously known as East Kildonan Municipality.
†Previously known as St. James Municipality.
‡Previously known as West Kildonan Municipality.
Note: Populations are reported as constituted at date of each census. Dash indicates place did not exist during reported census, or data was not available.

An excess of males over females has always been a feature of Manitoba's population, but this excess steadily declined and by 1961 had almost disappeared. The population is mixed by national origin; in 1961 only 43% were of British origin. There are large minorities of French, Ukrainian, German, Dutch, Polish, Scandinavian and Jewish origin; many other nationalities are represented by smaller groups. Several European languages are spoken in different parts of the province.

The United Church of Canada is the largest religious denomination (1961 census, 269,975 adherents), followed by the Roman Catholic (210,871) and Anglican (127,487) Churches; there are also considerable numbers of Lutherans, Mennonites, Presbyterians, Greek Orthodox, Ukrainian Catholic and Jews.

Education.—Public-school education (primary, secondary and technical) is administered by locally elected school boards under the general supervision of the provincial department of education, and financed by government grants and local rates. Many rural schools are one-room schools. There are two stages of secondary education: the junior high school offers a general program with options for special interests; the senior high school has five courses —general, agricultural, industrial, commercial and home economics. Teachers are trained at the University of Manitoba, the Manitoba Teachers' college and at Brandon college. The University of Manitoba, at Fort Garry near Winnipeg, has over 6,000 students. It was founded in 1877, modeled after the University of London, and empowered to offer instruction in 1900. Affiliated colleges are Brandon, nondenominational (founded 1899); St. Boniface, Roman Catholic (1818); and at Winnipeg, St. John's, Anglican Church of Canada (1866); United, United Church of Canada (established 1938 by union of Manitoba college, 1871, and Wesley college, 1877); St. Paul's, Roman Catholic (1926); and Manitoba Law school (1914).

Production.—*Agriculture.*—Although Manitoba is traditionally thought of as an agricultural province, the relative importance of farm produce declined steadily after 1937, and by 1957 the value of manufacturing was almost three times as great. Agriculture became more diversified with less dependence on grain crops. Out of a total production valued at more than $250,000,000 in the 1960s, field crops contributed a little over one-half while most of the remainder was made up of livestock and derived products. The importance of wheat declined while that of oats, barley, pasture land, canning crops and grass and fodder crops increased.

Wheat still led in value of production with oats second, although more of the latter were grown; barley was third in importance, followed by flaxseed, potatoes, mixed grains and rye. Sunflowers, grown for their oilseeds, occupied 25,000 ac. in the Red river valley. The production of sugar beets, though small and limited to lands close to the Winnipeg refinery, increased from 80,000 tons in 1948 to 188,000 tons by 1961. Wheat seeding normally takes place in May and the harvest in August. Frost in the ground stops plowing in November. There are more than 700 grain elevators with a total storage capacity of 60,000,000 bu.

The principal animal livestock is cattle (about 900,000), followed by swine and sheep; there is a large demand from the U.S. for Manitoba cattle. Because of mechanization there are very few horses left. Chickens and hens, turkeys, ducks and geese are raised and more than 30,000,000 dozen eggs are produced annually. Beekeeping and honey production (6,000,000 lb.) are noteworthy.

Agricultural land is concentrated in the southern part of the province, where about 7,000,000 ac. are cultivated (4,000,000 tilled, 3,000,000 summer fallow). Another estimated 2,500,000 ac. could be developed elsewhere in the province and after 1950 land reclamation projects were under way in northern Manitoba.

The federal government has worked an experimental farm at Brandon since 1888, with substations at Melita (soil reclamation), Portage la Prairie (special crops) and Wabowden (crop testing in the northern clay belt). There is a horticultural experimental farm at Morden. The province has about 50,000 farms; their average size is about 300 ac., which is relatively small for the prairie. About 95% are served with electricity.

Forestry.—Pulpwood accounts for 70% of forest production (over $25,000,000 annually). A survey made in 1956 showed that about 120,000 sq.mi. or about one-half the total area of the province was forested and that timber reserves amounted to 27,400,000 cords. The forested lands are almost all crown land and administered by the provincial forest service. Fire is a great hazard; annually nearly 300 fires burn more than 200,000 ac.

Fishing.—The fresh-water fishery of Manitoba is one of the most valuable in the world and produces about 30,000,000 lb. of fish a year valued at over $5,000,000. Lake Winnipeg provides about half the catch. The principal fish caught in order of poundage are pickerel, whitefish, pike, sauger, tullibee (cisco), suckers, perch, bass, trout and carp. More than 5,000 commercial fishermen take part, using motorboats in summer and fishing through the ice from snowtractors in winter. Aircraft and refrigerated boats, trucks and rail cars are used to transport the fish, 90% of which is sold in the U.S. Sports fishing is a major tourist attraction, with about 82,000 licensed anglers taking part in the summer season and about 3,000 in the winter season.

Mining.—The value of mineral production rose sharply after 1945; during the 1950s it increased from $25,000,000 to more than $50,000,000 and reached almost $200,000,000 in the 1960s. Nearly three-fourths is made up of metals, principally nickel, copper, gold and zinc. Petroleum, with annual production more than 4,000,000 bbl., has become one of the most important single minerals.

Copper, zinc, gold, silver, cadmium, selenium and tellurium are produced at Flin Flon, which has been the principal mining and smelting centre in the province since 1930. Copper and nickel

have been produced at Lynn lake since 1951, and there are gold mines at Bissett. Gold has been mined around Herb and Snow lakes since 1946.

In Dec. 1956 it was decided to begin mining nickel in the Mystery-Moak lake area. Private interests and the province invested $180,000,000 in the construction of mines, concentrator, smelter, refinery, railways, a hydroelectric power station and a townsite (Thompson). By the early 1960s rated capacity was 75,000,000 lb. a year.

Petroleum is produced in the southwestern part of the province near Virden, where commercial production began in 1951. The oil is of good quality, though sometimes affected by excess sulfur.

Electricity.—A remarkably rapid growth in the supply and consumption of hydroelectricity after World War II made Manitoba the most completely electrified province in western Canada. Six power stations were on the Winnipeg river 70 mi. N.E. of Winnipeg and supplied the towns and rural areas of southern Manitoba; others were in northern Manitoba on the Laurie and Nelson rivers and on Island lake.

Manufacturing.—The gross value of manufactured goods in the 1960s was more than $700,000,000, or more than double the combined value of agricultural, mining, forest and fishery output. Growth—an increase of 84% was recorded for the ten-year period 1947–57—was based upon increased population, advantageous position with respect to communications, greater diversification of agriculture and expanding mineral, forest and water-power exploitation. The industries of the province, which are mostly located in the Winnipeg area, serve a regional market extending from the Rockies to the Great Lakes and containing about 20% of Canada's population and national income.

Almost 50,000 workers are employed in industry and the payroll is about $150,000,000. The food and beverages industry is most important; its major subdivisions are meat packing and slaughtering. Iron and steel products come next, followed by petroleum and coal products; this industry rose from 12th to 3rd place in ten years. Fourth in value of output, but second in numbers employed, is the transportation-equipment industry, producing railway rolling stock, buses, and automotive and aircraft parts. The clothing industry, including fur processing, chemicals, electrical goods and textile and leather products, also is important.

Communications.—Southern Manitoba enjoys unusually good transport facilities because the approach of the northern wilderness toward the U.S. frontier compels east-west traffic to concentrate in the Winnipeg area. Westward from Winnipeg, rail, road and air routes fan out over the prairies.

Canadian National railways and Canadian Pacific railways operate nearly 5,000 mi. of railway in the province; these are centred on Winnipeg, the major rail town of western Canada, possessing some of the largest freight yards in the world. A 510-mi. railway, opened in 1929, connects The Pas with the northern port of Churchill on Hudson bay. Churchill is only about 450 mi. farther from Liverpool, Eng., than Halifax on the Atlantic coast, but this advantage is offset by the short navigable season (July–October) and the distance from Winnipeg. Nevertheless, nearly 20,000,000 bu. of grain are exported from Churchill in some years and it possesses a modern 5,000,000-bu. elevator. The nearby military base greatly increased the use and importance of the port.

The most important main roads are the Trans-Canada highway, running from east to west, and two highways into the U.S. Roads also serve the beach resorts on the lakes north of Winnipeg. There are bus services from Winnipeg, Brandon and other towns to most of the inhabited parts of the province. Winnipeg is a stopping place on all Canadian transcontinental air services, some of which also serve Brandon. The northern resort, mining and fur-trapping centres are accessible by regular or chartered aircraft.

The telephone system is owned and operated by the province; it has more than 280,000 subscribers, more than half of whom are in Winnipeg. The principal radio station is CBW with transmitter at Carman. There are several local privately owned stations. CKSB at St. Boniface is a French-language station. Television stations include CBWT and CBWFT (French) in Winnipeg and CKX-TV at Brandon.

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MANITOBA, LAKE, a narrow, irregularly shaped lake in the Red river lowlands of Manitoba, Can. Discovered by Pierre de la Vérendrye in 1738, the lake is 124 mi. long and lies 813 ft. above sea level. Its southern end is 80 mi. N.W. of Winnipeg and 25 mi. N. of Portage la Prairie. Separated from Lake Winnipegosis by a narrow isthmus, it is a remnant of Lake Agassiz which covered the area in glacial times. It has a valuable commercial fishery and there are small settlements and summer resorts located around its low and often swampy shores. Many of the settlers are Icelandic in origin. (W. H. PR.)

MANITOWOC, seat of Manitowoc county, Wis., U.S., is an industrial city and port on Lake Michigan at the mouth of the Manitowoc river, 83 mi. N. of Milwaukee. A French Canadian established a post there in 1795 and permanent settlement by Americans began in 1836. The city was incorporated in 1870. Manitowoc was early renowned for its shipbuilding; hence its nickname of "Clipper city." It built a sailing ship of 62 tons in 1847 and a steamboat of 434 tons in 1861. The harbour, which is kept open throughout the year, handles more than 2,400,000 tons of freight annually. Railway car and auto ferries connecting with Michigan ports account for about 60% of this total. The city has a diversified industry with a labour force of more than 6,000. One-third of that number is engaged in shipbuilding and maintenance, and as many more in aluminum work. Other important industries are food packing, lumber, wood products and furniture, paper, metal products including toys, and electrical and other machinery. The name Manitowoc means "spirit land." For comparative population figures *see* table in WISCONSIN: *Population.* (W. F. RY.)

MANIU, IULIU (1873–1953), Rumanian statesman, a peasant leader who was twice prime minister between 1928 and 1933, was born at Simleu Silvaniei (Szilágysomlyó) in Transylvania on Jan. 8, 1873, of a Rumanian peasant family, members of the Uniate Church. He was educated first at Blaj, seat of the Uniate metropolitan and centre of the Rumanian irredentist movement, and later studied law at Cluj, Vienna and Budapest. He early took an active part in the national struggle of his compatriots in Transylvania; and he was elected deputy to the Hungarian parliament in 1906. In World War I he served in the Austro-Hungarian army on the Russian and Italian fronts, but in May 1918 he organized a revolt of the Rumanian troops, in preparation for Transylvania's independence and ultimate attachment to Rumania. He was elected head of the short-lived regional government at Alba Iulia and subsequently sat in the Rumanian parliament, first as head of the National party of Transylvania and after 1926 as head of the National Peasant party, formed from the fusion of the former with the Peasant party of Ion Mihalache (*q.v.*).

Maniu formed a government on Nov. 10, 1928, and at the elections held on Dec. 12 (the first free elections in Rumania) his party won 349 seats out of 387. He was not opposed to the return of King Carol II from exile in June 1930, but resigned on Oct. 6, considering that the king had not kept his promises. Maniu was in power once more for a brief period (Oct. 1932–Jan. 1933). As he disagreed with Carol, he never again headed a government. His periods of office had coincided with the world depression and he never had full opportunity for carrying out his policies.

To the general surprise, Maniu formed an electoral alliance with the Fascist Iron Guard in 1937 in an attempt to forestall the king's plan to set up a dictatorship. He refused all offers of posts in the governments formed under the dictatorship.

Though he had no knowledge of France or England, Maniu was firmly on the side of the Allies during World War II. He did not oppose Rumania's entry into the war against the U.S.S.R. in June 1941, regarding the reconquest of Bessarabia as legitimate, but he protested strongly at the Rumanian army's crossing the Dniester river into Soviet territory beyond that province. Thereafter he became one of the principal resistance leaders and started clandestine negotiations with the Allies. He and Dinu Brătianu (*q.v.*)

were the main organizers of King Michael's *coup d'état* of Aug. 23, 1944. With the increasing control of Rumania by the Russians from the spring of 1945 onward Maniu's position became precarious, but he was left at liberty until after the peace treaty had been signed (Feb. 10, 1947). He was arrested on July 14, 1947, and sentenced on Nov. 11 to hard labour for life on charges of espionage and treason. He died in Sighet prison in 1953. Though more successful in opposition than in office, he was widely respected and is generally regarded as one of Rumania's leading statesmen of the 1920s and 1930s. (B. Br.)

MANIZALES, a city of Colombia on the western flank of the volcanic Central Cordillera, 75 mi. S. of Medellín. Pop. (1958 est.) 151,670. It is situated on a commanding ridge-top (elevation 6,988 ft.), its gray cathedral visible for miles in all directions. Manizales was founded in 1848 by colonists from Antioquia. In 1905 it was made capital of the newly created department of Caldas. The airport is located 20 mi. away, near the Cauca river. An unusual means of transportation, an aerial cableway across the crest of the Central Cordillera, connects Manizales with Mariquita and the Magdalena river. Manizales is the halfway point on the principal highway between Bogotá and Medellín and is also connected by highway and railroad with the Quindío region and Cali. It is the centre of Colombia's most important coffee-growing district; nearby, at Chinchiná, is an important coffee experiment station. (Js. J. P.)

MANKATO, a city in south central Minnesota, U.S., the seat of Blue Earth county, about 85 mi. S.W. of Minneapolis. The site was settled at the head of navigation on the Minnesota river in the early 1850s by Henry Jackson, Parsons K. Johnson and Daniel Williams of St. Paul. It was incorporated as a village in 1865, was chartered as a city in 1868, and adopted the city-manager form of municipal government in 1953. Mankato is the Sioux name for the blue earth of the region, once thought to be copper-bearing. In its early years as a frontier settlement it was menaced by hostile Indians. The Sioux uprising of 1862 culminated there in the multiple hanging of 38 Indians out of more than 400 who were tried for massacring white settlers. It is the centre of a prosperous farming region, and has an important hog market and many agricultural processing plants, two of which process a large part of Minnesota's soybean crop. Other industries include the manufacturing of cans, electrical equipment, brake assemblies, insulation and cement and the quarrying of limestone. The city is a large wholesale and retail trade centre.

Mankato State college (1868) and Bethany Lutheran college (1911), a junior college, are located there. For comparative population figures *see* table in MINNESOTA: *Population.*

(H. T. H.)

MAN LANGUAGES. The term "Man" (in Chinese, "southern barbarian") is applied to languages also known as "Yao" which together with the Miao languages constitute a group (Miao-Yao) spoken by hill peoples in southern China, North Vietnam, Laos and northern Burma. The Miao-Yao languages are imperfectly known but appear to be an independent group remotely related to the Mon-Khmer languages (Mon and Cambodian). They have no writing system of their own and no published literature.

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MANLEY, MARY DE LA RIVIÈRE (1663–1724), English writer of *romans à clef* directed against the Whigs (especially the duchess of Marlborough and her faction), who in 1711 succeeded Swift as editor of the *Examiner*. The daughter of Sir Roger Manley, governor of the Channel Islands, she was born in Jersey on April 7, 1663. In 1709 she achieved notoriety by her *Secret Memoirs . . . of Several Persons of Quality*, a scandalous chronicle "from the New Atalantis, an island in the Mediterranean," in which she sought to expose the private vices of the ministers whom Swift, Lord Bolingbroke and Robert Harley, earl of Oxford (*qq.v.*), combined to drive from office. She was arrested as the author of a libelous publication but was discharged on Feb. 13, 1710. Mrs. Manley (her cousin John Manley married her bigamously *c.* 1688) wrote her "fictitious autobiography" as *The Adventures of Rivella: or, the History of the Author of the Atalantis* (1714). Other works are her tragedy *Lucius, the First Christian King of Britain* (1717) and *The Power of Love, in Seven Novels* (1720). She died in London July 11, 1724.

See articles by G. B. Needham in the *Huntington Library Quarterly*, xii (1949), xiv (1951).

MANLIUS, the name of a patrician Roman family. The two most famous Manlii were the following:

MARCUS MANLIUS CAPITOLINUS (d. 384), consul 392 B.C. According to tradition, when in 390 B.C. the besieging Gauls were attempting to scale the Capitol, he was roused by the cackling of the sacred geese, rushed to the spot and threw down the foremost assailants. Several years after, seeing a centurion led to prison for debt, he freed him with his own money and sold his estate to relieve other debtors. He was charged with aspiring to kingly power and condemned to death when the assembly had adjourned to a place whence they could no longer see the Capitol which he had saved (384). His house on the Capitol was razed and the Manlii resolved that henceforth no Manlius should bear the name of Marcus. The account of his alleged revolution was much elaborated by the annalists writing after the time of the Gracchi.

See Livy, v, 47; vi, 14–20.

TITUS MANLIUS IMPERIOSUS TORQUATUS, twice dictator (353, 349 B.C.) and three times consul (347, 344, 340). When his father was brought to trial by the tribune M. Pomponius for abusing his office of dictator, he forced Pomponius to drop the accusation by threatening his life. In 361, during a war with the Gauls, he killed one of the enemy, a man of gigantic stature, in single combat and took from him a *torques* (neck ornament), whence his surname. When the Latins demanded an equal share in the government of the confederacy, Manlius vowed to kill the first Latin he saw in the senate house. During the Latin revolt Manlius, consul for the third time, gained two great victories in Campania (340). In this campaign Manlius executed his own son, who had killed an enemy in single combat and thus disobeyed the express command of the consuls.

See Livy, vii, 3–5; 10; viii, 3–7.

MANN, HEINRICH (1871–1950), German novelist and man of letters, the elder brother of Thomas Mann, was born at Lübeck on March 27, 1871. He entered the publishing profession, but after the death (1891) of his father, a substantial grain merchant, he became financially independent, and lived in Berlin, spending long periods abroad, particularly in France. His early novels portray the decadence of high society (*Im Schlaraffenland*, 1900; Eng. trans. *In the Land of Cockaigne*, 1929), but his later books show him as a more serious critic of the greedy seeking for wealth, position and power in Wilhelmine Germany (*Professor Unrat*, 1905, Eng. trans. *The Blue Angel*, 1932; *Der Untertan*, 1918, written 1914, Eng. trans. *The Patrioteer*, 1921; *Die Armen*, 1917; *Der Kopf*, 1925). His novels were accompanied by essays attacking the arrogance of authority and the subservience of the "subjects"; particularly noteworthy is the *Zola* essay of 1915, which led to a breach with his brother. After 1918 he became a prominent spokesman of writers' associations and radical democracy, and published volumes of political essays, *Macht und Mensch* (1919) and *Geist und Tat* (1931). Forced into exile in 1933, he spent the rest of his life in France and the United States. His historical novel *Henri Quatre* (two parts, 1935 and 1938) is his most mature work, and represents his ideal of the humane use of power. He hoped to return to the German Democratic Republic, but was prevented by the illness from which he died in Santa Monica, Calif., on March 12, 1950.

See H. Ihering, *H. Mann* (1951); A. Kantorowicz, *H. und T. Mann* (1956). (Ro. P.)

MANN, HORACE (1796–1859), U.S. educator, "the father of American public education," was born in Franklin, Mass., on May 4, 1796. He grew up in an environment governed by poverty, hardship and self-denial. His early schooling came in brief and erratic periods of eight to ten weeks a year, and from comparatively poor teachers. But he managed to educate himself in the Franklin town library, and with the help of some tutoring by an

itinerant schoolmaster he gained admission at the age of 20 to the sophomore class at Brown university. He did brilliant work at Brown, manifesting great interest in problems of politics, education and social reform; his valedictory address, on the progressive character of the human race, was a model of humanitarian optimism, portraying the way in which education, philanthropy and republicanism can combine to allay the wants and shortcomings that have traditionally beset mankind.

Upon graduation in 1819 Mann chose law as a career. There was a brief period of reading law with a Wrentham, Mass., lawyer, followed by an interlude of teaching at Brown. Then came a time of more concentrated study at Litchfield (Conn.) Law school, and finally admission to the bar in 1823. Meanwhile, he had decided to settle in Dedham, and there his legal acumen and oratorical skill soon won him a seat in the state legislature. From 1827 to 1833 he served in the Massachusetts house of representatives, where he led in the establishment of a state hospital for the insane at Worcester, the first of its kind in the United States. In 1833 he moved to Boston and was elected to the Massachusetts senate, where he served four years, the last two as president of that body.

Of the many causes Mann espoused, none was dearer to him than the education of the people. Nineteenth-century Massachusetts could boast a public school system going back to 1647. Yet during Mann's own lifetime, the quality of education had steadily deteriorated as school control had gradually slipped into the hands of economy-minded local districts. A vigorous reform movement arose, committed to halting this decline by reasserting the state's influence over the schools. The result was the establishment in 1837 of a state board of education, charged with collecting and publicizing school information throughout the state. Much against the advice of friends, who thought he was tossing aside a promising political career, Mann accepted the first secretaryship of this board.

Endowed with little direct power, the new office demanded moral leadership of the highest order and this Mann supplied for 12 years. He started a biweekly *Common School Journal* for teachers, and lectured widely to interested groups of citizens. His 12 annual reports to the board ranged far and wide through the field of pedagogy, stating the case for the public school and discussing its problems. Essentially his message centred in six fundamental propositions: (1) that a republic cannot long remain ignorant and free, hence the necessity of universal popular education; (2) that such education must be paid for, controlled and sustained by an interested public; (3) that such education is best provided in schools embracing children of all religious, social and ethnic backgrounds; (4) that such education, while profoundly moral in character, must be free of sectarian religious influence; (5) that such education must be permeated throughout by the spirit, methods and discipline of a free society, hence harsh pedagogy in the classroom is undesirable; and (6) that such education can be provided only by well-trained, professional teachers who have mastered their subject matter and the pedagogical arts as well. Mann encountered strong resistance to these ideas—from clergymen who deplored nonsectarian schools, from educators who condemned his pedagogy as subversive of classroom authority and from politicians who opposed the board as an improper trespass on local educational authority—but in the end his views prevailed.

Mann resigned the secretaryship in 1848 to take the seat of former Pres. John Quincy Adams in the United States congress. There followed a stormy period during which he took an uncompromising stand against slavery. In 1853, having run unsuccessfully for the Massachusetts governorship a year before, he assumed the presidency of Antioch college in Yellow Springs, O., a new institution committed to coeducation, nonsectarianism and equal opportunity for Negroes. There, amidst the usual crises attendant upon the running of an infant college, Mann finished out his years. He died at Yellow Springs on Aug. 2, 1859. Two months before, he had given his own valedictory in a final address to the graduating class: "I beseech you to treasure up in your hearts these my parting words: Be ashamed to die until you have won some victory for humanity."

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(L. A. C.)

MANN, THOMAS (1875–1955), German novelist and essayist, who won the 1929 Nobel prize for literature and whose work is a significant expression of the spiritual situation in Germany and Europe during his lifetime, was born at Lübeck on June 6, 1875. His father, a patrician and substantial grain merchant, died in 1891, and Mann, after perfunctory work in an insurance office and on the editorial staff of *Simplicissimus* in Munich, devoted himself to writing.

Influenced by Schopenhauer, Nietzsche and Wagner, Mann at first saw in art the creation of value in a world unconcerned with meaning, and his early stories centre in the incompatibility of art and life. But he distinguished himself from the aestheticism of those years through his ironical treatment of the "decadent" artist and through an almost involuntary appreciation of normal practical life. His first great success, *Buddenbrooks* (1900), was intended to show how a merchant family loses its grip on life as its members become engrossed with spiritual values and art, but it became too a tender celebration of work and family loyalty. The semi-autobiographical *Tonio Kröger* (1903) delineates Mann's position, an artist cut off from practical social existence yet attracted to its orderliness and positivism and hostile to bohemianism. Still preoccupied with this problem in *Königliche Hoheit* (1909), where he imposes an idyllic reconciliation, in the tragic *Tod in Venedig* (1912) Mann transfers his attention to the conflict within the artist himself, between his nervous and decadent sensibility and his self-discipline through formal mastery.

The outbreak of war in 1914 roused Mann to patriotic fervour. In *Betrachtungen eines Unpolitischen* (1918) he defended German authoritarianism as the rampart of artistic "inwardness," of "Kultur," while he attacked democracy as the political concomitant of superficial "civilization." But in the early years of the Weimar republic he began to be critical of these formulations, which he later repudiated. A first somewhat tortuous declaration of democratic principle (*Von deutscher Republik,* 1922) was succeeded by a major statement in the novel *Der Zauberberg* (1924). Its theme is the development of the young hero through the seductions of inwardness and death that he experiences as a voluntary inmate of a tuberculosis sanatorium, up to the point where he decides for life and service to his fellow countrymen. The protracted arguments between the rationalist democrat Settembrini and the irrationalist totalitarian Naphta document the crisis of Europe; Hans Castorp seeks a middle way, skeptical but humane.

Some of Mann's most charming personal pieces belong to the decade after 1918 (*Herr und Hund,* 1919; *Unordnung und frühes Leid,* 1926), but the mounting political crisis in Germany forced him, against his own nature as he felt, to become more and more a political figure. *Mario und der Zauberer* (1929) is a short story that depicts Fascism in the form of a seedy illusionist, and *Ein Appell an die Vernunft* (1930) is a bold address calling on Germans to unite against Hitlerism. After 1933 life in Germany was no longer possible for Mann, and he went to the United States, visiting Germany after 1945 but never living there again. He died in Zürich on Aug. 12, 1955. Numerous essays and speeches express his humanistic passion and his hatred for National Socialism and the mystical primitivism that nurtured it in intellectual circles. After World War II he sought to maintain bridges between east and west, particularly between East and West Germany.

All Mann's later novels emerge from his deep engagement in the spiritual crisis of Europe. In the four volumes of *Joseph und seine Brüder* (1933–44) he rewrote the "fairy tale" of the biblical Joseph in order to create a consoling myth for modern humanity. *Lotte in Weimar* (1939) celebrates Goethe's renunciation of the destructive raptures of his youth in favour of life and work.

Both are distinguished by that "reverence for man" that Mann defined as true religion. His most sombre novel, *Doktor Faustus* (1947), the story of a composer who sells his soul to the devil, is a symbolical description of the corruption of German and European humanism in Mann's lifetime. The last works show a certain relaxation of imaginative intensity (*Der Erwählte*, 1951; *Die Betrogene*, 1953), though *Felix Krull* (1954), the continuation of an earlier fragment, is a brilliantly humorous story of a swindler.

Mann was a writer of great range and subtlety, equally successful in the evocation of figures and scenes as in philosophical discussion. His works lack simplicity and, sometimes, human feeling; indeed he distrusted simplicity in a world that so easily abused it. But despite its sophisticated irony his work is full of tender concern for mankind.

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MANNA. Although the word "manna" is familiar and widely quoted, it has no exact meaning; it may refer to plants or even birds. However, it popularly connotes a miraculously supplied food—"the bread of heaven." Not all the references to manna (in at least ten books of the Bible) signify the same species of plant; that falling from heaven, in the wilderness (Ex. xvi), was presumably wind-borne lichens, while the "honeydew" manna of many later references signifies gummy exudations or resins from several desert trees and shrubs. Exodus xvi: 13–15 states ". . . Behold it will rain bread from Heaven . . . the children of Israel saw it, they said one to another, it is manna: . . . taste of wafers made with honey . . . and the children of Israel did eat manna forty years. . . ."

Lichens.—The biblical manna is believed to be the lichen *Lecanora esculenta*—perhaps also *L. affinis*, *L. fruticulosa* and *L. tartarea*. A lichen (*q.v.*) is a synthetic plant, consisting of a partnership of a green alga and a fungus. *Lecanora* is a relative of reindeer moss (*Cladonia rangiferina*), famed in the arctic tundra as sustenance for reindeer herds.

Lecanora manna ranges from southern U.S.S.R. to Syria and Iran; it is absent from the Sinai desert and eastern north Africa but is found in Algeria and the Atlas mountains. During drought, it curls into lightweight flakes or balls, which break loose easily. Strong winds carry it great distances and windrows often accumulate in the desert, wafted from the mountains. In 1854 a manna shower fell upon Persia during drought and famine. In 1891 an abundant fall was reported in Turkey. It is supposed that manna was, in this way, provided Moses while en route to the Promised Land, or that a migration of quail may have coincided with the blowing in of lichen, providing additional food. Bedouin herdsmen collect lichen manna and consume it mixed with one-third meal. In many parts of the near east, lichen breads are baked and a manna jelly is prepared.

Resins.—The camel's-thorns of Asia Minor (*Alhagi maurorum* and *A. pseudalhagi*) are spiny-branched shrubs up to 3 ft. tall, with simple leaves. They occur in the wastes of the Middle East. Heat or insect activity causes them to exude a resin, which hardens and may be collected by shaking the bushes over a cloth spread on the ground.

The French tamarisk (*Tamarix gallica*), a shrub up to 15 ft. in height, with scalelike leaves and clusters of tiny pink flowers, occurs in the deserts of the same area as the *Alhagi* and is common in the Sinai. A scale insect either punctures the stem, triggering the exudation, which hardens in drops, or secretes the manna itself. Bedouins collect this honeylike material, considering it a great delicacy.

The flowering ash (*Fraxinus ornus*), a tree up to 50 ft. high, with pinnate leaves, ranges from southern Europe into Syria and Lebanon and is cultivated on some Mediterranean islands. In summer the branches are slashed and the juices exude and harden as manna (the source of commercial manna). Ash manna is a sweetish exudate, finding limited commerce as flakes (flake manna) or fragments (common manna) or viscid droplets (fat manna). Chemically it consists of mannin, which is a laxative, demulcent and expectorant.

One of these purchasable "sweet mannas" was likely referred to in the book of Baruch i: 10, ". . . and prepare ye manna, and offer upon the altar of the Lord. . . ." Authorities have also suggested a dozen other arid land species that might be the source of gum-resinous mannas, including legumes, willows, oaks, pears, cedars and members of the genus *Eucalyptus* and the composite family. (R. W. Sv.)

MANNAEANS. The Mannaeans occupied the country called Mannai or Mana in northwestern Iran which lay south of Lake Urmia in modern Azerbaijan and Kurdistan. During the period of its existence in the early 1st millennium B.C., Mannai was surrounded by three major powers: Assyria to the west, Urartu to the north and Media to the southeast. The Mannaeans are first recorded in the annals of the Assyrian king Shalmaneser III (859–824 B.C.) during a period of Assyrian expansion eastward. Following the Assyrian decline at the end of the century the area is first mentioned by the Urartian king Menuas (810–781 B.C.). An inscription at Tas Tappeh (Tash Tepe), near modern Miandow Ab (Miyanduab), celebrates his victory in the plain of Missi over the Mannaean town of Meista. In 714 B.C. the Assyrian Sargon II (722–705 B.C.) broke the power of Urartu in his famous eighth campaign with a long march around Lake Urmia. Mannaeans are last mentioned in the annals of Urartu by Rusa II (685–645 B.C.) and in Assyria by Esarhaddon (681–669 B.C.). Minor references occur in Neo-Babylonian literature, but in general with the intrusion of the Scythians and the rise of the Medes in the 7th century Mannaeans lose their identity and are subsumed under the term Medes. Scattered references by later historians refer to the people of this area as the Minni (Jeremiah), Matieni (Herodotus and Polybius), or Mantiane (Ptolemy).

Archaeological investigations at Hasanlu Tepe, near Nagadeh, and the Ziwiye treasure found near Saqqez, show a culture rich in metal work with a local art style which was originally quite distinct from that of surrounding areas but which gradually came under Assyrian and Scythian influence. Architecture and pottery show a fusion of elements related to prehistoric Iran, northern Mesopotamia and eastern Anatolia. Motifs on the gold Hasanlu bowl suggest strong contact with these Hurrian-speaking areas. This contact may be historically significant since both place names and personal names in Mannai are thought to be in a Hurrian-related dialect.

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MANNAR (MANAAR), **GULF OF,** a shallow gulf of the Indian ocean lying between the southern coast of Madras state on the west and the coast of Ceylon on the east. Its width varies from 80 to 170 mi. and its length from north to south is approximately 100 mi. Its northern limit is marked by a low-lying peninsula on the Indian side, extended by a number of islands and a line of rocks known as Adam's bridge (*q.v.*) to Mannar Island on the Ceylonese side. Channels between the islands (of which Pamban channel is the most used) lead into the shallow Palk strait lying between northern Ceylon and the Indian mainland. A branch of the South Indian railway was built out over the islands on the Indian side to a small rail port at Dhanushkodi, only 22 mi. from a similar rail port, Talaimannar, on the Ceylon side. Until the development of air traffic, this was the main route for passengers and mail from south India to Ceylon. (L. D. S.)

MANNERHEIM, CARL GUSTAF EMIL, BARON (1867–1951), Russian and later Finnish army officer, called the George Washington of modern Finland, was born at Villnäs, near Turku, Fin., on June 4, 1867. He began his military career as a lieu-

tenant of cavalry in the Russian army in 1889, and served in the Russo-Japanese War and in World War I. By 1917 he was a corps commander with the rank of lieutenant general. In Dec. 1917, following the Russian Revolution, he returned to his native Finland, which had declared its independence. In Jan. 1918 he assumed command of the "White" forces opposing the Bolsheviks, leading them to victory in four months. He became regent of Finland in Dec. 1918, holding this position for seven months until a republic was declared.

In 1931 Mannerheim returned from retirement to become chairman of the defense council. During his eight years in this post there was built a line of fortifications across the Karelian isthmus, popularly called the Mannerheim line in his honour. At the age of 72, Mannerheim served as commander in chief in the defensive "winter war" against the Soviet Union (Nov. 1939 to March 1940). The brilliance and remarkable skill of this campaign against a great power led to a relatively favourable peace settlement. Following a new Soviet attack in June 1941, Mannerheim continued to serve as commander in chief until peace was negotiated in Aug. 1944. He was named the only marshal of Finland in June 1942. Mannerheim became president of the republic in 1944, retiring because of ill health in 1946.

He died at Lausanne, Switz., on Jan. 27, 1951. He wrote *Across Asia From West to East in 1906–1908* (1940); the *Memoirs of Marshal Mannerheim* was published in English in New York in 1954. (R. L. Gf.)

MANNERISM is the name now given to the style which prevailed in the arts in Italy from about 1520 until about 1590. The word derives from the phrase *di maniera*, meaning "by rote," frequently used by G. Vasari and others to describe the creation of a work of art without reference to nature but by dependence on an inner idea, formed originally in the artist's mind from nature, but modified by aesthetic considerations and by the study of other works of art.

Early in the 20th century it was realized that the art of the period between the death of Raphael and the rise of the Carracci and Caravaggio (*qq.v.*) is not simply a decadent version of the high Renaissance but a fundamentally different style. The reasons for this change are manifold, although a school of Marxist historians in the 1920s sought to explain the phenomenon in terms of the economic and social crises precipitated by the rise of Lutheranism and, still more, by the catastrophe of the sack of Rome in 1527. The sack of Rome came as a numbing shock to contemporaries; and it led to the complete collapse of the serene and apparently stable world of humanist values which had given birth to the Renaissance and to a marked increase in religious emotion in the arts, but the external causes do not explain Mannerism as an artistic phenomenon: it is also necessary to refer to artistic reasons. A desire for a new style, expressed in what would now be called Mannerist terms, can be traced well before 1527 and even in Raphael's own last works, most notably in the "Transfiguration" (Vatican gallery) begun in 1517. This was the result of two main factors: the general feeling that the Stanze (in the Vatican palace) of Raphael, or the architecture of Bramante, represented a norm of classical perfection and that no further progress was possible on that road; and the opening of new vistas in the use of the nude as a means of emotional expression by Michelangelo's "Battle of Cascina" and Sistine chapel ceiling, whereby many artists fell into the trap of regarding "clever" poses, much foreshortening and anatomical knowledge as ends in themselves. Others, perhaps more sensitive to approaching disaster, began to impart a tension into their works directly at variance with the serenity of the Renaissance style. In architecture the deliberate flouting of Bramante's ideas in favour of a new style, both exciting and deliberately allusive, can best be seen in the Palazzo del Tè at Mantua, begun in 1525 by Raphael's pupil Giulio Romano (*q.v.*).

The neurosis implicit in much early Mannerist art was partly caused by its exponents, for Rosso, Jacopo da Pontormo and Parmigianino were all somewhat unbalanced; but they created a religious art of direct and personal expressiveness which was later continued outside central Italy by Tintoretto and El Greco, who, with the aged Michelangelo, were the greatest artists of the style.

Mannerism is a negative style based on rejections and unresolved conflicts. The imitation of nature is modified in favour of the "idea" in the artist's mind (*see* G. P. Lomazzo, *Trattato dell' Arte . . .*, 1584), compositions are deliberately asymmetrical and too little picture space is allotted to the figures, thus crowding them together and emphasizing the twisted and elaborate poses imitated from Michelangelo. Figures are much elongated to gain in grace and also for the sophisticated pleasure of breaking the classical rules of proportion. It is essentially a learned art, for the spectator is supposed to be both shocked and thrilled by this rule-breaking, as where Michelangelo, in his Laurenziana library in Florence, recessed columns into the wall thus contradicting their strengthening function.

In the second half of the century Mannerism itself became codified into a set of elaborate rules, but many fine portraits of cold elegance were painted (by Bronzino in Florence and N. Hilliard in England, for example), and much of what began as an Italian movement was copied, though rarely understood, by the Romanists in the Low Countries, France and elsewhere. According to some critics, Mannerist influences are discernible in certain trends of modern art and literature, such as Surrealism (*see* G. R. Hocke, *Die Welt Als Labyrinth*, 1957).

See also references under "Mannerism" in the Index.

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MANNERS, CHARLES (1857–1935), Irish bass singer and operatic impresario, whose real name was Southcote Mansergh, was born in London on Dec. 27, 1857. After studying singing in Dublin, London and Italy, he joined the D'Oyly Carte company and in 1882 became known for his performance as the sentry in *Iolanthe* at the Savoy theatre. Subsequently he appeared in operatic productions in London, the U.S. and South Africa. He married Fanny Moody, a leading soprano, in 1890. In 1897 they formed the Moody-Manners opera company, which made a number of successful tours in the provinces and also performed three seasons in London. Manners died at Dundrum, County Dublin, on May 3, 1935.

MANNHEIM, a town of Germany which after partition of the nation following World War II was located in the *Land* (state) of Baden-Württemberg, Federal Republic of Germany. It lies at the confluence of the Neckar with the Rhine and is joined by a railway and road bridge with Ludwigshafen on the left bank of the Rhine. The old town, which is surrounded by the *Ring*, is built like a chessboard in 136 rectangular blocks of houses, known as the *Quadraten*. Pop. (1961) 313,890.

First mentioned in 766 as a village, Mannheim was fortified in 1606 and received its privileges and municipal law in 1607. It was destroyed in 1622 during the Thirty Years' War and again in 1689 in the struggle for succession which led to the War of the Grand Alliance. In 1720, however, when Charles Philip of the Palatinate moved his residence from Heidelberg to Mannheim, it was rebuilt. The castle, the Jesuit church, the old town hall in the market place with the Unteren Pfarrkirche, the Kaufhaus and the Zeughaus or arsenal are among the baroque buildings of this period. Learning and the arts were cultivated and the Mannheim school of conductors, violinists and composers, the art gallery and the academy of sciences had a European reputation. In 1778 the court moved to Munich. In the same year the National theatre was opened and in 1782 it gave the first performance of Schiller's *Die Räuber*. In 1795 Mannheim was destroyed for the third time, during the French wars, and in 1802 it was transferred to Baden. In 1848–49 it was at the centre of the revolutionary movement.

Mannheim's economic rise in the 19th century was due to its position at the highest navigable point on the Rhine for large ships. By the end of the century it had developed from a commercial into an industrial city. In World War II more than half the town was destroyed in air raids but the castle, the Jesuit church, the old town hall and the arsenal were later rebuilt.

Mannheim's chief manufactures are chemicals, cellulose, soap,

machinery, steel, electrical and railway equipment, foodstuffs and tobacco. Of special importance is the import trade and trade in coal and iron. With more than 1,000 yd. of quays, numerous docks and a dock railway, Mannheim has the second largest inland harbour in Europe. Mannheim has remained a cultural centre with the National theatre (rebuilt 1954–57, with two stages), colleges for music and drama, engineering and industry, and art collections in the Reiss museum and the Kunsthalle. (G. Jb.)

MANNING, HENRY EDWARD (1808–1892), English cardinal and archbishop of Westminster, was born July 15, 1808, at Totteridge, Hertfordshire, youngest son of William Manning, banker and member of parliament. He went to Harrow school in 1822 and to Balliol college, Oxford, in 1827. He was president of the union in 1829. In the following year he took his degree with first class honours in classics. He was a clerk in the colonial office until, on resolving to be ordained in the Church of England, he returned to Oxford in 1832 as a fellow of Merton college. Without regarding himself as a Tractarian, he accepted the tenets of the Oxford movement (*q.v.*). His relations with J. H. Newman (*q.v.*) were friendly but not intimate. He was ordained deacon in 1832 (priest, 1833), became curate at Lavington, Sussex, and married a daughter of his rector, John Sargent, whom he succeeded as rector (1833). Manning gave himself completely to his parish work. The death of his wife in 1837 affected him profoundly, but he found relief in the reading of the early Fathers and in his increasing responsibilities in the diocese of Chichester of which he became archdeacon in 1840.

The problem of the relation between church and state was foremost in Manning's mind. He opposed any government interference in ecclesiastical and educational affairs; it was along this line, rather than that of doctrine, that he was to make his way to the Roman Catholic Church. He was critical of those who left the Church of England, but he found Newman's *Development of Christian Doctrine* (1845) unanswerable. During a long visit to Rome in 1847 he studied the organization of the Roman Catholic Church and had an audience with Pius IX, but he was shocked to find the little concern shown for the Anglican Church. He was forced to consider his position when in March 1850 the privy council overruled the refusal of a bishop to institute G. C. Gorham on grounds of unorthodoxy (*see* England, Church of). Manning felt that this was an intolerable interference by a lay tribunal, but when he tried to mobilize opinion on his side the response disheartened him. It was the parting of the ways. On April 5, 1851, he saw Cardinal Wiseman and on the following day was received into the Roman Catholic Church. In taking this step, he was throwing away the certainty of high preferment for an uncertain future in a church regarded with aversion by his countrymen.

Wiseman was quick to appreciate Manning's outstanding abilities, and ordained him priest on June 14, 1851. Manning studied theology in Rome and soon won the regard of Pius IX and of the cardinals, but he also became the intimate of George Talbot, a tattler who amused the pope; their association brought out the least admirable side of Manning's character—his readiness to achieve ends, however disinterested, by backstairs influence.

In 1857 he founded and was the superior of the congregation of the Oblates of St. Charles who were put at the disposal of the archbishop of Westminster; at the same time, Manning was appointed by the pope to be provost of the Westminster chapter. This rapid promotion combined with his increasing influence with Wiseman roused the opposition of those who felt that Manning had not yet "worked his passage." When complaints reached Rome, Wiseman wrote a detailed report setting out Manning's considerable achievements—his success in winning converts, his effectiveness as a preacher and, above all, his devotion to the needs of the poorer Catholic children. This tribute and his personal knowledge of Manning during visits to Rome influenced the pope when, on Wiseman's death in 1865, he made Manning archbishop of Westminster. It was a startling appointment, for his name had not been put forward by the bishops or by the chapter, but it was fully justified. Manning intensified his efforts to safeguard Catholic children by building many more schools and by establishing institutions for the neglected and homeless. After the rather lenient rule of Wiseman, the new archbishop's authoritative rule seemed hard to some, but priests soon found a friend in Manning.

He was an extreme ultramontanist, and was determined to make the church in England a true reflection of the church in Rome. In all this he was encouraged by W. G. Ward, editor of *The Dublin Review;* unfortunately both regarded any opposition as disloyalty to the church. It was here that they clashed with Newman and accused him of minimizing, as they put it, the authority of Rome.

Manning played a leading part in the debates on infallibility at the Vatican council of 1869–70, but the resultant definition was more moderate than he wished. He was created cardinal in March 1875.

In the last phase of Manning's life he gained a high position in public regard. He served on the royal commission on housing in 1884 and readily supported many charitable causes. His successful intervention in the London dock strike of 1889 was his most publicized achievement. The encyclical *Rerum novarum* of Leo XIII on the condition of the working classes of 1891 put the seal of papal approval on Manning's social work. He died in London on Jan. 14, 1892.

None of his many articles and books has endured; they were effective for the occasions for which they were written, but there was not sufficient depth of thought to give them permanence.

Bibliography.—E. S. Purcell, *Life of Cardinal Manning,* 2 vol. (1896), is a primary source as most of the documents are no longer available; it needs to be read with qualifications, since it misrepresents some episodes and ignores others. Shane Leslie, *Henry Edward Manning* (1921), helps to correct this distortion. Lytton Strachey, "Cardinal Manning," in *Eminent Victorians* (1918), should not be taken too seriously. A. W. Hutton, *Cardinal Manning* (1892), is still of interest as an Anglican view; it contains the only bibliography of Manning's writings. V. A. McClelland, *Cardinal Manning, His Public Life and Influence, 1865–1892* (1962), concentrates on Manning's social work. *See* also E. E. Reynolds, *Three Cardinals* (1958).

(E. E. Re.)

MANNING, JAMES (1738–1791), American Baptist clergyman and first president of Brown university, was born at Piscataway, N.J. on Oct. 22, 1738. He attended the Baptist Latin school at Hopewell, N.J., graduated from Princeton (B.A., 1762) and was ordained to the Baptist ministry at Scotch Plains, N.J., on April 19, 1763. Between his graduation and ordination he traveled throughout the colonies, partly in a missionary interest and partly to survey possible sites for a college. Baptists were intent on founding a college, and Manning, who stood second in his class at Princeton, was put in charge of the project. Rhode Island, which was near the geographical centre of the 14 colonies, was selected, and Manning was commissioned to stop at Newport on his way to Halifax in July 1763 to put the plan in operation. A charter was granted by the Rhode Island assembly in March 1764, and in April, Manning settled in Warren, R.I., opened a Latin school, and organized a church to help provide his support. The following year the college opened its doors, and in 1770 it was shifted to Providence, where Manning also served as minister of the First Baptist church. Instruction was disrupted by the American Revolution, but by the end of Manning's 26-year administration the college was firmly established. Manning also helped organize the Baptists of New England into the Warren association (1767), presented a memorial for religious liberty to the Continental congress in 1774, represented Rhode Island in the Congress of the Confederation in 1786, and drafted a report in 1791 urging the establishment of free public schools. He died on July 29, 1791.

Documentary materials are printed in R. A. Guild, *Early History of Brown University* (1897).

(W. S. H.)

MANNY, SIR WALTER DE MANNY, Baron de (d. 1372), soldier of fortune, military and naval commander, and founder of the London Charterhouse, was a native of Hainaut. The friend and patron of Froissart, his career is an example of how an able and talented young man, nobly born but without resources, could end his life a peer, a landowner and a person of considerable importance in the England of Edward III.

Manny probably went to England in 1327 in the retinue of

Philippa of Hainaut, when she went to marry Edward III. Knighted in 1331, he was appointed admiral of the fleet north of the Thames in 1337 and again in 1348, and appears to have done some good convoy work. In 1347 he was summoned to parliament as a baron by writ, and attended intermittently till his death. He married a granddaughter of Edward I, and by 1372 he had possessions in 16 English counties.

Manny, according to Froissart, was a person of unusual charm. He was also devout, and in 1371 he founded a house for Carthusians, the famous Charterhouse, near Smithfield. It is possible that Michael Northburgh, bishop of London from 1355 to 1361, had been associated with the project, but Manny was the effective founder and in his will he directed that he should be buried without pomp in the monastery he had begun. In fact, when he died in London about Jan. 15, 1372, the funeral of this former landless squire was attended by a great company, headed by the king and his sons. (I. P. S.)

MANNYNG (OF BRUNNE), **ROBERT** (*fl.* 1283–1338), early English poet and author of *Handlyng Synne*, a poem of popular morality, and of the chronicle *Story of England*. He is probably to be identified with a Sir Robert de Brunne, chaplain, named as executor in a Lincoln will of 1327; apart from this mention his biography can only be reconstructed from his writings. He was born at Brunne (Bourne), Lincolnshire, in 1283 or somewhat earlier, and in *c.* 1300 was at the University of Cambridge, where he met Alexander, brother of the future King Robert the Bruce of Scotland. For 15 years (*c.* 1302–*c.* 1317) Mannyng was a Gilbertine canon at Sempringham priory, Lincolnshire, the original foundation of the order. There in 1303 he began *Handlyng Synne* and was still working at it after 1307. For many years before 1338 he was engaged on the *Story of England*, which he wrote at the request of the prior of the Gilbertine house at Sixhills near Market Rasen, Lincolnshire. The *Story of England*, the author relates, was finished between three and four o'clock, on Friday, May 15, 1338.

Handlyng Synne is an adaptation in about 13,000 lines, in short couplets poorly versified, of the *Manuel des Péchés*, which is usually ascribed to William of Waddington (or Widdington), an Englishman, probably a Yorkshireman, writing in Anglo-Norman between 1250 and 1270. The text of the *Manuel* remains amorphous; there are more than a score of manuscripts, which present the work in many degrees of completeness and expansion—evidently it was highly popular and influential. Like Waddington, Mannyng aimed to provide a handbook which should serve to stimulate careful self-examination as preparation for auricular confession. *Handlyng Synne* is thus an exact title, and the English work and its source represent extensions into the terms of popular thought and into vernacular languages of the copious clerical literature on confession which had developed in western Europe from the end of the 12th century.

Mannyng follows his original closely. He sometimes omits, but more often amplifies to elucidate doctrine, does not hesitate to soften the rigour of injunctions and in general shows a superior power in organization. He deals in turn with the Ten Commandments, the Seven Deadly Sins and the sin of sacrilege, the Seven Sacraments, the 12 requisites of confession and the 12 graces of confession. There is much direct instruction, exhortation and didactic comment, but each of the topics is illustrated by one or more tales. These *exampla* have sometimes been considered to provide the particular interest of the work. Most of them are drawn from the *Manuel*, but Mannyng sometimes provides a local setting and sometimes goes back to Waddington's sources for further detail. He also adds 13 fresh stories, some from the Bible and several of local provenance. The whole work is designed for oral delivery. Mannyng's merit as a storyteller lies in his apt management of material and in his lucid, direct narration. Otherwise the literary merits of *Handlyng Synne* are negligible, although its documentary value for social history is great. It illustrates clearly the attitudes and values of the English minor clergy and peasantry in the early 14th century; throughout there is much comment on the social, domestic, parochial and commercial scene. The poem was popular in the 14th and 15th centuries; passages from it were worked into other compositions. Its modern appeal will be found in its moralized realism.

Of similar literary quality is Mannyng's later work, the *Story of England;* but, as Mannyng's editor, F. J. Furnivall, observes, whereas the matter of *Handlyng Synne* is fact, the basis of the *Story of England* is fiction. As history it is almost worthless. The work falls into two parts. The first, in something less than 9,000 lines written in short couplets, tells the story from Noah to the death of Caedwalla in 689. In form and substance Mannyng follows *Le Roman de Brut* by the Anglo-Norman poet Wace, but he draws also on Bede, on Geoffrey of Monmouth (Wace's source) directly and on the Anglo-Norman *Chronicle* of Peter Langtoft (*q.v.*). In the 9,000 lines of the second part, taking the story to the death of Edward I (1307), Mannyng relies primarily on Langtoft's *Chronicle* and again adopts the metrical form of his original, in this case the alexandrine couplet, which he manages clumsily.

He continues to incorporate material from other sources—from Bede again, from lives of English saints and from later historians —and he adds scraps of his own. Of particular interest is his use of popular romance. Into his account of Aethelstan he inserts the story of Guy of Warwick's encounter with the giant Colbrand, he affects surprise that no reputable historian has dealt with Arthur or with Havelock and he draws heavily on the extravagant 14th-century romance of Richard the Lion-Hearted. Following Langtoft, but with some variations from Langtoft's text, he works into his narrative several topical songs, mainly on the Scottish wars of Edward I's time.

Handlyng Synne and the *Story* are preserved independently in several manuscripts, none contemporary with Mannyng and none of certain provenance; but insofar as the original east midland dialect of composition can be discerned, Mannyng's language is of importance in tracing the development of the spoken and literary standard of English. *Meditations of the Supper of Our Lord*, a verse rendering of part of the *Meditationes vitae Christi* of St. Bonaventure, has been ascribed to Mannyng on no better ground than that in two manuscripts it is transcribed immediately after *Handlyng Synne*.

BIBLIOGRAPHY.—Mannyng's *Handlyng Synne* was ed. by F. J. Furnivall, with text of the *Manuel* in parallel, for the Roxburghe club (1862) and with extracts from the *Manuel* for the Early English Text society, original series 119, 123, 2 vol. (1901–03); there is no satisfactory edition of the *Manuel des Péchés*. The 1st pt. of *The Story of England* was ed. by F. J. Furnivall, "Rolls Series," 2 vol. (1887); for the 2nd pt. see *Peter Langtoft's Chronicle*, T. Hearne (ed.), 2 vol. (1725). *See* also Ruth Crosby, "R. M. of B.: A New Biography," *Publications of the Modern Language Association of America*, vol. lvii (1942); E. J. F. Arnould, *Le Manuel des Péchés, Étude de littérature religieuse anglo-normande* (1940); and, for full bibliography, J. E. Wells, *A Manual of the Writings in Middle English, 1050–1400* (1916) and *Supplements* (1919–51). (G. So.)

MANOAH (in the Douai version of the Bible MANUE), in biblical history the father of Samson (*q.v.*). The story, according to Judg. xiii, is that a messenger appeared first before Manoah's wife, who had been childless, and announced that she was to bear a son, who would begin to deliver Israel from the Philistines. He admonished her to abstain from drinking wine or strong drink and to "eat nothing unclean." After learning of this visit, Manoah prayed to have the messenger return to give him more instructions concerning the child. When he appeared before Manoah, the angel answered his questions by repeating his instructions to the woman. When Manoah made a burnt offering of a kid, the angel ascended with the flames toward heaven. The child that was later born to them was named Samson. Samson was buried, according to Judg. xvi, 31, in his father's burying place between Zorah and Eshtaol.

MANOBO, a pagan people of the Philippines. Numbering about 70,000 in the 1960s, they occupy a large, sparsely settled territory in east-central Mindanao Island. The name Manobo does not designate a single sociopolitical unit; rather it refers to peoples who speak closely related dialects of what is probably a single language and who share similar cultures. In physical type the Manobo are not markedly distinguishable from most neighbouring groups, including the Christian Filipinos. They speak one of the Central Philippine group of Malayo-Polynesian

languages (*q.v.*) which includes Tagalog, Bisayan (*qq.v.*) and many other Philippine tongues. Rice and other crops are grown on dry fields annually cleared and burned in the forest; houses are rectangular, thatched pile dwellings. Manobo traditionally made their own clothing from abacá fibre (*q.v.*) or from imported cloth. Iron tools and weapons, occasionally home-forged, typically are imported from neighbouring pagan groups (*see* Bagobo; Bukidnon; Mandaya). A community of dispersed single-family households under the informal leadership of an influential warrior forms the largest political unit. Ties of bilateral kinship bind the Manobo within and between communities. Although warriors and religious specialists are accorded special prestige, Manobo society is basically egalitarian; everyone is primarily a farmer. Increasing economic and political pressures by Christian settlers have seriously disrupted the Manobo way of life. Large numbers of Manobo have been acculturated to the ways of Christian Filipino peasants.

See J. M. Garvan, *The Manobos of Mindanao,* Memoirs of the National Academy of Sciences, vol. 23 (1931); H. W. Krieger, *Peoples of the Philippines* (1942). (C. O. Fr.)

MANOMETER: *see* Vacuum; *Measurement of Low Pressures;* Circulation of Blood: *The Blood Vessels: The Blood Pressure.*

MANOR. The term *manerium* (manor) was introduced into England and the English language by the Normans to describe an institution which was already in existence there, as well as in the rest of Europe and elsewhere. It occurs in societies where the predominant unit of organization of agricultural production is the peasant family holding and where the ruling class, a territorial aristocracy, depends for the greater part of its income on profits derived from agriculture rather than from industry. It is not a term that can properly be applied to estates where the chief labour force consisted of slaves, as in parts of the ancient world, and it is equally inapplicable to estates where the labour force consists of free hired men.

The manor was, essentially, an organization through which a lord exercised economic and political domination over his men. It often coincided with the natural unit of settlement and agricultural exploitation, the village, but a village could contain more than one manor, or a manor could contain more than one village. The boundaries of manorial domination therefore, could, often divide the natural peasant community. The manor's importance as an institution varied from time to time and from place to place. In western Europe it was already flourishing by the 8th century and was beginning to decline in the 13th century, whereas in eastern Europe its growth was complicated in the central period of the middle ages by big population movements, and it achieved its greatest strength after the 15th century.

Early Manorial Organization.—The most satisfactory early descriptions of manorial organization are to be found in the 9th-century estate surveys of the great landowners of the Carolingian empire, supplemented by instructions for the administration of the imperial estates. The most famous estate record is the *polyptyque* of Irminon, abbot of St. Germain des Prés, near Paris, probably drawn up at the beginning of the 9th century, but there are analogous documents from estates in other parts of the empire. These surveys show that at that time the big estates were composed of a number of *villae,* that is, manors. The *villa* at this time normally included one or more of the natural units of settlement, the village or hamlet. Its land was divided in varying proportions into arable, vineyards, meadow and woodland, and it was also divided in varying proportions between the demesne (the *mansus indominicatus*) of the lord and the peasant holdings (also known as *mansi*). Over the 21 *villae* of St. Germain des Prés for which there are details, the extent of the demesne and tenant holdings were roughly equal, though the tenant holdings contained nearly four times as much arable as the demesne.

This division between demesne and tenements was the principal feature of manorial organization in the early middle ages and existed in Lorraine, in the Low Countries, in northern Italy and in western Germany. The demesne-tenement ratio naturally varied considerably, from one to ten to one to one. In rare cases the demesne area was even larger than the tenanted area. It is certain that the Carolingian estate documents did not record a new phenomenon, for the division between demesne and tenures is found in the late Roman empire and is referred to in the laws (*c.* 690) of the Anglo-Saxon king Ine of Wessex. Far away from the influence of either Rome or of the Franks, in the lands of both eastern and western Slavs, basically the same type of agrarian organization made its appearance. Polish historians date the growth of the big estates with demesne production from the establishment of the Polish state in the 9th century. In Kievan Russia the same phenomenon probably existed in the 10th century and perhaps earlier. It is not possible, however, to give any exact details about proportions of demesne and tenant land, for detailed estate surveys are not found at an early date in eastern Europe. Even in pre-Conquest England the evidence for the manor is very incomplete. Domesday Book (1086), however, provides abundant evidence of widespread manorial organization, undoubtedly of Anglo-Saxon origin. There, as on the continent of Europe, large demesnes were surrounded by, and closely associated with, the holdings of the dependent tenants.

Closely related to the division of the manor between demesne and tenements was the organization of the labour force that worked the demesne. The manor grew up in an era when the predominating feature of social organization was the comprehensive network of personal dependency. In conditions of war, poverty and lack of government, men exchanged their freedom and gave their services in return for the protection of the powerful. The jurisdiction that landowners claimed as lords of slaves and freedmen was strengthened by the wider jurisdiction that as immunity (*q.v.*) holders they obtained from the public authority. Added to more or less accepted rights was the sheer coercive pressure of the class that had not only wealth but military force. As early as the end of the 8th century Charlemagne had complained in the Second Capitulary of Mantua (*c.* 787) that officials and powerful vassals had forced men, with the pretense that it was simply a request (*quasi deprecando*), to do various services, such as plowing, sowing, weeding and mowing. These were the conditions that determined the particular features of demesne cultivation on most of the big estates of northwestern Europe between the 8th and the 13th centuries.

The nucleus of the labour force consisted of permanent farm servants whose entire time was spent in the lord's service. In the earliest times, before the manor proper had developed, these consisted of slaves; but in the early middle ages slavery was being replaced by serfdom. By the 11th century, permanent farm servants began to be recruited from the servile families and were paid wages in money or in kind. Alternatively they were allowed a small holding of land as a remuneration for full-time service. This did not provide a labour force sufficient for the cultivation of the demesne, and consequently part of the rent from the peasant holdings of the manor was taken in the form of labour. Thus was created the economic interdependence of demesne and peasant tenements characteristic of early medieval estate management.

Labour obligations due from different types of peasant holding varied according to the size of the holding and also according to its origin. The tenants were responsible for several different types of labour service on the demesne, such as plowing services, week work, boon work and carrying services. The plowing services (often including harrowing and even sowing with the tenant's own seed) could be specifically attached to a named piece of the demesne land but were more generally arranged as a supplement to the main work done by the permanent servants with the demesne plows. Week work constituted the heaviest burden and was often associated with the most servile kind of tenements. From the full family holding (the manse) no less than three days' work a week on the demesne was normally demanded, sometimes more. The nature of this work was usually unspecified. Boon works, theoretically a voluntary offering, were usually associated with haymaking and harvest. At this season the maximum labour force was required, and consequently boon works were often owed from free tenements not otherwise burdened with labour services.

Carrying services were needed for supplying the market or the lord's household.

Manorial Organization in England.—The internal economics of the manor are best illustrated from the English evidence. The manor was a very ancient institution in England, and there is a school of historians that believes that there was direct continuity between the Roman *villa* and the medieval manor. This has not been proved, but it seems certain that manorial organization, in the form described above, was to be found at a much earlier date in the Anglo-Saxon period than the opponents of the theory of Roman origin have admitted. But if there exists fragmentary evidence suggesting forms of manorial organization as early as the 7th century, it is not until the 10th century that documentary evidence becomes adequate enough to show that English estates closely resembled those in contemporary Francia. From the time of the invaluable Domesday survey a large number of estate surveys were made, containing detailed manorial descriptions; from the mid-13th century their evidence can be supplemented by estate accounts and records of manorial courts.

English manors varied considerably from region to region. The large manors of old-established estates usually coincided with the village or parish. But England was also full of small, often impermanent manors, containing only a fraction of a village's land and population. Some manors were in areas of primarily arable farming; others were in pastoral areas. Some were hardly more than loose groups of rent-paying tenants; others were tightly organized institutions where the tenants were fully involved in the economy of the demesne. But the principal features common to all types of manors sprang from the essential fact that the lord of the manor had jurisdictional control over his tenants. This control was exercised through the manor court (*see* COURT BARON), presided over by the steward. Here were appointed such officials as the reeve to act as general overseer, the hayward to watch over the demesne crops and to bring offenders to court, the rent collector and the woodward. Here the tenants were directed, punished and mulcted. Here they had to register land transactions between themselves (where permitted) and to surrender or take up holdings under the lord. The court and the officials were a permanent feature of all manors, but the way in which the lord made his profit varied from time to time.

Later Developments in England.—On the big estates in the 10th, 11th and 12th centuries the landlords for the most part demanded from their manors a fixed return in cash or kind. The agent appointed to collect and pay over this farm (Lat. *firma;* O.E. *feorm*) was, therefore, almost in the position of a lessee. But at the turn of the 12th century an increasing need for cash income, coinciding with increased monetary circulation and rising agricultural prices, moved landlords to replace the farmers responsible for fixed returns by professional bailiffs or peasant reeves; these were expected to maximize manorial cash profits and had therefore to render annual accounts.

Manorial income was made up of rent from the peasant holdings, sales of produce from the demesne (mainly of grain and stock but also of wool in sheep-raising districts), profits of manorial justice and payments made by such tenants as were serfs. These included heriots (payment of the best beast from the peasant holding at death or on surrender), entry fines paid to take up a holding, tallage (*q.v.*) and licence payments for permissions, for instance, to marry or to sell livestock. Costs consisted of maintenance or purchase of equipment and buildings, purchases of seed and livestock, and wages. Labour costs naturally bulked large.

By the end of the 13th century on most manors the system of labour services due from the peasant holdings, especially from the servile or customary holdings, had been elaborately classified and valued at so much for a day's work of a specific type. These services appear, at any rate on the bigger estates, to have been more onerous than the labour services listed in the Carolingian *polyptyques,* sometimes involving as many as five or six days' work a week from holdings that may have been smaller than the Carolingian manse. These heavy labour services were long established; they existed in Wessex in the time of Ine, were fully elaborated in the 10th century, were in no way diminished by the 12th century and seem to have increased by the mid-13th century. Paradoxically, however, by the latter date they were only sparsely used, usually at the critical periods of haymaking and harvesting.

Otherwise the main labour force on the demesne was hired for wages. The permanent staff, the plowmen, carters, herdsmen and dairymaids, were paid partly in money and partly in kind. In addition, at peak periods casual labour was hired, almost entirely for cash payments. Such traditional labour services as were not required (usually the majority) were "sold"; *i.e.,* temporarily commuted. The detailed valuation of labour services must have been drawn up with this transaction in view, and increases in labour services may have been imposed as much with the object of increasing the lord's cash income as for increasing labour supplies on the demesne. It was always convenient to be able to call on peasant labour due from the holdings, but by the mid-14th century most manorial demesnes were worked by hired labour.

As this situation was reached, however, demographic and other crises brought about another change in manorial management. Falling profits made manorial lords realize that the costs of direct administration were too great, and by the end of the 14th century, at any rate on the bigger estates, they leased their demesnes to farmers, usually for a money rent, and permanently commuted the labour services from the peasant holdings. The rent paid by the demesne lessee (often a peasant) was sometimes greater than the net cash revenue under the old bailiff system, which suggests that the new lessee may have managed to make a better profit from the demesne than the landlord had done.

Although the legal framework of the English manor, as of the continental *seigneurie,* lasted long after the abandonment of direct control of production by the lord, it lost much of its institutional vitality. The peasant farmers, or more particularly the small group of wealthy peasant families in each village, became for perhaps two centuries, until the big technical and social changes of the 17th and 18th centuries, the driving force of the agrarian economy.

Later Manorial Development on the Continent.—In western Europe the earliest type of manorial organization, characterized by the interdependence of demesne and tenements, quickly disintegrated, especially after the era of population expansion and commercial revival that began in the 11th century. Peasant holdings were subdivided to provide for increased numbers, labour services became difficult to enforce, and customary money rents failed to keep pace with rising prices. As labour became more difficult to obtain and as an increasingly numerous class of military tenants and estate officials was provided with fiefs, the demesnes on some estates were reduced. But, in general, demesne production remained an important item of income and was rendered the more valuable in face of declining rents. Gradually an important new source of income was created from the extension of landlord power over the population as a whole. This power was now exercised not only on the few huge estates of the earlier potentates but also in the counties, baronies and castleries of wider categories of the nobility. Between the 10th and the 13th centuries these nobles extended their control over all the families living in the area of their private jurisdictions, irrespective of whether or not they were tenants. This jurisdiction enabled the nobility to establish monopolies of the wine press, the oven and the mill; they were able to require hospitality and other services, to exact aids and arbitrary tallages, to levy tolls and to demand a new range of labour services not only from tenants but from all "subjects."

Ultimately the new profits greatly exceeded the diminishing income provided by the rents and services paid by tenants for their holdings. This transformation of manorial forms was mainly characteristic of France and western Germany, though in Italy the old organization had disintegrated even earlier.

Eastern Europe, particularly eastern Germany, Poland, Bohemia, Moravia and Hungary, experienced a curious evolution of manorial forms. A manorialism analogous to that of the west

existed on a few big ecclesiastical and other estates before the 12th century. But during this century the colonization of wood and waste that was taking place piecemeal in the west became a mass phenomenon in the east, and hundreds of free villages of German and Slavonic peasant colonizers were created. In these free villages the person of importance was not the lord of the manor but the village mayor. Distinguished from his neighbours only by a larger holding than theirs, he had no claim on labour services and possessed little jurisdictional power.

Nevertheless, this development of a free peasantry did not long affect the social structure. The disturbed conditions of eastern Europe, brought about by Prusso-Polish wars, Russo-Lithuanian and Russo-Tatar wars and by the Hussite wars in Bohemia, rapidly reproduced the social and political insecurities that had earlier been so productive of peasant enserfment. In addition, the growing demands of western Europe for the grain of the Baltic area gave the landlords an added incentive for the enserfment of the peasants in order to bind them to provide labour services for grain-growing demesnes. By the 16th century in many parts of eastern Europe, but especially in eastern Germany and Poland, the manor, with its interdependence of demesne and tenures, was re-created.

Meanwhile, in western Europe the manor, *seigneurie* or *Grundherrschaft*, though persisting as a form of social and political organization, was tending to lose its economic significance because the management of the demesne was no longer connected with the control of the peasant population. Until the early 14th century, demesnes in both England and France were kept in hand by the estate owners, but in the latter part of the 14th and in the 15th century they were progressively leased, in whole or in part, to lessees of peasant, urban or gentle origin. This dissociation in western European agriculture of peasant from landlord farming—perhaps even the absorption of landlord farming by the peasants—opened the way to those early capitalist forms which contrasted so notably with the reactionary manorial developments in eastern Europe and Russia.

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(R. H. Hi.)

MANOR HOUSE, the dwelling of the lord of the manor or his residential bailiff, and the administrative centre of the feudal estate. Development in the middle ages is related to that of the castle (*q.v.*), which is however distinguished by its primarily defensive character and greater political significance as a military strong point. Early manors were generally fortified, licence to crenelate being required from the king, and the evolution of domestic planning at the expense of more military considerations is in proportion to the degree of peaceful settlement of any country or region. With the church, the medieval manor house was the centre of village life, its hall the scene of the manorial court and the place of assembly of the tenantry. Usually the work of local craftsmen, the house was more subject than the castle to local influences, physical and political, giving rise to distinctive regional forms of building. The particular character of the manor house is most clearly represented in England and France, but under different names the dwellings of feudal overlords are to be found in all countries wherein the manorial system developed, fulfilling similar functions within the national expression of style and period.

In England in the 11th century, the early manor house was an informal group of related buildings in timber or stone comprising the hall, chapel, kitchen and farm buildings contained within a defensive wall and ditch. The manor house of Boothby Pagnell,

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Lincolnshire, is of late 12th-century date and comprises a hall and private chamber placed defensively at first-floor level over a storage undercroft, and contained within a moated enclosure. In large houses at this time the hall (*q.v.*), which throughout the medieval period was the major element of domestic architecture, was more conveniently planned at ground level, as in Oakham castle, Rutland, within a more strongly defended enclosure, and subsequently this hall arrangement was generally adopted. Stokesay castle, Shropshire, is the finest surviving example of a fortified manor house of the 13th century, the ground-floor hall being flanked by towers and further defended by a moated enclosure. By the 14th century the manor house plan was clearly defined, with private living apartments and service rooms planned at opposite ends of the great hall, the parts being more closely integrated, in many major instances enclosing an irregular courtyard, while battlements, gatehouse and moat continued to be provided as at Ightam Mote, Kent. Cothay manor, Somerset, is a characteristic house of the 15th century showing little advance in planning but having more domestic character than earlier instances, while Ockwells manor, Berkshire, also built in the 15th century, is the regional timber framed expression of the same hall plan, without defensive pretensions.

Comparable development in France was delayed by internal conflict, and until the ending of the Hundred Years War, in 1453, considerations of defense dominated manorial building. Such early manor houses as that at Saint Medard en Jalle, near Bordeaux, built in the 13th century, and the 14th-century Manoir de Camarsac (Gironde) comprise a rectangular fortified tower in which the principal rooms are at first-floor level above cellars, standing with subsidiary buildings in a walled and moated enclosure. In Normandy, the Manoir d'Ango, near Dieppe, reveals some advance in domestic planning in the 15th century, the house standing at one end of a courtyard, flanked by farm buildings and defended by a gatehouse.

With the decline of manorial significance coinciding with increased prosperity and the call for more commodious dwellings, development of the manor house in the 16th century emerges into that of the Renaissance country house. In England, increased formality combined with the new use of bricks and terra cotta produced more elaborate buildings, frequently of regular quadrangular plan, the hall declining in size and importance. Sutton place, Surrey (*c.* 1525), illustrates this phase, which leads to the more complex block plans of the Renaissance as at Ramsbury manor, Wiltshire (*c.* 1680), where the hall is reduced to the status of an entrance. The defended tower-house tradition persists in France throughout the 16th century in such instances as the Manoir des Tourelles, at Rumilly, near Troyes, generally retaining corner turrets and other defensive archaisms, while revealing classical influence in the symmetry of the *appartement* plan, which was later to become a feature of the Renaissance château. In later years the title of manor house in England lost particular significance, being adopted by large country mansions which had no manorial foundation.

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MANRESA, a town of northeastern Spain in the region of Catalonia and province of Barcelona, lies on the Cardoner river 68 km. (42 mi.) N.W. of Barcelona by road. Pop. (1960) 52,216. Manresa is a picturesque old town, believed to be the Munorisa of the Romans and important during the middle ages. Three bridges cross the river there and on a rock above the oldest stands the yellow stone church of Santa María de la Seo (13th and 14th centuries). Below the 17th-century church of San Ignacio is the Cueva de San Ignacio (cave of St. Ignatius of Loyola) where he wrote the *Spiritual Exercises.* In the cloisters is the municipal museum. There is a conservatory of music. Industries include metallurgy and the making of textiles, tires and glass. . (A. O. S.)

MANRIQUE, GÓMEZ (1415?–1490?), Spanish poet, chiefly remembered as the earliest Spanish dramatist whose name is known, was born at Amusco, Tierra de Campos, and probably died at Toledo. He took a prominent part in the rebellions of the reigns of John II and Henry IV as soldier, politician and diplomat and won fame as an orator during his governorship of Toledo. His *Cancionero* contains 108 poems, written in the manner of the time. His nativity play, *Representación del nacimiento de Nuestro Señor,* his *Lamentaciones fechas para Semana Santa,* and his two *momos,* or interludes, contain the elements of the religious and secular drama of the future. (C. C. SH.)

MANRIQUE, JORGE (1440?–1479), Spanish poet and soldier, of a noble and literary family, nephew of Gómez Manrique (*q.v.*), is famous for his elegy on the death of his father. He was born probably at Paredes de la Nava, Palencia, *c.* 1440, and died near Garci-Muñoz on March 27, 1479. His love songs, satires and acrostic verses are little more than ingenious compositions in the manner of his age; he owes his imperishable renown to the *Coplas por la muerte de su padre* (1476), an elegy in the haunting *pie quebrado* metre, in which each 12-line stanza has 4 triplets, the triplets having lines of 8, 8 and 4 syllables. Although this is based in part on a similar lament by his uncle, and contains numerous echoes of the Bible and Boethius, its derived thoughts and commonplaces on death are transformed by grief into something intensely personal and (for the 15th century) unusually lyrical. The perfect technique and the sublimity of expression help to explain the poem's lasting fame. (C. C. SH.)

MANS, LE, a town of northwestern France, capital of the *département* of Sarthe and former capital of the province of Maine. It lies 75 mi. S.W. of Chartres on the railway line from Paris to Brest. Pop. 128,814 (1962 census; 136,083 with suburbs).

The town stands just above the confluence of the Sarthe and Huisne rivers. Several bridges connect it with the quarters of Le Pré and St. Lazare on the left bank. The cathedral is dedicated to St. Julian, the town's first bishop. The nave was built in the 11th and 12th centuries, the transepts in the 14th and 15th. The choir (13th century) is one of the tallest and handsomest in France, and is supported outside by buttresses of exceptionally light design. The cathedral has some magnificent stained glass and remarkable tombs, including the tomb of Queen Berengaria. The church of La Couture, on the site of an abbey founded in the 6th century by St. Bertrand, has parts dating from the 10th century, and a richly ornamented porch of the 13th. The town hall was built in 1775; the prefecture occupies the buildings of the former monastery of La Couture, enlarged in 1770. The 11th- and 12th-century church of Le Pré contains the remains of St. Julian; the church of St. Joan of Arc is a former maison-dieu built by Henry II of England. The Tessé museum exhibits valuable paintings and the famous Geoffrey Plantagenet enamel. Among numerous old houses are the Grabatoire, now the bishop's seat, and the so-called Queen Berengaria's house, both 16th century. Nearby is a museum of early motorcars. Le Mans is the seat of a bishopric and also has a prefecture and a court of assizes.

The town is an important rail and road centre. The principal industrial establishments are a motor works, railway repair shops and factories for the manufacture of railway carriages, electrical apparatus, tobacco, textiles, plastics, agricultural implements and motor parts. There is also a large dairy and an active trade in cattle, farm produce and wines. Le Mans is the seat of three important insurance companies. Each year it holds a four-day commercial fair and a famous motor race (*see* AUTOMOBILE RACING). It saw some of the first experiments in motoring (*i.e.,* those of Amédée Bollée in 1873) and the first European flights (1908) of the U.S. aviation pioneer Wilbur Wright, to whom there are three monuments in or near Le Mans.

As the capital of the Aulerci Cenomani (*see* CENOMANI), Le Mans was first called Vindinon, then Subdunum. At the end of the 3rd century the Gallo-Romans surrounded it with walls, parts of which can still be seen. After the 6th century, Le Mans became the seat of the counts of Maine. It was invaded by the Normans in 1063. Le Mans had secured a communal charter, but in 1076 William the Conqueror deprived the citizens of their liberties. At the death of William's son, Rufus (William II), the countship passed to the Plantagenets, counts of Anjou. Henry II, the first Plantagenet king of England, was born in Le Mans in 1133, and his sons, Richard Coeur-de-Lion and John, fought for the countship of Maine; Berengaria, Richard's widow, finally received it from Philip Augustus as a dower in 1204. After her death, Le Mans reverted to the French crown. It was occupied by the English during the Hundred Years' War and was besieged several times in the 15th and 16th centuries. In 1793 it was seized by the Vendéans, who were expelled by the Republicans, and it was again occupied by the Chouans in 1799. It was occupied by the Germans in 1815; again in 1871, after the battle of Le Mans (Jan. 1871); and during World War II. It was liberated, without much fighting, on Aug. 8, 1944, by the U.S. 3rd army, and served as a pivot for the U.S. forces and Gen. Leclerc's French corps in their drive toward Argentan and Paris. (HI. D.)

MANSARD ROOF, a roof having two slopes on every side, the lower slope being considerably steeper than the upper. Although used as early as the mid-16th century by Pierre Lescot at the Louvre, it was named after François Mansart (*q.v.*), who employed it for Paris *hôtels* and the châteaux of Balleroy, Blois and Maisons. It was probably first used because its predominantly horizontal profile was more in harmony with the classical orders than high-pitched roofs. The mansard, when pierced with dormers, also provides a more spacious and economical attic story. During the mid-19th century it was particularly popular, especially in France and the United States. *See* also ROOF. (Js. S. P.)

MANSART (MANSARD), **(NICHOLAS) FRANÇOIS** (1598–1666), French architect, who expressed more than any contemporary architect the classical spirit of the 17th century in France, was born in Paris on Jan. 23, 1598. He was the son of a Parisian master carpenter, probably worked under Salomon de Brosse and was certainly strongly influenced by him. By 1635 he was undertaking important commissions for the crown, but the masterpiece of his early period is the château of Balleroy (begun *c.* 1626) for Choisy, chancellor to Gaston d'Orléans, in which he combines the classicism of De Brosse with the Henri IV brick-and-stone style of building. Soon afterward Mansart reconstructed Blois for Louis XIV's brother. This work, although never completed, shows Mansart's classicism at its most subtle; it was there that he first used the two-sloped type of roof which bears his name (mansard), though, in fact, De Brosse had already used it at Rennes. In 1645 Mansart was commissioned by Anne of Austria to build the church of the Val-de-Grâce in Paris. Though he was replaced by J. Lemercier in 1646, the plan and much of the construction of the walls is Mansart's work. The design derives from Palladio's church of the Redentore at Venice, one of the purest examples of High Renaissance classicism, and a scheme adopted again by Mansart for the chapel at Fresnes. Between 1635 and 1655 he built a number of important houses in Paris in which his subtle and ingenious mind is revealed in skilful planning on sites often awkwardly shaped. The château de Maisons (now Maisons-Laffitte) is the most complete work by the architect to survive. It was completed save for the severely rich decoration by 1646.

Mansart's work is marked by extraordinary clarity and restraint. He was able to combine a flexible use of the classical with great richness of decoration.

See A. F. Blunt, *François Mansart* (1941) and *Art and Architecture in France 1500 to 1700* (1953). (F. J. B. W.)

MANSART (MANSARD), **JULES HARDOUIN** (1646?–1708), French architect, who designed Versailles under Louis XIV, was born in Paris probably on April 16, 1646, son of the painter Raphael Hardouin. He was a grandnephew by marriage of the architect François Mansart, whose surname he adopted in 1668. In 1674 Mansart was commissioned by Louis XIV to build a château for Madame de Montespan. He was by this time launched upon a brilliant career under the king's patronage. Among his earlier additions to St. Germain were a number of private houses, including the Hôtel de Lorges (later Hôtel de Conti), his own residence. As official architect to the king he was entrusted with the redesigning and additions to the palace of Versailles and its environs; there he built the new Galerie des Glaces and Orangerie, the Trianon and the north and south wings in a harmonious, classical style. In addition to this enormous project, which occupied much of his life, Mansart built many other public buildings, churches and sumptuous houses. After making additions to the Palais Royal and building part of Orléans cathedral, he completed the famous chapel of St. Louis des Invalides (Dôme des Invalides), Paris, in a blend of Greek classical and baroque styles. He was responsible for the Place Vendôme, the Place des Victoires and the Maison de St. Cyr, all in Paris. His country mansions included the Château de Luneville and the Château de Sagonne. The royal residence at Marly was his creation. One of the most successful architects of his day, Mansart had his own atelier where he worked with collaborators and trained his protégés. He was working on the chapel at Versailles when he died on May 11, 1708.

MANSBRIDGE, ALBERT (1876–1952), prominent English adult educationist and founder of the Workers' Educational association, was born at Gloucester on Jan. 10, 1876. He was educated at the local church school and later at Battersea grammar school, London. He started work at 15 as a clerk, working for the Co-operative Wholesale society, and later for the Co-operative Permanent Building society. In 1903 the *University Extension Journal* published his scheme for a "triple alliance" of the co-operative movement, university extension and the trade unions, and in the same year he founded the Association to Promote the Higher Education of Working Men which became the Workers' Educational association (W.E.A.) in 1905.

From 1906 onward he worked to establish the tutorial class system of the W.E.A. and the first courses were held at Rochdale, Lancashire, and Longton, Staffordshire, under the tutorship of R. H. Tawney. Bishop Charles Gore (*q.v.*) and Archbishop William Temple (*q.v.*) were also among Mansbridge's supporters. In 1916 illness compelled Mansbridge to resign the secretaryship of the W.E.A. The following year he started the Church of England tutorial classes; he also founded the World Association for Adult Education, the British Institute of Adult Education and the Seafarers' Education service, and served on several government and church commissions on education. He was made a Companion of Honour in 1931 and died at Torquay on Aug. 22, 1952. His most important works are *University Tutorial Classes* (1913), *An Adventure in Working Class Education* (1920), *The Older Universities of England* (1923) and *Margaret McMillan, Prophet and Pioneer* (1932). *See* also ADULT EDUCATION; UNIVERSITY EXTENSION.

See M. D. Stocks, *The Workers' Educational Association: the First Fifty Years* (1953). (S. J. C.)

MANSEL, HENRY LONGUEVILLE (1820–1871), English philosopher and churchman, born at Cosgrove, Northamptonshire on Oct. 6, 1820, was educated at Merchant Taylor's school and St. John's college, Oxford. He was elected Waynflete professor of moral and metaphysical philosophy at Oxford in 1859 and regius professor of ecclesiastical history in 1867, in which year he also became canon of Christ Church. He was appointed dean of St. Paul's in 1868. Mansel died at Cosgrove on July 30, 1871.

In philosophy, Mansel was a follower of Sir William Hamilton (*q.v.*), developing Hamilton's ideas in an article on metaphysics written for the eighth edition of the *Encyclopædia Britannica* (1857) and defending them, in *The Philosophy of the Conditioned* (1866), against the attacks of John Stuart Mill. In his Bampton lectures, *The Limits of Religious Thought* (1858), Mansel developed Hamilton's doctrine that human knowledge was strictly limited to the finite and "conditioned." The resulting contention that the human mind could not attain to any positive conception of the nature of God provoked much controversy in which Mansel was accused of agnosticism, though he had meant to attack deism, not theism. Mansel's other published works include *Prolegomena logica: an Inquiry Into the Psychological Character of Logical Processes* (1851) and *The Gnostic Heresies of the First and Second Centuries* (ed. by J. B. Lightfoot, 1875). He edited Henry Aldrich's *Artis logicae rudimenta* (1849) and, with J. Veitch, Sir W. Hamilton's *Lectures on Metaphysics and Logic*, 4 vol. (1859–60).

See J. W. Burgon, *Lives of Twelve Good Men* (1888).

MANSFELD, a name distinguished in German history, being derived from that of the countship of Mansfeld, whose territory lay in Saxony south of Anhalt, between the Harz mountains and the Saale river. HOYER, GRAF VON MANSFELD, a supporter of the Salian German kings against the dukes of Saxony, was killed fighting for Henry V at Welfesholz (1115). A new house of counts began with BURCHARD III VON MANSFELD (d. 1273). Seventh in descent from him, ALBRECHT (d. 1484) and ERNST (d. 1486) founded respectively the Vorderort and Hinterort lines of counts. The Hinterort line was subdivided into Mittelort and Hinterort branches by Ernst's sons GEBHARD (d. 1558) and ALBRECHT (1480–1560), famous for their protection of Martin Luther and for their services to the Protestant cause. The males of Mittelort, however, died out in 1622, those of Hinterort in 1666. For Vorderort, one of Albrecht's grandsons was JOHANN GEBHARD (d. 1562), archbishop elector of Cologne from 1558, while the others founded, from 1531, six branches of Mansfeld, namely Bornstedt, Eisleben, Friedeburg, Arnstein, Artern and Heldrungen. PETER ERNST I VON MANSFELD (1517–1604), head of the Friedeburg branch and governor of Luxembourg (from 1559) and of the Spanish Netherlands (1588 and from 1592 to 1594), was created a prince of the Holy Roman empire (1594); the famous Protestant general Ernst von Mansfeld (*q.v.*) was his illegitimate son. The male line of Bornstedt, the last surviving branch (with princely rank from the 17th century), died out in 1780; and in 1789 Franz Gundaccar, prince von Colloredo, who had married the eventual heiress of Mansfeld in 1771, was authorized to take the style of prince von Colloredo-Mansfeld.

MANSFELD, (PETER) ERNST, GRAF VON (1580–1626), German soldier of fortune prominent early in the Thirty Years' War (*q.v.*). He was born in Luxembourg, the illegitimate son of the governor of the Spanish fortress there, Peter Ernst I, prince of Mansfeld. The stigma of his birth influenced his career, for, though the Holy Roman emperor Rudolf II legitimized him, he was excluded from any share in his paternal estates. He therefore became an enemy of the house of Habsburg, in whose service he had gained his first military laurels, and in 1609 he turned Protestant.

In 1618 Mansfeld accepted a commission from Charles Emmanuel, duke of Savoy, who aspired to the imperial or, failing that, the Bohemian crown. Mansfeld then led an army to support the Bohemians against the Habsburgs and with the capture of Pilsen gained a firm foothold in the country, there first displaying his mastery of positional warfare. Yet he did nothing to avert the catastrophe that overtook the elector Palatine, Frederick V, whom the Bohemians had elected king. After Frederick's defeat, however, Mansfeld entered his service and for two years succeeded in defending first the Upper Palatinate (1621) and later the Rhenish Palatinate against Tilly, who suffered a reverse at Wiesloch on April 27, 1622.

When Frederick was unable to maintain the expensive mercenaries, Mansfeld, in conjunction with Christian of Brunswick, led his army through Lorraine and Flanders, where he defeated a Spanish corps at Fleurus (Aug. 1622). Now in the employment of the Dutch, he made the Spaniards raise their siege of Bergen op

Zoom and, later in 1622, conquered East Frisia, which he held for the Dutch until 1624. He then went to London and obtained an army and money for the impending Danish war. While Christian IV of Denmark operated in Lower Saxony against Tilly, Mansfeld tried to block the northward march of the imperial army under Wallenstein at the crossing of the Elbe river near Dessau but was dislodged by Wallenstein (April 25, 1626). Undaunted, he raised a fresh army with French subsidies and marched through Silesia into Hungary, where he hoped to obtain the assistance of Gabriel Bethlen, prince of Transylvania, for an attack on Austria. Disappointed in this expectation and pursued by Wallenstein, Mansfeld turned to Venice as his paymaster but died on the way in a Bosnian village near Sarajevo on Nov. 29, 1626.

See J. Massarette, *La Vie martiale de Pierre-Ernest de Mansfeld*, 2 vol. (1931). (S. H. S.)

MANSFIELD, KATHERINE (pseudonym of KATHLEEN MANSFIELD BEAUCHAMP) (1888–1923), New Zealand writer who pioneered in the short story the "stream of consciousness" technique and evolved a distinctive prose style with many of the overtones of poetry, was born on Oct. 14, 1888, in Wellington, N.Z., which she left at the age of 19 to establish herself as a writer. Her initial disillusion appears in the ill-humoured stories collected in *In A German Pension* (1911). From then till 1914 she published stories in *Rhythm* and *The Blue Review*, edited by the critic and essayist John Middleton Murry (1889–1957), whom she married in 1918 after her divorce from George Bowden. The death of her soldier brother in 1915 shocked her into a recognition that she owed a "sacred debt" to him and to the "remembered places" of her native country *The Aloe* (1916), later revised as *Prelude* (1918), was the beginning of a series of short stories beautifully evocative of her family memories of New Zealand. These, with others, were collected in *Bliss* (1920), which secured her reputation.

For the next two years she worked with intense concentration on her best work, and is seen at the height of her powers in *The Garden Party* (1922), which includes work of the calibre of "At the Bay," "The Voyage," "The Stranger" (with New Zealand settings) and the classic "The Daughters of the Late Colonel." Her final work (apart from unfinished material) was published posthumously in *The Dove's Nest* (1923) and *Something Childish* (1924). From her loose papers Murry edited the *Journal* (1927, rev. ed. 1954) and he also published with annotations her letters to him (1928, rev. ed. 1951). The last five years of her life were overshadowed by tuberculosis and despite visits to Switzerland, Italy and the south of France, she died near Fontainebleau on Jan. 9, 1923.

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MANSFIELD, RICHARD (1854 or 1857–1907), U.S. actor, intense, somewhat eccentric, but unquestionably brilliant and one of the last of the great romantic stars, was born on May 24 in Berlin, where his mother, Erminia Rudersdorff, was engaged in a concert tour. His father, Maurice Mansfield, died when Richard was two, and Madame Rudersdorff and Richard spent the subsequent years in concert tours of England and the continent. In 1872 they arrived for the first time in New York city, where young Richard alternately turned to singing, painting and acting. Dissatisfied with his lack of accomplishment, he returned to England in 1877 and during the next six years achieved moderate success as a singer of light opera, principally of Gilbert and Sullivan. In the United States again in 1882, he turned to the spoken drama, attracting considerable attention as Baron Chevrial in *A Parisian Romance*. Through the next 20 years he continued to build his reputation in both England and the United States as an exciting, though frequently unpredictable, star. His chief roles were Jekyll and Hyde (1887), Richard III (1889), Beau Brummell (1890), Shylock (1893) and Cyrano (1898). In 1894 Mansfield produced *Arms and the Man* in New York, the first production of Shaw in America. In 1906 his *Peer Gynt* was a success in its Chicago opening, but, after moving it to New York and playing Peer and Baron Chevrial on the same day, Mansfield collapsed, physically and nervously exhausted. After a year's struggle to regain his health, he died in New London, Conn., Aug. 30, 1907.

See Paul Wilstach, *Richard Mansfield, the Man and the Actor* (1908); William Winter, *Life and Art of Richard Mansfield*, 2 vol. (1910). (S. W. H.)

MANSFIELD, WILLIAM MURRAY, 1ST EARL OF (1705–1793), English judge, for 34 years chief justice of the king's bench, was born at Scone, in Perthshire, Scot., on March 2, 1705, the son of the 5th viscount Stormont. Only Sir Edward Coke and Sir Matthew Hale rivaled him as chief justice, parts of his work being published and becoming authoritative almost before he was off the bench. Subsequently, he three times procured position as a member of the cabinet, simultaneously getting the Great Seal (the chancellor's office) entrusted to a committee. Thus he retained the chief justiceship regardless of changes in administration but still exerted political power, a practice which later happily became unconstitutional. Educated at Perth grammar school, Westminster school and Christ Church college, Oxford, Mansfield was called to the bar at Lincoln's Inn in 1730. In Scotland he became famous by his appearance for the city of Edinburgh when it was threatened with disfranchisement for the affair of the Porteous mob, but his English practice remained scanty until in 1737 a single speech in one jury trial placed him at the head of the bar. In 1742 he was appointed solicitor general. In 1754 he became attorney general and acted as leader of the house of commons under the duke of Newcastle. In 1756 he claimed the chief justiceship of the king's bench and was made Baron Mansfield. In 1776 he was created earl of Mansfield. In 1783, during the coalition ministry, he declined cabinet office, but served as speaker of the house of lords. He resigned as chief justice in 1788 and died on March 20, 1793.

As must be the case with any court in central position, politics followed Mansfield to the bench. Three matters particularly reveal the man. After the burning of his house and precious library in 1780 in those "No Popery" riots, which involved mobs of 50,000 and invasion of parliament itself, Mansfield so fairly conducted the treason trial of the leader Lord George Gordon, that an acquittal resulted. In the Wilkes case (1768) he rose above both popular clamour and royal pressure by careful technical work on the precedents. This work developed legal flaws in the crown's case unknown to the defendant himself. Thus the Tory judge discharged an agitator because the Tory's own type of due process so required. The widespread view that Mansfield abolished slavery with one judicial decision, while it took a civil war in the United States, is, however, superstition. Mansfield sought, with all of his high tactical powers, to avoid any slavery issue: he was a property-minded man of commerce. Even the famous judgment in Somersett's case (1772) decided only that an escaping slave could not be forcibly removed from England to vengeance in a colony. This, as Benjamin Franklin rightly protested, meant no abolition of "a detestable commerce" or of slavery in the colonies —both encouraged by the British laws until statutory changes in 1807 and 1833. Indeed, no vital emotional issue can be settled—though it may be helped toward solution—by judicial decision. The Dred Scott case and the segregation cases make this clear.

Mansfield's permanent stamp upon Anglo-American law lies in commercial law. When he mounted the bench, two years before the start of that Seven Years War that riveted Britain's grasp upon America, India and international trade, the English law was land-centred and landbound in outlook and intrenched professional tradition. Reform was imperative. Mansfield's vision and ambition reached beyond following the continental model of a special body of rules for commerce and banking. He sought to make the international law of commerce not a separate branch but an integral part of the general law of England, both common law and equity, using the leverage thus gained to pry loose from feudalism whole blocks of other rules which had few or no direct commercial bearing. An important part of this brilliant venture succeeded.

In the area of bills of exchange (drafts), promissory notes and the then novel check, Mansfield, modeling on standard international practice, shaped the law in sweeping judgments, each typically canvassing the whole relevant situation and its reasons. *Heylyn* v. *Adamson* (1758) 2 Burrow 669 is an example. No

judge has ever surpassed him here. A second area involved fresh creation. Marine insurance, then a new industry, was centred in London and was a weapon of competition and cold war. Mansfield did not build here on models; he created the entire discipline.

He was not always so successful. In *Pillans* v. *Van Mierop* (1765) 3 Burrow 1663, he made enforceable without consideration, *i.e.*, roughly, without any bargained-for return, a merchant's (banker's) "confirmed credit" or promise to accept drafts drawn from abroad. This decision was viewed, though without good ground, as a flat attack on the whole doctrine of consideration, and that doctrine was reaffirmed in its entirety by the house of lords in *Rann* v. *Hughes* (1778) 7 T.R. 350, n. A second defeat was in his effort to make a document transferring land receive an interpretation according to plain intention, rather than have such intention frustrated by some technical rule giving unmeant effect to words. His decision on this, in *Perrin* v. *Blake,* was reversed in 1772 (one of six reversals during 32 years of active service). But he triumphed in his expansion of the idea that a man should turn back or turn over any value received by mistake or wrongdoing or otherwise under circumstances making it inequitable for him to retain it. The remedy was by a fictitious "promise" to pay over ("quasi-contract"; modernly, the fiction being discontinued: "restitution"). This decision involved not only a wide new range for remedy but, as in the case when the sum received on resale of another's goods was substituted for their arguable value, an important simplification and easing of the plaintiff's proof.

Despite his long tenure, the "father of commercial law" had almost no cases on the heart of modern commercial law: mercantile contracts for the sale of wares. But he had chosen to make commercial law and general law a single whole. When commercial sales cases did arise, they came, ironically, before judges who thought in terms of haystacks and of horses, and the central area of commercial law was for more than a century given a flavour of land and manure rather than of commerce.

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(K. N. L.)

MANSFIELD, a municipal borough (1891) of Nottinghamshire, Eng., lies on the river Maun, 14 mi. N. of Nottingham by road. Pop. (1961) 53,218. It is the chief town in Sherwood forest (*q.v.*), and the Forest courts were held in the old Moot hall (built in 1752) in a chamber known as the Swainmote. The annual Swainmote dinner to commemorate the Holyrood feast which always followed a sitting of the Forest court is still held. The parish church of SS. Peter and Paul dates back to Saxon times, but the main portion of the present church is early Norman. Remains of rock dwellings, which were in occupation up to the end of the 19th century, still exist. Mansfield is a thriving industrial centre exploiting the local coal resources, with many big commercial and industrial enterprises. Among the more important industries, apart from deep mining, are decorative tinware, hosiery, boot and shoe manufacture, nylon spinning, light engineering and the making of radio components, electronic equipment and plastics.

Newstead abbey, ancestral home of the poet Lord Byron, lies 4 mi. S., and Hardwick hall, an Elizabethan mansion belonging to the duke of Devonshire, is about 6 mi. N.W. (A. C. SH.)

MANSFIELD, a city in north-central Ohio, U.S., the seat of Richland county, is almost equidistant between Cleveland and Columbus, about 75 mi. from each city. Situated on rolling land at the very edge of the Allegheny plateau, it was first surveyed by Gen. James Hedges in 1808, three years after Indian titles were removed by the treaty of Fort Industry. Named after Jared Mansfield, surveyor general of the United States, the town grew slowly until the advent of the Mansfield and Sandusky railroad (later part of the Baltimore and Ohio system) in 1846; the Pittsburgh, Fort Wayne and Chicago railway (ultimately part of the Pennsylvania system) in 1849; and the Atlantic and Great Western railway (later included in the Erie system) in 1863. Thereafter its growth was more rapid; the city became an important manufacturing centre in the post-Civil War period. By the 1960s Mansfield's diversified industry embraced electric and gas appliances, tires and inner tubes, auto bodies, sheet steel, electric distribution equipment, plumbing fixtures, vitreous china and thermostats.

Distinctive features of the community include the Kingwood Center, a 47-ac. horticultural and botanical garden; a War of 1812 log blockhouse; and a monument to John Chapman (Johnny Appleseed), who for nearly 20 years considered Richland county his home.

The Malabar farm, established by novelist Louis Bromfield, is not far from the city. For comparative population figures *see* table in OHIO: *Population.* (P. R. S.)

MANSHIP, PAUL (1885–), U.S. sculptor, creator of the large bronze figure of Prometheus overlooking the Rockefeller Center plaza, in New York city, was born in St. Paul, Minn., on Dec. 25, 1885. After studying in St. Paul, Philadelphia and New York city, he won a scholarship in 1909 to the American academy in Rome. After three years abroad he settled in New York. Starting in 1913 with a prize from the National Academy of Design, his works continued to win awards. In their subjects and generalized style his statues are inspired by classical art. To a lesser degree he was influenced by the east, especially India. Renowned for excellent craftsmanship, he developed a distinctive style remarkable for its simplified modeling and rhythmical patterns. Among his large decorative works, mostly in bronze, are "Dancer and Gazelles" (1916), of which there are versions in several museums; the Prometheus fountain (1934) in Rockefeller plaza; "Celestial Sphere" (1939); and Woodrow Wilson memorial at the Palais des Nations, Geneva.

Manship executed many portraits in marble; most striking are "Pauline Frances—Three Weeks Old" (1914), Metropolitan Museum of Art, New York city, and "John D. Rockefeller" (1918), collection of John D. Rockefeller, Jr. His bronze "The Young Lincoln" is in Fort Wayne, Ind. Manship's delightful depictions of animals are much admired; particularly famous is the Paul J. Rainey memorial gateway at the Bronx zoo, New York city (1934).

See E. Murtha, *Paul Manship* (1957). (M. I. B.)

MANSLAUGHTER, in Anglo-American criminal law, the unlawful killing of another human being, without malice, either express or implied. In the U.S., several states define by statute two kinds of manslaughter: voluntary, in which there is intent to produce the injury; and involuntary, in which there is no such intent. Other states recognize several distinct degrees of the crime. All these distinctions are purely statutory and do not enter into the common-law definition. For the distinction between manslaughter, murder and other forms of homicide, *see* HOMICIDE. (A. DM.)

MANSON, SIR PATRICK (1844–1922), British parasitologist, the first outstanding modern practitioner, teacher and research worker in the field of tropical medicine, was born in Scotland on Oct. 3, 1844. He practised medicine in Takao, Amoy and Hong Kong (1866–89), and thereafter in London until his death. He was elected fellow of the Royal society in 1900, knighted in 1903, created Knight Grand Cross of St. Michael and St. George in 1912, became first president of the Society of Tropical Medicine and Hygiene (1907–08) and was recipient of many medals and honorary degrees. He published several hundred scientific papers. He died on April 9, 1922.

Manson was first to discover (1877–79) that an insect (mosquito) can be host to a developing parasite (the worm *Filaria bancrofti*) of a human disease (filariasis). In 1894 he published his mosquito-malaria hypothesis, which led to the discovery by Ronald Ross (*q.v.*) that malaria, like filariasis, is a mosquito-transmitted disease. In 1898 Manson published a textbook on tropical diseases that, frequently revised, has been a standard ever since. In 1899 he organized the London School of Tropical Medicine.

See P. H. Manson-Bahr and A. Alcock, *The Life and Work of Sir Patrick Manson* (1927). (P. F. R.)

MANSUR, AL-, throne name or honorific title assumed by several Muslim rulers, meaning "aided," or "rendered victorious [by God]." It is also used as an ordinary name. The best-known are discussed below.

ABU JA'FAR 'ABDULLAH AL-MANSUR (714–775), second Abbasid caliph (*see* CALIPHATE), who reigned from 754 to 775. Born in Aug. 714, the son of a Berber slave girl, he followed his brother Abu'l-Abbas al-Saffah on the throne. His main task was to secure the rule of the dynasty, which had come to power only in 750. So successful was he in this that he must be regarded as the real founder of the dynasty. First, with the help of Abu Muslim, he defeated his uncle Abdullah, governor of Syria, who disputed his succession. Then he had Abu Muslim treacherously murdered, since his power in Khurasan seemed to threaten the caliph's. Later, in 762–763, a Shi'ite rising in Mecca and Medina was ruthlessly crushed. Khurasan was pacified by the appointment in 759 of al-Mansur's son, known as al-Mahdi, as governor. The completion of the new capital at Baghdad in 766 was an outward mark of al-Mansur's success in pacifying the caliphate (apart from Spain) and firmly establishing Abbasid rule. The new capital also shows the shift of power eastward, since the Abbasids depended on the armies of Iraq and Khurasan. At the same time Persian traditions of government were followed more closely, and Persian Muslims had a greater share in the state. The Persian office of vizier was introduced, with a number of separate offices or ministries (diwans) subordinate to it. Al-Mansur died in Bir Maimun in Oct. 775 while on a pilgrimage to Mecca.

ABU TAHIR ISMA'IL IBN AL-QA'IM, third Fatimid caliph in north Africa, who reigned from 946 to 953.

ABU YUSUF YA'QUB AL-MANSUR, often called Jacob Almanzor, who ruled from 1184 to 1199 as prince of the Moorish dynasty of the Almohads (*q.v.*) in north Africa and Spain. He was the son of a Christian slave girl. The Giralda at Seville is a notable architectural monument of his reign. His defeat of Alfonso VIII of Castile at Alarcos (1196) is the culminating event of Almohad rule in Spain. Subsequently it rapidly declined.

MOHAMMED IBN ABI-'AMIR AL-MANSUR, known to European writers as Almanzor, chief minister and virtual ruler of the Omayyad caliphate of Córdoba from 978 to his death in 1002. (*See* CÓRDOBA, CALIPHATE OF.) Descended from an Arab who took part in the conquest of Spain, he rose by his own skill, tact and efficiency. He had the support of Subh, the Basque mother of the young caliph Hisham II, and she was said to be his mistress. With his father-in-law, the general Ghalib, he overthrew the previous chief minister in 978. A rupture with Ghalib led to the latter's defeat and death in battle in 981. By giving the African territories local independence under Omayyad suzerainty, he stopped a drain on his resources. This and the replacement of the Slavs in the army by Berber and Christian mercenaries enabled him to conduct a series of successful campaigns against the Christian states of northern Spain, including one against Santiago in 997. From 981, when he assumed the honorific name of *al-Mansur bi-Allah* ("the one made victorious by God"), he had supreme power and gradually adopted various outward marks of it. Though in 994 he took the title of "Noble King" (*al-Malik al-Karim*), the caliph continued as nominal head of state. He died at Medinaceli on Aug. 10, 1002, on the way back from a campaign. His rise to power is comparable to that of the Buyids and Seljuks in the east. A son succeeded him, but the family, known as the Amirids, retained power for only a few years. (W. M. WT.)

MANSURAH, AL (EL MANSURA), a town of lower Egypt on the eastern side of the Damietta branch of the Nile. It is the capital of Ad Daqahliyah *muhafaza* (governorate) and is 90 mi. N. of Cairo and 34 mi. S.W. of Damietta. Pop. (1957) 136,057; (1962 est.) 159,000. It has rail connections with Az Zaqazig and Cairo and is a market centre for the cotton, flax and rice of the northeast delta. Its principal industries include cotton ginning, cottonseed oil extraction, rice milling and textile manufactures.

Al Mansurah was founded in A.D. 1221. The only event of importance in its history was the battle of the same name, when King Louis IX, who was leading a crusade to attack Islamic power in Egypt, was outmaneuvered by the Mamelukes and his forces decimated on Feb. 8, 1250. It was this battle that largely contributed to the ultimate defeat of the French expedition (*see* CRUSADES). The fort, called St. Louis after the French king, is still standing. (A. B. M.; M. V. S.-W.)

MANTEGNA, ANDREA (1431–1506), greatest north Italian fresco painter of the 15th century, was born at Isola di Cartura near Piazzola, Italy, in 1431 and was apprenticed by his father, a carpenter, to the Paduan painter Francesco Squarcione. In 1441 he is mentioned as Squarcione's adopted son. He seems to have remained in this painter's studio for six years, moving with Squarcione to Venice in 1446. By 1448, when at the age of 17 he signed a lost altarpiece for Sta. Sofia in Padua, he was an independent artist. Padua was the seat of the most prominent university in north Italy, and from a very early date Mantegna must have been indoctrinated with the humanist culture that formed the mainstay of his art. In addition, he would have become familiar with the work of the Florentine artists who had been employed in the church of S. Antonio, notably Fra Filippo Lippi and Donatello. The latter was resident in Padua after 1443 and exercised a profound influence on Mantegna's work. In Venice the frescoes of Andrea del Castagno in S. Zaccaria, the mosaics of Paolo Uccello and the personality of Jacopo Bellini must also have left their impression on his mind. These experiences are summed up in Mantegna's first major work, the frescoes in the Ovetari chapel of the church of the Eremitani in Padua.

Before this chapel was destroyed by bombing in 1944, it contained a cycle of frescoes covering the lateral walls and vault, the altar wall and the upper part of the apse behind. The commission owed its origin to the will of Antonio Ovetari and seems to have been allotted in the first instance to Squarcione, by whom the work was subcontracted to Antonio Vivarini and Giovanni d'Allemagna, on the one hand, and to Mantegna and Niccolo Pizzolo, on the other. Of the sections executed by Mantegna, the "Martyrdom and Removal of the Body of St. Christopher" (begun by Pizzolo) and an Assumption of the Virgin survive in part. The poles of Mantegna's development in the Ovetari chapel are the still tentative full-length saints painted in the apse and the masterly scenes on the base of the left wall, which belong to the last phase of work in the chapel, and were probably painted in 1456. Viewed solely from the standpoint of space projection, Mantegna's frescoes are the most progressive paintings of their time. Throughout the scenes the architecture is authentically classical and incorporates the rich archaeological detail that is a feature of Mantegna's mature work.

In Aug. 1453 Mantegna received the commission for a polyptych for the chapel of St. Luke in Sta. Giustina at Padua. This altarpiece, now in the Brera gallery in Milan, was completed in November of the following year and corresponds in style with the intermediate frescoes in the Ovetari chapel. The style of the latest of the frescoes is translated to the field of panel painting in an altarpiece commissioned for S. Zeno at Verona by Gregorio Correr, probably in 1456 (completed 1459). Inspired by Donatello's high altar in the Santo at Padua, the main panels represent, between four massive wooden columns, the Virgin and Child enthroned with four saints in an open hall. One of the richest and most brilliant of all north Italian altarpieces, the S. Zeno triptych now lacks its predella which is distributed between the Louvre ("Crucifixion") and the museum at Tours ("Agony in the Garden" and "Resurrection").

Before 1453 Mantegna married Nicolosia, daughter of Jacopo and sister of Giovanni Bellini. Mantegna's influence on Bellini is evident in a painting of the "Transfiguration" in the Museo Correr in Venice and certain other early works. A point of comparison between the two artists is afforded by two paintings of the "Agony in the Garden" in the National gallery, London, both of which derive from a drawing by Jacopo Bellini. Mantegna's classicizing figures are set in the same arid landscape as the Ovetari "Martyrdom of St. James," whereas in Bellini's panel this academic classicism is replaced by a warm romantic apprehension of nature and natural forms.

On Jan. 30, 1459, Mantegna was appointed court painter to Lodovico Gonzaga, marquess of Mantua, and he moved to Mantua later in the year. No dated work by him survives between this year and the completion of the frescoes in the Camera degli Sposi of the ducal palace at Mantua in 1474, though it is known that he executed paintings (lost) in the chapel of the ducal palace (still

GIRAUDON

"THE CRUCIFIXION," CENTRE PREDELLA PANEL OF S. ZENO ALTARPIECE, BY ANDREA MANTEGNA. IN THE LOUVRE, PARIS

unfinished in 1464), in the castle of Goito and at Cavriana. In 1466–67 he visited Pisa and Florence. The commission for the Camera degli Sposi has been credibly assigned to the year 1472. The ceiling of the room is decorated with fictive reliefs of emperor heads and with triangular grisaille paintings of mythological scenes, also in imitation of the antique. In the centre is a circular aperture in which a number of figures are represented looking down over a balustrade. This detail forms a landmark in the history of illusionistic painting and was of fundamental importance for the illusionistic frescoes of Correggio. On the wall above the fireplace is a much damaged scene representing the court of Lodovico Gonzaga. There, too, the wall surface is treated illusionistically with consummate constructional resource. On the second of the two painted walls is a fresco of Lodovico Gonzaga and his son Cardinal Francesco (possibly in commemoration of the latter's visit to Mantua in 1472), a fragmentary fresco of two huntsmen and hounds and, above the doorway between them, a number of putti supporting a tablet recording the date of completion of the work.

The frescoes reveal Mantegna as a portrait painter of the first rank. Other examples of this aspect of his work are portraits of Cardinal Mezzarota (Kaiser Friedrich museum, Berlin), Cardinal Carlo de' Medici (Uffizi, Florence) and an unidentified man (National Gallery of Art, Washington, D.C.).

At this time Mantegna enjoyed a high reputation not only as an artist but as a connoisseur of the antique. His archaeological and epigraphic studies provide a context for the second of his great Mantuan commissions, that for nine canvases of the "Triumph of Caesar" (Hampton court, Middlesex). These were in course of execution in 1486 and were still unfinished in 1492. Gravely damaged as they are, they form one of the most significant monuments of 15th-century humanist art.

In 1488 Mantegna visited Rome to decorate a small chapel in the Vatican (destroyed) on the commission of Pope Innocent VIII and to execute *trompe-l'oeil* (illusionistic) paintings in the adjacent sacristy. Work in the Vatican interrupted the progress of the "Triumph of Caesar." In 1495, after the completion of the latter work, Mantegna began work on the "Madonna of the Victory" (Louvre, Paris), which was commissioned by Giovanni Francesco Gonzaga to commemorate his victory over the French at Fornovo and was installed in the Cappella della Vittoria (also designed by Mantegna) in 1496. The course of Mantegna's development in the last years of his life may be judged from two paintings of St. Sebastian, one in the Louvre (probably 1481) and the other in the Ca d'Oro in Venice (before 1506). His last important commission was for three allegorical paintings for the studio of Isabella d'Este in the ducal palace. Two of these are now in the Louvre. A third painting (later completed by Lorenzo Costa) was unfinished when Mantegna died on Sept. 13, 1506. He was buried in the church of S. Andrea, Mantua, in a funerary chapel of his own design.

In addition to these major works Mantegna was responsible for executing many smaller paintings. Among these is a notable series of Madonnas (Kaiser Friedrich museum, Berlin; Accademia Carrara, Bergamo; Museo Poldi-Pezzoli, Milan; Brera gallery, Milan), the form of which was clearly influenced by the Madonna reliefs of Donatello. Other paintings are a well-known panel of "St. George" in the Accademia in Venice, a triptych of the "Adoration of the Magi," "Presentation in the Temple" and "Ascension" in the Uffizi gallery, Florence, and a strongly foreshortened figure, the "Dead Christ," in the Brera gallery, Milan. After 1491 (and perhaps as early as 1475) Mantegna was active as an engraver. Seven engravings (four of them of classical subjects) are usually accepted as his work. Though Mantegna's work is less immediately appealing, because colder and more detached, than that of his contemporary and brother-in-law Giovanni Bellini, we are conscious in his paintings of the working of a powerful intelligence and of the presence of an inventive faculty richer than that of any other north Italian artist of his time. His late work, like Bellini's, bridges the transition to the 16th century and opens the way to a world of experience which was explored, in the decades following his death, by his disciple Correggio.

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(J. W. P.-H.)

MANTELL, GIDEON ALGERNON (1790–1852), pioneer English geologist and paleontologist, noted as a discoverer and collector, was born at Lewes, Sussex. Educated for the medical profession, he practised at Lewes, Brighton and Clapham. He studied the paleontology of the Secondary (Mesozoic Era) rocks, particularly in Sussex—a region which he made classical in the history of discovery. His most remarkable discoveries were made in the Wealden formations. He demonstrated the fresh-water origin of the strata, and from them he brought to light and described the remarkable dinosaurian reptiles known as *Iguanodon*, *Hylaeosaurus*, *Pelorosaurus* and *Regnosaurus*. He also described the Triassic reptile *Telerpeton elginense*.

Mantell was elected a fellow of the Royal society in 1825 and died in London on Nov. 10, 1852.

MANTEUFFEL, EDWIN, FREIHERR VON (1809–1885), Prussian field marshal, a victorious general of the Bismarckian era who was also an able diplomat, was born at Dresden on Feb. 24, 1809. He joined the guard cavalry at Berlin in 1827 and won the complete confidence of King Frederick William IV during the revolutionary events of 1848 and became his aide-de-camp. Late in 1848 he was sent on a mission to Sweden. He became a lieutenant colonel in 1852 and was commander of the 5th Uhlans from 1853. In 1854 he went on two diplomatic missions to Vienna and one to St. Petersburg; on the latter mission he persuaded the emperor Nicholas I to withdraw Russia's troops from the Danubian principalities (*see* CRIMEAN WAR). He then went again to Vienna to dissuade Austria from joining the war against Russia. In Feb. 1857 he was appointed chief of the military cabinet, a body which then rivaled the general staff for control of Prussia's armed forces. In 1861 he was promoted lieutenant general.

After service in the war of 1864 against Denmark, Manteuffel was made governor of Schleswig. During the Seven Weeks' War (1866) he occupied Holstein, commanded a division in the campaign against the Hanoverians and in July succeeded E. Vogel von Falckenstein in command of the army of the Main. His operations ended with the occupation of Würzburg. He was then delegated to explain Prussia's German policy to the Russians.

In the Franco-German War (1870–71) Manteuffel led the I corps and distinguished himself at the battle of Colombey-Neuilly and in the repulse of Marshal A. Bazaine at Noisseville. Succeeding K. F. von Steinmetz as commander of the 1st army in Oct. 1870, he won the battle of Amiens (Nov. 27) and occupied Rouen (Dec. 6). Commander of the newly formed army of the south (Jan. 1871), he quickly liquidated the French forces in southern France. When this army was disbanded, he commanded the 2nd army. From June 1871 to Sept. 1873 he commanded the occupation forces in France—a duty that he performed with remarkable tact. He was then made a field marshal and military governor of

Berlin. On his return from a last mission to the Russians after the congress of Berlin (1878) he was imperial governor of Alsace-Lorraine from 1879. He died at Carlsbad in Bohemia on June 17, 1885.

MANTINEA (Mantineia), an ancient city of Arcadia, in Greece, about 8 mi. N. of modern Tripolis in a long narrow marshy plain bounded on the west by Mt. Mainalon, on the east by Mt. Artemision; it is without opening to the coast, the water percolating through underground passages (*katavothra*) to the sea. The supremacy of the district was disputed with Tegea (*q.v.*).

Mantinea is mentioned in the catalogue of ships in Homer's *Iliad*, but in early Greek times it was only a cluster of villages, insignificant compared with Tegea and submissive to Sparta. But soon after the Persian wars its five constituent villages, at the suggestion of Argos, were merged into one city, whose policy was henceforth guided by three main considerations: its democratic constitution of small freeholders; its ambition to control the watershed of the Alpheus (Alfios) river and Arcadian roads to the Isthmus of Corinth; and its chronic disputes with Tegea. In 468 B.C. the Mantineans alone of Arcadian townships refused to join the combination of Tegea and Argos against Sparta, and they assisted Sparta during the revolt of the Messenian helots of 464. Though formally on the same side in the Peloponnesian War, they employed the truce of 423 in fierce but indecisive war with Tegea. After the peace of Nicias (421) Mantinea allied with Elis, Argos and Athens, but this alliance was defeated by the Spartans at the battle of Mantinea (418) and dissolved. During the 4th century and Hellenistic period Mantinea was of less importance, and in the later Roman empire the city dwindled into a mere village (which from the 6th century bore the Slavonic name Goritza) and as a result of malaria and Turkish rule has disappeared. The site was excavated by the French school at Athens, in 1888. The agora and adjacent buildings and the walls have been investigated. When the city was rebuilt in 370 B.C., the Ophis river, which formerly ran through the town, was divided so as to encircle the walls.

Battles of Mantinea.—Battles were fought in the years 418, 362 and 207 B.C. at Mantinea.

1. The first battle, in the Peloponnesian War (*q.v.*), is of some interest in the evolution of tactics. On the one side were the Spartans under the Spartan king Agis, while the other was composed of Argives, Mantineans and a small Athenian force. As the Spartan line advanced, a drift to the right occurred—a common occurrence in ancient battles, due to the natural instinct of each man to hug closely to his neighbour's shield as a protection to his own unguarded (*i.e.*, nonshield-bearing) side. Agis, seeing that this drift would cause his left flank to be overlapped by the enemy, sought to prolong his left. This stretching caused a gap in the centre, and the Spartan left wing was broken up by its adversaries who poured into the gap. This, however, was offset by the success of the Spartan right.

2. The second and more justly famous battle took place in 362 B.C. Epaminondas had followed up the sensational Theban victory at Leuctra (*q.v.*) by invading the Peloponnese in 370 and 369. A surprise attack on Sparta had narrowly failed, but strong opposition against it had been built up. Messenia had been re-established as an independent state with a new capital, Messene, on Mt. Ithome, and a new federal capital had been designed at Megalopolis for the Arcadian league. The position of Epaminondas, however, was not secure and Theban policy lacked consistency. A serious division also broke out in the Arcadian league reviving the old hostility between Tegea and Mantinea.

In 362 Thebes was driven to choose between reasserting its authority and sacrificing its prestige. Its move against Arcadia caused Greece to divide afresh into two hostile coalitions. Once more Epaminondas made a surprise spring at Sparta, but he was deprived of the fruits of his night march through a deserter, who warned the Spartan main army in time for it to hurry back and safeguard the capital. Epaminondas then stood on guard at Tegea while the enemy forces concentrated at Mantinea. The valley in which these places lay is shaped like an hourglass by the surrounding mountain ranges, and at the mile-wide waist the Spartans and their allies took up a strong position. Epaminondas determined to seek a decision by battle, and as in his strategy so in his grand tactics showed his art by an indirect approach.

At first he marched directly toward the Spartan camp, causing the enemy to form up in battle order facing his line of approach. But when still several miles distant, he suddenly changed direction to the left, turning in beneath a projecting spur. This surprise maneuver threatened to take in enfilade the Spartan right, and to dislocate still further the Spartans' battle dispositions he halted his troops and made them ground arms as if to encamp. The deception succeeded; the enemy were induced to relax their battle-order, allowing men to fall out and the horses to be unbridled. Meanwhile Epaminondas was actually completing his battle dispositions behind a screen of light troops.

Then, on a signal, the Theban army took up its arms and swept forward. Caught by surprise the enemy made haste to reform, but their cavalry were driven back by the Theban cavalry covering the left flank of the massed column, and this striking the Spartan line pierced it in two. But in the moment of decision Epaminondas himself was mortally wounded, and with his fall the advance came to a stop and failed to complete the victory.

3. The third battle for which Mantinea is notable was that of 207 B.C., in which Philopoemen, the commander of the forces of the Achaean league, routed Machanidas, tyrant of Sparta.

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(B. H. L. H.; R. Me.)

MANTIQUEIRA, SERRA DA, a range of mountains in southeastern Brazil, running for about 200 mi. in a southwest-northeast direction along the southern border of the state of Minas Gerais. The range comes to a distinct ending west of Juiz de Fora and does not connect with the Serra do Espinhaço as was formerly thought. It rises abruptly from the northwest side of the Paraíba valley, reaching a height of 9,482 ft. in Pontao da Bandeira.

The mountains were originally forest-covered except for the tops which stand above the tree line. They provide charcoal and pasture for cattle; on the lower slopes there are several health resorts, such as Campos do Jordão. (P. E. J.)

MANTIS (Mantid), any insect belonging to the superfamily Mantoidea (including Mantidae and related families), sometimes grouped with cockroaches in the order Dictyoptera but, by some, given ordinal rank of its own as the Mantidea (Mantodea). Formerly, mantids were placed in the order Orthoptera (*q.v.*).

The name mantis, meaning "a diviner," was used by the ancient Greeks for the common southern European *Mantis religiosa religiosa*, which they believed had supernatural powers; one of its present-day English names, "soothsayer," recalls that belief. Numerous legends and superstitions are attributed to the mantis because of its habit of remaining motionless or of swaying gently back and forth, with head raised and front legs outstretched in what appears to be an attitude of supplication. The scientific name, the common English name, praying mantis, and many other vernacular names, like *Gottesanbeterin* (German), *Prie-Dieu* (French), *Prega-Diou* (Provençal), together with similar names for other species, such as the West Indian "god-horse," all suggest piety. "Devil's horse" and "mule killer," among several names current in the United States, are perhaps more appropriate, since all mantids are ferocious carnivores and not at all of saintly demeanour; "preying" rather than "praying" is a more apt epithet for the mantis.

Most mantids live among vegetation, although some live directly on the ground. Almost all are camouflaged, and many bear remarkable resemblances to green or brown foliage. Some may be readily mistaken for withered, dried-up leaves, slender twigs, lichen, brightly coloured flowers or even ants. These adaptations, which provide them concealment from foes, also render them inconspicuous as they stalk or lie in wait for victims. Most species are comparatively slow-moving, but some ground forms can move

rapidly when pursuing prey. The front leg of a mantid is peculiarly modified: the tibia fits into a groove in the femur, forming a structure like a clasp knife, usually beset with spines. With these formidable weapons, a mantid can seize its prey in a viselike grip and hold it firm while tearing it apart with its mandibles. Mantids are voracious and very pugnacious, attacking and devouring not only noxious and venomous insects but even their own kind. When alarmed they adopt a "threatening" attitude, raising and rustling their wings (if any), often displaying bright "warning" coloration.

LOUIS QUITT FROM NATIONAL AUDUBON SOCIETY

YOUNG OF THE CHINESE MANTIS (TENODERA ARIDIFOLIA SINENSIS), AT THIS STAGE ABOUT THE SIZE OF A MOSQUITO, EMERGING FROM EGG CASE

Mating may be a hazardous undertaking for the male mantid, for it frequently terminates in his sudden demise at the hand of his usually larger spouse. Eggs are laid in large cocoonlike capsules (*oothecae*) that serve as protection during winter or drought and from enemies. The nymphs all emerge about the same time, and, if they do not disperse rapidly, often indulge in cannibalism. The young closely resemble their parents, but lack wings.

The vast majority of the more than 1,500 species of mantids are tropical or subtropical. Only about a score occur in Europe and about the same number in North America, in both cases mainly in the south. Representative European genera are *Mantis* (*M. religiosa* being the most widespread), *Ameles, Iris* and *Empusa;* North American genera include *Stagmomantis* (*S. carolina* being very widely distributed), *Litaneutria* (*L. minor* being a small western species and the only native mantid in Canada) and *Thesprotia* and *Oligonicella* (very slender southern forms). Two European and two Asiatic species have been introduced into North America. They are: *M. religiosa,* in northeastern United States and southeastern Canada; *Iris oratoria,* in California; the narrow-winged *Tenodera angustipennis,* in southeastern United States; and *T. aridifolia sinensis.* This last species, the familiar Chinese mantis, native in many parts of eastern Asia, is the largest mantid in North America, where it is most plentiful in the east but occurs as far west as Illinois and is found in California. Egg masses are sometimes sold by dealers to naturalists and gardeners to supply mantids to reduce insect pests; however, there is little evidence that mantids could ever become really effective in biological control.

See A. B. Gurney, "Praying Mantids of the United States: Native and Introduced," *Smithsonian Report for 1950,* pp. 339–362 (1951).

(D. K. McE. K.)

MANTIS FLY (Mantid Fly), insects of the family Mantispidae, order Neuroptera, related to the ant lions, lacewing flies, etc., and named from their superficial resemblance to a mantis (*q.v.*) because of the length of the prothorax and the shape and prehensorial nature of the anterior legs.

The larva, at first very active and having well-developed legs (campodeiform), makes its way into the egg case of a spider or the nest of a wasp to feed on the eggs or young. Subsequently it changes into a fat grub with short legs. When full grown it spins a silken cocoon in which it transforms into the pupa. Mantispids are widely distributed in both the old and new worlds, but occur chiefly in warm countries. *See* Neuroptera; Insect.

MANTO ("prophetess"), in Greek epic legends the daughter and assistant of the Theban prophet Tiresias. After the sack of Thebes by the Epigoni she was dedicated to Apollo at his oracular shrine of Delphi as the fairest of the spoil. Fulfilling an utterance of the oracle she married Rhacius the Cretan and founded in Ionia the famous Apolline oracle centre of Claros. Her son was the seer Mopsus (*q.v.*). *See* also Oracle. (H. W. Pa.)

MANTRA, a Sanskrit word meaning a sacred utterance considered to possess supernatural power. In the Vedic period the *mantras* are the words used in the ritual, especially the verses of the Vedic hymns; many are prayers or invocations of deities, but the texts emphasize their magical potency and symbolic interpretation. The cognate Iranian word denotes scriptural verses as well as magic spells to heal disease.

In post-Vedic India, *mantras* were particularly important in religious movements such as Tantrism. While often considered as purely mechanical magic to obtain worldly ends or religious salvation, they were also the subject of more sophisticated speculations. Thus the sacred syllable *OM,* analyzed into the three sounds A, U and M, came gradually in the Upanishads and the Brahmanas to symbolize the Vedas, the components of the universe (earth, atmosphere and air) and, taken as a whole, the Absolute. The constant repetition (*japa*) of *mantras* was utilized to concentrate the mind on an object of religious meditation; and the *bija-* ("seed-") *mantra* of a deity was considered to evoke the presence of that deity. The famous Gayatri mantra (Rigveda, iii, 62, 10), an invocation to the sun-god Savitar, was formally transmitted to the young Brahman when he was invested with the sacred thread (*see* Hinduism: *Social and Ethical Aspects*). The reception of a secret *mantra* from the teacher was normally a central feature of initiation into a religious sect. *Mantras* still play an important part in Hindu ritual.

Mantras were also luxuriant in popular Buddhism, especially as an aspect of the Mahayana, where this development has been called *mantrayana.* The normal Buddhist term for a formula of this type is *dharani,* and numerous specimens survive in the literature. In the modern period, the use of the "six-syllable *mantra*"—*om mani padme hum*—is a feature of Tibetan Buddhism.

MANTRAP, a mechanical device for catching or injuring a trespasser. Such traps include concealed pits, traps with jaws that close on the victim's leg, and spring guns, triggered when one steps on a concealed wire. Since 1827 their use in England has been a misdemeanour, except to protect dwellings between sunset and sunrise.

In the United States, a number of states have banned the use of such devices. In jurisdictions that have not outlawed them, the law is far from settled, but it appears that the trap setter may be both criminally and civilly liable for resulting death or injury and that liability may depend on whether the victim was bent on committing a felony, a circumstance which is hardly predictable in advance. Thus it appears that one who sets such a trap may be imposing as grave a risk on himself as on the potential intruder.

(H. L. Pr.)

MANTUA (Italian Mantova), chief town of the province of Mantova, Lombardy region, Italy, is located 40 km. (25 mi.) S.W. of Verona and 121 km. (75 mi.) E. of Milan. Pop. (1961) 62,411. Mantua stands on rising ground in a zone of lakes formed by the waters of the Mincio. Its fortifications were dismantled after 1866. It is divided in a north-south direction by the embankment of the Porta Molina and in an east-west direction by a long bridge on which runs the road to Padua. At the highest point of the city stands the cathedral, the interior of which was constructed after designs by Giulio Romano. The church of S. Andrea, which shares the privileges of the cathedral, was built according to plans by Leon Battista Alberti. It has a single nave without aisles and with barrel vaulting. The campanile, in brick, dates from 1414. The dome was added later (1732–82) after a design by Filippo Juvarra. The vast ducal palace, also called the Reggia dei Gonzaga, in the Piazza Sordello was begun *c.* 1302 by Guido Bonacolsi, but many of its apartments were added later and were decorated by Romano and his pupils. In the apartments of the empress are tapestries executed from cartoons of Raphael. The court castle, built (1395–1406) by Bartolino da Novara, contains the Camera degli Sposi, decorated with frescoes by Andrea Mantegna (*q.v.*). The Palazzo del Te, another work of Romano, on the boundary of the city, was built between 1525 and 1535 and is decorated with frescoes by Romano and his pupils and with stuccoes by Primaticcio. Other notable buildings include the

Palazzo della Ragione (13th–15th century); the Rotonda di S. Lorenzo (11th century, restored); the church of S. Sebastiano by Alberti (15th century); and the houses of Mantegna and Romano.

Among the cultural institutions of the city are the Accademia Virgiliana, which occupies a handsome edifice by Giuseppe Piermarini containing a Teatro Scientifico designed by Antonio Bibiena (1769); the communal library, founded in 1779 by the empress Maria Theresa and containing valuable incunabula and manuscripts; and the Archivio di Stato in which are kept the documents of the Archivio Gonzaga.

The economic activities of the city are primarily concerned with the processing and shipping of agricultural products. After World War II, however, industry increased, and an industrial area covers a large tract southwest of the city. As a result, the population grew rapidly, and large housing estates have given a new aspect to the city's outskirts. Mantua is a centre of road, rail and water transportation.

The city originated in settlements of the Etruscans and later of the Gallic Cenomani. Roman colonization began about 220 B.C. and in 70 B.C. the great Latin poet Virgil was born in the neighbourhood. In the 11th century the city became a fief of Boniface of Canossa, marquis of Tuscany. After the death of Matilda of Tuscany in 1115, Mantua secured a communal government which lasted until 1276, when the Bonacolsi (*q.v.*) family obtained control. They, in turn, were driven out in 1328 by Luigi Gonzaga, who established the supremacy of the Gonzaga (*q.v.*) family, under whom Mantua enjoyed a period of political prestige and cultural splendour. Following the downfall of the Gonzagas, in 1708, Mantua became a fief of the empire. In 1797, after a long siege, it was occupied by Napoleon. Returned to Austria by the congress of Vienna, it contributed to the cause of the Risorgimento and, after a plebiscite, was joined to the kingdom of Italy in 1866.

(Em. F.)

MANU, in ancient Indian mythology, the first of mankind and the supposititious author of an important Sanskrit treatise on law, the Manu Smriti. The name means simply "man" and is cognate with the Germanic word. A further and intrinsically improbable etymological connection with the verb *man-*, "to think," has sometimes been suggested. Manu has also been compared with that Mannus whom the Germans, according to Tacitus, considered to be the founder of their race. "Manu" may thus reflect an ancient Indo-European tradition, although the possibility remains open that Mannus was a parallel but independent development, as in the case of the Hebrew Adam (also meaning "man"), where a direct historical connection could hardly be suggested.

Manu appears in the Vedic hymns as the first sacrificer, to whom the gods gave fire for the sacrifice, and he is occasionally referred to as "father Manu." The Shatapatha Brahmana recounts how he was warned by a fish to which he had done a kindness that a flood would destroy the whole of mankind. He therefore built a boat, as the fish advised; and when the flood came he tied this boat to the fish's horn and was safely steered to a resting place on a mountaintop. When the flood receded, Manu, the sole survivor of mankind, performed a sacrifice, pouring oblations of butter and sour milk into the waters; and after a year there was born from the waters a woman who announced herself as "the daughter of Manu." These two then became the ancestors of a new mankind to replenish the earth. In the Mahabharata the fish in this story is identified with the god Brahma, while in the Puranas it was assimilated to the fish incarnation of Vishnu. (*See* also Flood [in Religion and Myth].)

In the exuberant cosmological speculations of later Hinduism, as expounded in the Puranas and in the Manu Smriti itself, there were said to be 14 Manus, a separate one for each of the 14 subsidiary cosmic periods within the great time cycle (*kalpa*) of 4,320,000,000 years. A new human race is produced for each of these "Manu intervals" (*manvantara*), our own being the seventh in the current cycle. After the 14th Manu interval the whole universe comes to an end and is succeeded after an enormous length of time by a new creation in an endless series of creations and dissolutions.

The Manu Smriti (the "Laws" or "Code of Manu"), more formally called the Manava Dharma Shastra, is among the earliest of the post-Vedic metrical treatises on legal and allied topics. Of uncertain date, it has been provisionally ascribed to the period between the 2nd century B.C. and the 2nd century A.D. In addition to an outline of civil and criminal law, the text discusses at length the four traditional stages (*ashrama*) of a Brahman's life—student, married householder, hermit and finally homeless ascetic; the four social classes (*varna*) which form the theoretical basis of the caste system (*see* Caste [Indian]); the theory of "mixed castes," their origin and duties; the duties of a king; rules for sacrifices, penances and other religious duties. The work is thus a valuable source of information on the classical theory of Brahmanical Hinduism as a social system. *See* also Sanskrit Literature.

See Eng. trans. by G. Bühler, "The Laws of Manu," *Sacred Books of the East* (1886).

MANUCODE, the common name given to the more somber coloured birds of paradise (*q.v.*) comprising the genus *Manucodia* and found in northern Queensland and New Guinea. The males resemble the females and help them with nesting duties; for these and other reasons manucodes are often regarded as an early group in the family Paradiseidae.

MANUEL I (Manuel Comnenus) (*c.* 1120–1180), Byzantine emperor from 1143 to 1180, the fourth son of John II and his Hungarian wife, was married first to Bertha of Sulzbach in 1146, and then in 1161 to Mary of Antioch. He was therefore well used to westerners, and his partiality for Latins has led to the suggestion that he may have deliberately tried to break down barriers between east and west. His opening policy was sound: he safeguarded his position against the Danishmends and Seljuks in Asia Minor and renewed his alliances in the west against his Norman rivals in both Sicily and Antioch. At the time of the second crusade he defended his Greek territory from Roger of Sicily whose fleet captured Corfu in 1147. This was retaken in 1149 with Venetian aid, and at the treaty of Thessalonica in 1148 Manuel consolidated his alliance with Conrad III of Germany who was returning from the second crusade. Manuel wished to re-establish Byzantine authority in Italy and he gained a foothold in southern Italy in 1155. But Roger II's successor William I of Sicily defeated the Byzantines at Brindisi in 1156, and in 1158 Manuel signed a 30-years' peace with him and withdrew his troops from Italy. After 1158 Manuel concentrated on diplomacy in Italy rather than direct military intervention. In Conrad III's successor, Frederick Barbarossa, he had a powerful opponent, but though he tried to exploit the rift between Frederick and the papacy he did not shut the door to a German alliance. He also kept open the possibility of an understanding with Sicily, whose king from 1166 onward was the young William II, while constant embassies attempted to secure papal support in return for ecclesiastical reunion. Byzantine gold was freely scattered in Italian cities, and Venice, Pisa and Genoa secured substantial trading privileges within the Byzantine empire. But Greek resentment of Venetian privilege and arrogance was shown by the Byzantine attack of 1171 on Venetian merchants throughout the empire.

In the Balkans Manuel defeated Stephen Nemanya of Rascia in 1172 and forced him to recognize his suzerainty. He maintained close relations with Hungary whose heir-apparent, Bela, was married to his daughter and heiress Mary, and regarded as his successor. Croatia, Sirmium and Dalmatia were ceded as Bela's appanage. But with the birth of Manuel's son Alexius in 1169 the marriage was dissolved, though when Bela succeeded to the throne of Hungary in 1173 his appanage lands were retained by Manuel.

On the eastern frontier Manuel gained some successes in Cilicia and Antioch, and in 1159 Raymund of Antioch submitted to Byzantine overlordship. Manuel also allied with Nureddin of Aleppo who was threatening the crusading position. But rising forces in the Muslim world, particularly Nureddin's commander Saladin in Egypt, remained victorious. The joint Greek and Latin siege of Damietta in 1169 failed. In Asia Minor Kilij Arslan II of Iconium had considerably strengthened his position. From 1174 onward Manuel attempted to counter this and he persistently re-

fused to renew his peace treaty with Iconium. In 1176 he was trapped and defeated at Myriocephalum, and though Kilij Arslan did not press home his victory Byzantine prestige suffered a crushing blow. In spite of successes in Cilicia and northern Syria Manuel's foreign policy was too ambitious to be sustained. His home policy, though in many respects traditional, yet bears the marks of his original personality, particularly in his use of westerners. He died on Sept. 24, 1180, and was succeeded by a minor, Alexius II, his son by Mary of Antioch.

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MANUEL II (Manuel Palaeologus) (1350–1425), Byzantine emperor from 1391 to 1425, was the second son of John V, who allotted him the principality of Thessalonica before making him co-emperor in 1373, and with whom he was imprisoned by his elder brother Andronicus IV in 1376. After his father recovered his throne in 1379, Manuel reigned as emperor in Thessalonica (1382–87); and in 1390 he deposed his nephew John VII who had seized the throne. When his father died in 1391 Manuel was living in custody at the court of the Ottoman sultan Bayazid I, but escaped to Constantinople, where he was crowned emperor. Bayazid retaliated by laying siege to the city for seven months. Manuel submitted to the payment of tribute, and ruled his capital only at the sultan's mercy. The crusade organized for its relief by Sigismund of Hungary was routed by the Turks at Nicopolis in 1396; and in Dec. 1399 Manuel set out for the west to beg for help, visiting Italy, England and France, where he stayed nearly two years. He returned with little but promises; but Bayazid had meanwhile been defeated by the Mongol Timur at Ankara in July 1402. The Ottoman empire dissolved in civil war, until Mohammed I, prudently supported by Manuel, triumphed over his rivals. During Mohammed's reign (1413–1421) Manuel was thus left in peace; and he took the opportunity to improve the administration of his empire and its surviving outposts by visiting Thessalonica and the Morea, which he fortified with a wall across the Isthmus of Corinth. But his last respite ended with the accession of Murad II, who laid siege to Constantinople in 1422. The Morea was again overrun by the Turks; and Thessalonica, in imminent danger of conquest, was sold to the Venetians by Manuel's son Andronicus. In 1424 Manuel was forced to pay tribute to the sultan once more; he died as a monk on July 21, 1425.

Manuel was an intelligent ruler, but with the meagre resources of his shrunken and enfeebled empire he was unable to take advantage of the misfortunes of his enemies. He was a patron of art and letters, and himself composed theological, rhetorical and poetical works; and his correspondence is of considerable historical interest.

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MANUEL I (1469–1521), king of Portugal from 1495 to 1521, was born at Alcochete on May 31, 1469, the younger son of Fernando, duque de Viseu, and the grandson of King Edward (Duarte). Manuel's elder brother, Diogo, duque de Viseu, was killed by his cousin and brother-in-law John II (*q.v.*) in 1484, so that John's only legitimate son, Alfonso, having died in 1491, Manuel succeeded to the throne at John's death (Oct. 25, 1495). Manuel's reign was characterized by religious troubles, by a policy of clever neutrality in the face of quarrels between France and Spain and by the continuation of overseas expansion. Manuel sought to influence Castilian policy and this explains his successive marriages, first to the daughters of Ferdinand and Isabella, Isabella (d. 1498) and Maria (d. 1517), and then (1518) to Eleanor, sister of the emperor Charles V. His marriage to Isabella was made conditional upon the adoption of a repressive religious policy and resulted in an order (1497) for the expulsion of all Moors and of all Jews refusing baptism. Overseas, there were important new discoveries including the sea passage to India via the Cape of Good Hope by Vasco da Gama (1497–98) and Brazil (1500), but the most notable feature of the reign was the establishment of Portuguese influence in India and the far east—largely the work of Affonso de Albuquerque (*q.v.; see* Portugal: *History*). Manuel died on Dec. 13, 1521, and was succeeded by John III, his eldest son by his second marriage. By his first wife Manuel had one son, Miguel da Paz (1498–1500), who was recognized during his brief life as heir to Portugal, Castile and Aragon; by his second wife he had six sons and three daughters; and by his third wife, one son and one daughter. (Da. A. P.)

MANUEL II (1889–1932), king of Portugal from 1908 to 1910, was born at Lisbon on Nov. 15, 1889, the younger son of Carlos I and Marie Amélie of Orléans. On the assassination of Carlos and the crown prince, Luís Filipe, on Feb. 1, 1908, Dom Manuel succeeded to the throne, but retained it only until Oct. 5, 1910, when the overthrow of the monarchy was proclaimed (*see* Portugal: *History*). He took refuge in England and settled at Twickenham. He became a popular figure in English society. On Sept. 4, 1913, he married, at Sigmaringen, Augusta Victoria, daughter of Prince Wilhelm of Hohenzollern. There were no children. In exile, Dom Manuel devoted himself to bibliography and wrote a monumental three-volume description of his rich library, *Early Portuguese Books, 1489–1600, in the Library of His Majesty the King of Portugal* (1929–35). He died at Twickenham on July 2, 1932. He left the bulk of his estate to the Portuguese nation. (M. Ca.)

MANUEL, NIKLAUS, sometimes erroneously called Deutsch (1484–1530), Swiss painter, soldier, writer and statesman, was born at Bern in 1484 and died there on April 28, 1530. He was *un uomo universale* and a great Swiss representative of the ideas of the Italian and German Renaissance and the Reformation. What he saw in Albrecht Dürer's and Hans Baldung's art and in northern Italy prompted him to use new forms of expression (instead of the prevailing late-medieval style) in his drawings, portraits and mythological and biblical paintings, most of which were done between 1515 and 1520. A self-assured, impulsive temperament permeates also his vigorous, polemic anticlerical writings (mainly plays, written 1522–26). Later he spent his energies in political activities as a member of the Bern city councils. His paintings included the "Dance of Death" in the Dominican monastery, Bern (1516–19, destroyed 1660), "Pyramus und Thisbe" and "Enthauptung Johannes des Täufers." Among his literary works are *Der Ablasskrämer* (1526), *Testament der Messe* (1528) and *Fastnachtsspiele* (1540). His *Sämtliche Dichtungen,* edited by J. Bächtold, appeared in 1878.

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MANUEL DE MELLO, DOM FRANCISCO: *see* Melo, Francisco Manuel de.

MANUL (*Felis manul*), often called Pallas's cat, a small desert and rock-dwelling wild cat, ranging from Tibet to Siberia. The coat is long and soft, of pale silvery gray or light buff, marked with black. It has been suggested that the high-set eyes and low-set ears are adaptations for peering over rocky ledges; the supposition is that the manul thus exposes the smallest portion of himself to his prey, small mammals and birds. *See* also Cat.

MANURES: *see* Fertilizers and Manures.

MANUTIUS, the Latin name of an Italian family (Mannucci, Manuzio), famous in the history of printing as organizers of the Aldine press.

Aldus Manutius (1449–1515) was born at Bassiano, southeast of Rome. He studied at Rome and Ferrara before going, in 1482, to Mirandola with his friend, Giovanni Pico, whose nephew, Alberto Pio, prince of Carpi, gave Aldus money to start a printing press. He reached Venice in 1490, and gathered around him Greek scholars and compositors, while Greek was the language of his household. In March 1494/95 he issued his first dated book,

the *Erotemata* of Constantine Lascaris. During 1495–98 Aldus printed five volumes of Aristotle; in 1495 the *Idylls* of Theocritus and Pietro Bembo's *De Aetna;* in 1498 Aristophanes and Politian. Francesco da Bologna acted as type cutter for him, designing his italic and cursive Greek. Traces of the new italic occur in the *Letters* of St. Catharine of Siena in Sept. 1500, but its first regular appearance is in the Virgil of 1501. In 1499 came Aldus' most famous book, the *Hypnerotomachia Poliphili* of Francesco Colonna, with its wonderful woodcuts by an unknown artist. In 1501 he printed Juvenal, Martial and Petrarch's *Cose volgari;* in 1502 Catullus, Lucan, Thucydides, Sophocles and Herodotus; in August 1502 the *Divina Commedia* of Dante first shows the famous device of the Aldine anchor. In the Sophocles of 1502 occurs the first mention of an Aldine academy, whose members had to speak Greek. In 1503 Aldus printed Xenophon's *Hellenica,* Lucian and Euripides; in 1504 Demosthenes and Homer; in 1505 Aesop, Bembo's *Gli Asolani,* Giovanni Pontano and Virgil; in 1508 Erasmus' *Adagia,* in 1509 Horace; in 1513 Pindar and Plato; in 1514 Hesychius, Athenaeus, Jacopo Sannazaro's *Arcadia* and Petrarch's *Canzoniere.* He apparently printed nothing in 1506, 1510 and 1511; during the struggle of Venice with the allied powers of Europe, Aldus' labours were suspended and he traveled to Ferrara and Mantua. In 1505 he married Maria Torresani, daughter of a printer, and had five children. Thereafter his father-in-law's name (Andrea Torresani di Asola) regularly appears with his in imprints. Aldus published three catalogues of his own books, in 1498, 1503 and 1513 (all photographically reissued by H. Omont in 1892). He died in Venice on Feb. 6, 1515.

PAULUS MANUTIUS (1512–1574) was born at Venice on June 12, 1512. After the death of Aldus, his brothers-in-law, the Asolani, carried on the Aldine press, until his third son, Paolo, took it over in 1533. The Asolani attempted the duties of editing, and, to reserve the honours for themselves, dispensed with the services of competent collaborators. As a result, some of their editions, notably their Aeschylus of 1518, are particularly bad. Paolo, determined to remedy this situation, separated from his uncles in 1540. He was himself an excellent Latinist, especially dedicated to Cicero; he issued corrected editions of Cicero's letters and orations, his own Latin version of Demosthenes (1554), his epistles in a Ciceronian style (1560), and his four treatises on Roman antiquities. From 1558 he directed a press for the Accademia Veneta, but this had to close down for lack of funds in 1561, when Paolo was invited by Pius IV to Rome and was offered a yearly stipend of 500 ducats. In Rome Paolo printed about 50 books before 1571, the profits being divided between himself and the Apostolic Camera. He died in Rome on April 6, 1574.

ALDUS MANUTIUS, JUNIOR (1547–1597), eldest son of Paolo, was born at Venice on Feb. 13, 1547. When only 14 he wrote a work on Latin spelling, *Orthographiae ratio.* Remaining in Venice to superintend the Aldine press after his father's move to Rome, he published in 1575 his *Epitome orthographiae* and in 1576 his commentary on Horace's *Ars poetica.* About the same time he was appointed professor of literature to the Cancelleria at Venice. In 1585 Aldus moved to Bologna, where in 1586 he published his life of Cosimo dei Medici; in 1587 he went to Pisa, and in 1588 Sixtus V called him to Rome. Aldus married a daughter of the publisher Bernardo Giunta. He died in Rome on Oct. 28, 1597, leaving children, but none who carried on the Aldine press.

It is probable that the Aldine family in 100 years (1495–1595) printed 1,000 editions.

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MANWARING, ROBERT (fl. 1760), English 18th-century furniture designer and cabinetmaker. The dates of his birth and death are unknown. He was a contemporary, imitator and rival of Thomas Chippendale (*q.v.*). His work shows the same surprising variations of quality characteristic of that of nearly all the English cabinetmakers of the second half of the 18th century. His best had an undeniable elegance, his worst was squat and ill-proportioned. He introduced the small bracket between the front rail of the seat and the top of the chair leg, or at all events made such constant use of it that it has come to be regarded as characteristic of his work. Among Manwaring's writings were *The Cabinet and Chair Makers' Real Friend and Companion, or the Whole System of Chairmaking Made Plain and Easy* (1765, reissued, 1937); *The Carpenters' Compleat Guide to Gothic Railing* (1765); and *The Chair-makers' Guide* (1766).

MANX LANGUAGE: *see* CELTIC LANGUAGES.

MANX LITERATURE. Printed literature in Manx is very limited and there is little evidence for the former existence of a rich oral literature in the Isle of Man. The first written text in the language is the translation of the Book of Common Prayer by a Welshman, John Phillips, bishop of Sodor and Man (1605–1633), completed by 1610, which survives in a unique manuscript of *c.* 1630, from which it was printed in 1893–94 (Manx society, vol. 32–33). This work seems to have been spurned by the clergy because of its unfamiliar spelling. A catechism, as he called it, *Principles and Duties of Christianity . . .* by Thomas Wilson, bishop of Sodor and Man (1698–1755), in Manx *Coyrle Sodjeh,* was translated and printed in 1707, and he set on foot a scheme for the translation of the Bible, which was completed by his successor, Bishop Mark Hildesley (1755–1772). St. Matthew's Gospel appeared in 1748, and the four Gospels, and Acts, in 1763 and Epistles and Revelation in 1767. Meanwhile the clergy of the island were working on the Old Testament, which together with the New, appeared during 1771–75. A new version of the Prayer Book, replacing the extempore translations in use since Bishop Phillips' time, was produced in 1765. In most of had these books the translators were either insufficiently expert or had too high a respect for the English original consistently to produce fully free and idiomatic renderings. Besides this published material the Manx Museum library contains more than 450 manuscript sermons dating from 1725 to 1850. Thomas Christian's abridgment of *Paradise Lost* (4,000 lines) appeared in 1796 (reissued for the Manx society, vol. 20, 1872).

Original compositions in Manx are in bulk much slighter. The Traditionary (or Manannan) ballad, purporting to give a digest of the history of the island, is known in manuscripts only from *c.* 1770, in print certainly only from 1802, but there seems to be good linguistic evidence for believing that it was composed early in the 16th century. *Baase Illiam Dhone,* a ballad on the death of William Christian (*q.v.*), who was executed in 1663, cannot have been written until a generation later since it refers to the fate of his accusers' families. It is first known from its revival, with additional verses, in 1781. A trace of the heroic tradition survives in the *Fin as Osshin* fragment, a ballad on an Ossianic theme, recovered from oral tradition in the mid-18th century under the stimulus of the Ossianic controversy (*see* MACPHERSON, JAMES). The main bulk of the verse in Manx is in the form of carvals, or carols, songs in various metres on religious subjects, not all connected with Christmas (the Fall and Redemption of Man being a favourite theme) and composed to be sung at the *Oie'l Verree,* the Christmas eve service. These are often of considerable length.

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MANYCH, a system of rivers and lakes in the Russian Soviet Federated Socialist Republic, U.S.S.R., extends northwest of the Caucasus mountains. The Western (*Zapadny*) Manych is 261 km. (162 mi.) long and drains a basin of 13,650 sq.mi. It can be said to begin from its main tributary, the Yegorlyk, since its apparent source, Lake (Ozero) Manych-Gudilo, rarely has any outflow. The river flows northwestward through the Manych depression ([Kumo-Manychskaya Vpadina] by which the Caspian was once linked to the Black and Azov seas) to join the Don,

93 km. (58 mi.) above its mouth. It lies in an area of low rainfall and its water supply is almost entirely from snowmelt. This causes a spring flood and very low water at other seasons. However, since the construction of a barrage and reservoir at Vesely and of the Nevinnomysski canal (1949), which takes water from the Kuban into the Yegorlyk, navigation has been possible as far as Proletarskaya. East of Lake Manych-Gudilo is the Eastern (*Vostochny*) Manych river, receiving water via the Kalaus river from the Stavropol uplands and flowing eastward through the depression toward the Caspian. The Eastern Manych soon dies out in reed beds and salt lakes. Proposals have been made to convert the Manych rivers into a waterway which would link the Azov and Caspian seas and irrigate the Manych depression.

(R. A. F.)

MANYEMA, a name given to the members of various scattered communities of Swahili-speaking Muslims of the eastern Congo and Tanganyika (*see* SWAHILI LANGUAGE). They consist of the descendants of slaves taken by the Arabs during the period of Arab slaving in this region, and also of half-caste Arab-Africans. The trade was based on Zanzibar and there are many Manyema in Zanzibar, the term also being applied to people coming as immigrants from the Congo-Tanganyika region. They are included in the term Arabisés, used for Swahili-speaking Muslims in the Congo. They do not form a single political entity, but a loose scattered community of people linked by their religion, their language and their occupation; most of them are traders and artisans in urban and semiurban centres. (J. F. M. M.)

MANZANILLO, a city in Oriente province, Cuba, about 85 mi. to the west and slightly north of Santiago de Cuba. Pop. (1953) 42,252. It is an important export-import centre, located at the head of the shallow Gulf of Guacanayabo. Manzanillo is also the centre of a rich sugar, tobacco and rice zone and serves as the outlet for the extensive Cauto plain.

The town was founded in 1784 as Puerto Real and was sacked by the French in 1792. Its development proceeded rapidly after it was opened to foreign ships in 1827. The name was changed to Manzanillo in 1837. (D. R. D.)

MANZANITA, the name given to several evergreen shrubs of the genus *Arctostaphylos* belonging to the heath family (Ericaceae) and confined chiefly to western North America, especially California. The fruit, which becomes red-brown and berry-like at maturity, is suggestive when young of a tiny apple, whence comes the Spanish name *manzanita*, "little apple." The shrubs are mostly from 3 to 12 ft. high, with dark red or chocolate-coloured smooth and polished bark; very crooked, usually stiff branches; small, mostly toothless, often vertical leaves; and handsome white or pink flowers borne in terminal, usually nodding clusters. Among the kinds used as ornamentals are the common (*A. manzanita*), great-berried (*A. glauca*) and woolly (*A. tomentosa*) manzanitas. *See* also BEARBERRY.

MANZIKERT, BATTLE OF. In the spring of 1071 the Byzantine emperor Romanus IV Diogenes, having collected an army of about 60,000 men, marched into Armenia to recover the fortresses of Akhlat and Manzikert, captured by Alp Arslan and his Seljuk Turks. Romanus' forces were composite, consisting of Byzantine cavalry and infantry, German mercenaries and Franks. At Akhlat he divided his army, leaving a division to besiege the fortress. With the main body he marched on to Manzikert and reduced that place. Hardly had he done so when he fell in with Alp Arslan's advanced guard. The sultan's army was 100,000 strong and mainly consisted of horse archers. The tactics the emperor should have employed were those laid down by Leo the Wise, namely, to maintain an unbroken front, to beware of surprise and never to fight with uncovered flanks or rear.

Romanus was a brave soldier, but impetuous. In the advanced guard encounter one of his generals, Basilaces, fell into an ambush, losing all his men. The emperor then drew up his army in front of his camp. The right wing was composed of Asiatic cavalry, the left of European and the centre of Byzantine horse. In rear he drew up a strong second line of Germans and Normans under Andronicus Ducas. As he advanced on his enemy, the Turks refused to close, hovering round the two lines and plying them with arrows. According to the Greek narratives the emperor, fearing that his camp was in danger, ordered a retirement. This order was misinterpreted, and confusion resulted, whereupon the Turks, closing in, compelled the emperor to face about. Andronicus refused to halt and retired to the camp, leaving the front line open to attack from the rear. According to the oriental sources, the Greek troops fell into an ambush prepared by the Turks. In either event Romanus was defeated and made a prisoner. The result was disastrous: Asia Minor was overrun, and by 1080 the old Byzantine army had all but ceased to exist. (J. F. C. F.; X.)

MANZONI, ALESSANDRO (1785–1873), Italian poet, and also the author of *I promessi sposi* (*The Betrothed*), a historical novel that has been ranked with the chief masterpieces of European literature, was born at Milan on March 7, 1785. His mother was the daughter of Cesare Beccaria, the penal reformer. He was brought up as a Catholic, but, after joining his mother in Paris (1805), he mixed with the literary circle of the so-called *"idéologues,"* and became a convert to Voltairian skepticism. In 1808, however, he married Henriette Blondel, a Calvinist from Geneva who in 1810 became a fervent Catholic; and he then reverted to his former faith. Settling in his villa at Brusuglio, Lombardy, he led for many years a retired life, devoted partly to literary and linguistic studies, and partly to farming. His wife died in 1833, and in 1837 he married again. His writing won him the esteem of Goethe, his religious thought made him a friend of Rosmini and he came eventually to be recognized as one of the leading spirits of his age. In 1860 he was made a senator of Italy. The Christian serenity of his life was unaffected by his fame and unshaken by many blows (not only both his wives but also eight of their ten children predeceased him). He died in Milan on May 22, 1873. Verdi's *Requiem* (1874) was written to honour his memory.

Manzoni's early poems, "Il trionfo della libertà," "Adda," the series of "Sermoni" (written 1801, 1803, 1803–04; all published posthumously) and *Urania* (publ. 1809), show the influence of Vincenzo Monti and Giuseppe Parini; it is in his elegy on the death of his mother's lifelong friend, *In morte di Carlo Imbonati* (1806), that his individual talent is first revealed. Then followed a series of sacred lyrics, *Inni sacri: La risurrezione, Il nome di Maria, Il natale, la passione* (written 1812–15; publ. 1815), and, the best of them all, his masterpiece *La pentecoste* (written 1817–22; publ. 1822); the treatise *Osservazioni sulla morale cattolica* (1819); and *Il conte di Carmagnola* (1820), a tragedy which, by its bold violation of classical convention and its passionate political inspiration, showed clearly the influence of the romantic movement. The Piedmontese revolution of 1821 inspired the beautiful ode "Marzo 1821" (publ. 1848, in *Pochi versi inediti*), and on the death of Napoleon in the same year Manzoni wrote another ode, *Il cinque maggio* (publ. 1823), declared by Goethe to be the greatest of many written to commemorate that event. His second tragedy, *Adelchi* (1822), dealing with Charlemagne's overthrow of the Lombard kingdom and conquest of Italy, although it lacks dramatic power, is nevertheless rich in passages of deeply moving poetry, especially in the choruses depicting the arrival of the Franks and the death of Ermengarda.

Manzoni's greatest work, however, is his novel *I promessi sposi*. After its first publication (3 vol., 1827, with imprint 1825–26) Manzoni patiently revised it, carefully removing anything that was not pure Tuscan idiom from the language, and finally republished it in 1842 (with imprint 1840). It is the story of two peasant lovers, Renzo and Lucia, in 17th-century Lombardy under Spanish rule: a wicked local tyrant, Don Rodrigo, forbids their marriage, and the parish priest, Don Abbondio, bows to his will; but a courageous friar, Cristoforo, takes up the lovers' cause and helps them through many adventures to safety and marriage. The description of such great historical events as the Milanese insurrection, the Thirty Years' War and an outbreak of the plague is cleverly woven into the narrative. But *I promessi sposi* is much more than a historical novel: it is one of the great literary works of modern times, comparable for richness of beauty and depth of meaning with Goethe's *Faust* and Cervantes' *Don Quixote*.

Manzoni's seriousness of purpose, Christian resignation to the evils of life, confident hope in the triumph of a righteous cause and concept of religion as the ultimate comfort of mankind give the novel its moral import, while his poetical inspiration, the charm of his style and a pleasant vein of humour contribute to its excellence as a work of art and to the reader's enjoyment.

For a portrait of Manzoni *see* ITALIAN LITERATURE.

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(F. DI.)

MAORI. This Polynesian people, composing about 7% of the population of New Zealand, came of a seafaring stock. Members of the great Polynesian linguistic and ethnic group which inhabits the far-scattered island groups of the eastern Pacific, they are the result of an intermixture of several distinct waves of canoe voyagers, the last of which, in the mid-14th century, came from Tahiti, with Rarotonga—about 1,800 mi. N.E. of New Zealand—as the port of call. Evidence of this is provided by comparison of the traditions and genealogies scrupulously preserved by the learned men in each tribe. The most important cultural influence in the Maori population was provided by the "great fleet" that arrived in 1350, and on this the traditional social organization largely depended. Prior to that time the islands were inhabited by the *tangata whenua,* "the people of the land," some of whom were descended from Toi-kai-rakau, a Polynesian immigrant of about 1150, and others probably from drift voyagers. With these folk the later arrivals intermarried and fought, ultimately gaining the ascendancy. The visit of Toi was in the nature of a search party for his lost grandson. The later migration, however, was a premeditated colonization; the *kumara* ("sweet potato"), taro, yam and other cultivated plants were introduced, as was the native dog.

This article will discuss traditional Maori customs and ways of life; for history and modern conditions, *see* NEW ZEALAND.

Social Grouping.—The Maori people are divided into a score or more tribes, *iwi,* each with its own well-defined lands, and tracing kinship to a common ancestor. Thus all members of Ngati Maru, a tribe around Hauraki, claim descent from Marutuahu, the famous 14th-century chief whose name they bear. The principal canoes associated with the fleet are Tainui, Arawa, Matatua, Takitimu, Tokomaru and Aotea, and, generally speaking, the particular group of tribes descended from the captain and crew of each vessel occupies contiguous territory and forms a separate unit of a loose political nature, known as a waka. Thus Ngati Maru, together with Waikato and the tribes of the King country make up the Tainui waka, a human canoe which extends from Hauraki to Mokau. A tribe is made up of several principal hapu or clans, each of which might in olden days include about 1,000 fighting men. The hapu was not a unilateral group, *i.e.,* a person could belong to it through either his father or his mother, nor was it exogamous, marriage within the group being favoured provided that the parties were not first cousins.

Within these major social units were lesser hapu, tracing descent to more immediate ancestors, and these in turn were composed of *whanau,* family groups of near relatives who together often occupied a dwelling hut. The individual family of parents and children existed, but, not forming a separate household, did not play a large part in public life. Through all Maori social structure ran this principle of kinship by common descent, a bond which linked men together and welded *whanau* to form hapu, and hapu to form tribes. One hapu might fight another but on the approach of a tribal enemy they turned against the common foe.

The system of primogeniture played a leading part in the social organization. The highest chief was the *ariki,* eldest son in a line of first-born men of rank. His mana was very great; his word was law. The people of his tribe were his relatives, their rank being broadly represented by the closeness of their kinship to him. Next to him came the chiefs of his own family, then the rangatira, and finally the commonalty (*ware*). But every ordinary man, however undistinguished, could claim some sort of distant connection with his chief and with a noble family. Slaves (*taurekareka*) were mainly recruited from prisoners of war, and performed much of the menial labour.

Traditional Economy.—The Maori lived in villages (kainga), usually with a fort or defended position (pa) close at hand. The economic life of the different tribes varied according to the resources at their command. In the north, fertile soil and a warm climate allowed the cultivation of the *kumara* but in less-favoured districts forest products and the edible rhizome of the bracken (*aruhe, Pteris esculenta*) formed the staple food supply. Birds and the frugivorous native rat were snared and preserved by inland tribes; eels were taken by weirs on the Whanganui river, while around Rotorua and adjacent lakes crayfish and the fresh-water mussel were obtained. Fish was the main food of the dwellers on the seacoast. In economic pursuits the Maori were industrious.

Advantage was taken of the communal mode of life to secure co-operation in various tasks, and such labour was lightened by work songs. Division of labour was practised, though in somewhat rudimentary form. The men did harder work such as tree climbing, carving, fishing and fowling and tilling the ground for crops. The women weeded the crops, collected shellfish, plaited mats and wove garments from the useful harakeke and attended to the cooking of the two daily meals. In each industry were specialists (tohunga) who had received training, including knowledge of the magic of the craft.

Warfare was frequent and each man was trained in the use of weapons. Hand-to-hand fighting was preferred, and ambuscade and stratagem were frequent. In later warfare against Europeans the Maori proved extraordinarily proficient in the military art. In time of peace the social side of life was developed, visits were made, and neighbouring tribes were invited to feasts at which dart throwing, wrestling, top spinning and posture dancing held the interest of the people. Such receptions were held on the marae, the temple enclosure in the centre of the village. Feasts also took place at tangi, the ceremonial wailing for the dead, at which many relatives assembled from long distances.

Religion.—The traditional religion of the Maori was closely bound up with social and economic life. The common people recognized a number of gods, as Tane-mahuta, guardian deity of the forest, trees and birds, or Tangaroa, the Polynesian Neptune, lord of the sea and fish. The higher priests and chiefs also held belief in Io, a supreme god of rather negative attributes, to whom appeals were made in birth, baptism and marriage ceremonies for people of rank. This knowledge was jealously kept from the common people and from foreign anthropologists for many years. All Maori believed in a host of minor *atua,* rather malignant beings who provided omens, gave force to black magic, and punished breaches of tapu. The tapu was one of the strongest forces of law in the Maori community. With a sacred or unclean significance, according to circumstances, it conveyed essentially the idea of a prohibition. For instance, the person of a chief, his goods, his place by the fire and the remnants of his meal; all things connected with the gods; a corpse and the surroundings of death were all tapu, as were also a cultivated field or a new house or canoe. Thus things of social importance were protected from improper interference.

According to Maori belief, man was endowed with several spiritual *potentiae,* the *wairua,* the spirit which wanders abroad in dreams, the *mauri* and the *hau,* allied metaphysical concepts representing the vitality of a person, his essential life principle. At death the latter are dissolved, but the *wairua,* the soul, wends its way to Te Reinga, or Te Po, the underworld beneath the sea, a peaceful abode where men pursue their ordinary avocations as in life. *See* also references under "Maori" in the Index.

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Teach Yourself Maori (1955); A. G. Armstrong and R. Ngata (eds.), *Maori Action Songs* (1960); A. W. Reed, *Myths and Legends of Maoriland*, 3rd ed. (1961). (R. F.)

MAO TSE-TUNG (1893–), Chinese revolutionist and statesman, Communist party leader and founder of the Chinese Communist state, was born into a moderately prosperous peasant family in the central Chinese province of Hunan, on Nov. 19, 1893. He early betrayed a restless, rebellious temper and left the paternal farm; for ten years he attended school after school, and clutched at creed after creed, while China lapsed into chaos. An avid reader, he felt briefly attracted to constitutional monarchism and English idealism, utopian socialism and anarchism. He finished normal school in 1918 and went to Peking, where he took a humble post in the library of Peking university. There he met two professors whose social criticism drew him into their orbit; these were Li Ta-chao and Ch'en Tu-hsiu, eventually the principal founders of the Chinese Communist party.

Mao returned to Hunan in 1919 and briefly taught school before Marxism finally became his faith and revolution his career (1920). He helped to found the Chinese Communist party (1921), and as its leader in Hunan devoted his principal energies to launching a trade-union movement. His local successes earned him a place in the party's national leadership (1923); he went to Shanghai, then to Canton, to serve in its two biggest headquarters (1923–26). But his old restlessness reappeared in the headquarters atmosphere; he often changed posts and seized any pretext to return to Hunan. One such return, in 1925, became a historic turning point: Mao discovered the latent strength of the peasants and organized them for action. Other party leaders had done so before him and might have risen as high from their own rural bases if they had not met early deaths in subsequent wars with the Kuomintang (*see* CHIANG KAI-SHEK; KUOMINTANG).

So far, the Kuomintang remained an ally, and Mao received various posts in it, even that of chief propagandist (1925–26); but rather than wait for the certain split he returned once again to Hunan (summer 1926). While the alliance fell slowly apart, he staged his first peasant rebellions, each quickly suppressed by Kuomintang troops, until he had to flee to the mountains (1927). He turned his few hundred followers into a band of guerrillas; other fugitive bands joined his, until he had a small army (1928–30). Roaming the mountainous southeast, he found some tenable bases; he expanded these into Red enclaves and proclaimed them a "soviet republic" (1931). He became chairman but shared actual power with a Soviet-trained group of leaders, who considered his knowledge of Marxism weak and his policies opportunistic. Like other good Marxists, they thought that he showed an inborn peasant mentality, seeming content that backward peasants should fill a communist party. They also grew more and more distrustful of his guerrilla tactics and finally made the Red command switch to positional warfare. But the defenses that they ordered built broke under the next assault by superior Kuomintang numbers; and the defenders found themselves forced to abandon the "soviet republic" (1934). Mao, vindicated as a strategist, led his remaining forces across China to the northwest, where they settled on new bases (1935–36). During this trek, the so-called Long March, he gained full control of the party; henceforth he determined its policies and proclaimed them dogma.

War with Japan forced Mao and the Kuomintang into an uneasy armistice; it also made Mao adopt moderate policies that won him much liberal sympathy. But civil war quickly resumed after Japan surrendered; the Communists won, sooner than they had hoped, by superior morale and leadership. Once they controlled continental China they proclaimed a people's republic (1949); Mao became chairman (*i.e.*, chief of state), a post that he kept through the following decade. He visited Moscow (his first trip abroad) to conclude an alliance with the Soviet Union and to secure all possible aid for China's economic development (winter 1949–50).

After Stalin's death (1953), Mao's influence grew throughout the Communist orbit, and he became freer to assert claims to ideological leadership. These rested on his contributions to Marxist-Leninist doctrine: actually new adaptations of it, not additions of substance. As China's ruler, Mao soon abandoned his moderate wartime policies for radical programs to transform the country ever more quickly and thoroughly. He drove the bulk of the Chinese people into a collective existence and into a race to catch up with the west in industrial production. With a fixed vision and determination to translate it into reality, he built in ten years the most tightly controlled and most taut-nerved of modern societies. By the time he resigned his government though not his party chairmanship (1959), Mao had gone far toward making China more Communist than the Soviet Union.

See also CHINA: *History;* and references under "Mao Tse-tung" in the Index. (C. BT.)

MAP (MAPES), **WALTER** (*c.* 1140–*c.* 1209), medieval ecclesiastic, satirist and wit, author of the *De nugis curialium* ("Of Courtiers' Trifles"), came from the Anglo-Norman marcher aristocracy of Herefordshire. He studied in Paris between *c.* 1154 and *c.* 1162. On his return to England he became a clerk in the household of Henry II and an itinerant justice. He attended the third Lateran council at Rome (1179) as Henry's representative and while there disputed with some members of the sect of the Waldenses. His connection with the court seems to have ended with Henry's death (1189). Successively a canon of St. Paul's, Lincoln and Hereford, he became archdeacon of Oxford (1197). He was considered for the bishopric of Hereford in 1199 but failed to be appointed. He died between March 1208 and March 1210.

De nugis curialium, a miscellaneous collection of essays, homilies and anecdotes, of which one late 14th-century manuscript survives in the Bodleian library, was probably written between 1181 and 1193. Full of biblical, scholastic and classical allusions, it bears potent witness to Walter's erudition and excessive preoccupation with literary precedent. It provides a racy and often ribald picture of contemporary opinions and manners, reflecting its author's immense prejudice against monks, especially against the Cistercians and St. Bernard. It gives interesting accounts of the military orders, the Templars and Hospitallers, and adds to our knowledge of Henry II's eldest son, the "Young king" (d. 1183). Walter Map has also, doubtfully, been credited with the authorship of the original Latin versions of the Arthurian legends, the *Lancelot*, the *Queste del Saint Graal* and the *Mort Artu* and of much surviving Latin Goliardic verse.

BIBLIOGRAPHY.—The Latin text of *De nugis curialium* has been ed. by M. R. James (1914). For English versions *see* M. R. James (ed.), *Walter Map's "De Nugis Curialium"* (1923); F. Tupper and M. B. Ogle (ed.), *Master Walter Map's De nugis curialium (Of Courtiers' Trifles)* (1924).

MAP, a systematic representation on a surface of the nature and distribution of phenomena in space. For example, terrestrial and celestial globes are maps of the earth and of the heavens, respectively, on a spherical surface. In a more restricted sense, a map depicts on a flat surface (plane) the relationships between selected items on or about the nearly spherical surface of the earth. Most maps are of this kind. A map projection is a system whereby horizontal positional relationships on the earth's curved surface are shown on a plane. There are innumerable projections, though only a few are in common use. Vertical relationships, essentially elevations above sea level, can be indicated on a flat map both quantitatively and qualitatively by various methods, which come under the general heading of relief representation.

Cartography is the art and science of map making. The development of the map is a part of the story of discovery, exploration and accumulation of detailed geographical knowledge; thus, in this article the history of cartography will be dealt with in its broadest sense. The article is outlined as follows:

I. Elements of Maps
  A. Maps in the Modern World
    1. Uses of Maps
    2. Concepts of Scale
    3. Classification of Maps
    4. Modern Map Makers and the Status of Mapping
  B. Techniques of Map Making
    1. Compilation
    2. Drafting and Reproduction
    3. Detailed Design
    4. Relief Representation
    5. Terrain Models
    6. Geographical Names

C. Special-Purpose Maps
1. Categories
2. Density Maps
D. Map Projections
1. Basic Concepts
2. Properties of Projections
3. Perspective Projections
4. Conic and Related Projections
5. Shape of World Maps
6. Discontinuities
7. Modern Uses
E. Globes and Gazetteers
II. History
A. Primitive Peoples
B. Greece and Rome
C. Medieval Europe and Orient
1. "T and O" Maps
2. Portolan Charts
3. Mauro and Behaim
4. Islamic Maps
5. Far East
D. Early Modern Period
1. Revival of Ptolemy
2. Cartography of the Discoveries
3. 16th-Century Chart
4. 16th-Century Cartographers
5. Regional Cartography
6. Printed Maps and Atlases
7. 17th Century
E. Modern Period
1. Transportation, Travel and Maps
2. War and Maps
3. Governmental Mapping
4. Influence of Science and Technology
5. Outstanding Characteristics of Modern Cartography

I. ELEMENTS OF MAPS

A. Maps in the Modern World

1. Uses of Maps.—Maps provide an efficient and unique means for communicating certain types of information. Though a listing of all the countries in the world and their areas may be prepared, only a map can show the arrangements of these countries with respect to one another and the configuration of their boundaries. A map, unlike a photograph, does not reveal all the detail that can be seen in a landscape, but it provides a more comprehensive and selective picture. By a suitable choice of projection it is possible to prepare a map on which an observer can see at a glance a representation of the whole surface of the earth. This is not possible in the case of a terrestrial globe.

Maps are useful in many activities: in the appraisal, conservation and development of natural resources; in analyzing and forecasting weather conditions; in agriculture, fisheries and general commerce; in regional planning; in the building and development of communications; in the location of industry; and in property surveys and the demarcation of boundaries. Governments need maps for aid in settling boundary disputes and controlling floods and droughts, taking censuses, levying taxes, organizing franchises, law enforcement and the promotion of justice and health. Without maps the regulation of transportation and traffic control, on land and sea or in the air, cannot be undertaken efficiently. Maps aid in navigation by sea and air (*see* Chart). Planning and execution of military operations, defensive and offensive, tactical and strategical, would be impossible without maps. In fact, considerable mapping in the past was done for military purposes, and mapping activities were greatly stimulated and advanced during World Wars I and II.

One of the most significant uses of maps is that made by scientists concerned with the causes and effects of the distributions of phenomena, in such disciplines as geology, oceanography, meteorology, climatology, animal and plant ecology, agronomy, economics and the social sciences, as well as geography itself. In all these fields maps are indispensable tools. They record observations in succinct form; they aid in analysis; they stimulate ideas and aid in the formulation of working hypotheses; they make it possible to communicate findings.

Maps promote accessibility and freedom of movement by showing where places are and how they may be reached. They aid people to understand their own and others' environments, and they frequently accompany articles on important world events in newspapers and other periodicals. On occasion maps have been designed for propaganda—to promote local or national interests or to mislead for political purposes—in much the same way as statistics are sometimes abused. Fortunately such maps are rare; nevertheless all are not necessarily equally reliable in their content, and in the past cartographic sins of omission and commission frequently have been masked, wittingly or unwittingly, by excellent draftsmanship and reproduction. Thus an intelligent use of maps requires an appreciation of the factors that contribute to making maps reliable and an awareness of both the advantages and limitations of maps as mediums for the communication of factual information.

2. Concepts of Scale.—Scale means the size of the representation of an object in respect to its actual size. If a ship model's scale were to be given as 1 in. to 12 ft., few would fail to understand what is implied. On maps, more generally convenient methods of expressing scales are by means of the representative fraction or proportion as, for example, $\frac{1}{144}$ or 1:144, because these are independent of the unit of measurement employed. Thus $\frac{1}{144}$ is equivalent in meaning to 1 in. to 144 in. or 1 ft. to 144 ft. or 1 m. to 144 m. The scale of a map is smaller than the scale of another map if its scale denominator is larger: $\frac{1}{10,000}$ is a smaller scale than $\frac{1}{1,000}$.

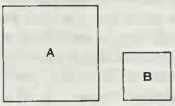


FIG. 1.—THE LINEAR SCALE OF SQUARE B IS $\frac{1}{2}$ OR 1:2 IN RESPECT TO SQUARE A; ITS AREAL SCALE IS $\frac{1}{4}$ OR 1:4

On maps it is necessary to distinguish between linear and areal scale. In the fractional notation the areal scale denominator is equal to the square of the linear scale denominator (*see* fig. 1). Areal scale can be made constant by using a particular type of map projection (see *Map Projections*, below). On the other hand, it is impossible to maintain a precisely constant linear scale. Expressed in another way, the measured distance between two points will bear a definite scale relationship to the true curved distance on the earth, but this relationship will vary from one pair of points to another. When two points are extremely close a finite linear scale relationship still exists. A useful mathematical abstraction, therefore, is the concept of the scale at a point; *i.e.*, scale when the distance mapped is infinitely small. Such a concept gives meaning to such statements as "the scale is constant along a line on a map," or "the scale varies on a map as a function of distance and direction from a point."

FIG. 2.—CHORD AND SURFACE ROUTES BETWEEN PAIRS OF POINTS ON A SPHERE

Because linear scale may vary from point to point, it is convenient to refer to the "nominal scale" of a map. This may mean the scale at a central point, or the constant scale along a particular line or set of lines on the map. It also may refer to the scale of a hypothetical globe from which the flat map has been projected. The term map scale without a qualifying statement usually refers to the nominal linear scale.

Scale ratio is a convenient term for the scale at a point divided by the nominal scale. For example, if the nominal scale is $\frac{1}{100,000}$ and the scale at the point is $\frac{1}{200,000}$, the scale ratio is 0.5, and if the scale at the point is $\frac{1}{50,000}$ the scale ratio is 2. The scale ratio at every point would be approximately equal to 1 only on a globe.

The difference between the chord distance and the surface distance between two points on the earth increases, of course, rapidly with distance. For example, the differences for 100 mi. and 1,000 mi. are 1 part in 39,458, and 378 respectively. These figures suggest that short distances can be scaled from a map with a fair degree of accuracy, even though in the mapping process the earth were to be considered flat. Consequently on large-scale maps of small areas it is customary to give a graphical scale as in fig. 3; on a very small-scale map, showing the whole world or large parts of it, a graphical scale of this sort may be misleading.

3. Classification of Maps.—Maps may be classified according to the method of their construction or according to their content and scale. In classifications of the first kind the major divisions

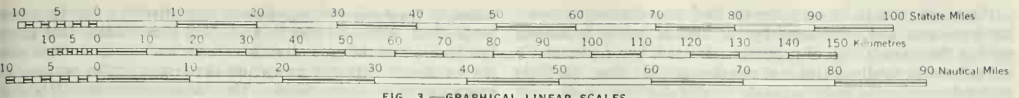


FIG. 3.—GRAPHICAL LINEAR SCALES

are usually between (1) surveyed maps made directly from precisely controlled surveys on the ground or from the air, and (2) maps compiled from a selection of the information contained in the surveyed maps. Surveyed maps are rarely on scales smaller than $\frac{1}{250,000}$ (roughly 1 in. to 4 mi.), usually on considerably larger scales and frequently on much larger scales. For example, the whole of Great Britain and Ireland with the exception of waste or mountainous areas has been mapped on the scale of $\frac{1}{2,500}$ or about 25 in. to 1 mi.

Though there is no hard and fast division between the scales of surveyed and compiled maps, the latter are usually on smaller scales and may be on very small scales indeed. A map of the world appearing in a book may show the equator as a straight line six inches in length; since the equatorial circumference of the earth is approximately 24,900 mi., the scale on the equator would be 1 in. to 4,150 mi., or approximately $\frac{1}{263,000,000}$.

Surveyed maps which show physical features such as rivers, lakes, forested areas and swamps, together with man-made features such as roads and towns, but with no representation of relief, are called planimetric (United States usage). When relief representation is added they are called topographic. Cadastral maps show property and political boundaries, roads and the shapes of buildings, etc., in sufficient detail so that dimensions may be recovered from them within the limits of accuracy controlled by the scale. Compiled maps may also be planimetric or topographical, but these terms usually are limited to map scales greater than $\frac{1}{1,000,000}$. On smaller scales, a general-purpose map is perhaps a preferable term.

An outline map, usually on a small scale and covering a large region, shows in simplified form coast lines, principal rivers and lakes and sometimes political divisions. Base maps may be simple outline maps or somewhat more complicated; their purpose is to present a base upon which specialized data can be plotted.

4. Modern Map Makers and the Status of Mapping.—Most of the topographical and cadastral mapping in the world is undertaken by national governments, though in the second half of the 20th century private corporations such as oil companies were still undertaking large mapping operations in underdeveloped regions.

Governments also produce maps compiled from their original source maps on smaller scales and from statistical and other data either as general-reference maps or for special purposes. The most important results of international co-operation in the production of compiled maps are the International Map of the World and the World Aeronautical Charts, the latter subsequently discontinued and replaced with a series called the Operational Navigation Chart; all are on the scale of $\frac{1}{1,000,000}$. The International Map of the World consists of series of topographical or general-purpose maps prepared by the various participating countries according to internationally accepted standards. The other series contain for the most part less general information but a wealth of detail needed for air navigation.

Various geographical societies compile and publish maps showing the results of exploration and geographical discovery. Some of these societies—notably the National Geographic society (Washington, D.C.), the British Royal Geographical society (London) and the American Geographical society (New York)—undertake large cartographical projects. The National Geographic society produces many general reference maps for popular use, and the Royal Geographical society and the American Geographical society, among their numerous cartographical activities, have done much to promote the International Map of the World. For example, the American Geographical society, over a period of 25 years ending in 1947, compiled from thousands of original sources a series of 107 sheets covering the whole of Latin America on the scale of $\frac{1}{1,000,000}$ and conforming in essentials to the international scheme.

While most of the maps produced by commercial map publishers are based on surveys and compilations made by governments and private nonprofit organizations, this is by no means always the case. For example, the widely used road maps require special compilation and considerable research and revision to keep them up-to-date.

Maps appearing as illustrations in newspapers, other periodicals and books are often prepared by free-lance cartographers. These maps must often be prepared in a hurry, and to make them effective, special skills and artistry are required.

Not all national governments are willing to reveal the extent to which their countries have been mapped; hence it is not possible to give exact figures as to the status of mapping throughout the world. By the 1960s, however, probably less than 25% of the world's land surface had been mapped adequately on topographical scales and far less than that on cadastral scales. Because of man's activities in changing the face of the earth, mapping is a continuous process, and map revision is almost as serious a problem as the initial surveying. A map satisfactory at one time may become quite unreliable within a very few years. The general use of aerial photography from World War I and especially from about 1930 has helped solve this problem; the mapping process has been greatly accelerated and mapping revision has become easier. Nevertheless, it cannot be positively stated that mapping as such has kept pace with the mapping needs of a rapidly expanding world population.

B. Techniques of Map Making

1. Compilation.—There are two principal steps in map compilation: (1) appraisal and selection of original source maps; and (2) selection of features to be shown and of the manner of their depiction, so that the compiled map, usually on a smaller scale than the original source material, will contain only essential information and will be legible and uncluttered. The first step poses no problem when the source material consists of accurately controlled survey maps, but difficulties occur when the area is poorly mapped or is mapped unevenly in patches by small local surveys or by reconnaissance surveys, the latter consisting largely of explorers' traverses and descriptions. For example, on a single sheet of the International Map of the World, hundreds of different sources, all varying in quality, may have been used. In such cases a small index map may be included in the margin to show the relative reliability of the source material. This procedure, now standard for sheets of the International Map, was first employed on the American Geographical society's maps of Latin America.

2. Drafting and Reproduction.—A completed map compilation is comparable with an author's typewritten manuscript. Before a finished map can be published, it must be redrawn in finished style and printing plates must be made. A draftsman must be able to draw smooth straight lines and curved lines varying both in their curvature and their width. He must be adept in the positioning of place names, so that important details are not masked. Up until about 1930, lettering was done mostly by hand; now, though there are still expert hand letterers, and hand lettering allows flexibility in size and spacing, large map-making establishments for the most part employ "stick up" lettering, in which names are printed, cut out, placed in position on the map drawing and stuck or burnished on. It is still an open question whether this process materially speeds up lettering; its main advantage is that it can be accomplished by relatively unskilled workmen. A similar procedure is frequently followed in laying down background patterns of fine lines or dots to differentiate among different types of areas. Patterns of many different kinds are printed for this purpose. When a map is to be printed in only one colour, the printing process may follow any one of a number of methods. Coloured maps are generally printed by photolithography rather than by letterpress, on rotary offset presses.

When colour is to be used, the finished map drawing is rarely hand coloured and reproduced by the kind of colour processing used in the reproduction of paintings. Instead, line copies of the compilation generally are made in nonphotographic blue. On these copies the draftsman makes separate finished drawings in black for each solid printing colour to be used, using the blue lines as guides. When background tints are required, a colour guide is provided for the printer, who can produce in addition to the solid colours a wide variety of tints by means of half-tone screens, etc., used in conjunction with platemaking photography. In some cases, as many as a dozen printing plates have been used to produce a required colour effect on a single map sheet.

The chief technical problem to be surmounted by colour separation in the drafting stage is to insure that on the composite reproduction of the separate drawings there will be no interference between the different-coloured symbols and place names and that there is precise register, or fit, among the different colours. To accomplish this, it is necessary before the printing plates are made to proofread and edit the composite. This can be done by superimposing the various drawings over a "light table," which has a translucent surface illuminated from below. This, however, is an exacting and time-consuming procedure, and after World War II, several proofing processes were developed to facilitate the final checks. Contact prints of each colour separation drawing are made onto a single base by using a new emulsion for each successive exposure; separate drawings thus can be reproduced in different colours on the same sheet, and necessary adjustments will be indicated before the printing plates are made.

This proofing process does not by itself solve the technical problem of obtaining good register. For this, the separate finished drawings must be made on material that will not expand or contract significantly because of use or of changes in temperature and humidity. Printing plates must be made with great precision, and temperature and humidity control are essential during the actual printing.

Before World War I, first-class coloured maps were published for the most part in small editions. After that time, and especially after World War II, technological developments made possible the economical production of highly precise maps in editions that may run into millions of copies. Register was brought under better control, for instance, by the development of synthetic plastic materials, which keep their shape better than paper does, on which to make the colour separation drawings. Again, most map printing is done on multiple-colour presses, reducing the danger of paper distortion that might occur when there is considerable time lapse between the printing of one colour and the next on single-colour presses.

After plastics were introduced, the trend in most of the big mapping organizations was to eliminate as far as possible pen and ink drafting. In addition to "stick-up" lettering, "scribing" is widely used. In this work, a transparent glass plate or plastic sheet is coated with a thin opaque film. A light-sensitive emulsion is then spread over the surface, an exposure of a negative of the original compilation is made onto it and a line image developed. The finished line drawing is prepared by means of a scribing tool that scrapes or cuts the opaque coating away as desired, leaving a sharp transparent line against the opaque background. The main advantage of scribing over pen and ink work lies in the fact that fine sharp lines can be produced by persons with comparatively little training.

3. Detailed Design.—The minimum width of line that can be reproduced by offset lithography is about 0.002 in. A single black line of this width against a white background can be perceived by the normal human eye at the usual reading distance of between 10 and 20 in. As the viewing distance is increased, the eye soon fails to resolve the line, and if the distance is decreased there is difficulty in focusing. If a series of parallel straight lines 0.002 in. in width spaced 0.004 in. from centre to centre is viewed at normal reading distance, the average eye will see this pattern only as a smooth tint against the background.

These limits of printing and visual acuity have great significance in the rendering of detail and in the over-all design of a map. On scales of $\frac{1}{100,000}$ and $\frac{1}{1,000,000}$, respectively, 0.002 in. represents 16 ft. 8 in. and 166 ft. 8 in., and it is evident that many line features on the ground, such as roads and minor streams, cannot be shown distinctly except on the largest scales without an exaggeration of their widths. This, however, immediately suggests that variations in the width of printed lines on a map can be used to distinguish between line features of greater and lesser importance. Two effects occur when the width of a line feature is exaggerated: details in the neighbourhood of the line are masked, and the true shape of the line is smoothed out or generalized.

As the scale of a map becomes smaller, more and more detail must be eliminated and there must be greater generalization of what is left. In many cases, the outlines of important features (for example, towns or airport runways) must be eliminated and purely artificial symbols substituted.

Thus, except on very large scales, the representation of pertinent information on maps is not a true simulation to scale of features of the landscape but rather a symbolization or codification of information which requires learning. A well-established convention is to orient maps so that in general the north direction is toward the top of the map sheet. Convention is also important in the use of colour to differentiate between different types of lines or different types of areas. There is often an association of ideas, such as blue for water and green for forested areas, but colour is used principally for distinctiveness rather than to portray the landscape.

Names, essential items on most maps, also are symbols, whose selection and positioning constitute a specially difficult problem in composition. They tend to mask essential details of the landscape and otherwise to cause clutter. Without the exercise of thought and skill, they either may be hard to read or else may dominate the map at the expense of all other features. If properly composed, they not only name and locate places but may also, by means of different styles of type, aid in differentiating among different classes of features; *e.g.*, size of lettering may give a general indication of the size of a town or city.

The foregoing considerations indicate that the functional elegance of a reliable map is dependent largely on a critical selection of detail and place names, and on the portrayal of these legibly, with the proper emphasis and with the right degree of generalization or symbolization. This is the cartographer's art.

Because the interpretation of symbols, or as they are sometimes called conventional signs, is not immediately obvious, it is customary to provide an explanation in the margins of a map. This, together with details such as the title of the map and its nominal scale, combine to form what is called the map legend. When a number of sheets cover a region on a uniform nominal scale and with the same system of symbolization, a separate conventional sign sheet is often printed.

4. Relief Representation.—Relief, the variation of the earth's continuous surface in slope and in elevation either above or below sea level, influences many of man's activities—transportation, agriculture, housing, flood control and military tactics, to name but a few. It is therefore important that relief be shown clearly. This, however, involves representing a third dimension on a two-dimensional surface, a representation that can be achieved only symbolically.

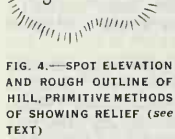
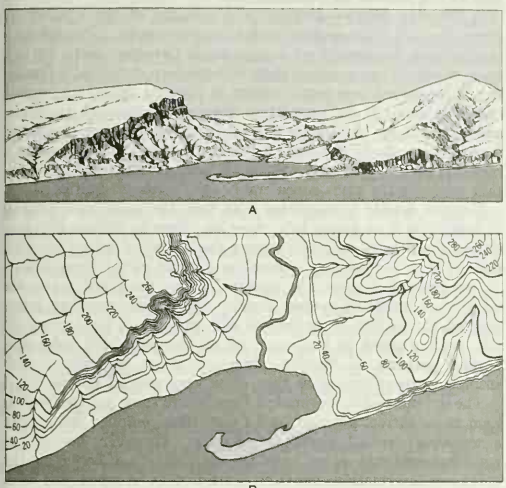


FIG. 4.—SPOT ELEVATION AND ROUGH OUTLINE OF HILL, PRIMITIVE METHODS OF SHOWING RELIEF (*see* TEXT)

In fig. 4, two primitive methods are shown. The number and dot show the elevation and position of a single spot, usually a hilltop or mountain whose general shape and location are indicated by the "caterpillar" type outline. On a map covered with a composite of such crude symbols, the character of the relief cannot be properly interpreted; there is no quantitative representation of slope. On most maps that show relief, such selected spot elevations do appear: usually they are supplemented with contouring, layer or hypsometric tinting, hill shading, hachuring or other symbolic representations, singly or in combination.

Contouring.—Contouring, which depicts relief both quantitatively and qualitatively, is by far the most important method. A contour line (*q.v.*) on a map is the representation of an imaginary line on the earth's surface having a constant elevation above sea level. The nearest approach to a contour line in reality is the outline of a lake. The pattern produced by contour lines at uniform vertical intervals makes it possible to determine the elevations of points by interpolation. Slopes can be estimated from the horizontal spacing between adjacent contours, since the closer the contour lines the steeper the slope represented, and it is this feature of the contour method, together with the general arrangement of



ADAPTED FROM U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL SHEET

FIG. 5.—LANDSCAPE SHOWN IN PERSPECTIVE (A) IS REPRESENTED WITH THE AID OF CONTOUR LINES ON MAP (B)

the contour lines, which gives expression to the relief character of the ground. The method has its limitations, however.

A uniform vertical contour interval on a particular scale may be adequate for representing major land forms but may fail to catch small but significant details. If the vertical contour interval is small enough to catch such details, the contour lines may have a tendency to merge on steep slopes; this occurs because it is necessary to show contours, theoretically of no width, as printed lines of finite width. For example, on the scale of $\frac{1}{63,360}$ (one inch to the mile) if the width of the printed contour lines is 0.004 in. 20-ft. contours will be hard to see separately (if at all) on slopes greater than about 26°, yet in otherwise flat country they will not portray steep rises of less than 20 ft., though these may be important features in the landscape.

In areas of moderate but complex relief, the visual picture given by contour lines is often hard to interpret. This difficulty can be partly obviated by emphasizing certain contour intervals as, for example, every 100-ft. contour when the regular contour interval is 20 ft. Finally, from a graphical standpoint, contours must be printed boldly. If they are subdued or overprinted by a multitude of names or other features, they lose their visual effectiveness.

Hypsometric Tinting.—With layer or hypsometric tinting, successive zones of elevation are coloured differently. This aids in the visualization of relative elevations and can be quickly understood even by schoolchildren. If the area mapped is of moderate relief, only a few tints may be sufficient and these may be in one hue, usually darkening as higher land is covered. More often, in order to obtain sufficient distinction between a large number of zones, variation in hue is introduced. Established convention generally demands that the hues follow the spectrum, starting with green for low land and proceeding through the buffs and oranges to dark red or brown or even purple for higher elevations. Even so, however, not enough colour differentiations are available to make the method altogether effective. For example, for the sheets of the International Map on the scale of $\frac{1}{1,000,000}$, it is specified that the elevation range of the colour zones increase with elevation and that above 3,000 m. (9,842 ft.) all land be shown in the same tint; thus, relief detail diminishes as elevation increases, and hills and valleys in high upland regions may have no representation at all.

Hill Shading.—Hill shading, a qualitative method of presenting relief features, gives a three-dimensional or plastic effect somewhat similar to that provided by an actual model of a landscape. It is based on the optical theory that the brightness of any small area on a perfectly diffusing undulating surface varies as the cosine of the angle of incidence of parallel light falling on it. The method thus has nothing to do with shadows cast by hill features. Oblique hill shading is customary. It usually assumes that the incident light is inclined at 45° to the vertical, and, for a reason not clear, the convention has arisen that the light is assumed to come generally from a northwesterly direction. This convention is so strongly intrenched that if an oblique hill shaded map is turned around so that south is at the top of the map, many people have difficulty in retaining the plastic impression. In practice, the optical theory is not always strictly followed. Oblique hill shading is a specialized art, brought to a high degree of effectiveness notably in Switzerland and, during the 20th century, increasingly used on topographical maps in combination with contouring. The method loses its effectiveness as scale becomes smaller, though it can always be made to give a generalized plastic effect to the major mountain masses. In inexpert hands, the method can be misleading; for example, the artist may overemphasize the relief in gently undulating country so that it looks as rugged as more mountainous country.

Hachuring.—Hachuring consists in laying down a pattern of short lines to indicate the directions of slopes. By varying the width of the lines, some indication of steepness of slope is also obtained. Well-executed hachuring reveals the character of the relief and when used as a supplement to contouring can be effective. Though this method should allow for a more precise interpretation than hill shading does, and was used extensively on topographical maps in the 19th century, it is more difficult to execute properly and in the 20th century has largely been abandoned as a technique.

Other Methods.—There are other methods of relief representation, many of which are ingenious and some of which are statistical or diagrammatic, but only two will be mentioned here. One is a technique that characterizes land form features on small scales by perspective or semiperspective symbols, a qualitative method requiring skill and considerable knowledge of geomorphology. The second is the depiction of zones of slope by succession of tints. This method, though not in common use, gives on very small scales a revealing characteristic pattern of landscape when combined with the representation of drainage features; it may be useful, for example, in assessing the suitability of regions for development projects such as housing.

5. Terrain Models.—These are three-dimensional maps, which not only supply the user with a real plastic effect rather than the simulated effect obtained by hill shading, but also make possible the adequate representation of steep slopes and vertical precipices. The earth is, however, a remarkably smooth surface in respect to its radius. The elevation of Mt. Everest is only about $\frac{1}{4}$ of 1% of the earth's radius, and on a scale of $\frac{1}{1,000,000}$ its elevation is represented by about 0.35 in. In order, therefore, to give emphasis to the relief on models, the vertical scale on any but extremely large-scale models is usually made larger than the horizontal scale. This "vertical exaggeration" usually is increased as the horizontal scale becomes smaller. One effect of vertical exaggeration, not often noted, is that gentle slopes are given more exaggeration than are steep slopes. Obviously a vertical slope cannot be exaggerated by increasing vertical scale over horizontal scale.

Though vertical exaggeration actually distorts the representation of slope, the proponents of terrain models do not consider this to be a defect. In fact, in some cases, the vertical exaggeration is

purposely varied with slope to emphasize the gentle slopes still further.

The principal difficulty in constructing a terrain model lies in the making of the master base model itself. Though this process is comparable to sculpturing, modern technology has reduced it to the point where it is nearly automatic. Modern methods for reproducing printed terrain models quickly and in quantity, which began to develop about the time of World War I and were greatly improved during and after World War II, involve printing the maps on flat sheets of opaque plastic. The sheets are vacuum pressed onto the master model or a facsimile and heat is applied so that the plastic nearly melts and molds itself to the model. When it is cooled and removed, a lightweight printed model is produced.

6. Geographical Names.—Names of places are established, for the most part, from a multitude of complex considerations. Only an indication of the intricacies of toponymy (the study of place names) can be attempted here. If all nations used the same alphabet and spoke and wrote in one language, the rendering of geographical names on maps would be a comparatively simple matter, though this is not the only difficulty in place names: the same name is often given to different places (for example, Boston, Columbus, Washington and Lincoln); sometimes local usage varies from official usage (a mountain may be called by different names by the peoples living on opposite sides of it); the same place name has various spellings or is entirely different in different languages ("Wien" in German is "Vienne" in French, "Vienna" in English and "Becs" in Hungarian, and the English channel and the Straits of Dover in English become respectively La Manche and Pas de Calais in French).

The greatest difficulties in the rendering of geographical names, however, occur because there are numerous different scripts and because sounds in one language may have no adequate representation in the alphabets used for another language. Sometimes names are translated; the Cabo da Boa Esperanca in Portuguese, for instance, has become the Cape of Good Hope in English. More often, the transcription of alphabets or the transliteration of syllabic symbols is attempted.

In passing, it may be noted that explorers not sufficiently versed in local languages to fully comprehend answers to questions have been known to place on their maps absurdities with meanings such as "I don't know."

In the English-speaking world, since the beginning of the 19th century the Royal Geographical society has pioneered in establishing order in the rendering of geographical names, and in 1919 it established the Permanent Committee on Geographical Names. In the United States, the Board on Geographic Names was established under a slightly different name in 1890. These two organizations deal specifically and exclusively with the subject, and considerable co-operation and co-ordination have been effected between them.

C. Special-Purpose Maps

1. Categories.—Special-purpose maps fall into several distinct categories. Air navigation charts and road maps, for instance, comprise one. Another divides the land up into areas or regions according to a system of classification. For example, a geological map may show the areas occupied by different kinds of outcropping rock. Land-cover maps may show forests, grasslands, swamps, tundra or deserts. The soil map is another important type. Such maps as these are compiled from intensive observations in the field. Other types within this category may have been derived from a combination of field observations and statistical analysis; for instance, maps may show the land divided up into climatic regions based on a complex of criteria, or may divide the land according to the predominance of certain crops or of certain races of mankind.

A map may show the variation in the amount of intensity of a single phenomenon. This is perhaps best exemplified in climatic maps that show the distribution of such items as temperature, barometric pressure or rainfall averaged over periods of time. Such maps are compiled from measurements at a discrete number of points. When it is possible to do this, as it is for numerous kinds of phenomena, it is also permissible to interpolate isolines, or lines of equal intensity, in the same way as contour lines may be interpolated from spot elevations.

Another category of special-purpose maps comprises those that show flow lines, such as sea currents or winds. The rate or amount of flow can be indicated. For example, a useful type of map for analyzing road traffic problems is one that differentiates between the number of cars passing over different sections of a road system in a given period. One way of depicting this is by regulating the representation of the width of the roads in proportion to the amount of traffic carried.

2. Density Maps.—Density is a measure of the number of items in a unit space or area, such as a square mile. The difficulty in depicting the density of a population (whether cattle or oak trees or human) on a map is that the necessary statistical information is summated over areas varying in size and shape; *e.g.*, minor civil divisions. If the population densities in counties are given as so many items to a square mile, there is no assurance that these items are regularly distributed over each area. In fact, quite a different picture generally will be obtained if it is possible to obtain statistics for areas considerably smaller than counties.

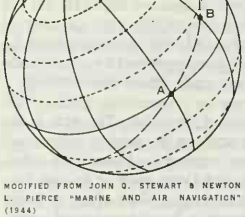
Because density is associated with area, the most valid method of indicating it on a map is to show by colour or pattern differentiation the density variation among the statistical areas; but this method may fail to give a revealing over-all picture graphically. If, on the other hand, the centres of the statistical areas are adopted as points of average density and isolines are then interpolated, the pattern of the isolines will depend to a large extent on the size and shape of the areas and on the compiler's judgment. Isoline patterns of density, therefore, must be viewed with suspicion except insofar as they show very general relationships.

The dot method in its simplest form would show each individual item in its correct position, and a map thus compiled would give a revealing over-all picture of density. However, because of considerations such as scale and the impossibility of collecting the necessary information, individuals are usually grouped, and each dot may represent hundreds or even thousands of individual items not necessarily at the mean position of the group. This method thus requires skill and judgment to be successful.

D. Map Projections

1. Basic Concepts.—It is impracticable to record detailed surveys on topographic and cadastral scales and, in general, to compile maps from these surveys on anything but a plane surface. Nevertheless, these surveys and compilations must be tied to geodetic control points, whose positions have been determined with reference to the surface of an oblate spheroid which is a close approximation to the form of the earth. In practice, this problem is solved by expressing the positions of the control points in terms of their projected positions on a plane.

Though the subject of map projections is a highly specialized branch of applied mathematics, the principles involved and the properties of most map projections can be described in terms of elementary geometry and trigonometry by assuming the earth to be a sphere. (*See* Sphere; Surface.) The following concepts and definitions are valid on the basis of this assumption.



MODIFIED FROM JOHN Q. STEWART & NEWTON L. PIERCE "MARINE AND AIR NAVIGATION" (1944)

FIG. 6.—SOLID AND LONG-DASH LINES INDICATE GREAT CIRCLES, SHORT-DASH LINES ARE SMALL CIRCLES, AND THE PORTION BETWEEN A AND B IS A GREAT CIRCLE ARC

The geographical poles (north and south) lie on the surface of the terrestrial sphere on its axis of rotation. The plane of the equator is perpendicular to this axis. The equator is only one of an infinite number of circles, called great circles, which divide the surface of the sphere into two equal parts. All other circles on

the surface of the sphere are called small circles. Two points on the surface of the sphere can always be connected by a great circle, and the shortest surface distance between them lies along it. The portion of a great circle between two points is called a great circle arc. Because an arc subtends an angle at the centre of the sphere, it is convenient to express it either in arc measure (degrees, minutes and seconds) or in circular measure (radians). (*See* RADIAN MEASURE.)

At all points on the surface of the terrestrial sphere, the vertical direction is assumed to be perpendicular to the surface. A horizontal line or area, therefore, lies on or parallel to this surface. Horizontal position on the terrestrial sphere is stated in terms of the geographical co-ordinates latitude and longitude (*see* LATITUDE AND LONGITUDE). Lines of equal latitude are small circles parallel to the plane of the equator and are thus frequently referred to as parallels of latitude. Latitude as shown on maps varies between 0° on the equator and 90° N. and 90° S. at the poles.

Meridians are arcs of great circles connecting the two geographical poles. The angular difference between two meridians at the poles is called a difference of longitude. By international agreement in 1884, the meridian passing through the Greenwich observatory near London, Eng., long used by the British as a zero or prime meridian, was accepted as standard, and by 1950 the system was in universal use on the maps of practically all nations.

Longitude on maps is given almost invariably in arc measure up to 180° E. or 180° W. of the prime meridian.

The azimuth or direction at one point A of a second point B on the terrestrial sphere (*see* fig. 6) is the angle usually measured clockwise from the north direction of the meridian passing through A and the great circle arc passing through both A and B. Because of the convergence of the meridians toward the poles the reverse azimuth of A from B is in general not equal to the azimuth of B from A plus 180°.

The sides of a spherical triangle consist of great circle arcs. It is shown in spherical trigonometry that the sum of the angles of any spherical triangle exceeds 180°, and this excess is in direct pro-

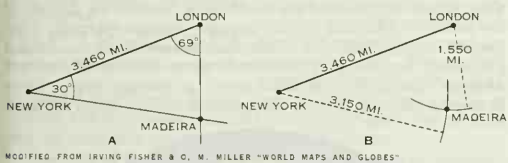


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FIG. 7.—(A) MADEIRA PLOTTED SO THAT ITS AZIMUTHS FROM LONDON AND NEW YORK ARE CORRECTLY SHOWN; (B) MADEIRA SHOWN AT ITS CORRECT SCALE DISTANCE FROM BOTH POINTS

portion to the area of the spherical triangle. Thus, it is impossible to represent any spherical triangle on a plane without distorting some of the angles and sides. The two-point equidistant and two-point azimuthal projections are simple kinds of map projection that demonstrate this clearly. In both projections two points on the sphere are chosen and shown on a map at their correct scale distances apart. In the first projection, the position of any other point is mapped so that it is shown at its correct scale distance from both points. In the second projection, it is mapped so that its azimuths from the two points of origin are correct.

2. Properties of Projections.—A representation of meridians and parallels of latitude at regular intervals is often referred to as the map projection itself; more correctly, it is called a map graticule. A primary classification of map projections separates them into three groups: (1) equal-area, sometimes called equivalent or authalic; (2) conformal, frequently called orthomorphic; and (3) any other types. On equal-area projections the areal scale is constant from point to point; linear scale at a point, however, will in general vary with direction, and differences of direction will be distorted. On a conformal projection, the linear scale at a point is constant in all directions and angles around a point are shown correctly; in general, however, the scale varies from point to point. It is obvious that no map projection can be both equal-area and conformal.

The properties of map projections can be precisely described mathematically with the aid of the infinitesimal calculus. A. Tissot in his *Mémoire sur la représentation des surfaces et les projections cartographiques* (1881) demonstrated that when projecting a surface onto a plane in a continuous fashion so that there is a one-to-one point correspondence, an elementary (infinitesimally small) circle becomes an ellipse. Such an ellipse has consequently been called a Tissot indicatrix. It is possible, once a map projection has been defined, to calculate the relative dimensions of the elliptical indicatrix and the orientation of its major and minor axes for any point mapped. On an equal-area projection, the area enclosed by the ellipse will be the same as that within the elementary circle, but the shape of the ellipse and its orientation will vary from point to point. On a conformal projection the ellipse degenerates into a circle, but its relative size will vary from point to point. On all other projections the ellipse does not degenerate into a circle, nor is it equal-area at all points.

It is a necessary, but not a sufficient, condition for conformality that the meridians and parallels on a map projection intersect at right angles as they do on a sphere. However, conformal map projections are no exception to the general rule that shapes of areas of considerable extent will be distorted.

Any properly conceived map projection can be defined by means of a pair of mathematical formulas which enable the positions of the intersections between meridians and parallels of latitude to be calculated in terms of plane co-ordinates on the map projection. When these calculated positions have been plotted, the graticule is obtained by drawing smooth, continuous curves through all the points plotted for each meridian and for each parallel of latitude.

3. Perspective Projections.—Certain projections can be constructed by using the principles of perspective (*q.v.*). Points on a sphere of nominal scale are projected onto a plane tangent to it by perspective rays from a perspective centre.

The orthographic projection puts the perspective centre at infinity. Thus, the projecting rays are parallel to each other and perpendicular to the plane of projection. A map plotted on this projection gives the impression of the world as seen at a great distance away.

The stereographic projection places the perspective centre at the point on the sphere diametrically opposite the point of tangency of the plane of the projection. This projection is conformal and has in addition the remarkable property that all great and small circle arcs on the sphere are shown as either arcs of circles or as straight lines on the projection.

The gnomonic projection places the perspective centre at the centre of the sphere. It has the property that all great circle arcs are shown as straight lines, and this is useful for laying out the shortest route between two points. An innumerable variety of projections that will show great circles as straight lines can

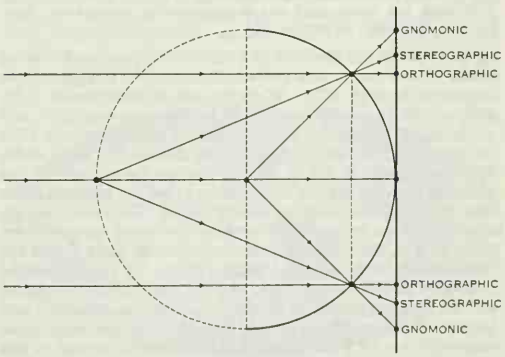

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FIG. 8.—ORTHOGRAPHIC, STEREOGRAPHIC AND GNOMONIC PROJECTIONS OF A SPHERICAL SURFACE ONTO A TANGENT PLANE BY PERSPECTIVE RAYS

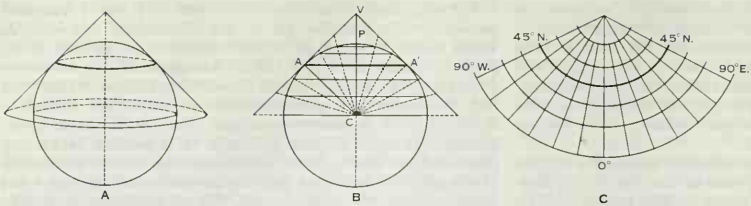

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FIG. 9.—THE DEVELOPMENT OF A PERSPECTIVE CONIC PROJECTION (*see* TEXT)

be derived from the gnomonic by making other perspectives of the plane of the gnomonic onto other planes inclined to it. This is because any projection of one plane onto another transforms straight lines into straight lines. Two-point azimuthal projections result from this procedure, and any particular case can be derived easily by orthogonal projection.

With the perspective centre at the centre of the sphere, a projection can be constructed onto a conical surface tangent to the sphere along any small circle. By cutting the conical surface along any straight line from the vertex, it can be developed into a plane by unrolling it. In such a projection, the scale ratio along the circle of tangency is equal to one. This circle is sometimes called the standard small circle or standard parallel when the centre of the projection is at one of the geographical poles. In

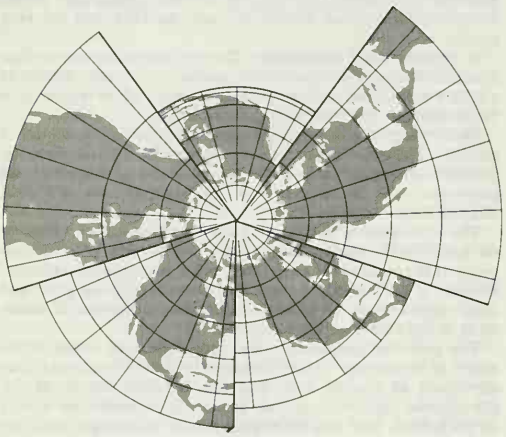

FIG. 10.—FIVE AZIMUTHAL PROJECTIONS FROM THE POLAR ASPECT. CLOCKWISE FROM TOP RIGHT THEY ARE STEREOGRAPHIC, EQUAL-AREA, EQUIDISTANT, GNOMONIC, ORTHOGRAPHIC

fig. 9(B) AA′ is the diameter of a circle of tangency and V is the vertex of the cone. The projected distance V is equal to the tangent of the angle VCA. When the cone is unwrapped as in fig. 9(C) all circles parallel to AA′ will be shown as concentric arcs of circles centred on V. All great circles passing through P on the sphere will be straight lines passing through V. Their angles of intersection at V will be smaller than on the sphere. It can be shown that this angular compression, called the constant of the cone, is equal to the cosine of the angle VCA. Thus this constant, usually denoted by n, varies between the limits one and zero. When n is 1, the vertex V coincides with the point P and the gnomonic projection results. When n is zero the vertex V can be considered as being at infinity so that the cone becomes a cylinder and the resulting projection is called a perspective cylindrical projection. The great circles passing through P and the small circles concentric around P are shown in this cylindrical version as sets of parallel straight lines, one set cutting the other at right angles.

Except for the limiting case of the gnomonic projection, these perspective conical projections have no practical value. They are, however, the genesis of a much larger category of projections that fall under the general heading of conic.

4. Conic and Related Projections.—Conic projections include equal-area, conformal, so-called equidistant and other variants. All have the common characteristics that great circles radiating out from the origin, corresponding to V in fig. 9(B) in the perspective variant, are shown as straight lines and that concentric circles around the origin are shown as arcs of concentric circles. Geometrically, they vary one from another only in the manner in which the concentric circular arcs are spaced and in the value adopted for the constant n.

When n equals one the various projections are called azimuthal (azimuths of all points are correct at the centre) or zenithal (British usage). The group includes the orthographic, stereographic and gnomonic described above, the important azimuthal equal-area projection devised by Johann Heinrich Lambert and the azimuthal equidistant projection which represents all points at their correct distances to scale from the centre. When the centre of an azimuthal projection is at one of the geographical poles, it is called a polar azimuthal projection; when on the equator it is called a normal or equatorial azimuthal projection. With any other centre it is called an oblique or horizon azimuthal projection.

Mercator and Other Cylindrical Projections.—When n is zero the various projections are called cylindrical; and normal, transverse and oblique when the equator, a meridian and any other great circle is represented by the central straight line. The normal cylindrical projections in common use are the Mercator, the simple or equidistant (parallels of latitude are spaced correctly to scale), Gall's stereographic and Miller's modified Mercator. The equal-area variant is little used for world maps because the spacing of the parallels of latitude must of necessity become extremely compressed in high latitudes. Gerardus Mercator's (*q.v.*) famous projection, besides being conformal, shows all lines of constant azimuth (rhumb lines or loxodromes) as straight lines. These properties combine to make this projection more useful for navi-

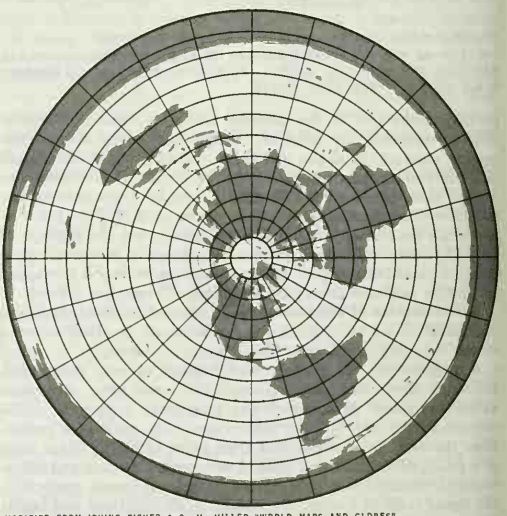

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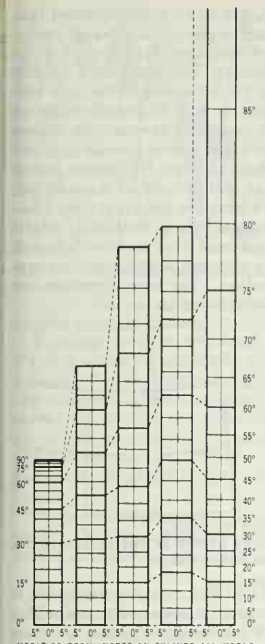
FIG. 11.—A POLAR AZIMUTHAL EQUIDISTANT PROJECTION OF THE WORLD, WITH THE SOUTH POLE REPRESENTED AS THE BOUNDARY LINE OF THE PROJECTION



MODIFIED FROM "NOTES ON CYLINDRICAL WORLD MAP PROJECTIONS," "GEOGRAPHICAL REVIEW," VOL. 32 (1942)

FIG. 12.—SPACING OF PARALLELS FOR FIVE NORMAL CYLINDRICAL PROJECTIONS

From left to right: cylindrical equal-area, simple, Miller's modified Mercator, Gall's stereographic and Mercator

gation than the gnomonic even though the rhumb line route between two points is longer than the great circle route.

When n is greater than zero and less than one it is always possible to select two small circles less than 90° from and concentric about a centre as standard. Thus, these may be chosen best to suit a given region. In the normal cases when one of the geographical poles is the centre, the important variants of the conic projections with two standard parallels are Alber's equal-area, Lambert's conformal and the "simple," which last has the property that the meridians as well as the two standard parallels have constant scale ratios equal to one.

Closely related to the conic family of projections are Bonne's equal-area and the polyconic projections. In Bonne's projection a standard parallel is developed as in the case of the perspective conic. All other parallels are concentric arcs of circles of constant scale ratio equal to one and spaced along a central straight line meridian at their correct scale distances apart. All other meridians are curved lines which do not cut the parallels of latitude at right angles. One limiting case of this projection is when the equator is taken as the standard parallel. The resulting projection is called the sinusoidal or Sanson-Flamsteed. In this case, the equator, the parallels of latitude and the central meridian are straight lines true to scale and the remaining meridians are sinusoidal curves.

One form of the polyconic projection is developed by constructing the parallels of latitude as if they were standard parallels on a perspective conic and then spacing them at their correct scale distances apart on a central straight-line meridian. The other meridians are curves and the projection is neither conformal nor equal-area.

5. Shape of World Maps.—Many other types of map projections have been conceived, but only a few can be mentioned here. Many world map projections are characterized by the shape of the area on the map which portrays the whole sphere. It is possible, for example, to obtain conformal maps of the world within the confines of a square, a rectangle, a circle and an ellipse

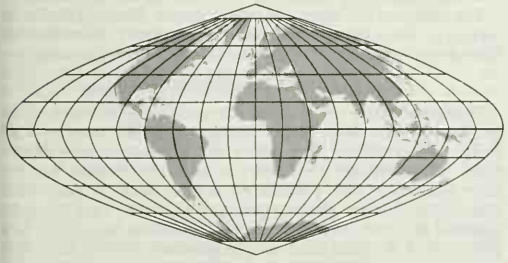


FIG. 13.—SINUSOIDAL OR SANSON-FLAMSTEED EQUAL-AREA PROJECTION OF THE EARTH

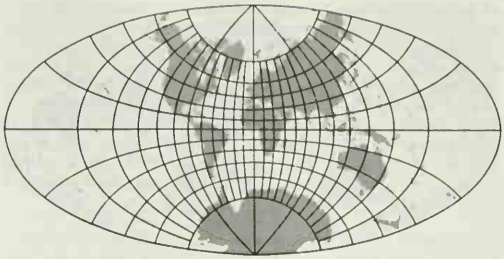


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FIG. 14.—ADAM'S CONFORMAL PROJECTION OF THE EARTH WITHIN AN ELLIPSE

Two types of equal-area projection which represent the whole earth within an ellipse are the Mollweide and the Hammer (often wrongly called the Hammer-Aitoff or even the Aitoff). The Mollweide in its normal form represents the equator and parallels of latitude as parallel lines. The Hammer projection encloses the whole world within an ellipse of the same dimensions but, in this case, the parallels are curved. Both these projections have been used in their oblique forms with centres at latitude 45° N., and when the central meridian is the Greenwich meridian or one

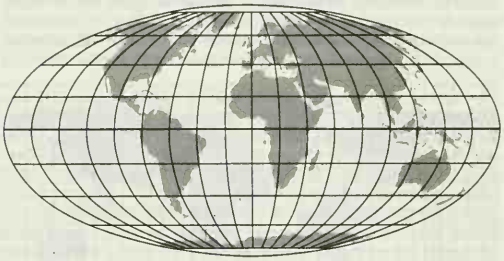

FIG. 15.—HOMOLOGRAPHIC OR MOLLWEIDE'S EQUAL-AREA PROJECTION OF THE EARTH WITHIN AN ELLIPSE

somewhat west of it, the general relationships between the land masses on the earth are shown well.

6. Discontinuities.—A spherical surface is continuous. When it is projected onto a plane, this continuity must be interrupted at least at one point, more often two points, and frequently along the whole or part of one or more small or great circles. Azimuthal equidistant and equal-area projections interrupt the sphere at only one point, which is diametrically opposite the centre of projection. This point becomes the boundary of the projection. The cylindrical projections are interrupted at two points diametrically opposite one another. These become straight lines on the map unless, as in the case of the Mercator projection, the points

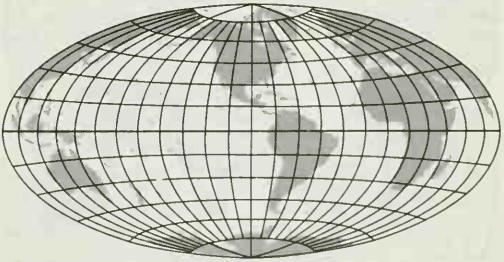

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FIG. 16.—HAMMER'S EQUAL-AREA PROJECTION OF THE EARTH WITHIN AN ELLIPSE

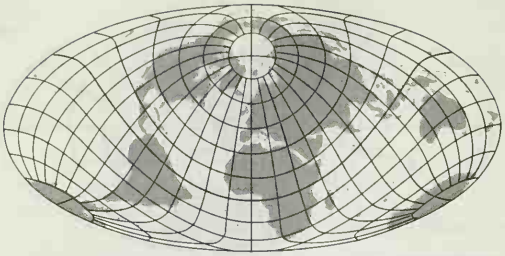

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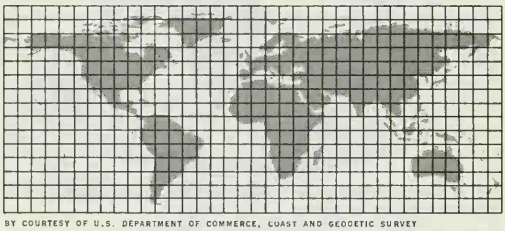
FIG. 17.—OBLIQUE MOLLWEIDE PROJECTION WITH CENTRE AT 45° N.

project at infinity. The cylindrical projections, however, have the useful property of being periodic or continuous in the direction of their central lines. The world shown enclosed in an ellipse is interrupted along the half of one great circle. Sometimes interruption is purposely introduced in order to reduce over-all shape distortion. This is done usually in the ocean areas in order to show the principal land areas with good shape characteristics. It is an open question whether much is to be gained by sacrificing continuity when these interruptions are asymmetrical.

When the nominal scale of a map is so large that the whole world or the region to be mapped cannot be shown on one sheet, another problem of continuity occurs. A single projection can be used so that all sheets can be assembled together. If, however, a separate projection is used for each sheet so that scale anomalies



BY COURTESY OF U.S. DEPARTMENT OF COMMERCE, COAST AND GEODETIC SURVEY

FIG. 18.—SIMPLE CYLINDRICAL EQUAL-SPACE PROJECTION OF THE EARTH

and shape distortion are limited to the single sheets, then, though it is possible to maintain fit along the edges of adjacent sheets, over-all continuity will be lost. Such a system is adopted, for example, for the sheets of the International Map of the World on the scale of $\frac{1}{1,000,000}$. Compromises between the two systems are to be found in the use of the polyconic projection for the topographical sheets of the United States geological survey. In this system, sheets falling into one zone of longitude are on the same projection. The World Aeronautical Charts are on a system of conformal conic projections with two standard parallels. Here sheets falling into one zone of latitude are on the same projection.

7. Modern Uses.—Map projections in actual use to any great extent are limited in number, especially in the case of large-scale maps. On topographic and cadastral maps, the fact that the shape

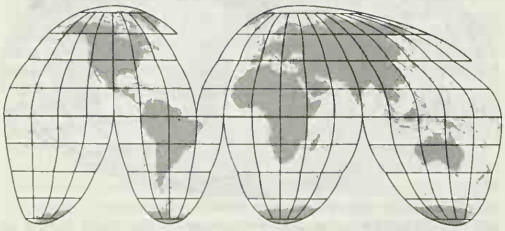
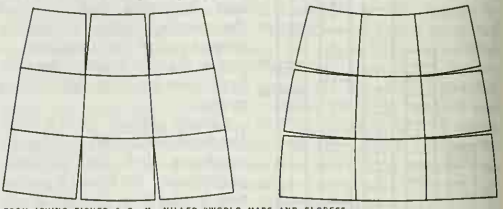


FIG. 19.—GOODE'S HOMOLOSINE EQUAL-AREA PROJECTION

of the earth more nearly corresponds to an oblate spheriod than to a sphere is invariably taken into account. Equal-area projections such as Bonne's and nonconformal projections such as the transverse simple cylindrical (Cassini) were sometimes adopted for the maps of small countries. From the turn of the 20th century, however, the trend has been to base large-scale maps on conformal projections such as the transverse Mercator for regions having their greatest extent north and south; on the Lambert conformal conic with two standard parallels for regions having their greatest extent east and west, and the oblique stereographic for regions roughly circular. For example, until 1935 the topographical sheets of the United Kingdom were on the Cassini projection but after that time, the transverse Mercator was adopted. The Laborde projection used for mapping Madagascar is essentially an oblique Mercator projection. The latter type also has been used for strip maps along established air routes.



FROM IRVING FISHER & O. M. MILLER "WORLD MAPS AND GLOBES"

FIG. 20.—TWO METHODS OF ASSEMBLING SHEETS OF THE INTERNATIONAL MAP OF THE WORLD, BOTH INVOLVING DISCONTINUITY

For world maps on one sheet equal-area map projections are in great demand because they make possible an over-all visualization of the relative sizes of regions. Cylindrical projections often are used for general reference maps over the populated areas of the world, because parallels of latitude and meridians are shown in the form of a rectangular network. Except for special purposes, conformal map projections are not suitable for world maps. On the other hand, they have certain technical advantages over other types for compiled maps on intermediate scales such as $\frac{1}{5,000,000}$. Principally, they permit compilation from sources on large-scale maps having little significant shape distortion to be accomplished quickly and accurately, since small areas on the large-scale maps, when suitably reduced in size, can be made to fit into the conformal small-scale projection with little adjustment.

A rectangular, usually square grid often is superimposed or indicated on a map in addition to the map graticule. Grids are useful for determining the relative positions of points in terms of map rectangular co-ordinates on large-scale maps of limited areas when the map projection distortion is relatively insignificant. They are also useful for locating place names on maps from an alphabetical index with references to the grid areas.

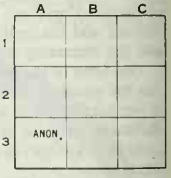


FIG. 21.—SIMPLE GRID REFERENCING SYSTEM ANON followed by A3 in an alphabetical index indicates the approximate location of the place on the map (*see* text)

The mathematical aspects of projection are discussed further in Analytic Geometry; Descriptive Geometry; Differential Geometry; Geodesy; Trigonometry: *Spherical Trigonometry.*

E. Globes and Gazetteers.

Terrestrial globes are maps of the earth on spherical surfaces, and because they show shapes without distortion, they are ideal objects wherewith to learn and visualize geographical relationships. However, they are difficult to construct precisely, and few have been made with a diameter of more than six feet. The schoolroom or office globe is generally not more than 18 in. in diameter and often less. It must be appreciated that a map on a globe cannot be constructed until geographical features have been depicted on flat maps. When printed information is on a globe, this usually means that flat maps of narrow sections of the earth,

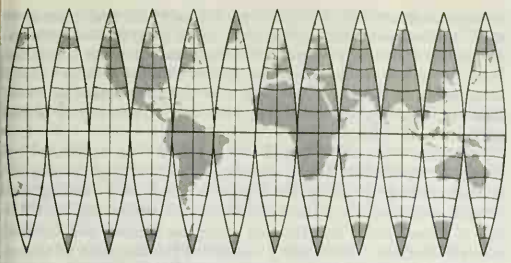


FIG. 22.—THE WORLD DIVIDED INTO 12 GORES SUITABLE FOR MOUNTING ON A GLOBE

usually gores, have been cut out and stuck on.

Gazetteers are the antitheses of globes. They list place and physical names alphabetically and also supply in varying degrees written information concerning the places or features referred to. The minimum information given in any gazetteer is the location of named places. Additional information may include the size and population of towns, cities, states and countries, their industries and histories, and descriptions of physical features such as rivers and mountain ranges. The more detailed gazetteers are usually national.

Maps are the practical compromise between globes and gazetteers. They are not limited in scale as are globes and they show spatial relationships which gazetteers cannot. (O. M. M.)

II. HISTORY

Human existence would be impossible without knowledge of the sort that maps convey. Primitive folk carry such knowledge in their minds—mental "maps" of the areas where they live or hunt, fish or fight. As culture develops, such mental maps no longer suffice, and real maps are made to meet countless practical needs, to satisfy scientific curiosity and to give aesthetic pleasure. The history of maps and of all that they have meant to mankind is therefore an immense field, potentially as vast, perhaps, as the history of art or of literature.

Like modern science and technology, modern cartography throughout the world is essentially of western origin. It represents a phase in the development of a cartographic tradition that stems from ancient Greek times and that may have been stimulated in its beginnings by borrowings from the earlier cultures of southwestern Asia and Egypt. Four distinctive periods may be roughly blocked out (with arbitrary dividing dates): (1) the Greco-Roman (600 B.C. to A.D. 400); (2) the medieval (400 to 1500); (3) the early modern (1500 to 1700); and (4) the modern (after 1700).

No maps, at least in their original form, have come down to us from the Greco-Roman period. Hence the nature of Greco-Roman cartography can only be inferred from what ancient authors wrote about geography and maps and from examination of a few extant medieval versions of ancient maps. There is enough evidence, however, to show that, until about the mid-2nd century of the Christian era, cartography made substantial if often halting progress and that many of its basic mathematical problems were recognized and understood, if not fully solved. Thereafter several centuries of retrogression and stagnation ensued.

Of the many late medieval and early modern maps that have been preserved, a goodly proportion have been reproduced and studied in detail from the beginning of the 19th century. Indeed, of the entire field of cartographic history, this part has been cultivated in by far the most systematic and intensive manner, and for two chief reasons: (1) medieval and early modern maps have, to our eyes, a quaintness, a naïveté and an artistic quality that make them exceedingly attractive; and (2) perhaps more significantly, early modern maps, in a way and to a degree achieved by the maps of no other age, record and illumine events of supreme historical importance—the voyages and travels of the great age of geographical discovery and the widening of man's geographical horizons that they brought about.

During the modern period maps have increasingly come to be based on accurate measuring, counting and computing, rather than mainly on speculation and guesswork. Modern cartography has stressed the scientific and the practical functions of maps at the expense, if not to the total neglect, of their aesthetic functions. The development of scientific instruments and statistical techniques and the accumulation of scientific data have enormously enlarged the variety and quantity of mappable facts and consequently of maps and their uses. So many and so diverse are these uses today that maps have become indispensable.

A. Primitive Peoples

Travelers have described the remarkable ability of certain primitive folk—particularly those who, like the Eskimos or Bedouins or Polynesians, wander far and wide—to draw sketch maps of their territories, and a goodly number of crude maps that such people have carved on wood or bone or put together with sticks and shells or made in other ways may be seen in ethnographical museums. Better maps were produced by early civilized peoples—Egyptians, Babylonians, Chinese, Aztecs and Peruvians of the Inca empire. Their cartography was practical: they made cadastral plans, real-estate plots, specifications for the construction of temples, palaces, canals, roads—the equivalent of the blueprints of modern engineers. None of these peoples except the Babylonians gave much heed to speculative mapping of the world as a whole. A diagrammatic world map on a late Babylonian tablet (6th century B.C.), suggests that the Ionian Greeks may have borrowed from, or shared with, the Babylonians the long-lived belief in a flat, disk-shaped earth surrounded by an ocean stream and bordered on the north by a great range of mountains. (J. K. W.)

B. Greece and Rome

The Greeks, more than any other people in the ancient world, were fitted to pursue and develop geographical knowledge. Shortage of arable land and adverse economic or political conditions at home induced impoverished or adventurous men to seek a livelihood overseas. Travel tales of Jason and his Argonauts and of Odysseus indicate that the Greeks were attracted to sailing from early times. During the great age of colonization (8th to 6th centuries B.C.) they established maritime settlements from the east coast of Spain to the far reaches of the Black sea. Miletus, the leading colonizing city, alone founded more than 40 city-states. Daughter colonies usually maintained close relations with the mother city, and these opportunities to exchange informa-

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FIG. 23.—HECATAEUS' MAP OF THE WORLD

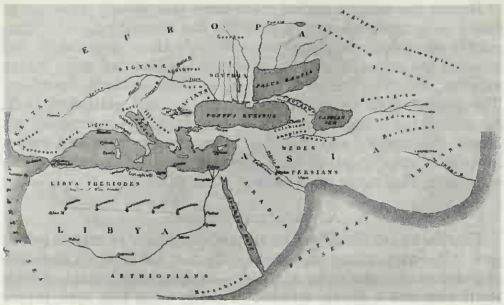

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FIG. 24.—HERODOTUS' MAP OF THE WORLD

tion about distant regions greatly stimulated the Greeks to speculate about the shape of the world and the causes of physical phenomena.

By 600 B.C. Miletus had become the leading centre of cosmographical speculation and geographical knowledge. Thales of Miletus (*q.v.*) was the founder of natural philosophy. His pupil Anaximander (*q.v.*), also of Miletus, was reputed to have been the first to publish a geographical map. Hecataeus of Miletus (*q.v.*) may have produced the first book on geography (*c.* 500 B.C.), surviving fragments of which make it possible to reconstruct the author's conception of the earth (fig. 23) as a circular plane, surrounded by a continuous belt of ocean. He located Greece at the centre. A generation after Hecataeus, the celebrated historian Herodotus (*q.v.*) traveled widely and had more precise and extensive knowledge of geography than did his predecessors. He expressed contempt for the map makers of his day who supposed Europe and Asia to be of equal size and represented the earth as circular, surrounded by an assumed ocean. He himself presumed to know the size and actual shape of each region. Herodotus' *History* includes accounts of the Phoenician circumnavigation of Africa (*c.* 600 B.C.) and of the voyage of Scylax down the Indus river, concrete evidence of the broadening effect that reports of early explorations were having upon Greek geographical horizons. Herodotus found no evidence for a northern ocean but concluded from the report of the Phoenician voyage that the southern ocean extended from India to Spain. He regarded the Caspian as an inland sea, opposing the prevailing view that it was a gulf of the northern ocean (fig. 24).

Numerous other military and sailing expeditions, conducted by Greeks or reported by Greek writers, served to enlarge geographical conceptions. Early in the 6th century B.C. two Carthaginian navigators cruised along the Atlantic coast, Hanno along west Africa to Cape Palmas and Himilco along the Spanish and Gaulish coasts to Brittany. Xenophon's account of the campaign of 10,000 Greek mercenaries (401 B.C.) against the Persian king, deep into Persia, and of their subsequent retreat across Armenia to the eastern shores of the Black sea, provided much geographical information. Far more important to geographers than these expeditions was the campaign of Alexander the Great, who in the 4th century penetrated to the shores of the Caspian sea and into northern India, sailing down the Indus, and dispatched his admiral Nearchus with a fleet along the coast of southern Asia and the Persian gulf while he was returning with his army through Gedrosia and Persia. A few decades later, Megasthenes, a Greek ambassador sent by Seleucus I to King Chandragupta, resided at his court on the Ganges river and wrote a book on India. About this time the Greek navigator Pytheas of Massilia rounded Spain and circumnavigated Britain; his precise recording of the sun's declination in northern latitudes served as the basis for Eratosthenes' research in mathematical geography.

Meanwhile a city was being built at Alexandria which was to serve as the Greek administrative capital of Egypt and to become the focal point of the highest developments of Greek science. Alexandria quickly became the new centre of geographical knowledge and research. Eratosthenes (*q.v.*), head of its famed library, a mathematician as well as scholar, succeeded in measuring the earth's circumference within an error of a few hundred miles, and employing the recorded observations of Pytheas and others who had ascertained the latitudes of various places on the globe by measuring the sun's angle, he was able to produce a map based

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FIG. 25.—SECTION OF THE PEUTINGER TABLE

upon astronomical principles (*c.* 225 B.C.). Hipparchus, greatest of Greek astronomers and a leading mathematician, criticized this work (*c.* 130 B.C.), rebuking Eratosthenes for basing his map upon previously determined positions of latitude of a small number of places. He proposed instead a grid scheme of 360° of latitude and longitude for a map based solely upon astronomical observations, devising a method of determining longitudes by timing observations of eclipses. But precise determinations of geodetic positions depend upon precise instruments of timing and observation, and consequently Hipparchus' scheme could not be successfully applied until modern times. Nevertheless he laid the foundations for scientific cartography.

Poseidonius (*q.v.*), not himself an important original thinker, indirectly exerted an extraordinary influence upon the science of western Europe until the Renaissance. The intellectual age to which Poseidonius belonged was lacking in creative genius. Many of the best minds were engaged in synthesizing and reconciling the more plausible views of earlier Greek philosophers and scientists. Of these compilers Poseidonius proved to be the most apt at assimilating the work of his predecessors and embodying their findings in readable compendiums of knowledge in many fields. The Greek compilations of this period provided the bulk of the scientific material of leading Roman intellectuals—Varro, Lucretius, Cicero, Seneca and Pliny the Elder—who in turn transmitted this body of handbook information to the Latin middle ages. And so, whereas Greek science went on to reach new heights at Alexandria in the 2nd century A.D. and to flourish at a high level at Byzantium and among the Arabs during the middle ages, scientific studies in the Latin west stagnated for 1,000 years in the hands of bookish laymen who were satisfied to copy or revise stock material largely originating in Greek compendiums of the Poseidonian age. The sort of influence Poseidonius wielded was demonstrated when he made a revised calculation of the circumference of the earth, reducing Eratosthenes' nearly correct estimate by over one-fourth; two centuries later, Ptolemy preferred Poseidonius' estimate. Ptolemy's acceptance of a smaller figure of the earth's dimensions and his enormous reputation as a geographer in the 15th century afforded Columbus encouragement to attempt a westward sailing to the Indies.

Strabo's *Geography*, in 17 books, is one of the two major works on the subject to survive from antiquity. He presents conventional handbook information on mathematical geography, sometimes without understanding it, yet has the temerity to criticize Pytheas, Eratosthenes and Poseidonius. Strabo traveled widely in Mediterranean regions and his extensive geographical treatment of the countries of the known world contains valuable information. His book is the chief source on the history of earlier geography.

The Romans were not interested in the theoretical aspects of geography. While the Greeks were attempting to fix locations on the earth's surface and to ascertain the dimensions of the known world and of the entire globe, the Romans were producing crude but practical maps of battlefields and itineraries. As the empire expanded, the realization grew that maps were essential not only for military operations but for provincial administration as well. The emperor Augustus put his general Marcus Agrippa in charge of a mapping project of the entire empire, an undertaking that teams of surveyors required almost 20 years to complete. A survey of over 50,000 mi. of paved highways, recording mileages marked on milestones, served as a framework for the map, and other vital information, such as junctions of rivers and highways, provincial boundaries and facilities available to travelers in towns and cities along the highways, was compiled in the survey. At the conclusion a large master map, engraved in marble, was erected on a wall near the Roman forum. Countless copies were made on papyrus rolls and distributed among military and administrative officers.

A late copy of this map, known as the Peutinger Table (*q.v.*; fig. 25), has survived, presumably belonging to the 3rd century A.D., although the present copy was reproduced in the 13th century. Because the map is in the form of a parchment roll, 22 ft. long and 13 in. wide, designed to be folded in a portfolio, it grossly distorts the shape of the known world. Roman officials, interested only in the data recorded on the map, were not disturbed by its elongated form, which made rivers like the Nile take an east-west direction and made the Mediterranean and Black seas resemble canals. The 11 sheets of the map include the territory from the eastern tip of England and the Pyrenees to China and the supposed shores of the eastern ocean. A missing segment included the British Isles and Iberian peninsula. The segment in fig. 25 shows the southeastern tip of Britain, the northeastern part of Spain, and Gaul. The map contains 534 illustrations: 311 in Europe, 62 in Africa and 161 in Asia. The vignettes may have indicated the kinds of facilities available in towns; *e.g.*, 33 temples and 38 bathing establishments appear on this map. Distances between towns along the highways are fairly accurately recorded in Roman miles.

Meanwhile, scientific studies continued to flourish among the Greeks, particularly at Alexandria. Geographical and astronomical research reached its apex in antiquity in the work of Ptolemy (*q.v.*), whose *Geography* (*c.* A.D. 150), in eight books, culminated the researches of his predecessors. Ptolemy appeared to the ancient world to have fulfilled Hipparchus' scheme of constructing a map of the known world from geodetic positions located precisely upon a network of 360° of latitude and longitude. Book I of his *Geography* discusses the principles of mathematical cartography and the methods of representing a spherical surface on a plane. The remaining seven books are little more than a list of some 8,000 place names—cities, islands, mountains, river mouths, etc.—whose locations were presumably determined even to minutes and seconds. Ptolemy's theory was excellent but his practice shoddy. Actually he had almost no scientific cartographic data—a few latitudes determined astronomically and a token attempt to ascertain longitudes by timing of eclipses. Instead he depended mainly on dead reckoning from reports of travelers. His book was accompanied by an atlas of sectional maps, 10 for Europe, 4 for Africa, 12 for Asia and a map of the known world. A modern reconstruction of his world map, based upon his 8,000 co-ordinates, reveals its most glaring defects (fig. 26). The Eurasian land mass covers 180° (instead of 130°), Scotland is at a right angle to England, lower Italy askew, the Sea of Azov exaggerated and too far north, the Caspian sea in a prone instead of upright position, the triangular shape of India not realized, Ceylon grossly exaggerated and the China coast, beyond the Malay peninsula, verging into Terra Australia and enclosing the Indian ocean. Despite its defects Ptolemy's work had canonical authority for 1,500 years. Maps in the "Ptolemaic style" continued to appear in atlases more than a century after Columbus and Magellan had disproved Ptolemy's conceptions, and some of his errors persisted on maps even in the 18th and 19th centuries.

Solinus early in the 3rd century wrote a geographical book largely copied from Pliny and Mela. In order to make his book entertaining, he culled the more incredible statements from Pliny's *Natural History* and inserted them in his geographical account. The result was a fascinating book of wonders that did much to popularize in later ages the tales of monstrous creatures in Africa and India. (W. H. S.)

C. Medieval Europe and Orient

Three main sources were used by the makers of medieval maps: the classics, Scripture and its interpretation by the fathers of church, and the information provided by the world of Islam. To the writers of the classical schools of geography the medieval map maker was indebted for names of places, for statistical and historical information; to the Christian sources, for authority to support the framework of the map and for references to religious matters; to the Arabs, for topographic detail, and possibly for the knowledge of the magnetic compass. A fourth source was first-hand observation, the results of which are evident in many maps.

Little survives of the maps of the late Roman empire. Besides some fragments of surveyors' sketches, part of one unusual map escaped destruction, the mosaic map of Madeba (Ma'daba), which formed the floor of a Christian church in modern Jordan, southeast of the Dead sea. The fragments, found in the 1890s, show that it was a large map of the Holy Land, made during the first

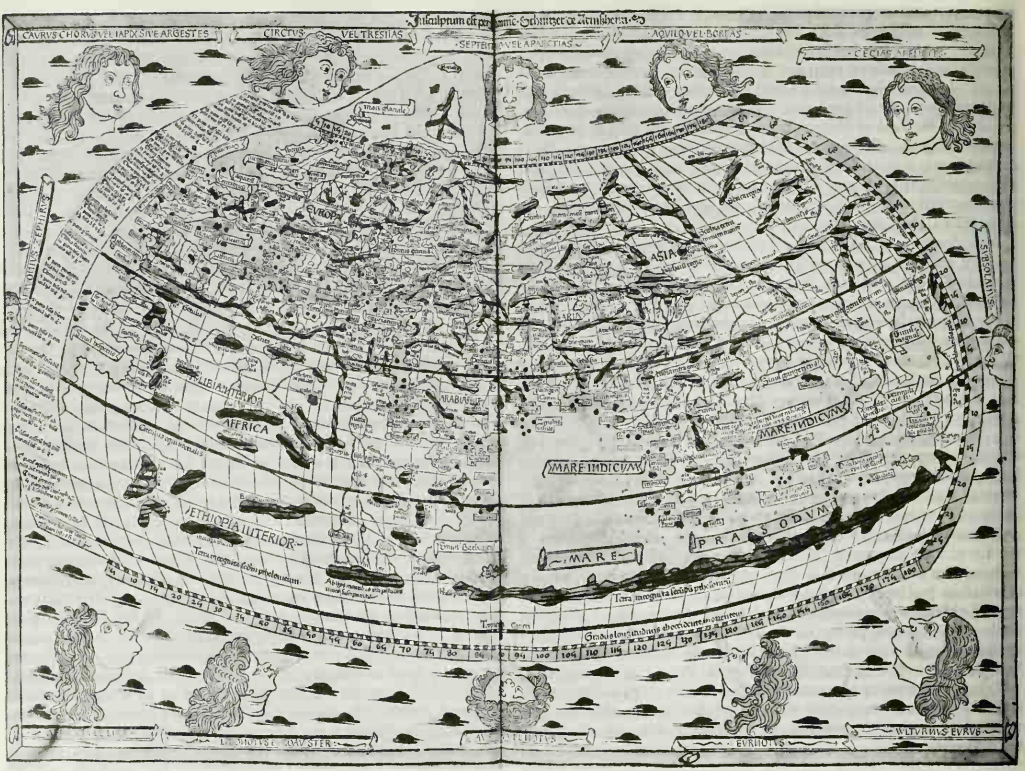

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FIG. 26.—PTOLEMY'S MAP OF THE WORLD, AS PRINTED AT ULM IN 1482

half of the 6th century. Its outstanding feature is a plan, in the form of a bird's-eye view, of Jerusalem before the Arab conquest.

Pilgrims' guidebooks, some undoubtedly illustrated with crude maps, were popular as early as the 4th century A.D. The concern of theologians with an accurate interpretation of the world also led to the preparing of maps, the most famous and earliest of these being the world map of Cosmas (*q.v.*), a merchant of Alexandria turned Christian monk, who wrote his *Christian Topography* during the 6th century. Although only later copies of his world map survive, the book itself described the map in detail. It was a rectangular one, showing the world surrounded by the ocean sea, and surmounted by the heavens, the whole in the image of the tabernacle as described in the Bible. A later but equally primitive world map accompanied the commentaries written by Beatus, a Spanish monk, on the Revelation of St. John, during the 8th century. There are many variants of the Beatus world map, the earliest dating from the 10th century, all of them presenting a distorted, inaccurate view of the world.

1. "T and O" Maps.—The notion of the earth being round, though at times condemned by the church, never completely disappeared. Yet medieval maps, practically without exception, appear to show the earth as a flat disk. On this type of map, which often accompanied such church-approved encyclopaedias as that of Isidore of Seville (*q.v.*), the world is shown consisting of the three continents of Europe, Asia and Africa, with the top of the map being east, and the centre of the earth, in accordance with Scripture, at Jerusalem.

The threefold division of the world was best shown in the maps called "T and O" maps. These, popular throughout the medieval period, showed the world surrounded by a circular ocean, the "O"; the three continents of Europe, Asia and Africa were divided by a perpendicular line, the stem of the "T," representing the Mediterranean, and a horizontal line, the top bar of the "T,"

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FIG. 27.—MAP FROM ISIDORE OF SEVILLE'S ENCYCLOPAEDIA

consisting of the Nile, separating Africa and Asia, and the Dnieper, separating Asia and Europe.

The simple framework of the "T and O" map eventually came to be embellished by a wealth of detail, some real, some imaginary, taken from Pliny, from later Roman and from early medieval writers. While some of the originals of this type barely measured an inch across and fitted into the top of the letter "P," as an illuminated initial, others were as much as 60 in. wide. The two most famous of this latter type, both made during the 13th century, are the Hereford map, in England, and the Ebstorf map, in northwest Germany. There existed also simple map sketches which, in defiance of the denial that life could exist beyond the torrid zone around the equator, showed the world divided into five climates, following closely the classical Greek scheme.

2. Portolan Charts.—The maps of Britain by Matthew Paris, an English chronicler of the 13th century, are among the very few medieval maps that show a definite attempt to present an accurate image of a single country. It was not until the latter part of the 14th century that a successful attempt was made to include in a map of the world at least some of the recently acquired

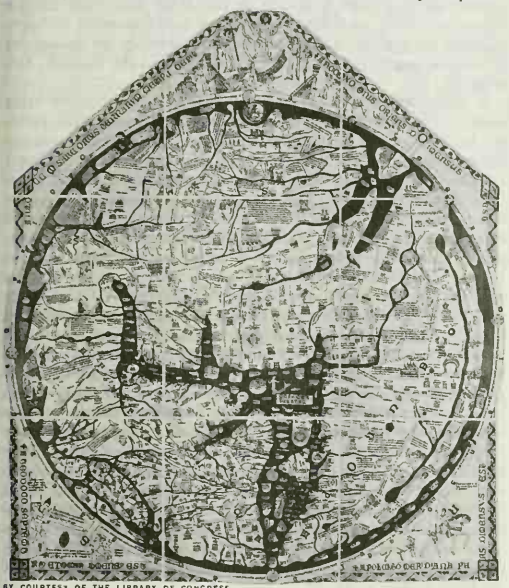

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FIG. 28.—THE HEREFORD MAP (13TH CENTURY)

knowledge of Africa and Asia. The Catalan map of the world of 1375, prepared for the king of France, was the work of a new and much improved technique of map making. The "T and O" and other medieval maps were schoolmen's maps, made to illustrate a preconceived and highly stylized view of the world. The Catalan map, on the other hand, derived much of its contents from portolan, or seamen's charts, which were drawn in as strictly factual a manner as the tools of the time allowed. While there is some doubt as to the originals of the portolan charts, there is agreement on certain points in their history. They were made possible by the extensive use of the magnetic compass; they conformed to a common, now lost, model in their outline, in their scale and in many minor details; and they were based, in part at least, on the pilot books or *periploi* of Greco-Roman origin.

The oldest portolan chart is the so-called Pisan chart, made around 1300. Its name is derived from the portolano, the pilot book that listed courses, anchorages and ports. Some 30 or so portolan charts made during the first half of the 14th century survive. All were drawn by Italians, of whom several are known by name, John of Carignano, Petrus Vesconte and Angelino

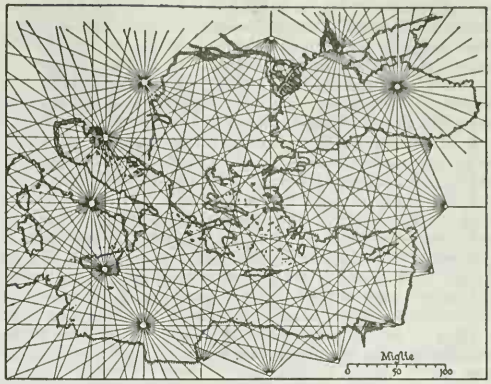

FIG. 29.—PORTOLAN CHART OF THE EASTERN MEDITERRANEAN AREA (1311) BY PETRUS VESCONTE

Dalorto among them. All of these charts show the Mediterranean sea, the Black sea and parts of the Atlantic. There is evidence that they were used as early as 1270, and the general outline of the map itself, and much of the detail of the coast lines, did not change between 1300 and 1600. The portolan charts are more accurate than any medieval map. When the centre of chart making shifted from north Italy to the Balearic Islands and to Catalonia, much of the detail so well presented in these maps was incorporated in the Catalan map of 1375.

One of the important characteristics of all portolan charts is the network of lines radiating from several centres distributed all over the chart. These lines conform to the 8 or 16 principal parts of the compass rose, and they were probably used by seamen to lay out courses from port to port, in the manner used on modern navigation charts.

3. Mauro and Behaim.—The map makers' art of the middle ages culminated in the works of two men of the 15th century. Fra Mauro, a monk and cartographer of Venice, completed his world map in 1459. It shows the world in the shape of a wheel, and contains a wealth of accurate and important detail on Asia and Africa, taken from the intelligence accumulated during the previ-

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FIG. 30.—THE WESTERN HEMISPHERE ACCORDING TO MARTIN BEHAIM'S GLOBE (1492)

ous two centuries. Martin Behaim (*q.v.*), a German who served the court of Portugal as astronomer during the great age of Portuguese discoveries, prepared a globe, the oldest terrestrial globe extant, for his native city of Nürnberg in 1492. On it the western coast of Europe and the east coast of Asia face each other across the waters of the Atlantic, and there is no indication as yet of the new world, to be discovered within a few months by Columbus.

4. Islamic Maps.—Map making among the Muslims did not match the accomplishments of their European contemporaries. The mathematical and astronomical skill of the Muslims, and the fact that Muslims sailing the Indian ocean used maps that had much in common with the European portolan charts, was not reflected in the primitive sketches that illustrate Muslim works of geography. The only medieval Muslim map of note, known through later copies, is the famous map of Idrisi, prepared in Sicily at the court of the Norman kings during the 12th century. Idrisi's map was based, in part, on Ptolemy, following his scheme of climates, and its portrayal of the Mediterranean and of the near east was far superior to that of any European map of the time.

5. Far East.—Maps were well known in China, Japan and Korea during the middle ages, yet no original maps are known to have survived. There were prototypes, such as the Gyogu map of Japan, probably first prepared during the 9th century, and maps of China and of the world known to the Chinese were made during the first centuries of the Christian era. The maps drawn in the far east were as self-centred as were medieval maps, and the mythical element occupies fully as important a place on them, regarding Europe, western Asia and much of Africa, as it does on their European counterparts, regarding the far east. (G. Kh.)

D. Early Modern Period

1. Revival of Ptolemy.—By 1400 Greek manuscripts of Ptolemy's *Geography* had reached Italy, and its contents became known to western Europe in the Latin translation made by Jacobus Angeltus in 1410, first in manuscript copies and from 1475 in printed editions. The world map and 26 regional maps derived from Ptolemy's text, drawn on a conical projection and graduated in latitude and longitude, were first printed at Bologna in 1477, from copperplates. The maps were redrawn in Florence, on a new trapezoidal projection, by the German monk Donis Nicolaus, whose maps were printed in the woodcut edition of Ulm (1482). The *Geography* was the first world atlas; it coloured geographical thought until the end of the 16th century, and 31 Latin or Italian editions with maps were printed before 1600.

"Modern" maps (*tabulae novae*) were early added to the Ptolemaic atlas, both in manuscripts and printed editions. The earliest was a map of the north drawn at Rome in 1427 by the Dane Claudius Claussön Swart, known as Claudius Clavus. Cardinal Nicholas Krebs (1401–64), of Cusa (Cues, on the Moselle), drew the first modern map of Germany, which was engraved in 1491. By the beginning of the 16th century the hemispheric division of the world, into the "old world" of Ptolemy and the "new world" of the discoveries in the west, was becoming familiar. The enlargement and correction of Ptolemy's world map by new knowledge derived from exploration called for increasing numbers of maps. The Strasbourg edition of Ptolemy (1513) had no fewer than 20 modern maps by its editor Martin Waldseemüller; and the edition by Sebastian Münster printed at Basel in 1545 had 32.

2. Cartography of the Discoveries.—The great discoveries of the 15th and 16th centuries, both those to the east and those to the west by Columbus and John Cabot and their successors, were laid down on compass charts, or portolan charts (*see* above), of traditional type, developed from that of the Mediterranean area. Chart making flourished in the Italian ports, notably Genoa, Ancona and Venice; and it is on charts drawn in these centres that the Portuguese voyages along the coasts of Africa are recorded, since only one Portuguese chart made before 1500 has survived. The Casa da India at Lisbon had however from an early date been responsible for training pilots and cartographers, and Portuguese chart makers were held in high repute throughout the 16th century, although the Portuguese authorities sought to keep their work secret. The Cantino world chart, which depicts the lands discovered in the east and west, was obtained surreptitiously in Lisbon in 1502 by Alberto Cantino, agent of Duke Ercole d'Este, of Ferrara. The leading Portuguese cartographers of the 16th century were Pedro Reinel and his son Jorge, Lope Homem and his son Diogo, Diogo Ribeiro, Fernão Vaz Dourado and Luís Teixeira. In Spain the Casa de la Contratación de las Indias, established at Seville in 1508, was charged with the supervision of charts and the maintenance of a master chart (*padrón general*); among its cosmographers were Nuño García de Toreno (who prepared the charts for Magellan's circumnavigation), Ribeiro (who spent his working life in Spanish service) and Alonso de Santa Cruz. Between 1540 and 1566 a number of manuscript world maps were drawn, largely from Portuguese sources, by hydrographers of Dieppe, notably Pierre Desceliers and Nicolas Desliens.

Columbus' belief that Cathay could be reached by sailing westward was no doubt inspired by the study of a globe. Like the (now lost) world chart which the Florentine Paolo Toscanelli appears to have sent Columbus in 1474, Martin Behaim's globe (*see* above) encouraged belief in the western route by ascribing a width of only 126° longitude to the ocean separating Europe from Asia. Juan de la Cosa, who sailed with Columbus in 1492–94, drew the earliest surviving world chart showing the discoveries in the new world by John Cabot, Columbus and the Spanish; this is dated 1500.

3. 16th-Century Chart.—The "plane chart," drawn from compass bearings and dead reckoning, with north-south lines parallel, had two serious defects for navigation. It did not represent the convergence of the meridians, and therefore falsified east-west distances in higher latitudes; and it did not allow for differences in magnetic variation. The first of these problems was to be solved only when Mercator's projection, employed in his world chart of 1569, came into use. The second was serious for navigation in American waters, where a large westerly variation was found; among the devices adopted to overcome it was the drawing of a second, "inclined" meridian, as on the chart of the North Atlantic by Pedro Reinel (*c.* 1504), to indicate local variation. Coastal charts, with "rutters" or sailing directions, were developed by northern seamen from the early 16th century. In the first printed sea atlas, the *Spieghel der zeevaerdt* (1584), by Lucas Janszon Waghenaer of Enkhuizen, the chartwork already shows many modern characteristics, notably soundings and the profile representation of shore marks.

4. 16th-Century Cartographers.—The maps and globes of the 16th century, as an index of contemporary geographical knowledge, illustrate the gradual modification of the Ptolemaic world picture to admit new concepts derived from discovery—the outlines of Africa, India and southeast Asia as revealed by the Portuguese voyages; the unbroken extension of America from the Arctic circle to Magellan strait; the existence and longitudinal span of the Pacific ocean, disclosed by Magellan.

The principal centres of cartographic activity, outside the Iberian peninsula, were Italy, the Rhineland, the Netherlands, France, Germany and Switzerland. Martin Waldseemüller (1470?–1518?), who worked at St. Dié in the Vosges, produced two large woodcut world maps; that of 1507, the earliest to use the name America, was compiled from "the tradition of Ptolemy and the voyages of Amerigo Vespucci and others," while the *Carta marina* of 1516 was drawn in chart style. Waldseemüller's world view was popularized by other German cartographers, notably Johannes Schöner (1477–1547), who worked at Nürnberg and produced four globes between 1515 and 1533; Peter Apian (1495–1552) of Ingolstadt; Kaspar Vopel (1511–61) of Cologne; and Sebastian Münster (*q.v.*), who worked at Basel. The leading cartographer in France during the century was Oronce Finé (1494–1555) and in Italy Giacomo Gastaldi (*c.* 1500–65).

The Netherlands school of cartography stems from Gemma Frisius (1508–55) of Louvain, whose enlarged edition of Peter Apian's *Cosmographia*, with its world map, was frequently reprinted from 1533. Gemma applied himself to many geographical problems, including those of the longitude and the convergence of meridians. Among his pupils was Gerardus Mercator (*q.v.*; *see*

FIG. 31.—MERCATOR'S CHART OF THE WORLD (1569)

also *Map Projections*, above), who assisted in the preparation of Gemma's pair of engraved globes (1535 and 1537) and published his own globes in 1541 and 1551. Mercator, who worked at Louvain until 1552 and thereafter at Duisburg, became the leading cartographer of the age; his principal maps were those of Palestine (1537), the world (1538), Flanders (1540), Europe (1554 and 1572) and the British Isles (1564), besides his world chart of 1569 (*see* fig. 31), his Ptolemy edition and his *Atlas*.

By the last quarter of the 16th century the main European centre of map production had shifted from Italy to the Netherlands, and particularly to Antwerp, where Abraham Ortelius and Gerard de Jode published their atlases (*see* below). In the northern Netherlands cartography developed with overseas enterprise. Petrus Plancius (1552–1622), first cartographer to the Dutch East India company, had a copious output, including two large printed world maps (1592 and 1594). In England, Flemish cartographers and map engravers gave an impetus to the art; the first English globes, those of Emery Molyneux, were engraved by Jodocus Hondius in 1592. In 1599 Edward Wright explained the construction of Mercator's projection in mathematical terms, and a world chart on this projection, ascribed to Wright, accompanied Richard Hakluyt's *Principall Navigations* (1598).

5. Regional Cartography.—The regional maps of the middle ages had been drawn from route surveys or eye sketches, supplemented by linear measurement. During the 15th century local maps constructed from the road system were made in Italy; and a woodcut map by Erhard Etzlaub of Nürnberg, printed in 1500 with the title *Das ist der Romweg*, showed the roads of central Europe and Italy with mileages between towns.

In the first half of the 16th century geometrical methods of survey, with more precise instruments for observation of angles, were introduced by geographers of Germany and the Netherlands, and the principle of triangulation was described in 1528 by Münster and in 1533 by Gemma Frisius. This enabled a relatively large area to be surveyed more rapidly as well as more accurately and many countries or regions were first mapped during the century. Among such maps may be mentioned Finé's France (1525), the maps of parts of Germany published by Münster from 1545, Prussia (1542) by H. Zell, maps of Switzerland by Konrad Türst, Johannes Stumpf and Aegidius von Tschudi between 1495 and 1538, the provinces of the Netherlands (1556–60) by Jacob van Deventer, Austria (1561) by Wolfgang von Lazius and Bavaria (1568) by Philip Apian. Scandinavia and the north were delineated by Olaus Magnus (1539); Russia and eastern Europe by Anton Wied (1542), Sigismund von Herberstein (1549) and Anthony Jenkinson (1562). The prototype for maps of Great Britain was that by "G. L. A." (George Lily) engraved at Rome in 1546. Many of these regional maps, including those of the British Isles by Humphrey Lhuyd (1527–68), were reproduced in Ortelius' *Theatrum* (*see* below). The first survey of the English counties was made by Christopher Saxton (*c.* 1542–1606); his county maps were engraved during 1574–79 and his large map of England and Wales in 1583. The earliest atlas of the French provinces was published by Maurice Bouguereau at Tours in 1594. Here too may be mentioned the popular collection of views or plans of cities, the *Civitates orbis terrarum* (1573–1618), by G. Braun and Frans Hogenberg.

6. Printed Maps and Atlases.—Although the maps in the Italian editions of Ptolemy of the 15th century had been printed from engraved copperplates, the woodcut was the dominant medium for map reproduction until nearly the middle of the 16th century. From about 1540 copperplate engraving established itself, first in Italy, as the fittest technique for map printing, and this process was to maintain its ascendancy for four centuries.

The prototype of the atlas was the collection of Ptolemaic maps, increasingly supplemented by "modern" maps. In 1528 Münster appealed to German geographers to survey their regions and send him their maps, many of which were included in his edition of Ptolemy (1540) and in the successive editions of his *Cosmographia* from 1545. In Italy there was a copious production of engraved sheet maps, and such map dealers as Antonio Lafreri at Rome and G. F. Camocio and P. Forlani at Venice offered for sale sets of maps from their stock, covering the world and systematically arranged "in Ptolemy's order." The first modern atlas, however,

compiled on uniform principles laid down by its editor, is the *Theatrum orbis terrarum* published at Antwerp in 1570 by Abraham Ortelius (*q.v.*). Its 70 maps on 53 plates, mainly engraved by Frans Hogenberg, were compiled from the best sources available and reduced to a common size and style; and the *Theatrum* was enlarged and kept up to date in successive editions until the last in 1612. Its rival, the *Speculum orbis terrarum* of Gerard de Jode (1509–91), published at Antwerp in 1578, was less popular.

Mercator planned his *Atlas* (the first book of maps to which this name was given) as part of a great cosmographical project, earlier stages of which were represented by his world map (1569) and his edition of Ptolemy's maps (1578). The first two parts of the *Atlas,* engraved in his Duisburg workshop, appeared in 1585 and 1589; the third was published after his death by his son Rumold in 1595. In 1604 the plates were acquired from Rumold's heirs by the Amsterdam mapseller Jodocus Hondius.

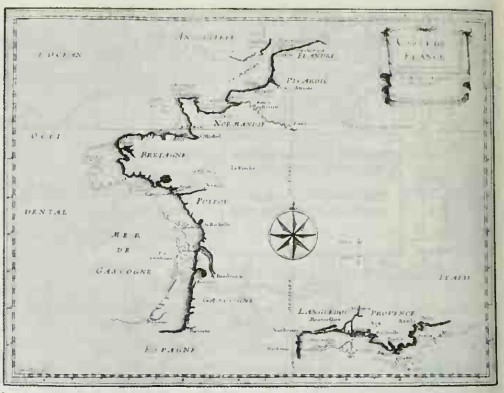
7. 17th Century.—By 1600 Amsterdam had succeeded Antwerp as the centre of cartographic industry in the Netherlands, and the 17th century was the great age of Dutch map production. From the Amsterdam workshops of Jodocus Hondius (1563–1611), Willem Jansz Blaeu (1571–1638) and Jan Jansson (1596–1664), Frederik de Wit (*fl.* 1648–89) and other mapsellers, the European market was supplied with printed charts and sea atlases, globes, wall maps, town plans and views and, above all, atlas maps. Mercator's atlas was continually enlarged by Hondius and, after him, Jansson; Blaeu's first atlas, in two volumes, was published in 1635, and, like Jansson's, it had by 1660 expanded to 11 or 12 volumes. Blaeu became hydrographer to the East India company and the states-general, and his *Zee-spiegel* (1623) was the prototype of a long series of fine sea atlases by various map makers, notably Pieter Goos, J. A. Colom, A. Jacobsz and Hendrik Doncker. The earliest sea atlas drawn throughout on the Mercator projection was *L'Arcano del Mare,* compiled by Sir Robert Dudley and published at Florence in 1646. *Le Neptune françois ou atlas nouveau des cartes marines,* published at Paris in 1693, marked a further advance in hydrography; drawn on the Mercator projection, its charts laid down the positions of many places from "fixes" made by the French astronomers.

The most prolific and influential French cartographer of this period was Nicolas Sanson of Abbeville (1600–67), who established his Paris workshop about 1634 and published his first atlas in 1654. After his death his business was carried on, in turn, by his sons and by A. H. Jaillot (1640–1712); and his son-in-law Pierre Duval (1619–83) was also a productive cartographer. Their work foreshadowed the authority enjoyed by French cartography in the first half of the 18th century.

At the end of the century Johann Baptist Homann (1664–1724) of Nürnberg established a vigorous map business which continued into the next century. V. M. Coronelli (1650–1718), cartographer to the republic of Venice, produced many fine globes and maps, based on careful research.

In England, apart from the popular county atlas of John Speed, *The Theatre of the Empire of Great Britain* (1611–12), in which the maps were engraved by Hondius, map production languished until after 1660. The Restoration period saw a revival of activity; John Ogilby made the earliest survey of the English roads, published in his *Britannia* (1675), and the printing of charts began with the work of John Seller, John Thornton, Greenville Collins and others. In 1681–88 Collins first surveyed the coasts of Great Britain. Not until the 18th century, however, was English map production to overtake that of the Netherlands and France.

Reformation of Cartography.—During the 17th century few major new data were added to the world map by discovery, although these included the coast of Australia revealed by Dutch voyages, parts of the interior of North America explored by the French, and fuller knowledge of China contributed by Jesuit missionaries. Yet in this period the foundations of the modern map were laid by improvements in the technique of instrumental observation and survey, particularly the introduction of telescopic sights and the development of instruments for leveling and for



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

FIG. 32.—MAP OF THE RESURVEY OF FRANCE, 17TH CENTURY, BY J. D. CASSINI AND JEAN PICARD, INDICATING THE FORMERLY ACCEPTED AND THE CORRECTED COAST LINE OF FRANCE

the precise measurement of horizontal and vertical angles. In 1671 the Paris observatory was established, and from this time the latitude and longitude of an ever-increasing number of points were fixed by instrumental observations under the auspices of the French Académie Royale des Sciences.

The framework of an accurate world map depends on determinations of the size and shape of the earth, derived from measurement of the length of a degree along a meridian. Arcs of a meridian had been measured in 1606 by Willibrord Snell, in Holland, and in 1635 by Richard Norwood, in England. The measurement was attempted by more scientific methods in France in 1669–70 by Jean Picard, whose measured arcs were extended between 1700 and 1718 by J. D. Cassini (1625–1712) and his son Jacques, the first two directors of the Paris observatory. The geodetic data thus obtained served as the basis for the redrawing of the world map by French cartographers of the early 18th century.

Special Maps.—During the 17th century some of the earliest experiments were made in the drawing of maps to represent the data of special sciences in their geographical relationship. Edmund Halley's chart of the trade winds (1686) is the first meteorological map; and maps of the ocean currents were published by Athanasius Kircher in 1665 and by E. W. Happel in 1675. Attempts to illustrate magnetic variation on maps had been made by C. Burrus in 1630 and by Kircher in 1643; but the first variation charts based on observation were those of Halley (the Atlantic, 1701; the world, 1702). In these Halley introduced the isopleth, or curve-line of equal value, which was long known as the "Halleyan line." (R. A. Sn.)

E. Modern Period

In 1700 nearly half of the earth's surface was still unexplored or little known. After World War II the initial reconnaissance mapping of the earth was brought to its close in the antarctic wastes. For millenniums this task, with the related riddle of what lay beyond the margins of the "known world," had confronted the cartographer with his most challenging problem. From the beginning of the 18th century a more difficult problem has replaced it—that of mapping the known world to meet the demands of a civilization that has come to use maps for purposes never before dreamed of.

1. Transportation, Travel and Maps.—Transportation and travel always have been powerful stimulants to mapping. In the modern period, mapping the world's coast lines has been pushed forward along traditional lines, and many maps of wholly new kinds have been made to help ships move from place to place—maps of the sea floor, ocean currents, winds, storm tracks, air and water temperatures and the like—the making of which has yielded great quantities of scientific data as by-products. In the sparsely

tled parts of Australia, Siberia, Latin America, western North nerica, and elsewhere, the first detailed reconnaissance mapping s often carried out as part of the search for routes for railways, d the precise leveling done in connection with the construction railways, canals and highways supplied many of the data upon nich the earliest hypsometric mapping was based. Successive provements in travel by road gave rise to the post-route and age-route maps of earlier times and to the modern motorists' aps. The airplane, like the ship, has occasioned world-wide rograms of surveying and observation to procure air navigation narts and meteorological maps for air traffic guidance and pro- ection; it also has facilitated the task of mapping for countless ther purposes. The airplane brought these revolutionary changes n cartography within three decades.

2. War and Maps.—War is another stimulant of human mo- bility and hence of cartography. The campaigns of Alexander the Great and Genghis Khan opened vast and little-known tracts for subsequent mapping, but in modern times the influence upon map- ping of preparations for war has been greater than that of mili- tary campaigns as such. The small, lightly equipped armies of pregunpowder ages had little need for maps; local guides showed the way, and arrows and spears could find their targets without the aid of cartography. The advent first of artillery and later of the nation-in-arms changed the situation. The topographic mapping of modern Europe, which began in the 16th century and has been pursued comprehensively from the mid-18th century, was under- taken largely to facilitate the aiming of field guns, the finding of cover and the moving of large bodies of men and matériel. Na- poleon was alert to the military value of topographic maps and did much for cartography.

World War II, coming as it did after aviation and photogram- metry had been well developed, far exceeded all previous wars in the extent of its effects upon map making. During its course im- mense areas, even in regions remote from the theatres of war, were flown over, photographed and mapped on the chance that the maps might be needed; and totally unprecedented in magnitude was the work of making new and reproducing old maps to show not only routes and targets of concern to the planners of military operations but also a variety of special matters of possible value to those directing the political, economic and psychological phases of the war. During World War II two agencies of the United States armed forces are said to have printed about 650,000,000 copies of some 50,000 different maps.

3. Governmental Mapping.—As long as maps were used for relatively few socially indispensable purposes, cartography was left mostly in private hands. As the essential uses of maps have multi-

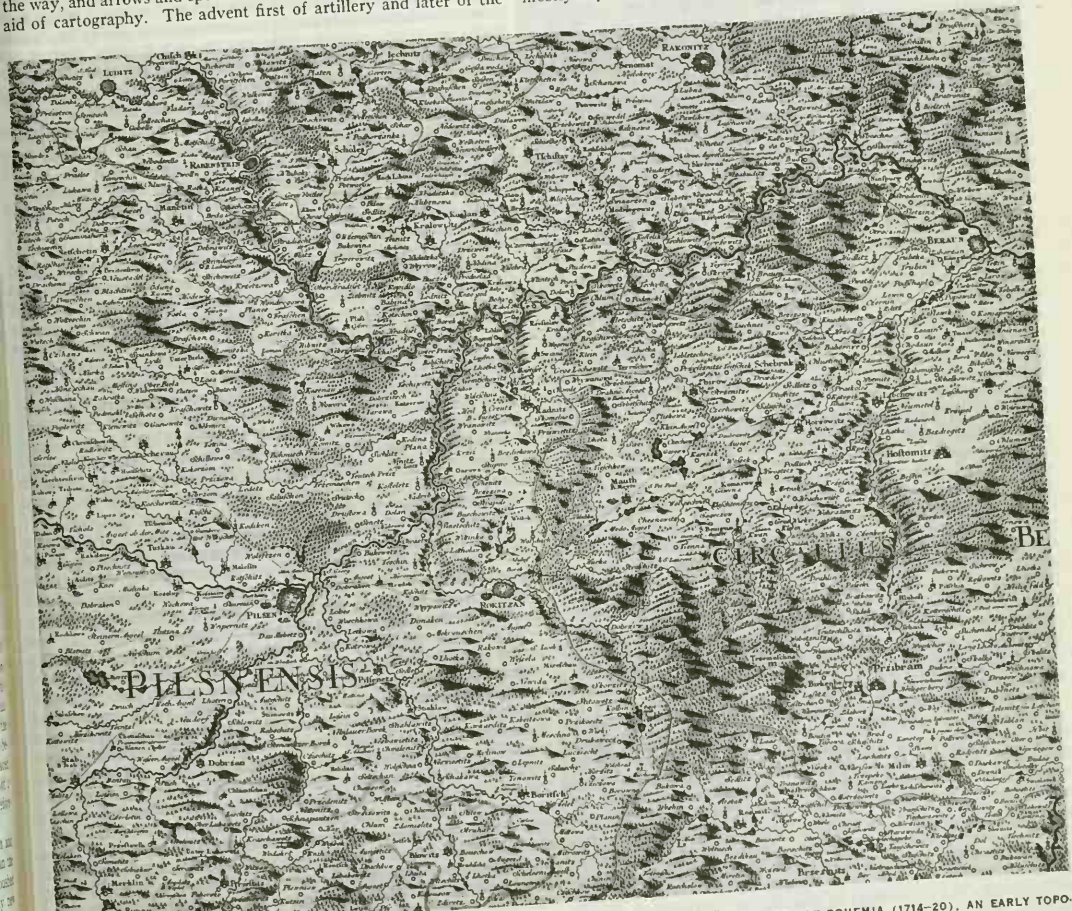


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FIG. 33.—PART OF ERZ MOUNTAINS SOUTHEAST OF DRESDEN AS SHOWN ON JOHANN CHRISTOPH MÜLLER'S MAP OF BOHEMIA (1714–20), AN EARLY TOPOGRAPHICAL MAP ON WHICH RELIEF IS STILL REPRESENTED AS ON MEDIEVAL MAPS

plied, however, certain basic cartographical enterprises, such as police, postal, water supply and other indispensable services, have been taken over by governments. At first these enterprises consisted mostly in the production of topographic maps and marine charts, but they have been extended to the mapping of minerals, soils, geological formations, climate, vegetation, land use and much else. Before the 19th century in most countries and until well into it in some, topographical mapping was based upon occasional surveys, and the maps were usually known by the names of the surveyors or engineers in charge (*e.g.*, the Cassini map of France, 1750–93; the Rizzi Zannoni map of Poland, 1772; the Dufour map of Switzerland, 1842–72). Eventually, however, the work was taken over on a continuing basis by great technical organizations such as the Ordnance survey of Great Britain (founded 1791), the Service Géographique de l'Armée in France (replaced in 1940 by the Institut Géographique National) and the Federal Topographic bureau of the Swiss general staff. Most of these, at least in Europe, have been set up by the armed forces or their responsible ministries. In the United States and Canada, by contrast, the principal governmental mapping agencies (*e.g.*, the U.S. coast and geodetic survey, founded as the U.S. coast survey in 1807; and the U.S. geological survey, founded in 1879) have been under civilian administration, a result in part, no doubt, of the freedom from fear of invasion that the geographical isolation of North America fostered until as late as World War II. During and after World War II the armed forces in the United States and Canada greatly enlarged the scope of their cartographical work.

4. Influence of Science and Technology.—The development of cartography during the modern period also has been affected profoundly by the general advancement of science and technology, and in particular by adaptations that have been made, one after another, of certain instruments and techniques to the uses of surveyors and cartographers. Foremost among these, in so far as the basic mapping of the visible features of the earth's surface is concerned, were the telescope in the 18th century and the camera in the 20th.

During the 200 years following its invention (about 1608), the telescope (*q.v.*) was increasingly put to use in the making of astronomical observations to determine geographical positions. It was also introduced into surveying and navigational instruments as an integral part of their structure, thus greatly enhancing their precision. By the mid-18th century, the telescope had had two important effects upon cartography: it had made possible the accurate construction of modern map projections (as, *e.g.*, in the work of J. H. Lambert) and it had helped furnish a quantity of astronomically and trigonometrically determined control points for topographic maps, marine charts and reference maps in general. Thus, largely by means of the telescope were obtained many of the new data upon which Guillaume Delisle, J. B. d'Anville and others based the extensive revision of earlier maps that has been called the cartographic reformation of the 18th century. Since this movement was mainly directed toward the correction of errors, it was, indeed, a reformation rather than a revolution. It led, however, to genuinely revolutionary changes toward the close of the century. Max Eckert, the German cartographer, writing in 1921, maintained that since the Renaissance no greater change had taken place in the general appearance, accuracy and construction of maps than that which differentiated the maps of the 19th century from their predecessors.

The years after Eckert expressed this view, however, saw a second and even more radical cartographical revolution, in which the camera played a part comparable to that of the telescope in the earlier reformation. Carried aloft in airplanes, the aerial camera advanced the mapping of the visible face of the earth at a speed and with a fullness of detail never before remotely approached and disclosed for mapping much that had remained invisible to earthbound observers (*e.g.*, facts of archaeological or botanical interest). Also, in the rooms where maps are actually produced, special cameras have effected hardly less spectacular improvements in the processes of compilation, drafting and reproduction. The application of photography to mapping gave birth to that new handmaiden of cartography and surveying, photogrammetry, with a whole repertory of techniques and a battery of instruments of its own. During and after World War II, moreover, the cartographic revolution entered a second stage in which, for many operations, the use of electronic devices came to supplement or supersede the older optical and photographic techniques. (*See* also PHOTOGRAMMETRY.)

Another development of the modern period is maps that show, by means of isolines or other symbols standing for specified quantities, the distribution of variables such as elevations, depths, temperatures, population densities, differences in wealth, etc. Such quantitative maps, now in universal use, were almost totally unknown before 1700. Edmund Halley's isogonic (compass-declination) map of certain oceans (1702), though not the very first of its kind, is the first known upon which isolines were used with fair success to show quantitative differences over large areas, and it inspired Alexander Humboldt many years later to propose that temperatures might be similarly shown by means of isotherms (1817). About 1730 Samuel Cruquius made the first recorded use of contour lines, when he employed them (not altogether correctly) to represent the depths of certain estuaries and rivers of the Netherlands coast, but contours were seldom used in the representation of land relief until the mid-19th century. While the barometer, thermometer and hygrometer were all greatly improved during the 18th century, they, too, were but little applied in hypsometric or meteorological mapping until the mid-19th century, for not until then had comparable data sufficiently numerous for cartographic purposes been assembled with their aid. Later a profusion of mechanical, optical, photographic, acoustical and electronic instruments for measuring conditions and forces in the depths of ocean, atmosphere and solid earth brought about an immense efflorescence of quantitative maps as tools of research and exposition in the various earth sciences (notably geophysics, geology and their allied fields of geomagnetism, meteorology, physical oceanography, geomorphology).

In many branches of the study of man and his affairs, historians, anthropologists, economists, sociologists, demographers and others also have come to depend, though to a lesser degree, upon quantitative maps based upon censuses and similar statistical inventories that likewise were unknown before 1700 and little used before the second half of the 19th century. Although such censuses are mentioned in the Bible, nobody seems to have thought of mapping the results until the early 19th century, when modern national census bureaus and the like had begun to gather large quantities of data for extensive areas. Notable pioneers in the advancement of statistical mapping were a British engineer, Henry Drury Harness (1804–83), whose population and traffic maps of Ireland appeared in 1837, and a German geographer, August Heinrich Petermann (1822–78), founder of the well-known geographical and cartographic journal *Dr. A. Petermanns Mitteilungen* (1855).

5. Outstanding Characteristics of Modern Cartography.—As a result of these various influences, cartography during the modern period differs essentially from the cartography of all earlier periods by reason of the great gains that have been made in the diversity, accuracy and quantity of maps produced.

Before 1700 the facts presented on maps were restricted mostly to the salient, visible features of the earth's surface—bodies of water, mountains, towns, roads, forests—and to such portrayals of human beings, animals, monsters and curiosities as the draftsman saw fit to add in the blank spaces. Since most modern maps have been designed to serve utilitarian, educational or scientific purposes, few carry the pictorial embellishment that added charm to the maps of earlier times. In this respect the 18th century was transitional: although 18th-century maps were somewhat more austere and accurate than those of the 17th century, a good deal of pictorial decoration was retained. By the 19th century it was almost wholly gone and today is found only on maps made in imitation of medieval and Renaissance models; indeed, all too many modern maps are in fact ugly. Nevertheless, it always has been understood that cartography can be not only accurate but also pleasing to the eye, and exquisite maps have been produced during the modern period, more, perhaps, in continental Europe

than elsewhere. The artistry that the early cartographers lavished on embellishment has been largely replaced by ingenuity in the finding of new types of phenomena to map and new symbols with which to map them.

Every map obviously presents a definite, if not readily measurable, amount of information. If it were possible to measure the total amount of information concerning any area presented by all maps that cover it, and then divide this figure by the area's extent in square miles or similar units, a figure would result that might be called the "map-area ratio" of the area. Could maps be made showing the values of this ratio, they would disclose at a glance how relatively well mapped (or, at least, thoroughly mapped) different areas are or have been (as is now suggested by coverage maps, but only with respect to maps of specific types; *e.g.*, large-scale topographic maps, coast charts). World maps of map-area ratios for different dates during the modern period would show patterns conforming broadly with densities of population, but with the highest ratios and the greatest gains in areas where economic and educational levels have stood highest and risen most. Throughout the period by far the most numerous and extensive tracts of very well-mapped territory have doubtless lain in western Europe (including Germany), where topographic mapping to large scales has been supplemented by the intensive special mapping of a multitude of natural and cultural circumstances, past and present. Where such cartographical treasures have been accumulated, they have frequently, though not invariably, inspired the publication of national or regional atlases (*see* ATLAS).

Correlation between population and map-area ratios of course is not perfect; certain uninhabited or sparsely settled areas—such as frontier zones of strategic importance (*e.g.*, northeastern France), strips of wilderness along international boundary lines (*e.g.*, Alaska-Canada), submarginal farming areas under paternalistic governments, undeveloped areas that attract tourists or present problems of special scientific interest, and, especially, areas believed or known to contain valuable natural resources—have been well mapped. Conversely, certain areas have been less well mapped than the comparative prosperity and enlightenment of their inhabitants might suggest; this has been true of large parts of the United States, and perhaps also of the country as a whole.

The number of maps that the people of a village or city or nation own or make or use per capita could be called a map-population ratio. Such ratios, like map-area ratios, though not readily determined as actual figures, are useful as concepts, in that they suggest realms of investigation that have been neglected by historians of cartography, most of whose work has dealt with individual maps and cartographers rather than with the larger historical bearing of the subject.

Map-population ratios would signify varying degrees of "map-mindedness," "map-dependence," and the like, and would also be found to correspond roughly with differing economic and educational levels. In their map-population ratios, France, Germany, the Netherlands and Great Britain must have led the world by a wide margin in 1700, and, along with the United States, Canada and the other more fully industrialized countries, are doubtless still in the lead. Here again, the ratios have probably stood higher in western European countries and lower in the United States than the respective relative levels of prosperity and education might lead one to expect. While it cannot be stated categorically that western European peoples make and use more maps per capita than Americans or Russians do, western European pre-eminence throughout the modern period in the production and use of maps for educational, scientific and scholarly purposes can hardly be questioned. This superiority is due, in part at least, to the high standards that have been set and consistently maintained by the great governmental cartographic establishments and certain of the geographical societies and geographical departments in the universities of western Europe, and also by such renowned old map-publishing houses as Justus Perthes in Gotha (name changed to Veb Hermann Haack Geographisch-Kartographische Anstalt in 1954), Bartholomew in Edinburgh and Hachette in Paris. Throughout the 19th century and until the eve of World War II

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FIG. 34.—TOPOGRAPHIC MAP OF HARPERS FERRY, W.VA., ALSO SHOWING PART OF VIRGINIA AND MARYLAND (1953)

Germany produced the best general reference atlases, but after that the lead passed to the U.S.S.R. American standards in atlas and school-map production rose after the 1920s.

Other articles related to maps and mapping are referred to in the article GEOGRAPHY (ARTICLES ON). *See* ATLAS; CHART; GEODESY; NAVIGATION; PHOTOGRAMMETRY; SURVEYING; etc. *See* also references under "Map" in the Index. (J. K. W.)

BIBLIOGRAPHY.—*Techniques:* Few books in English deal comprehensively with modern techniques of map compilation, drafting and reproduction or with map design. The authoritative literature on the subject is mostly scattered in the technical publications issued by various government mapping agencies and in periodicals such as the *Geographical Journal* (Royal Geographical society, London), the *Geographical Review* (American Geographical society, New York), *Surveying and Mapping* (American Congress on Surveying and Mapping, Washington, D.C.), *Cartography* (the Australian Institute of Cartographers, Melbourne, Austr.). Most of the following books include extensive or specialized bibliographies and references: Arthur R. Hinks, *Map Projections* (1912; 2nd ed., 1921), *Maps and Survey*, 4th ed. (1942); H. S. L. Winterbotham, *A Key to Maps* (1936); Irving Fisher and O. M. Miller, *World Maps and Globes* (1944); Charles H. Deitz and Oscar S. Adams, *Elements of Map Projections*, 5th ed., Special Publication No. 68, U.S. Coast and Geodetic Survey (1945); W. Chamberlin, *The Round Earth on Flat Paper* (1947); Erwin Raisz, *General Cartography* (1938); T. W. Birch, *Maps, Topographical and Statistical* (1949); Arthur N. Strahler, *Physical Geography* (1951); Arthur H. Robinson, *The Look of Maps* (1952), *Elements of Cartography* (1953); J. A. Steers, *An Introduction to the Study of Map Projections*, 8th ed. (1950); M. Aurousseau, *The Rendering of Geographical Names* (1957); Eduard Imhof, *Gelände und Karte* (1950); François Reignier, *Les Systèmes de projection*, 2 vol. (1957). (O. M. M.)

History: G. R. Crone, *Maps and Their Makers* (1953) and the first four chapters of Erwin Raisz, *General Cartography* (1938), give concise, well-balanced general accounts of the history of cartography. Raisz's chronological charts are useful for quick reference, and his fourth chapter deals with American cartography. More elaborate are Leo Bagrow, *Die Geschichte der Kartographie* (1951), which deals with the development of mapping, especially as an art and craft, until the mid-18th century; R. V. Tooley, *Maps and Map-makers* (1949), essentially an annotated catalogue of maps dating mostly from the period 1475–1877; R. A. Skelton, *Decorative Printed Maps of the 15th to 18th Centuries* (1952) and *Explorers' Maps* (1958). Max Eckert's monumental *Die Kartenwissenschaft . . .*, 2 vol. (1921, 1925), is a store-

house of detailed information concerning the history of cartography arranged according to categories of maps.

All these works include bibliographical references. *Imago Mundi: A Periodical Review of Early Cartography* (1935–) contains articles and book reviews. For further bibliographical guidance *see* W. W. Ristow and Clara E. LeGear, *A Guide to Historical Cartography* (1954), the general cartographical periodical *Surveying and Mapping* (1941–), and current bibliography, *Bibliographie cartographique internationale* (1949–), as well as geographical periodicals and bibliographies, a fundamental source of data, since the history of cartography is inextricably interwoven with that of geography (*see* J. K. Wright and E. T. Platt, *Aids to Geographical Research,* 2nd rev. ed. (1947).

The history of cartography was in general neglected until the mid-19th century, when the first great collections of reproductions of early maps were published (M. F. de Santarem, *Atlas composé de mappemondes, de portulans . . . depuis le VIe jusqu'au XVIIe siècle,* 1842–53; E. F. Jomard, *Les monuments de la géographie . . . ,* 1842–62). These paved the way for a succession of similar works, of which four may be cited as representative examples, covering broad subjects with great erudition: A. E. Nordenskiöld, *Facsimile Atlas to the Early History of Cartography* (1889), *Periplus: An Essay on the Early History of Charts and Sailing Directions* (1897); Konrad Miller, *Mappaemundi: Die ältesten Weltkarten,* 6 vol. (1895–98), *Mappae arabicae,* 6 vol. (1926–31). Growing interest in the history of the geographical discovery, exploration and early surveying and mapping of particular parts of the world, especially the Americas but also notably Africa, central and northern Asia and the Pacific, inspired the publication of similar collections, together with commentaries and pertinent monographs and periodical articles (partially listed by Bagrow, *op. cit.,* pp. 378–383).

The 19th and 20th centuries have been given comparatively little attention in the study of the history of cartography. The characteristic plainness or austerity of most modern maps, together with their superabundance and the many complexities that are involved in studying them, have made them less appealing to scholars and collectors than the maps of earlier times have been. Three publications bearing on cartography in the modern period may be cited as representative: G. M. Wheeler, *Facts Concerning the Origin, Organization, Administration, Functions, History, and Progress, of the Principal Government Land and Marine Surveys of the World* (1885); Walter Thiele, *Official Map Publications* (1938); W. W. Ristow, *Aviation Cartography: A Historico-Bibliographic Study of Aeronautical Charts* (1956).

(J. K. W.)

MAPLE, the name of more than 150 species of trees and shrubs belonging to the genus *Acer* of the family Aceraceae *(q.v.).* Two unrelated species, *Flindersia brayleyana* and *Cryptocarya oblata,* are productive of timber known as Queensland maple and Macquarie maple, respectively.

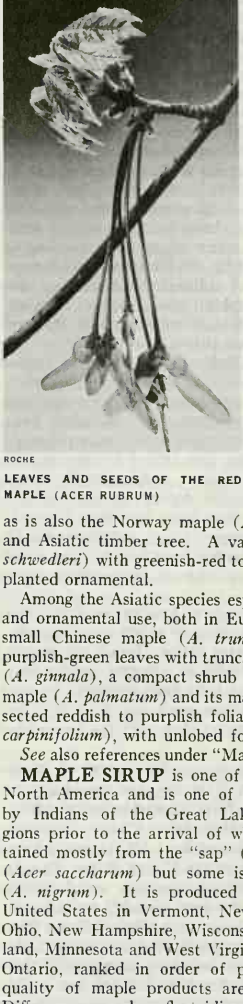
Maples feature opposite, deciduous (rarely persistent), mostly palmately lobed leaves. Their small (but en masse often showy) red, orange or greenish flowers appear before, with, or after leaf emergence. The two-winged samaralike fruits, sometimes referred to as keys, are also diagnostic. Several species are noted for their excellent timber; others are better known because of their ornamental use.

The North American flora includes the 13 native maples listed here and several introduced kinds. Big-leaf maple (*A. macrophyllum*), the only commercial western species, is the second most important hardwood in the Pacific northwest. Ranging from Alaska to southern California, it often attains a height of 100 ft. The wood is used for furniture and flooring; large burls occasionally found on old trees are sliced into fancy face veneers for decorative panels. A small, often prostrate or vinelike, understory tree, vine maple (*A. circinatum*) is the only other maple indigenous to the areas bordering the Pacific.

Box elder or ash-leaf maple (*A. negundo*), a small transcontinental tree that occurs sparingly in nearly every state, features three- to seven-pinnately compound leaves, a characteristic rare among maples. Big-tooth maple (*A. grandidentatum*) and Rocky Mountain maple (*A. glabrum*) are small, little known trees of the Rocky mountain region.

Eight eastern species are divided into the hard, soft and mountain maple groups. Hard maples include the sugar (*A. saccharum*), black (*A. nigrum*), Florida (*A. barbatum*) and chalk (*A. leucoderme*) maples. The latter two species are small southern trees of little commercial value. Sugar maple, an important timber and shade tree, and with black maple the principal source of maple sirup *(q.v.),* extends from Newfoundland to North Dakota and south to Georgia and Texas. Often 90 ft. tall, its hard, pinkish-white wood is fabricated into furniture, flooring, musical instruments, sporting goods and a host of other commodities. Timber with wavy or curly grain or bird's-eye figure is prized for cabinetry. Black maple, restricted to the northeast and lake states, produces timber of comparable quality.

The soft maples, red (*A. rubrum*) and silver (*A. saccharinum*), are medium-sized trees of wide distribution east of the Great Plains. The former, the leaves of which are silvery white below, grows very rapidly and is used as a street and shade tree. There are few trees more resplendent in flamboyant crimson autumn foliage than the red maple. While the wood of neither species is the mechanical equal of the hard maples, both are similarly used.



ROCHE

LEAVES AND SEEDS OF THE RED MAPLE (ACER RUBRUM)

Striped maple or moosewood (*A. pennsylvanicum*), featuring smooth greenish bark striped with white, and the shrubby mountain maple (*A. spicatum*), are two understory species of northern forests. Hedge maple (*A. campestre*), of northern Europe and western Asia, is the only maple indigenous to Great Britain. Seldom exceeding a height of 20 ft., it is easily identified by its small leaves with rounded lobes.

The handsome sycamore maple (*A. pseudoplatanus*), an important timber tree of central Europe and western Asia, is a commonly used ornamental in the United States and Great Britain, as is also the Norway maple (*A. platanoides*), a lofty European and Asiatic timber tree. A variety, the Schwedler maple (var. *schwedleri*) with greenish-red to reddish-bronze leaves, is a widely planted ornamental.

Among the Asiatic species especially well suited for decorative and ornamental use, both in Europe and North America, are the small Chinese maple (*A. truncatum*), featuring deeply lobed, purplish-green leaves with truncate bases; dwarf or Siberian maple (*A. ginnala*), a compact shrub with three-lobed leaves; Japanese maple (*A. palmatum*) and its many varieties, featuring deeply dissected reddish to purplish foliage; and the hornbeam maple (*A. carpinifolium*), with unlobed foliage similar to the hornbeams.

See also references under "Maple" in the Index. (E. S. Hr.)

MAPLE SIRUP is one of the few crops produced solely in North America and is one of the oldest, having been produced by Indians of the Great Lakes and St. Lawrence river regions prior to the arrival of white settlers. Maple sirup is obtained mostly from the "sap" (sweet water) of the sugar maple (*Acer saccharum*) but some is obtained from the black maple (*A. nigrum*). It is produced in commercial quantities in the United States in Vermont, New York, Pennsylvania, Michigan, Ohio, New Hampshire, Wisconsin, Massachusetts, Maine, Maryland, Minnesota and West Virginia, and in Canada in Quebec and Ontario, ranked in order of production. The same type and quality of maple products are produced throughout the area. Differences merely reflect idiosyncrasies of producers and equipment.

The production of maple sirup is subject to yearly climatic and economic fluctuations. A record crop was produced in 1860 and a very small crop in 1959. The sweet water "sap" of the maple tree from which sirup is made is different from the circulatory sap of the growing tree. When the tree is dormant the sap will flow from any wound, such as a tap hole, in the sapwood each time a period of freezing is followed by a period of thawing. The sap contains 1½% to 3% solids, mostly sucrose. It does not contain either the colour or the flavour of maple sirup. These are imparted to it as the sap is concentrated by evaporation in open

pans to 65.5° Brix. Thirty to fifty gallons of sap are required to yield one gallon of sirup.

The usual maple sirup season begins in mid-January in the more southern states and ends in mid-April in the northern states, lasting four to six weeks in each place. Until the late 1940s the method of making maple sirup had remained almost unchanged over the more than 300 years of its history, with the exception of the development of the flue evaporator. During the next 10 years modernization began. The equipment for drilling tap holes was mechanized, sanitary methods of sap handling effected, precision instruments for sirup making developed, plastic tubing adapted for the transportation of sap from the tap holes of entire sugar bushes to storage tanks, and central evaporator plants established which serve whole communities of sap producers. These modernized methods improved and standardized maple products. The major products of maple sap are pure and blended table sirups, confections (cream, hard and soft candies), toppings for ice cream, flavourings and casing for cigarette tobaccos. (C. O. W.)

MAPLEWOOD: *see* SAINT LOUIS (MO.).

MAQDISI (MUQADDASI), **AL-** (MOHAMMED IBN AHMAD AL-MAQDISI; *i.e.*, "the Jerusalemite") (*c.* 946–*c.* 1000), Arab traveler and geographer, author of a noted work in Arabic on the lands of Islam entitled in one manuscript *Kitab al-Aqalim* ("The Book of Countries"), though another manuscript has a longer title. This work, published in 985 and based mainly on his personal observations during 20 years of travel (in the course of which he visited all the Muslim lands except Spain, Seistan and Sind), is a mine of detailed information on the populations, manners and economic life of these lands in the 10th century.

See *Bibliotheca Geographorum arabicorum*, ed. by M. J. de Goeje, vol. iii (1877; rev. 1906). *See* also introduction to vol. iv of the same work for a discussion by M. J. de Goeje of al-Muqaddasi and his work. (H. A. R. G.)

MAR, EARLS OF. The Scottish earls of Mar emerge during the 12th century as successors of the Pictish rulers of Mar, one of the ancient provincial kingdoms of Scotland (comprising part of modern Aberdeenshire). The first earls were shadowy figures whose existence is known chiefly from their witnessing charters. Donald McEnhim was Mormaer of Mar by 1014 and the position apparently came to him through a female line since he was "of the race" of clan Leod. Earl GRATNEY (fl. *c.* 1300) married Christian, sister of Robert I, the Bruce, and their son DONALD (d. 1332) was a supporter of Edward II of England and was regent of Scotland shortly before he was slain at the battle of Dupplin on Aug. 12, 1332. His daughter MARGARET (d. *c.* 1393) brought the earldom to her husband, Sir William (later Earl of) Douglas, and on the succession of their daughter ISABELLA (*c.* 1360–1408) troubles followed. While she was living at Kildrummy castle it was stormed by SIR ALEXANDER STEWART, to whom she was ultimately married and to whom (under duress) she granted the earldom in 1404. His claim to the earldom was confirmed by the crown in 1405 and (in a new grant) by James I in 1426, whereafter, as part of James's policy, it was deemed to have lapsed. It was annexed to the crown in 1435 and became the subject of rival claims until 1565. During this period the Erskine family made repeated claims on the lands and title of the earldom. Sir Robert Erskine (d. *c.* 1451), who became Lord Erskine in 1438, was styling himself earl of Mar by 1439. When, therefore, JOHN ERSKINE (d. 1572; *see* MAR, JOHN ERSKINE, 1st earl of), was made earl of Mar in 1565, there was much subsequent doubt whether this was a creation or a restoration, and it appears that (looking to the long disputes) he was invested in both the ancient and a new dignity. His successor JOHN (*c.* 1558–1634; *see* MAR, JOHN ERSKINE, 2nd earl of), 2nd earl, was a prominent politician. The title was forfeit when JOHN (1675–1732; *see* MAR, JOHN ERSKINE, 6th earl of), 6th earl, was attainted in 1716. The title was restored in 1824 for his grandson, JOHN (1741–1825), who became 7th earl of this line. His grandson, JOHN FRANCIS MILLER (1795–1866), 9th earl, also inherited the earldom of Kellie in 1835 and at his death in 1866 the Mar title was again subject to rival claims.

The earldom of Kellie and barony of Erskine descended to the 9th earl's cousin and heir-male, WALTER CONINGSBY (d. 1872), whose son, WALTER (1839–88), 13th earl of Kellie, had his claim to be 11th earl of Mar (enumerated from the 1565 creation) upheld by the house of lords in 1875. The title was also contested by the 9th earl's nephew and heir-general, JOHN FRANCIS ERSKINE GOODEVE (1836–1930), who assumed the additional surname of Erskine and who was confirmed as earl of Mar (enumerated as 27th from the ancient earls of Mar) by a statute in 1885.

JOHN FRANCIS HERVEY ERSKINE (1921–) succeeded in 1955 as 13th earl of Mar and 15th earl of Kellie, while LIONEL (1891–) 29th earl of Mar, succeeded to the ancient title in 1932. (T. I.)

MAR, JOHN ERSKINE, 1ST EARL OF (d. 1572), regent of Scotland, was a son of John, 5th Lord Erskine, who was guardian of James V, and afterward of Mary Stuart. Erskine at various periods held the keeperships of Edinburgh and Stirling castles, which were semihereditary offices in his family. During the struggle between the regent, Mary of Lorraine, and the lords of the Congregation, he acted consistently in the interests of peace; and in the religious disputes of the time he was a moderate member of the reforming party. When Mary Stuart returned to Scotland in 1561, he was made a privy councilor and favoured her marriage to Lord Darnley. Erskine was granted the earldom of Mar in 1565, thus substantiating the claims of his ancestors. With his wife, Annabella Murray, he acted as guardian of the young prince James, later James VI, who lived much of the time at Stirling castle. Mar prevented the prince from falling into the hands of the earl of Bothwell, and was a leader of the group of nobles who rose against Mary and Bothwell in 1567. He took part in the government during Mary's imprisonment at Lochleven and also after her abdication. He was chosen regent of Scotland in 1571 but his regency was not notably active and he was overshadowed by the earl of Morton. He was respected throughout his life as a man of principle, tending to follow a middle way in politics. Mar died at Stirling on Oct. 29, 1572. (GR. G. S.)

MAR, JOHN ERSKINE, 2ND EARL OF (*c.* 1558–1634), Scottish politician and friend of James VI, was the only son of John, 1st earl, and was brought up at Stirling castle with the young James VI whose guardian he later became. Mar was concerned in the seizure of James VI at the "raid of Ruthven" (1582) and had to flee to England where he had the support of Elizabeth I, while the earl of Arran dominated Scottish politics. He was restored to favour in 1585 after marching on Stirling castle. He remained on terms of personal friendship with the king who in 1594 entrusted his eldest son, Prince Henry, to the guardianship of Mar and the dowager countess of Mar. In 1601 the earl was sent as envoy to London and conducted a mission which resulted in Elizabeth's assurance that James should be her successor.

After James's accession to the English throne in 1603, Mar was made a privy councilor and was one of the channels whereby James governed Scotland, as he said, by the pen. Mar was a member of the Scottish court of high commission and was treasurer of Scotland from 1616 to 1630, displaying energy in administering the country's scanty financial resources. He was also involved in many legal actions to recover his family heritage, lost when doubts existed about the state of the earldom of Mar (*see* MAR, EARLS OF). Mar died at Stirling on Dec. 14, 1634. (GR. G. S.)

MAR, JOHN ERSKINE, 6TH EARL OF (1675–1732), foremost Scottish Jacobite leader in the 1715 rebellion, was the eldest son of Charles (1650–89), 5th earl. Initially a supporter of William III, he was secretary of state for Scotland and keeper of the signet under Queen Anne, playing a large part in the management of Scotland. He helped to carry the Act of Union of 1707, although he was so disappointed by its results that in 1713 he supported a motion for its repeal. Throughout, however, Mar's principal consideration was personal gain and because of his inconsistency he was known as "Bobbing John." It was dismissal from office on George I's accession in 1714 that gave birth to Mar's Jacobitism. In Aug. 1715 he secretly traveled to Scotland, and on Aug. 27 he held a hunting party at his seat at Aboyne where the plans for a rising were discussed. The government had neglected security arrangements in Scotland and Mar and his new associates

started with great initial advantages. Shortly after proclaiming King James at Braemar on Sept. 6, Mar had a force composed of Highlanders and northeast lowland Episcopalians which outnumbered the small government army of 1,500 in Scotland. These advantages were thrown away by Mar's ineptitude. He occupied Perth on Sept. 28, but wasted time when he ought to have crossed the Forth river immediately, to join up with the lowland Jacobites under Lord Kenmure (*q.v.*). John Campbell, 2nd duke of Argyll, who commanded for the government in Scotland, was a soldier of genius. He occupied the key point, Stirling, and refused to be drawn from it. Mar showed no initiative and when he did finally make an effort to get south of the Forth it was only to be checked by Argyll's inferior force at Sheriffmuir (Nov. 13). In spite of the belated presence of the Pretender the rebellion thereafter collapsed and in Feb. 1716 Mar fled with James to France. He was high in the Pretender's councils for some years and was in 1722 confirmed by him as titular duke of Mar. But the inveterate treachery of Mar's character cost him the favour of James and from 1725 until his death at Aix-la-Chapelle in May 1732, Mar had no connection with the exiled court.

Mar was attainted and his estate and title forfeited in 1716. Parts of the estate were salvaged by his family but the title was not restored until 1824; thereafter it was the subject of much dispute concerning its destination.

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MAR, SERRA DO, the name given to the Great Escarpment on the eastern margin of the Brazilian highlands. The escarpment extends all the way from Rio Grande do Sul to southern Bahia, but it is known as the Serra do Mar only in the middle section in Rio de Janeiro and São Paulo. Because of its name ("mountains of the sea") many map makers show this as a range of mountains rather than an escarpment on the edge of a plateau. The escarpment stands between 2,600 and 3,000 ft. above sea level at its top, but in Rio de Janeiro state it is surmounted by the Serra dos Orgãos (7,365 ft.) which overlooks Guanabara bay at Rio de Janeiro. The escarpment was originally covered with a dense rain forest. (P. E. J.)

MARABOUT (for classical Arabic *murabit*), originally, in the Maghreb (north Africa), a member of a religious community living in a *ribat* (a fortified Muslim monastery), an institution both religious and military. The building of a *ribat* was a state concern and service in it came within the scope of *jihad* (holy war). In the early days of Islam in the Maghreb, the marabouts, particularly at the *ribats* of Monastir and Sousse (both in modern Tunisia), performed a dual function, part defensive and part cultural. Men who possessed certain religious qualifications (such as reciters of the Koran, transmitters of the traditions of the Prophet's sayings and life, jurists of Islamic law and ascetics) lived in the *ribat* and were held in honour by the common people. When in the 12th century Islam spread to west Africa, its propagators became known as *al-murabitun* ("the people of the *ribat*," Almoravids; *q.v.*). From that day every missionary who organized a group of disciples became known as a *murabit*, the word coming more and more to denote "guidance" and losing its connotation of military defense. In the 14th century, when Sufism pervaded Muslim religious life, the *ribat* became a Sufi institution, often called a *zawiya*, and the *murabit* in the Maghreb came to be any preacher calling for the formation of Sufi confraternities according to the "order" (*tariqa*) of Abu Madyan. Thus the word *murabit* lost all trace of its original literal meaning of military defense and the *murabit* began to affix to his name the word "sidi" (the Maghrebi version of the classical Arabic *sayyidi*) meaning "my lord," or the word "moulay" or "mulay" ("my master"). A *ribat* came to be called after its leading *murabit*, who was often buried in the place. Thus, particularly in Algeria, marabout came to be used for the *ribat* or *zawiya* in which a pious religious man is buried. (F. B. A.)

MARACAIBO, second largest city in Venezuela, the country's most important seaport and capital of the state of Zulia, is situated in the northwestern corner of the country on the west shore of the channel connecting Lake Maracaibo with the Gulf of Venezuela. Pop. (1961) 432,902. The city was a primitive coffee-exporting port of 40,000, mostly Indians and Negroes, until petroleum was discovered in 1917. Within a decade Maracaibo became the country's oil metropolis, with paved streets, modern public services, tall office buildings, golf clubs, air-conditioned hotels, supermarkets and very substantial dwellings. Its population more than doubled during the 1920s, in spite of the climate. The city is located in a basin surrounded by higher land which prevents the steady trade winds from relieving the oppressive humidity. The annual average temperature is 28° C. (82° F.), ranging from an average of 27° (80°) in January to an average of 29° (84°) in August. The oil companies set up headquarters there, the government erected new buildings and the city installed electricity. Attractive modern suburbs reached out in all directions. Commerce thrived but living costs doubled.

Because of its strategic location near the outlet of the lake, Maracaibo has long been important as a trading centre although the channel connecting the lake with the Caribbean was too shallow to permit the passage of large ocean freighters and tankers. A major dredging operation completed in 1957 (*see* MARACAIBO, LAKE) provided a major stimulus to the economy of all of northwestern Venezuela and quickened the entire maritime life of the city.

In addition to being one of the most important petroleum-exporting ports in the world, the city exports cacao, coffee, hides, fruits, vegetable oil and timber. It imports manufactured products of all kinds and considerable food. It also serves as the transshipment point for nearly all the trade for northwestern Venezuela.

Maracaibo's oil industry is the result of foreign enterprise. Powerful oil groups own all the major concessions. Billions of dollars of American, British and Dutch capital have been invested, but in 1956 Venezuelan capital, in alliance with foreigners, entered the industry. (L. WE.)

Maracaibo's wealth dates from the 20th century but its history goes back to the age of exploration. It was founded in 1571 by Alonso Pacheco, who gave it the name of Nueva Zamora. The shipment point for the inland settlements was originally a station named Gibraltar at the head of the lake, but its destruction by pirates in 1669 transferred this trade to Maracaibo. The city did not figure actively in the war for independence until Jan. 28, 1821, when the province declared its independence and alliance with Colombia. This ended the armistice between Simón Bolívar and Pablo Morillo and thereafter the city experienced the changing fortunes of war until its final capture by the revolutionists in 1823. In the years of destructive civil war, Maracaibo was usually much less involved than eastern and central Venezuela.

MARACAIBO, LAKE (LAGO DE MARACAIBO), a large lake in the northwestern corner of Venezuela, lies in the Maracaibo lowland immediately to the east of the Sierra de Perijá. It extends southward from the Gulf of Venezuela, into which it opens through a long neck. Roughly shaped like an oil drop hanging from a spout, the lake is 133 mi. long and 72 mi. wide and covers an area of about 5,000 sq.mi. In the southern portion the lake water is fresh but in the northern portion, where the tidal influence is stronger, it is somewhat brackish.

Lake Maracaibo receives the waters of many rivers, principally from the west and south sides. The heavy rainfall on the eastern slopes of the Eastern Cordillera (more than 86 in. annually) is responsible for the great volume of water discharged into the lake. The average annual precipitation over the entire basin is about 70 in. The area around the lake is hot and humid and its average temperature is reported to be the highest in South America.

Lake Maracaibo is the centre of the petroleum industry of Venezuela and of Latin America. About 90% of the oil produced is exported, but until 1957 the northern outlet of the lake was obstructed by a very large sand bar which allowed only shallow-draft (17,000 ton) tankers to enter and leave the lake. In that year, after many months of dredging and at a cost of $48,000,000, a new channel 35 ft. deep and 21 mi. long was opened. Now fully

loaded 33,000-ton tankers are able to leave the lake.

The Lake Maracaibo basin (including the lake and adjacent land area) is one of the world's richest and best located oil-producing areas. Particularly outstanding are the 65 mi. along the east shore and the 15 mi. out into the lake. Thousands of derricks protrude from the water and thousands more line the shore. Underwater pipelines transport the oil to storage tanks on the land. Well over one-third of Venezuela's total oil production comes from Lake Maracaibo. As oil contributes over 90% of the country's foreign exchange and many national revenues, the economic importance of Lake Maracaibo is considerable.

Much natural gas (wet gas) is obtained with the oil. For many years billions of cubic feet of this fuel were flared off, since there was no appreciable market. In the middle 1950s a petroleum corporation installed three plants several miles offshore for reinjecting gas into the oil-bearing formation with the purpose of recovering more oil and of conserving gas for potential future use. Enough pressure is put on the oil in the deposit to increase immediate production by 50% and ultimate recovery by 30%. One of these plants injects 300,000,000 cu.ft. of gas per day into the reservoir it serves.

Until 1918 Lake Maracaibo basin was one of the poorest and least important areas in the country. The people made a miserable living ignorant of the potential wealth at their feet. The oil industry there is the result of foreign (chiefly American, British and Dutch) enterprise, technological skills and capital. In the early 1960s less than 5% of the total production came from Venezuela-owned wells. (L. We.)

MARACAY, capital of Aragua state in Venezuela. Pop. (1961) 134,123. A handsome city, it lies about 76 mi. W. of Caracas in the central highlands at an elevation of 1,500 ft. It was but a sleepy town until the dictator Juan Vicente Gómez transferred his centre of activities there from Caracas. During his long dictatorship (1908–35) he built up Maracay until it became the actual if not the nominal capital of the country. The city is situated in excellent cattle country; by gaining possession of these pastures, Gómez virtually cornered the entire Venezuela cattle industry. He built a modern dairy plant and slaughter-house at Maracay, and then supplied the urban market in Caracas with the products of these enterprises.

Determined to make the city the cultural and social centre of the nation, Gómez constructed the Hotel Jardín, with its Moorish arcades, second-story balconies, gracious patio and beautiful park and fountain; an opera house (never completed); a bull ring (an exact replica of the one in Seville); and military airports. The current importance of the city lies in its military training institutions and its school of agriculture and experiment station. (L. We.)

MARAGHEH (Maragha), the chief town of a *shahrestan* (district) in East Azerbaijan *ostan*, Iran, on the southern slopes of Kuh-e Sahand (12,138 ft.), south of Tabriz. The town is pleasantly situated in a well-watered valley, opening toward a richly cultivated plain which merges into the salty southeastern shores of Lake Rezaiyeh (Urmia). The population, mainly of Azeri Turkish stock, was 36,556 in 1956. Since 1958 Maragheh has been connected by railway with Tabriz and Teheran, and by metaled roads with Tabriz and southward with Mahabad and Kermanshah. It is the moderately prosperous centre of a large fruit-growing district, and its exports are mainly dried fruits. Modern development has been slow.

Once a Persian-speaking city, Maragheh played a prominent role under several Turkish princes in the middle ages. Its zenith was reached during the reign of the first Ilkhan, the Mongol Hulagu (1256–65), who made it his capital. The two stone bridges crossing the Safi Chai are ascribed to him. Five tomb towers dating from the 12th to 14th centuries are the most notable monuments. The earliest, Gunbad-i-Surkh (1147), is one of the finest examples of brickwork in Iran. On a hill west of the town are traces of the famous observatory constructed in 1259 for the great astronomer Nasr-ud-Din of Tus (Nasir al-Din al Tusi). The stone, which is known throughout Iran as Maragheh marble, is a travertine of yellow, pink, greenish or milkwhite colour streaked with red and green veins, which hardens after being worked. It is mainly quarried at Azar Shahr (formerly Dashkesan), 30 mi. N.W. of Maragheh. (H. Bo.)

MARAIS, MARIN (1656–1728), French composer and virtuoso viola da gamba player, was born in Paris on March 31, 1656. He was a choirboy in the Sainte-Chapelle in Paris and studied the viola da gamba under Hautmann and Sainte-Colombe. From 1685 onward he played in the royal orchestra and shared with Pascal Colasse the direction of the orchestra of the Académie Royale de Musique, where he studied for a short time with J. B. Lully. In 1686 Marais published his first book of pieces for two viols, and in 1693 brought out his setting of *Alcide*, in which he collaborated with Louis de Lully. His other operas were *Ariane et Bacchus* (1696), *Alcyone* (1706) and *Sémélé* (1709), but of these only *Alcyone* was really successful, although the others contain much good music. Meanwhile Marais produced several more books of *Pièces de Violes* (1701, 1711, 1717, 1725), in which genre he was the acknowledged master. He retired in 1725 but continued to give a few lessons. He died in Paris, Aug. 15, 1728. His family continued to publish music and instruction books for the viola da gamba. (Cs. Ch.)

MARAJÓ, an island at the mouth of the Amazon river in Brazil, 183 mi. long and 124 mi. wide; area 15,444 sq.mi. The main flow of the Amazon passes to the north of Marajó, but numerous *furos* or narrow passages direct part of the water into the Pará river, an estuary that separates the island from the mainland to the south. The densely forested western half of the island is part of the overflow land (*várzea*) of the Amazon, but the slightly higher eastern half, underlain by sandstone, has extensive areas of treeless savannas (*campos*), which support large herds of cattle. Numerous archaeological mounds in the northeastern part of the island are rich in well-made pottery vessels and other objects that suggest an affinity with pre-Columbian Andean cultures. Soure, a modern town and beach resort on the Atlantic coast, is linked to Belém by overnight ferry service. (Js. J. P.)

MARANHÃO, a northern state of Brazil, bounded north by the Atlantic, east and southeast by Piauí, southwest and west by Goiás and Pará. Area 126,897 sq.mi. Pop. (1960) 2,492,139. The coastal zone and the northwest corner of the state belong to the Amazon valley region, being a heavily forested plain traversed by numerous rivers. The eastern and southern parts, however, belong to the lower terraces of the great Brazilian plateau, broken by eroded river courses between which are high open plains. There are no true mountain ranges in Maranhão, those indicated on the maps being only plateau escarpments marking either its northern margin or the outlines of river valleys. The climate is hot, and the year is divided into wet and dry seasons, though no part of the year is rainless. Extreme humidity is characteristic of the wet season. The heat, however, is greatly modified on the coast by the southeast trade winds.

The coast itself is broken and dangerous, there being many small indentations, which are usually masked by islands or shoals. The largest of these are the Bay of Turiaçu, facing which are the island of Tocansa and several others of small size, and the contiguous bays of São Marcos and São José, between which is the large island of São Luís, the site of the city of São Luís. The rivers of the state all flow northward to the Atlantic, and a majority of them have navigable channels. The Parnaíba forms the eastern boundary while the Tocantins and the Gurupí bound the state on the west.

The principal industries of Maranhão are agricultural, the highly fertile river valleys and coastal zone being devoted to the cultivation of sugar cane, cotton, rice, coffee, tobacco, *manioc* (cassava) and a great variety of fruits. Babassu nuts are an important export. The southern highlands are devoted to cattle raising. Phosphatic bauxite deposits that occur on Turiaçu Island at the mouth of the Maracaçumé river are undeveloped. In 1956 oil was discovered at Balsas, deep in the interior near the Goiás border. A railway, 250 mi. long, crosses the eastern part of the state connecting São Luís on the coast with Teresina, the capital of Piauí.

The capital is São Luís, pop. (1960) 124,606; other principal

towns, with their population in 1960, are: Caxias (19,092); Pedreiras (10,189); Rosário (6,999); and Viana (5,385).

The coast of Maranhão was first discovered by Vicente Yáñez Pinzón in 1500, but it was included in the Portuguese grant of captaincies in 1534. The first European settlement was made by a French trading expedition under Jacques Riffault of Dieppe in 1594, who left a part of his men there when he returned home. Subsequently Daniel de la Rivardière, commissioned by the French crown, founded a colony on São Luís Island in 1612. The French were expelled by the Portuguese in 1615 and the Dutch held the island from 1641 to 1644.

In 1621 Ceará, Maranhão and Pará were united and called the Estado do Maranhão, which was made independent of the southern captaincies. Ceará was later detached, but the state of Maranhão remained independent until 1774, when it became subject to the colonial administration of Brazil. Maranhão did not join in the declaration of independence of 1822, but in 1823 the Portuguese were driven out by Admiral Lord Cochrane and the province became a part of the empire of Brazil. (Js. J. P.)

MARAÑÓN, a river of northeast Peru, rising in Lake Lauricocha in the southwest of Huánuco department, just north of Cerro de Pasco, about 100 mi. from the Pacific ocean. It flows 350 mi. northwest between mountain ranges before descending eastward to enter the Amazon basin.

The Marañón, together with the Ucayali (*q.v.*) and Huallaga rivers which join it downstream, is one of the principal affluents of the Amazon (*q.v.*). From its source, a series of unnavigable rapids characterize the Marañón for a distance of 350 mi.; it drops from a height of 12,000 ft. in the Andes to 575 ft. above sea level at Pongo de Manseriche. Navigation is only possible below Manseriche. The Marañón is navigable to Limón, a distance of 484 mi. (during both high and low water), for steamers of 4- to 8-ft. draft. From Limón to Manseriche, a distance of 74 mi., it is navigable by vessels of 2- to 4-ft. draft at any season.

The Marañón flows through a forested, sparsely inhabited region. Climatic conditions vary from a mountain climate in the upper extension of the river to rainy tropical in the Amazon basin. (J. L. Tr.)

MARANTACEAE, the arrowroot family of monocotyledonous perennials, all tropical and mainly American. The West Indian *Maranta arundinacea* is the source of arrowroot (*q.v.*). Various species of *Maranta* and *Calathea* are cultivated for their ornamental foliage as house plants. *Thalia* species, cannalike swamp plants, occur in the warmer parts of the world.

MARA REGION, TANGANYIKA, established in May 1963 following a reorganization of administrative units in Tanganyika, comprises North Mara, Musoma and Ukerewe mainland districts, formerly part of Lake region. Area 11,000 sq.mi. (including 3,000 sq.mi. of water); pop. (1957) 347,587. It is bounded north by Kenya, west by Lake Victoria, southwest by Mwanza region, south by Shinyanga region and east by Northern (Arusha) region.

The gently undulating landscape of peneplained granites and volcanic rocks, overlain in parts by volcanic ash and Recent sediments, is broken by hills of banded ironstone and granite tors, and rises eastward from lake level at 3,720 ft. to 5,000–6,000 ft. The Mara, Grummetti and other rivers drain to Lake Victoria, where the drowned shore line is sinuous. Rain, falling mainly November–December and March–May, increases from 20–30 in. in the southeast to 40–50 in. in the lake basin, although the weather is somewhat drier along the lake shores where storms tend to drift westward with the prevailing wind. Soils vary with topography, but are mostly derived from granite. Wooded grassland with acacia is characteristic.

The regional headquarters is at Musoma. The population is dense near the lake, where cotton is grown together with maize (corn), millet, peanuts, rice and sesame. Farther east the population is sparse. The main tribes are the Sita, Kuria, Luo, Kwaya and Zanaki. Pastoralism is everywhere important, despite the prevalence of the tsetse fly, and there is fishing from the lake shores. Part of the region lies within the Serengeti national park where a great wealth of wild life is a tourist attraction. There are gold mines in North Mara and in Musoma, where the Kiabakari mine is the largest producer in Tanganyika. Lake steamers call at Musoma, which is connected by road with Kenya and central Tanganyika through Mwanza, and by air with Nairobi and Mwanza. (J. M. Ke.)

MARAS (Marash), a city of Turkey and capital of a mountainous *il* (province) of the same name, is situated east of the Ceyhan Nehri (ancient Pyramus river), on the edge of a fertile plain below Ahir Dagi in the Taurus mountains, 80 mi. N.N.E. of Iskenderun. Population, 54,447 in 1960, is heavily Armenian.

The city, on the Cilicia-Kurdistan railway line and near the southern outlets of three important mountain passes (from Göksun, Elbistan and Malatya), is a centre of light industry and commerce. An old Seljuk castle towers above the town, which has several mosques, churches and schools, including an American mission and college. During most of the year the climate is temperate.

Maras was one of the post-Imperial Hittite city-states during the early 1st millennium B.C., known as Marqasi (Markasi) to the conquering Assyrians. A variety of sculptured monuments of that period, including a gate lion inscribed with Hittite hieroglyphs, have been discovered. In Roman times it reappears as Germanicia Caesarea (later Germanicia Marasion, or on coins Caesarea Germanice) of the region then known as Commagene (hence the Armenian name Kermanig). It was conquered by Muslims before 700 A.D., and was subsequently rebuilt by the Khalif Mu'awiya. It figured in the struggles with the Byzantines; after 770, however, it remained in the hands of Harun al-Rashid (*c.* 800), who strengthened its fortifications. The crusaders captured it in 1097 during their march on Antioch, and the Seljuks took it in 1147. During the 16th century it became part of the Ottoman empire.

Maras Il (area 5,634 sq.mi.) had a population of 389,857 in 1960. It is drained by the Ceyhan Nehri. There are rich mineral deposits (iron, silver) near Maras city, and wheat, rice and legumes are grown in the fertile areas. (J. Pl.)

MARAT, JEAN PAUL (1743–1793), one of the most virulent journalists of the French Revolution and a leader of the extremists in the Convention, was born at Boudry, in the principality of Neuchâtel, Switz., on May 24, 1743, the son of a Sardinian father and a Swiss mother. After studying medicine in Bordeaux and Paris, he became a physician in London and received an honorary degree of doctor of medicine from the University of St. Andrews in 1775. He published several tracts on philosophical and scientific subjects and one on politics. After returning to France he held the post of physician to the bodyguard of the comte d'Artois (later Charles X of France) from 1777 to 1783, combining with it a lucrative private practice of medicine. He continued to publish scientific and philosophical works that won some recognition, but he failed to secure election to membership in the Académie des Sciences, which he most desired.

At the beginning of the French Revolution in 1789, Marat became a political journalist. After issuing some tracts favouring the Revolution, he began to publish, on Sept. 12, a daily paper which, from Sept. 16, carried the name *Ami du Peuple*. Assuming the role of friend of the people, the guardian of their interests and the denouncer of their enemies, Marat at first expressed confidence that the Revolution could be achieved by the cooperation of Louis XVI and the National Assembly. By early October, however, he was berating the municipality of Paris and certain deputies and ministers at Versailles; on Oct. 8 he was condemned by the Paris court of the Châtelet for abetting the attack on Versailles of Oct. 5–6. He then went into hiding for a time, but soon resumed publication. Because of his virulence the Châtelet ordered his arrest in Jan. 1790, but he escaped and fled to England.

Returning in April 1790, Marat directed his invective against almost every conspicuous person. His appeal was no longer to the middle class, but to the workers and the poor, whom he called upon to form popular clubs to direct the Revolution. Suspecting counterrevolutionary activities in many places, he grew more and more immoderate. By midsummer 1790 other journalists

were following his lead, and together they made a formidable attack on the advocates of moderation. Marat gradually won the confidence of many of the lower classes as their political self-consciousness awakened, in no small measure because of his dramatic tirades against "suspects." His pamphlet, *C'en est fait de nous* (July 26, 1790) called for violence: "Five to six hundred heads cut off would have assured your repose, freedom, and happiness. A false humanity has held your arms and suspended your blows. It will cost the lives of millions of your brothers . . . . The National Assembly will do nothing more for the people's welfare." This diatribe brought an indictment from the National Assembly, but Marat, in hiding, continued to publish his journal. After the royal family's flight from the capital (June 20, 1791), he urged the people to elect a temporary dictator, apparently meaning himself, to rid them of their enemies, and he demanded the execution of Louis XVI. When the National Assembly took no such action, Marat dubbed many of its deputies "traitors," but soon found his own position so precarious that he again fled from Paris. As a candidate for the Legislative Assembly in Sept. 1791, he received only two votes, and in December he retired to England. Even so his journal's reputation was so great that during his absence several papers appeared purporting to be his *Ami du Peuple*.

In the spring of 1792 Marat returned to Paris and began once more to publish his paper. His opposition to the declaration of war against Austria brought an indictment against him on May 3, but he went into hiding again and managed to continue publication. His frequent hiding was rapidly undermining his health. By midsummer, suspecting the authorities and the generals on the frontier of treason, he urged the Parisians to rise, to secure the royal family as hostages, to place the deputies under surveillance and to substitute patriots for the treacherous generals. His appeals probably contributed to the insurrection of Aug. 10, which led to the suspension of the monarchy. After this revolution, Marat came out of hiding. The military disasters of August led him to write: "Rise and let the blood of traitors flow again. It is the only means of saving the *patrie*." On Sept. 2, when the Paris populace began the lynchings known as the September massacres, he joined the Paris committee of police and surveillance; and on the following day he approved the massacres. He continued his journal and was elected to the Convention as a deputy for Paris (Sept. 9).

Though previously he had not advocated a republican form of government, Marat accepted the republic decreed on Sept. 22, 1792; and on Sept. 25 he changed the name of his paper to *Journal de la République française*. He conceived of the Revolution as a movement for the welfare of the lower classes, though he had little faith in the ability of the people to govern themselves and often urged them to choose a dictator. Since king, clergy and nobles seemed to have been vanquished, the enemies of the people were now the rich, whose property must be shared with the poor. Marat demanded the trial of Louis XVI by the Convention and voted for his execution (Jan. 1793). He also favoured the establishment of the Revolutionary tribunal and of the committee of public safety, which eventually became the instruments of the Terror. Since the Girondins (*q.v.*) disagreed with him, Marat launched a vitriolic attack on them in his journal and found himself a target for their denunciation in the Convention. In the Paris club of the Jacobins, of which he was then president, he accused the Girondins of complicity with General Dumouriez on the latter's desertion to the Austrians. The Convention, under Girondin leadership, passed a decree (April 14), indicting Marat for preaching pillage and murder, for attempting to destroy the sovereignty of the people and for urging the dissolution of the Convention. Marat's acquittal by the Revolutionary tribunal (April 24) was a serious blow to the Girondins; and on June 2 the Convention, now dominated by him, ordered the arrest of the Girondin leaders.

By this time, Marat was too ill to profit from his triumph. As early as 1788 he had contracted a skin disease, which had been aggravated by living in underground hiding places; and now his lungs were infected as well. He could find relief from pain only by warm baths. The rebellions encouraged by the Girondins in the provinces called forth his demands for ruthless suppression. On July 13, 1793, a young follower of the Girondins from Normandy, Charlotte Corday (*q.v.*), gained entrance to Marat's apartment and stabbed him to death in his bath. (*See* also FRANCE: *History: September Massacres;* FRENCH REVOLUTION.)

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MARATHA (MAHRATTA, MAHRATTI), a major people of India, famed in history as yeoman warriors and champions of Hinduism. Their homeland is Maharashtra (*q.v.*), the Marathi-speaking region of peninsular India, which extends from Goa, Bombay city and Thana district on the Arabian sea eastward for 800 mi. to a point about 100 mi. east of Nagpur.

The term Maratha is used in three overlapping senses: within the Marathi-speaking region it refers to the single dominant Maratha caste or to the group of Maratha and Kunbi castes, which included between 7,000,000 and 9,000,000 persons in the 1960s (*see* MAHAR); outside Maharashtra, the term often loosely designates the entire regional population speaking the Marathi (*q.v.*) language, numbering more than 27,000,000; used historically, the term denotes the regional kingdom founded by the Maratha leader Sivaji in the 17th century and expanded to the status of an empire by his successors of many castes in the 18th century.

The Maratha caste, or group of castes, is a largely rural class of peasant cultivators, landowners and soldiers. Some Marathas and Kunbis have at times claimed Kshatriya (*q.v.*) standing, and supported their claims to this rank by reference to clan names and genealogies linking themselves with epic heroes, Rajput clans of the north, or historic dynasties of the early medieval period (*see* CASTE [INDIAN]). Beginning in the 1920s and led by the Chhatrapati maharaja of Kolhapur, many Marathas evidenced a new interest in education, put on the sacred thread of the twice-born Hindu castes, and declared that they would continue to employ Brahman priests to conduct their rites only if the Brahmans would recite the Vedic words previously denied to Marathas as presumed members of the low-caste Shudra class. This non-Brahman movement, strongest in southwestern Maharashtra, symbolized the rise of Marathas to modern political awareness as well as their opposition to the previous Brahman control of many higher offices and professions.

The Maratha and Kunbi group of castes is divided into subregional groupings of coast, western hills and Deccan plains, among which there is little intermarriage. Within each subregion, clans of these castes are classed in social circles of decreasing rank. A maximal circle of 96 clans is said to include all true Marathas, but the lists of these 96 clans are highly various and disputed. Beyond this outer circle are many clans that still claim to be Marathas, and still further out are the many allied Kunbi groups. A structure of similar type tends to take shape in each subregion through repeated marriages in which grooms of the higher clans take brides from equal or lower clans, preferring by custom to marry their own mothers' brothers' daughters. In western Maharashtra, about 1930, several millions of former Kunbis in search of prestige and wider political solidarity began calling themselves by the formerly aristocratic caste name, Marathas. In the areas of Khandesh, Berar and Nagpur, however, the caste name Kunbi is retained throughout the social hierarchy.

In physical type the large Maratha group of castes shows much variation by subregion. Occasional roundheadedness and a relatively low incidence of blood type B distinguish Marathas from the averages of the Indian population as a whole and suggest minor genetic affiliations toward the west. However, the same features join Marathas with many other apparently indigenous peoples of western India.

The once-powerful Maratha empire holds an important place

in the history of India. It is often stated that British conquest or annexation in India succeeded Muslim rule under the Mogul empire, and to a considerable extent that was the case. However, the principal power and the widest sovereignty that the British overthrew in India was that of the Maratha empire. During the earlier Muslim invasions beginning in the 12th century A.D., the Marathas do not seem to have made much resistance. The historic rise of the Marathas occurred in a time of Hindu religious reform and unrest under the narrowly Muslim policies of the Mogul emperor Aurangzeb (*q.v.*). In the 17th century Sivaji (*q.v.*) led his fellow Marathas against the Muslims. Although he and his fighting officers were Hindus of humble caste, his ministers were Brahmans. When the Mogul empire absorbed the Bijapur kingdom he defied the emperor. He imparted a self-reliant enthusiasm to his countrymen; his outnumbered mountaineer infantry proved desperately courageous, his cavalry unusually daring. Sivaji seized hill forts and plundered neighbouring territories until he held the entire western half of Maharashtra. The new state which he founded was maintained in the face of violent resistance after his death, and the Maratha upsurge continued on a widened scale. At Poona, the centre of Maratha territories, power passed in the 18th century to a line of Chitpavan Brahmans serving as peshwas (prime ministers) to the weaker descendants of Sivaji. Peshwa Baji Rao I founded the Maratha empire in 1739 by annexing a large part of northern India; ultimately a number of independent or loosely allied Maratha states were established at Baroda, Indore, Gwalior, Berar, Nagpur, Tanjore and elsewhere, supplanting the Moguls. The armies of the Maratha empire, although drawn from all parts of India (*see* PINDARI) in enormous numbers (the cavalry alone included about 100,000 men), began to encounter difficulties in attempting to adopt the modern methods of the British and French advisers who entered Maratha service. Thus, when Ahmad Shah Durrani (*q.v.*) invaded from Afghanistan, the Marathas were badly defeated near Delhi (1761). However, it was collision with the British that finally shattered the Maratha confederation. Between 1778 and 1818 the British (*see* WELLINGTON, ARTHUR WELLESLEY) fought three wars with the disunited Maratha powers which led to full British supremacy. *See* also INDIA; BARODA; BOMBAY; GWALIOR; KOLHAPUR.

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MARATHI (or *Marāṭhī*) is the name of an important Indo-Aryan language spoken in western and central India.

Marathi occupies an irregular triangular area of approximately 100,000 sq.mi., having its apex about the district of Balaghat in the Madhya Pradesh (old Central Provinces) and for its base the western coast of the peninsula from Daman on the Gulf of Cambay in the north to Karwar on the open Arabian sea in the south. It covers parts of Maharashtra and Madhya Pradesh states with numerous settlers in central India and Madras, and is also the principal language of Goa and of the northwestern portion of Hyderabad. The standard form of speech is that of Poona in Maharashtra, and in its various dialects it covers the larger part of that state.

Dialects.—Besides the standard form of speech, there is only one real dialect of Marathi, viz., Konkani (*Kōnkaṇī*), spoken in the country near Goa. There are also several local varieties; the Marathi of the Deccan, that of Madhya Pradesh (including Berar) and that of the northern and central Konkan are distinguishable. In the southern part of the district of Ratnagiri this latter Konkani variety of Marathi gradually merges into the true Konkani dialect through a number of intermediate forms of speech. There are also several broken jargons, based upon Marathi, employed in the hill country.

Relations With Other Indo-Aryan Languages.—Marathi has to its north, in order from west to east, Gujarati, Rajasthani, Western Hindi and Eastern Hindi. To its east and south it has the Dravidian languages, Gondi, Telugu and Kanarese. Marathi does not merge into any of the cognate neighbouring forms of speech, but possesses a distinct linguistic frontier. This isolated character of Marathi is partly due to the barrier of the Vindhya range which lies to its north and partly to the fact that none of the northern languages belongs now to the Outer Band, but they are in more or less close relationships to the language of the Midland (according to G. A. Grierson's classification). Eastern Hindi is more closely related to Marathi than the others, and in its bordering dialects may be found few traces of the influence of Marathi.

Written Character.—Marathi books are generally printed in the Nagari character, and this is also used in private transactions and correspondence. In the Maratha country it is known as the *Bālbōdh* ("instructing children," *i.e.*, "easy") character. A cursive form of Nagari called *Mōḍī*, or "twisted," is also employed as a handwriting. It is said to have been invented in the 17th century by Balaji Avaji, the secretary of the celebrated Sivaji. Each word can be written as a whole without lifting the pen from the paper.

Origin of the Language.—The word "Marathi" signifies the language of the Maratha country. It is the modern form of the Sanskrit *Māhārāṣṭrī* just as "Maratha" represents the old *Māhārāṣṭra*, or Great Kingdom. *Māhārāṣṭrī* was the name given by Sanskrit writers to the Prakrit spoken in Māhārāṣṭra, the great Aryan kingdom extending southwards from the Vindhya range to the Kistna, broadly corresponding to the southern part of Bombay state and to the state of Hyderabad. This Māhārāṣṭrī became the form of Prakrit employed as the language of lyric poetry and of the formal epic (*kāvya*). Dramatic works were composed in it, and it was the vehicle of the noncanonical scriptures of the Jaina religion. The oldest work in the language is the *Sattasaī*, or "Seven Centuries of Verses," compiled at Pratisthāna on the Gōdāvarī, the capital of King Hāla, at some time between the 3rd and 7th centuries A.D.

General Character of the Language.—The Prakrits fall into two well-defined groups, an Inner, Śaurasēnī, and its connected dialects on the one hand, and an Outer, Māhārāṣṭrī, Ardhamāgadhī, and Māgadhī with their connected dialects on the other. These two groups differ in their phonetic laws, in their systems of declension and conjugation, in vocabulary and in general character. Suffixes such as *-alla*, *-illa*, *-ulla*, etc., can be added to any noun, adjective or particle in Māhārāṣṭrī and Ardhamāgadhī, but are hardly ever met in Śaurasēnī. These give rise to numerous secondary forms of words, which give a distinct flavour to the whole language.

Vocabulary.—Māhārāṣṭrī Prakrit, the most independent of the Outer languages, was distinguished by the large proportion of *dēśyas* (vocables whose origin cannot be traced to original Indo-Aryan sources) found in its vocabulary, and the same is consequently the case in Marathi, although the proportion of *tatsamas* (words identical with Sanskrit words) to *tadbhavas* (words derived from Sanskrit) in the language is fairly high. The proportion of Persian and, through Persian, of Arabic words in the Marathi vocabulary is comparatively low.

Phonetics.—In the standard dialect the vowels are the same as in Sanskrit, but *ṛ* and *ḷ* only appear in words borrowed directly from that language (*tatsamas*). Final short vowels (*a*, *i* and *u*) have all disappeared in prose pronunciation, except in a few local dialects, and final *i* and *u* are not even written. After an accented syllable a medial *a* is pronounced very lightly, even when the accent is not the main accent of the word. Almost the only compound consonants which survived in the Prakrit stage were double letters, and in Marathi these are usually simplified, the preceding vowel being lengthened in compensation. It is not usual to lengthen the vowel in compensation in Konkani, which appears to contain many relics of the old Prakrit (Saurāṣṭrī) spoken in the Gujarat country before the invasion from the Midland.

On the whole, the consonantal system is much the same as in other Indian languages. Nasalization of long vowels is very common, especially in Konkani. The palatals are pronounced as in

Sanskrit, in words borrowed from that language or from Hindustani, and also in Marathi *tadbhavas* before *i, ī, ē* or *y*. In other cases they are pronounced *ts, tsh, dz, dzh* respectively. There are two *s*-sounds in the standard dialect which are very similarly distinguished: *ś*, pronounced like an English *sh*, is used before *i, ī, ē* or *y;* and *s*, as in English "sin," elsewhere. In the dialects *s* is practically the only sibilant used, and that is changed by the vulgar speakers of Konkani to *h*. Aspirated letters show a tendency to lose their aspiration, especially in Konkani. Generally speaking, Marathi closely follows Māhārāṣṭrī when that differs from the Prakrits of other parts of India. There is, similarly, both in Marathi and Māhārāṣṭrī a laxness in distinguishing between cerebral and dental letters.

Declension.—Marathi retains the three genders, masculine, feminine and neuter. In Marathi the neuter denotes both inanimate things and animate beings when both sexes are included, or when the sex is left undecided. In the Konkani the neuter gender is further employed to denote females below the age of puberty. Numerous masculine and feminine words, however, denote inanimate objects. The rules for distinguishing the gender of such nouns must be learned from the grammars. For the most part, but not always, words follow the genders of the Sanskrit originals. Strong bases in *ā*—and these do not include *tatsamas*—are masculine, and the corresponding feminine and neuter words end in *ī* and *ẽ* respectively. Sex is usually distinguished by the use of the masculine and feminine genders, and large and powerful inanimate objects are generally masculine, while small delicate things are generally feminine. In the case of some animals sex is distinguished by the use of different words.

A pleonastic suffix of *-(a)ka* (masculine and neuter) could in Sanskrit be added to any noun, whatever the termination of the base might be. Modern forms made with this pleonastic suffix and ending in *ā, ī* or *ē* are called strong forms, while all those made without it are called weak forms. As a rule the fact that a noun is in a weak or strong form does not affect its meaning, but sometimes the use of a masculine strong form indicates clumsiness or hugeness. Other pleonastic suffixes are employed in Marathi, usually with specific senses. Thus the suffix *-illa* generally forms adjectives, while *-ḍa-ka* implies contempt.

The synthetic declension of Sanskrit and Prakrit has been preserved in Marathi more completely than in any other Indo-Aryan language. In the formation of the plural the Prakrit declensions are very closely followed by Marathi.

The usual postpositions are: (1) Instrumental: *nẽ̄*, plural *nī̃*, "by." (2) Dative: *lā*, plural also *nā*, "to" or "for." (3) Ablative: *hūn, ūn*, "from." (4) Genitive: *tsā*, "of." (5) Locative: *āt*, "in."

The accusative is usually the same as the nominative, but when definiteness is required the dative is employed instead. The termination *nẽ̄*, with its plural *nī̃*, is really the oblique form, by origin a locative, of the *nā* or *nō*. The suffix *nā* of the dative plural is derived from the same word. For the postposition *lā*, "for the benefit of," compare Hindi *liyẽ* and Gujarati *lidhẽ*. The genitive *gharātsā* is really an adjective meaning "belonging to the house," and agrees in gender, number and case with the noun which is possessed. The suffixes *tsā, cī, cẽ̄*, are derived from the Sanskrit suffix *tyakas*, Prakrit *caō*, which is used in much the same sense.

Strong adjectives, including possessive adjectives, can be declined like substantives, and agree with the qualified noun in gender, number and case. Weak adjectives are not inflected in modern prose, but are inflected in poetry. Comparison is effected by putting the noun with which comparison is made in the ablative case.

The pronouns closely follow the Prakrit originals. There is no pronoun of the third person, its place being supplied by the demonstratives. In all the plural is employed honorifically instead of the singular.

Conjugation.—Marathi has two conjugations. The first as a rule consists of intransitive verbs, and the second, corresponding to the *e*- or causal-class, of transitive verbs, but there are numerous exceptions.

In Marathi the old present has taken on the meaning of a habitual past. It is also the base of the Marathi future, which is formed by adding *l*, or in the first person singular *n*, to the old present. In the second person singular the *l* has been added to a form derived from the Prakrit *uṭṭhasi*, which is also the origin of the old present *uṭhēs*. The remaining tenses are modern forms derived from the participles. The conjunctive participle is derived from the Apabhraṁśa form *uṭṭhiu*, to which the dative suffix *n* (old Marathi, *ni, niyā̃*) has been added.

Various tenses are formed by adding personal suffixes to the present, past or future passive participle. When the subject of the verb is in the nominative the tense so formed agrees with it in gender, number and person. In the present, the terminations are relics of the verb substantive, and in the other tenses of the personal pronouns.

The present tense is formed by compounding the present participle with the verb substantive. Further tenses are similarly made by suffixing, without compounding, various tenses of the verb substantive to the various participles.

Literature.—The modern vernacular literature of the Maratha country arose under the influence of the religious reformation inaugurated by Rāmānuja early in the 12th century. The earliest writer is Nāmdēv (13th century), whose hymns in honour of Vithoba, a personal form of Vishnu, are found in the Sikh *Ādi Granth*. Dnyānōbā, a younger contemporary, wrote a paraphrase of the Sanskrit *Bhagavad Gītā*, which is still much admired. Sivaji was a disciple of Rāmdās (1608–1681), who exercised great influence over him, and whose *Dāsbōdh*, a work on religious duty, is a classic. Contemporary with Rāmdās and Sivaji was Tukārām (1608–1694), a Śudra by caste, the greatest writer in the language. Being unsuccessful both in his business and in his family relations, he abandoned the world and became a wandering ascetic. His *Abhangs* or "unbroken" hymns are famous in the country of his birth, but do not rise to any great height as poetry. Other Marathi poets are Śrīdhar (1678–1728), who translated the *Bhāgavata Purāna*, and the learned Mayūra or Mōrōpant (1729–1793). Mahīpati (1715–1790) was an imitator of Tukārām, who collected the popular traditions about national saints.

Lāvaṇīs or erotic lyrics by various writers are popular, and by western standards hardly proper. The *Pawaḍas* or war ballads, mostly by nameless poets, are sung everywhere throughout the country. There is a small prose literature consisting of narratives of historical events (the so-called *Bakhars*), moral maxims and popular tales.

Konkani once had a literature of its own, which is said to have been destroyed by the Inquisition at Goa. Temples and manuscripts were burned wholesale. Under Roman Catholic auspices a new literature arose, the earliest writer being an Englishman, Thomas Stephens (Thomaz Esteyão), who came to Goa in 1579, wrote the first Konkani grammar and died there in 1619. Among other works, he was the author of a Konkani paraphrase of the New Testament in metrical form. *See* also Indo-Aryan Languages.

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MARATHON, BATTLE OF, was fought in Sept. 490 B.C. in northeastern Attica on the plain, about 2 mi. wide and 5 mi. long, between Marathon village and the sea. The Persian fleet, based on Eretria (*see* Greco-Persian Wars), landed a strong force of cavalry, infantry and archers on the southern part of the beach. At Athens the people decided, on Miltiades' proposal, to send 9,000–10,000 heavy-armed infantry to Marathon, while other forces defended their walled city. They also sent a runner, Philippides or Pheidippides, to Sparta. He returned next day to report that the Spartans would only leave at the end of a religious festival in six days' time. Meanwhile the Athenians, reinforced by 1,000 Plataeans, held the lowest foothills facing the Persian position.

The Athenian command was headed by Callimachus, a civil official (polemarch). He presided over ten generals who, according to Herodotus, took operational command for one day each.

Of these, five wished to await the Spartans and five to attack if a chance arose. Callimachus decided in favour of the latter, headed by Miltiades (*q.v.*), to whom his four supporters gave their days of operational command. The Athenian infantry could not face the Persian cavalry in the plain, but they narrowed their distance from the enemy by felling trees at night and moving them as obstacles into the plain. The Persians remained on the defensive, expecting the impetuous Greeks to attack and be outflanked by the Persian cavalry.

Shortly before dawn some Ionians serving with Persia came to the Greeks at the felled trees and reported "the cavalry are away." Miltiades saw his chance. He thinned the centre and strengthened the wings of his infantry line, charged at dawn a mile across the plain and struck the Persian infantry with strong momentum. Although considerably outnumbered, the Greek infantry had longer spears and swords and heavier protective armour of bronze than the Persians, who wore turban, tunic and trousers and carried wicker shields. The Greek wings defeated their opponents and wheeled inward. Meanwhile the Persian centre drove the Greek centre backward, but as the Greek wings wheeled they outflanked and defeated the Persian centre at a point which is still marked by a high mound, covering the ashes of the Greek dead. The Greeks pursued vigorously, but the Persian fleet came inshore and rescued the fugitives. As it put out to sea, a message was flashed to it by shield signal from the hills, presumably by a Greek traitor. Turning, the fleet sailed for Athens. Most of the Athenian army marched rapidly to Athens and arrived in time to contest any landing. The Persians departed, having lost 6,400 men as compared with 192 Athenian dead.

Many points are disputed. No one knows why the cavalry were absent. Perhaps the horses were delayed when being watered at the springs in the northern plain.

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(N. G. L. H.)

MARATHON RACE, a modern road race first staged at the revival of the Olympic games at Athens, Greece, in 1896. It commemorates the legendary feat of a Greek soldier, who in 490 B.C. is supposed to have run from Marathon to Athens, a distance of 22 mi. 1,470 yd., to bring news of his countrymen's victory over the Persians.

Michel Bréal of the Sorbonne at Paris originated the idea that the commemorative race should be added to the Olympic games program and, appropriately, the first marathon winner was a Greek, Spyros Louis.

Not until 1924 was the Olympic marathon distance standardized at 26 mi. 385 yd. The distance of the first race at the 1896 Olympics was 24 mi. 1,500 yd. At Paris (1900) the distance was 40 km. (24.85 mi.); at St. Louis, Mo., (1904), 40 km.; at the 1906 unofficial Olympic games at Athens, 26 mi.; at London (1908), 26 mi. 385 yd.; at Stockholm (1912), 24 mi. 1,725 yd.; at Antwerp (1920), 26 mi. 990 yd.; at Paris (1924), 26 mi. 385 yd. From 1924 on each succeeding Olympic marathon was run over a 26 mi. 385 yd. course. The reason for the additional 385 yd. in 1908 was that the British Olympic committee decided to start the race from the royal residence at Windsor castle and finish in front of the royal box in the stadium at London.

Because marathon courses are not standardized, the International Amateur Athletic federation does not list a world's record for the event. Except for the Olympic games championship, perhaps the most coveted honour in marathon running is victory in the Boston (Mass.) Athletic association race, held annually after 1897. Athletes from all parts of the world have participated. For a period of 11 years (1945–56) the winners were exclusively from nations other than the United States; they represented Greece, Korea, Canada, Sweden, Japan, Guatemala and Finland.

The South African Comrades' marathon is run over a 54 mi. 1,100 yd. course. One year the race is from Durban to Pietermaritzburg, the next from Pietermaritzburg to Durban. When the race starts from Durban, the course is uphill to an elevation of 3,000 ft. in the first 18 mi., and there is a rise of 500 ft. in 1 mi., near the end of the course. It was in this race that Arthur F. H. Newton, one of the most remarkable all-time distance runners, won his first success. In 1922, at the age of 39 and with no previous athletic experience, he won this endurance run from 87 other runners. In 1925, when 42, he ran the course in 6 hr. 14 min. 30 sec. Indoors, at Hamilton, Ont., in 1931, Newton ran 152 mi. 540 yd. in 24 hr. At the age of 51, he ran 100 mi. on the Bath-to-London road in 14 hr. 7 min. 10 sec.

Another example of the fact that in the marathon road race older runners have a chance for victory was Clarence De Mar of the U.S. who won the Boston Athletic association marathon for the seventh time in 1930. He began road racing in 1909 against the advice of his physician, who predicted he would die of heart disease, but De Mar outlived the doctor. In 1951 when 63 De-Mar started and finished in his 1,000th road race.

Because so many races of this type were won by veterans, it was believed that a younger runner would not have a chance in a major event. However, in 1951 Shigeki Tanaka, a 19-year-old Japanese boy, won the Boston Athletic association marathon in 2 hr. 27 min. 45 sec.

In the matter of preparation for a 26 mi. 385 yd. road race it is considered necessary to train over that distance. At the 1952 Olympic games, however, Czech Emil Zatopek set an Olympic record of 2 hr. 23 min. 3.2 sec., even though he had never run the distance before, his only training being in preparation for his victories in the 5,000- and 10,000-m. races. Zatopek's record was broken in 1960 by Ethiopian Bikila Abebe, who covered the distance, barefooted, in 2 hr. 15 min. 16.2 sec.

See also OLYMPIC GAMES.

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(H. AR. RN.; SY. S.)

MARATTI (MARATTA), **CARLO** (1625–1713), Italian painter who became one of the two leading painters of the Roman school in the later 17th century (the other being G. B. Gaulli), was born on May 13, 1625, at Cammerino in the Marches. He went early to Rome where he studied under Andrea Sacchi. His reputation was established with his first public work, the "Nativity" (1650, S. Giuseppe dei Falegnami, Rome). A few years later he was noticed by Pope Alexander VII, and thereafter he secured an almost uninterrupted series of important commissions for altar-pieces in Italian churches. Among these are "The Mystery of the Trinity Revealed to St. Augustine" (*c.* 1655, Sta. Maria dei Sette Dolori), "The Appearance of the Virgin to St. Philip Neri" (*c.* 1675, Palazzo Pitti, Florence), and "The Virgin With SS. Charles Borromaeus and Ignatius" (*c.* 1685, Sta. Maria in Vallicella). He also executed a number of decorative ceiling frescoes in Roman palaces, and he was the most distinguished portrait painter in Italy during this period. His portraits include "Pope Clement IX" (Hermitage, Leningrad) and several of visiting Englishmen.

Maratti's early work shows the influence of Sacchi, through whom he learned to admire chiefly the art of Annibale Carracci and Raphael. Thus he became a convinced advocate of classicism, at least in theory, in opposition to the baroque painters, Pietro da Cortona, Gaulli and Padre Pozzo. But Maratti was only partly a classicist in practice. His work shows to the full the baroque quality of magnificence, and he was wholeheartedly engaged in the task of representing with the utmost splendour the dogmas of the Counter-Reformation. Maratti died in Rome on Dec. 15, 1713.

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(M. W. L. K.)

MARAZION, a small seaport and seaside resort in the West Penwith rural district of Cornwall, Eng., on the shore of Mount's bay, 13 mi. E.S.E. of Land's End by road. Pop. (1961) 1,352. A causeway of boulders and pebbles passable at low tide links the township with St. Michael's Mount (*q.v.*). It has an ancient reputation as a market town and its name is probably derived

from the Cornish words *marchas* ("market") and *bichan* ("small"). A charter of incorporation was granted by Elizabeth I to Marazion in 1595 but borough privileges were lost in the time of Edward VI because of the troubles of the religious rebellion. Marazion owed its former prosperity to the throng of pilgrims who came to visit St. Michael's Mount. It is now a quiet town in surroundings of much beauty. Market gardening is extensively carried on and there is a fishing industry. The inscribed stones in the churchyard of St. Hilary, 1 mi. distant, date from the 4th century, one being in honour of Constantine the Great.

MARBECK (MERBECKE), **JOHN** (*c.* 1505–*c.* 1585), English composer, organist and author, known for his setting of the Anglican liturgy. Some recently discovered evidence suggests the acceptance of *c.* 1505 as the date of his birth, rather than *c.* 1510 as has been heretofore assumed. Marbeck was apparently in Windsor in 1531 and, as far as is known, remained there throughout his life. His name appears in the records of St. George's chapel, Windsor, as organist (1541–42). In 1544 he was sentenced to the stake for heresy but was pardoned through the intervention of Bishop Gardiner of Winchester. At that time his "greate worke," his English *Concordance* to the Bible, was taken from him and destroyed. On his release he began it again and, under Edward VI, it achieved publication in an abbreviated form in 1550; in the same year his most famous musical accomplishment, *The Book of Common Prayer Noted* (*i.e.*, set to musical notes), was printed. This setting of the liturgy was superseded by the revisions of 1552, but interest in it was revived by the Oxford Movement in the 19th century. By that time, however, the traditional context of Marbeck's work had been lost.

During the last ten years of his life Marbeck published six books on religious subjects that show an uncompromising dedication to the principles of the Calvinist Reformation. Of his music, only three Latin compositions survive complete: a Mass, *Per arma justitiae*, an antiphon and a carol. These, together with an antiphon lacking the tenor part, were published in vol. x of *Tudor Church Music* (1929). *The Book of Common Prayer Noted*, together with Cranmer's *First Litany* (1544), has been issued in a facsimile edition, edited by J. Eric Hunt (1939).

See Robert Stevenson, "John Marbeck's 'Noted Booke' of 1550," *The Musical Quarterly*, xxxviii (1951); R. R. Terry, "John Merbecke," *A Forgotten Psalter and Other Essays* (1929).

MARBLE, a metamorphic rock used in many classic sculptures and buildings. Technically, the term (from the Greek *marmaros*, "stone," or "boulder") is restricted to granular limestones and dolomites that have been recrystallized under the influence of heat, pressure and aqueous solutions in metamorphic environments (*see* METAMORPHISM); commercially, it includes all decorative calcareous rocks that can be polished, as well as certain serpentines (verd antiques).

Marbles in the petrographic sense are massive and consist of a mosaic of calcite grains which under the microscope rarely show any traces of crystalline form but are traversed by minute cracks appropriate to the rhombohedral cleavage of calcite. Particularly in the more severely deformed rocks, the grains show stripes indicating polysynthetic twinning and may be elongated perceptibly in a particular direction or even crushed.

These marbles occur very often interbedded with mica schists, phyllites, gneisses and granulites, and are commonest in the older Paleozoic and pre-Cambrian layers of the earth's crust which have been deeply buried in regions of extreme folding and igneous intrusion such as the Appalachian belt of the eastern United States. The passage of limestones rich in fossils into true marbles as they approach such metamorphic regions is a common phenomenon; occasionally the recrystallization of the rock has not completely obliterated the organic structures; *e.g.*, at Carrara, Italy, and at Bergen, Norway.

Most of the white and gray marbles of Alabama, Georgia and western New England and that from Yule, Colo., are recrystallized rocks, as are a number of Greek and Italian statuary marbles famous from antiquity which are still quarried. These include the Parian marble, the Pentelic marble of Attica in which Phidias, Praxiteles and other Greek sculptors executed their principal works and the snow-white Carrara marble used by Michelangelo and Antonio Canova favoured by modern sculptors. The exterior of the National Gallery of Art in Washington, D.C., is of Tennessee marble, and the Lincoln memorial contains marbles from Yule, Colo., Alabama (roof transparencies) and Georgia (Lincoln statue).

Even the purest of the metamorphic marbles, such as that from Carrara, contain some accessory minerals, and in many they form a considerable proportion of the mass. The commonest are quartz in small rounded grains, scales of colourless or pale yellow mica (muscovite and phlogopite), dark shining flakes of graphite, iron oxides and small crystals of pyrite.

Many marbles contain other minerals which are usually silicates of lime or magnesia. Diopside is very frequent and may be white or pale green; white bladed tremolite and pale green actinolite are found; the feldspar encountered may be a potassic variety, but is more commonly a plagioclase such as albite, labradorite or anorthite. Scapolite, various kinds of garnet, vesuvianite, spinel, forsterite, periclase, brucite, talc, zoisite, wollastonite, chlorite, tourmaline, epidote, chondrodite, biotite, sphene and apatite may be mentioned as possible accessory minerals. Pyrrhotite, sphalerite and chalcopyrite may also be present in small amounts.

These minerals represent impurities in the original limestone which reacted during metamorphism to form new compounds. The alumina represents an admixture of clay; the silicates derive their silica from quartz and from clay; the iron came from limonite, hematite or pyrite in the original sedimentary rock. In some cases the original bedding of the calcareous sediments can be detected by mineral banding in the marble. The silicates, if present in any considerable amount, may colour the marble; *e.g.*, green from green pyroxenes and amphiboles, brown from garnet and vesuvianite, yellow from epidote, chondrodite and sphene. Black and gray colours result from the presence of fine scales of graphite.

Bands of calc-silicate rock may alternate with bands of marble, or form nodules and patches, sometimes producing interesting decorative effects, but these rocks are particularly difficult to finish because of the great difference in hardness between the silicates and carbonate minerals.

Later physical deformation and chemical decomposition of the metamorphic marbles often produces attractive coloured and variegated varieties. Decomposition yields hematite, brown limonite, pale green talc and, in particular, the green or yellow serpentine derived from forsterite and diopside which is characteristic of the ophicalcites or verd antiques. Earth movements may shatter the rocks, producing fissures afterward filled with veins of calcite; in this way the beautiful brecciated or veined marbles are produced. Sometimes the broken fragments are rolled and rounded by the flow of marble under pressure, and pseudoconglomerates result.

The so-called onyx marbles consist of concentric zones of calcite or aragonite deposited from cold-water solutions in caves and crevices and around the exits of springs. They are, strictly speaking, neither marble nor onyx, for true onyx is a banded chalcedony composed largely of silicon dioxide. Onyx marble was the "alabaster" of the ancients, a source of confusion since alabaster now is defined as a calcium sulfate rock (*see* GYPSUM). These marbles are usually brown or yellow due to the presence of iron oxide.

Well-known examples include the *giallo antico* ("antique yellow marble") of the Italian antiquaries, the reddish-mottled Siena marble from Tuscany, the large Mexican deposits at Técali near Mexico City and at El Marmol, Calif., and the Algerian onyx marble used in the buildings of Carthage and Rome and rediscovered near Oued-Abdallah in 1849.

Unmetamorphosed limestones showing interesting colour contrasts or fossil remains are used extensively for architectural purposes. The Paleozoic rocks of Great Britain, for example, include "madrepore marbles" rich in fossil corals and "encrinital marble" containing crinoid stem and arm plates with characteristic circular cross sections. The shelly limestones of the Purbeck forma-

tion and the Sussex marble, of Mesozoic age, consist of masses of shells of fresh water snails embedded in blue, gray or greenish limestone. They were a favourite material of medieval architects and may be seen in Westminster Abbey and a number of English cathedrals. Black limestones containing bituminous matter, which commonly emit a fetid odor when struck, are widely used; the well known *petit granit* of Belgium is a black marble containing crinoid stem plates.

Uses.—Marbles are used principally for buildings and monuments, interior decoration, statuary, table tops and novelties. Colour and appearance are the most important qualities overall. Resistance to abrasion, which is a function of cohesion between grains as well as the hardness of the component minerals, is important for floor and stair treads. The ability to transmit light is important for statuary marble, which owes its luster to light penetrating from $\frac{1}{2}$ to $1\frac{1}{2}$ in. and being reflected at the surfaces of deeper-lying crystals. Brecciated, coloured marbles, onyx marble and verd antique are used principally for interior decoration and for novelties. Statuary marble, the most valuable variety, must be pure white and uniform in grain size. For endurance in exterior use marble should be uniform and nonporous to prevent the entrance of water that might discolour the stone or cause disintegration by freezing, and it should be free from impurities such as pyrite that might lead to staining on weathering. Calcite marbles exposed to atmospheric moisture made acid by carbon dioxide and sulfurous and other gases maintain a relatively smooth surface during weathering, but dolomite limestone may weather with an irregular, sandy surface from which the dolomite crystals stand out.

The principal mineral in marbles is calcite (*q.v.*); the fact that calcite varies in hardness, light transmission and other properties in various directions has a number of practical consequences in the preparation of some marbles. Calcite crystals transmit more light in one direction than in others, so that slabs prepared for uses in which translucency is significant are cut parallel to that direction. The bending of marble slabs has been attributed to the directional thermal expansion of calcite crystals on heating. The basal faces of calcite crystals are less rapidly soluble than those at right angles; a number of marble tombstones from the 1800s, cut so as to expose the basal faces, have withstood weathering better than those not so prepared.

Quarrying.—The use of explosives in the quarrying of marble is very limited because of the danger of shattering the rock. Instead, channeling machines utilizing chisel-edged steel bars make cuts about two inches wide and several feet deep. Wherever possible, advantage is taken of natural joints already present in the rock, and cuts are made in the direction of easiest splitting ("rift" or "grain"), which is a consequence of the parallel elongation of platy or fibrous minerals. The marble blocks outlined by joints and cuts are separated by driving wedges in drill holes. Mill sawing into slabs is done with sets of parallel iron blades which move back and forth and are fed by sand and water. The marble may be machined with lathes and carborundum wheels, and is then polished with increasingly finer grades of abrasive. (*See* also QUARRYING.)

Even with the most careful quarrying and manufacturing methods, at least half of the total output of marble is waste. Some of this material is made into chips for terrazzo flooring and stucco wall finish. It is in various localities put to most of the major uses for which high-calcium limestone is suitable (*see* LIMESTONE).

See also references under "Marble" in the Index.

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MARBLEHEAD, a town of Essex county, Mass., U.S., is located 17 mi. N.E. of Boston. Built upon a rocky promontory, the town has narrow, twisted, hilly streets and a character of quaint charm. Among its historic buildings are the Jeremiah Lee mansion (1768), St. Michael's church (Episcopalian; 1714), the Old Brig (*c.* 1720), the Old Tavern (1680) and the Elbridge Gerry house.

Marblehead, originally part of Salem, was first settled in 1629 by a group of rugged fishermen from the Channel Islands and Cornwall, Eng. The village was known for its unruliness and disinclination to abide by many of the laws of the Puritan colony. It was incorporated as a separate town in 1649 and in the colonial period was an important commercial, fishing and shipbuilding port. After the passage of the Boston Port act (1774), it was made the port of entry in place of Boston, but its merchants invited the Boston merchants to use their wharves and warehouses. During the American Revolution many vessels set out from this port, the most famous being the "Lee," commanded by John Manley, which in Nov. 1775 captured the "Nancy," with a valuable and much needed cargo of military stores. The schooner "Hannah," manned and fitted there, was the first American warship regularly commissioned (Sept. 2, 1775, by Gen. George Washington) by authority derived from the continental congress. The port declined in importance after the War of 1812 and in the 19th century Marblehead turned to the manufacture of shoes, rope and cordage. The harbour, formed by a rocky peninsula known as Marblehead Neck, provides safe anchorage for craft of all kinds and has become a noted yachting centre. Marblehead is a suburban, residential and resort town. Manufactures include boats and marine equipment. For comparative population figures *see* table in MASSACHUSETTS: *Population*. (L. G. BA.)

MARBLES: *see* CHILDREN'S GAMES AND SPORTS.

MARBOT, JEAN BAPTISTE ANTOINE MARCELLIN, BARON DE (1782–1854), French general, author of memoirs on the Napoleonic period, was born at La Rivière, a château near Altillac, on Aug. 18, 1782. His father, Antoine Marbot, a landowner, was a general in the French Revolutionary Wars from 1793 and died during the defense of Genoa in 1800. The young Marbot was aide-de-camp successively to Pierre Augereau (at Jena and at Eylau in 1807), Jean Lannes (in Spain and at Essling in 1808) and André Masséna (at Wagram and in Portugal in 1809). Promoted major and then colonel of Belgian light cavalry in 1812, he fought in the battles on the Dvina and Berezina rivers in Russia (1812) and on the Katzbach in Silesia (1813). He was wounded by an arrow in the battle of Leipzig. Colonel of hussars in 1815, he was promoted general by Napoleon on the eve of Waterloo.

In exile after Waterloo, Marbot returned to France in 1819. His *Remarques critiques* (1820) on Gen. Joseph Rogniat's treatise on war admirably set out the human factors of war in contrast with Rogniat's pure theory. Napoleon read the book in St. Helena and in his will left Marbot a legacy to encourage him to write more. A work on the new French army followed in 1826. The influence of the house of Bourbon-Orléans brought Marbot back to service in 1829; and when Louis Philippe became king in 1830 he chose Marbot to be aide-de-camp to Ferdinand, duc d'Orléans. They were at the siege of Antwerp and served together in Algeria.

Marbot died in Paris on Nov. 16, 1854. His *Mémoires*, written for his children, were not published until 1891 (Eng. trans. 1892). More than any other work they revived interest in the incidents and personalities of the first empire. Their inaccuracy, however, is only too evident, and many of the exploits that Marbot brilliantly recounts are known to be fiction. (I. D. E.)

MARBURG (MARBURG AN DER LAHN), a university town of Germany which after partition of the nation following World War II was in the *Land* (state) of Hesse, Federal Republic of Germany. It is situated on the Lahn river, 96.6 km. (60 mi.) N. of Frankfurt am Main by rail. Pop. (1961) 44,853.

The name Marburg was first mentioned in 1130 and according to tradition the town gained civic rights in 1211. Marburg's oldest church, the Kilian (used for administrative offices), Romanesque in style, dates from that period. The Philipps-Universität, founded in 1527, was Europe's first Protestant university.

The early history of Marburg is associated with St. Elizabeth (*q.v.*), who went from the Wartburg to Marburg in 1228 and spent the rest of her life there in charitable works. Her bones are preserved in a golden shrine, a masterpiece of the Rhenish goldsmiths' craft, in the church of St. Elizabeth, completed in 1335. Above the Lahn rises the castle of the landgraves, the cradle of the *Land* of Hesse. The first part of the castle (the knights' chamber and the chapel) was begun in 1277 and the last part (the east wing) was completed in 1493. In 1529 Philip the Magnanimous summoned Luther and Zwingli and other Protestant reformers to the castle for the Marburg disputations (*see* MARBURG, COLLOQUY OF). Marburg has the Staatsbibliothek, one of the most important libraries in the Federal Republic. The Central Research Institute for German is associated with the university.

The town's economy rests on the university and tourist traffic and also a number of industries in applied arts, one of the most important being the Marburg art potteries. Marburg is a popular conference town; about 100 conferences and exhibitions take place yearly. The town is surrounded by woods and the old town affords many subjects of interest.

Marburg's open-air theatre in the castle grounds is dominated by a triad of Gothic arches, and in that setting German and other classics are produced annually. (B. St.)

MARBURG, COLLOQUY OF, the name given to a debate on the Eucharist (*q.v.*), held on Oct. 1–4, 1529, at Marburg, Ger., between the Reformers of Germany and Switzerland, which had far-reaching consequences for the history of the Reformation.

A majority resolution against the Reformation by the second diet of Speyer in April 1529 (*see* REFORMATION: *German and Swiss Reformers*) caused the "Protestation" by 19 German territories and prompted the landgrave Philip (*q.v.*) of Hesse to organize a federation of the "Protestants" which was to include also some Swiss cantons. Since the Lutherans had always insisted on a common confession as the basis of a federation, the landgrave revived his plan of a colloquy as a means of settling the controversy on the Eucharist which since 1524 had been dividing the adherents of the Reformation. The colloquy, summoned for Michaelmas at Marburg, was "a political action" (Walther Köhler), caused by the perils threatening the Reformation, prepared and accompanied by diplomatic negotiations between the landgrave and the participant states (mainly Saxony, Strasbourg, Zürich, Basel).

Preliminary discussions on Friday, Oct. 1, between Martin Luther and John Oecolampadius, Huldreich Zwingli and Philipp Melanchthon, the four colloquists, preceded the colloquy proper, which was held in four sessions from Saturday morning to Sunday afternoon in the presence of the landgrave Philip, Duke Ulrich of Württemberg, the delegates from the participant territories and up to 60 guests. The point at issue was the meaning of the words of Christ: "This is my body." Luther defended the traditional, Catholic, literal understanding against the spiritualizing interpretation by a humanistic Protestantism which was unable to accept the idea that in the sacrament the true, essential body of Christ is received orally. This was a genuine "contention of faith" between two concepts of the divine revelation in Christ, which according to Luther and Zwingli excluded one another, while Martin Bucer, who as a member of the delegation from Strasbourg spoke at the end of the colloquy, believed that they could be reconciled.

The colloquy was, despite some tense moments, dignified and Christian. After its breakdown on Sunday, Oct. 3, the landgrave, who wanted some tangible result, asked Luther to formulate what agreement existed between the parties. Accordingly, on the following day Luther composed the 15 articles of Marburg, on the basis of articles agreed upon at Wittenberg before the departure for Marburg (later called Articles of Schwabach). The Articles of Marburg stated what was regarded as the common doctrine of the German and the Swiss Reformation on God, the incarnation, the person of Christ, original sin, atonement, justification and faith, "the external word," baptism, works, "confession or seeking of counsel," secular authority, human traditions, infant baptism and the Lord's Supper. The carefully worded 15th article mentions points concerning which there had never been a difference of opinion between the Reformers and which had hardly been touched upon in the colloquy and puts the dissent in the words that "at present we are not agreed as to whether the true body and blood of Christ are bodily present in the bread and wine"—the question that had been the only object of the colloquy. The articles were read, alterations suggested and made, and the final draft signed by the theologians. Since the first 14 articles had not been discussed at the colloquy and the short time available on Monday made any thorough discussion impossible, they should not be regarded as the real result of the Marburg colloquy. But they provided Philip of Hesse with the syncretism he had wanted for the Protestant cause. Both these articles and those of Schwabach were in 1530 partially embodied in the Augsburg Confession (*q.v.*).

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MARC, FRANZ (1880–1916), German painter, one of the leaders of the "Blue Rider" Expressionist movement, was born in Munich on Feb. 8, 1880. His father was a minor landscape and genre painter. Marc studied at the Munich academy under Wilhelm Diez. A trip to Paris in 1903 brought him into contact with Impressionism, while the Art Nouveau movement in Munich made him conscious of the problems of formal structure. Perhaps the strongest influence on his early work was Van Gogh, but he did not fulfill the potentialities of his genius until he discovered the nonobjective paintings of Wassily Kandinsky (*q.v.*) with their pure colour and form. In 1911 he and Kandinsky edited the book *Der Blaue Reiter,* one of the great documents of modern art. The almanac also gave its name to a significant movement in Expressionism: the "Blue Rider." Whereas Kandinsky renounced the objective, Marc was drawn to nature, especially the animal motif, in which he sought a pantheist empathy with the vibrations and rhythms of nature. In 1913 and 1914 he created his most important paintings, "The Tower of Blue Horses," the "Fate of the Beasts" and "The Unhappy Tyrol." Influenced by nonobjectivity, Cubism and Futurism, he worked with sonorous colours and crystalline forms which interpenetrate to create an organic harmony. He used colour and form to dismantle the material and the objective and to help create the world of the spirit. Finally, he painted a series of entirely nonobjective paintings. In 1914 Marc joined the German army; he was killed near Verdun on March 4, 1916.

See also EXPRESSIONISM; PAINTING: *Expressionism and the German School.*

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MARCANTONIO (MARCANTONIO RAIMONDI): *see* RAIMONDI, MARCANTONIO.

MARCASITE, a mineral with the same chemical composition as pyrite, being iron disulfide, FeS_2, but crystallizing in the orthorhombic instead of the cubic system. Apart from crystalline form, the appearance and physical characteristics of marcasite (sometimes known as white iron pyrite) are very similar to those of pyrite, and in the absence of distinct crystals it is difficult to distinguish between the two species. The colour is pale bronze-yellow; on freshly fractured surfaces the colour is tin-white, but this rapidly tarnishes on exposure to air. The lustre is metallic and brilliant; the streak is greyish black; the hardness is 6 to 6.5; the specific gravity is 4.89. In the course of time, specimens of marcasite usually disintegrate, forming ferrous sulfate and sulfuric acid. In nature marcasite is frequently altered to hydrated iron oxide, goethite (*q.v.*) or limonite (*q.v.*). Under weathering conditions it is less stable than pyrite.

Distinctly developed single crystals of marcasite are rare; more often crystal aggregates occur twinned on a prism plane producing pentagonal stellate groups of fine crystals. This frequent twinning gives rise to characteristic forms, with many re-entrant angles, to which the names "spear pyrites" and "cockscomb pyrites" are applied. The commonest state of aggregation is that of

radially arranged fibres, the external surface of the mass being globular, nodular or stalactitic in form.

Marcasite is found in metalliferous veins associated with lead and zinc ores (Joplin, Mo.; Galena, Ill.). It is frequently found in sedimentary deposits. In the chalk of the southeast of England nodules of marcasite with a fibrous radiated structure are abundant, and in the chalk marl between Dover and Folkestone fine twinned groups of "spear pyrites" are common. Marcasite is often associated with organic matter: for example, as a concretion around organic remains; or in the plastic clay of the brown coal formation at Littnitz, near Carlsbad (Karlovy Vary), Czech., where it has been extensively mined for the manufacture of sulfur and ferrous sulfate. (A. J. F.)

MARCEAU (MARCEAU-DESGRAVIERS), **FRANÇOIS SÉVERIN** (1769–1796), the young military hero of the first French republic, was born at Chartres on March 1, 1769, a lawyer's son. He ran away to enlist in the infantry regiment of Savoy-Carignan in 1785 and took part in the attack on the Bastille in Paris in 1789. He joined the Chartres volunteers, who elected him lieutenant colonel, and they went to Verdun garrison in the summer of 1792, but he left them in the disorder following capitulation to the Prussians on Sept. 2. He obtained a cavalry captaincy when fighting the rebels of the Vendée in May 1793. A month later, in battle at Saumur, he saved the *représentant en mission*, Pierre Bourbotte, from capture; he was cited in the Convention and promoted. Bourbotte made him a general at the battle of Cholet on Oct. 16, 1793, and was able to make him temporarily the commander in chief (Nov. 27). Marceau's attractive heroism, guided by J. B. Kléber's maturer talents, led to decisive victory over the Vendean "grand army" in December (*see* VENDÉE, WARS OF THE).

Marceau was received with acclaim by the Convention in Feb. 1794 and given a division in the Ardennes against the Austrians. His capture of Coblenz, the former capital of the *émigrés*, gave special pleasure in Paris (Oct. 1794). In 1795 he was across the Rhine with Kléber, then led a wing of 17,000 men west of the Rhine facing Mainz and holding an exposed flank with prudence and skill. In 1796, when J. B. Jourdan and the main army retreated, Marceau's corps was the all-important rear guard. In action at Altenkirchen on the Lahn river, Marceau was shot by a Tirolese sharpshooter. He died on Sept. 21, 1796. (I. D. E.)

MARCEL, ÉTIENNE (*c.* 1315–1358), French bourgeois leader who played a major part in the Paris revolution of 1355–58, came of a family of cloth merchants descended from a sergeant of Louis IX. The wealthy Pierre Marcel (d. 1305), whose commercial enterprises covered all Europe, was Étienne's grandfather. After the death of his father, Simon (*c.* 1333), Étienne himself entered the family trade. A widower from 1344, he made a second marriage (*c.* 1346) with Marguerite, daughter of Pierre des Essars, a *maître des comptes* and banker to the king and the princes of the blood. Essars was condemned to pay a heavy fine in 1347, and Marcel, to evade any liability, renounced any rights to the inheritance in his wife's name. This proved to be a mistake, for in 1352 Essars was posthumously rehabilitated and his heirs shared between them 50,000 gold pounds.

Meanwhile, Marcel was becoming the champion of the Paris *bourgeoisie*. Already a member of several guilds, he was chosen in 1355 provost of the merchants, that is, their acknowledged leader. King John II, to raise money for defense against the English, then summoned the estates of *langue d'oïl* and in Dec. 1355 they agreed to a tax provided that they themselves should organize its collection. Marcel, who had taken part in the debates, co-operated with the king and led the Paris militia to join the royal army in Normandy, remaining with them until July 1356, when the inadequacy of the revenue from taxation forced the king to approach his usual financiers for new loans.

After the English had captured King John at the battle of Poitiers (Sept. 1356), the estates-general were convened in October. Marcel took a leading part in their deliberations and forced the reluctant dauphin (*see* CHARLES V, king of France) to reorganize the government and set up a committee for widespread reform (March 1357). Subsequently, however, the dauphin tried to assert himself against these measures and the captive king refused to endorse them; but Marcel, though he had no power in the royal council, remained master of Paris.

After a superficial reconciliation, the estates were again convened in Nov. 1357. At this point, moreover, the dauphin's problems were aggravated by the escape of Charles II the Bad (*q.v.*), king of Navarre, from prison and by his overtures to Marcel, with whom his chief spokesman, Robert le Coq, bishop of Laon, had already been associated. The dauphin, having no control over Paris, began to put his case in a series of public speeches. The city was divided and disturbed; Renaud d'Acy, one of the king's lawyers, was lynched by the mob, while Marcel with some followers forced an entry into the royal palace and killed Jean de Conflans, marshal of Champagne, and Robert de Clermont, marshal of Normandy, in the dauphin's presence. The dauphin had to acquiesce and put on a cap of the blue and red city colours. Marcel now thought that he could control the dauphin and so had him proclaimed regent (March 1358); but the new regent escaped from Paris and took up arms against him. The regent's operations were interrupted in May and June by a peasant revolt, the Jacquerie (*q.v.*), for which, however, Marcel denied himself to have been responsible; and after trying finally to blockade Paris the regent had to disband his army for lack of resources. The Parisians, however, had grown tired of their provost's dictatorship and resented the presence of English troops brought in by the king of Navarre. Revolt broke out, and after an angry scene at the bastille of the Porte St. Antoine, in which another draper, Jean Maillart, accused him of duplicity, Marcel was attacked and struck down (July 31, 1358). Shortly afterward the regent entered Paris. Even so, the cause of reform for which Marcel had worked was not lost, for many of his fellow reformers later became royal counselors.

See J. d'Avout, *Le Meurtre d'Étienne Marcel* (1960). (R. Cs.)

MARCEL, GABRIEL (1889–), French philosopher and dramatist, whose metaphysical journey toward acceptance of Christian belief enabled him to question the philosophical assumptions of his time, was born on Dec. 7, 1889, in Paris. His father became French minister at Stockholm, Swed., in 1898; his mother, who was Jewish, had died when he was four. In 1909 Marcel presented a thesis at the Sorbonne on the metaphysical ideas of Coleridge as related to the philosophy of Schelling; he took his doctorate in 1910. *Appearance and Reality* (1893) by F. H. Bradley (*q.v.*) was a considerable influence on him at this time and acted as a counterbalance to the prevailing cult of Henri Bergson. In 1912 ill-health took him to Switzerland, and there he began his *Journal métaphysique*, covering the years 1914–21 (1927; Eng. trans., 1952). During World War I he worked with the Red Cross; this experience caused him to develop an interest in paranormal cognition, experiments in which profoundly influenced his thought (*see* his Myers Memorial lecture, 1955). In 1940–41 he devoted himself to teaching.

Marcel's philosophy defies systematization. He would rather be called a neo-Socratic, content to ask men questions, than a Christian existentialist, though it is true that, in reaction from the *cogito ergo sum* of Descartes, he has been concerned with existence rather than with thought. A Socratic approach to the problems of other people's minds, their personalities, their hopes and their loves made it natural for Marcel to construct plays in which the dialogue helps to show the audience characters at grips with the type of question a writer who is also a philosopher wants to ask. Marcel does not dictate their answers or use his plays to sustain a thesis, for he holds (*see* his *Théâtre et religion*, 1959) that an author should subordinate himself to his characters.

His first play, *Le Soleil invisible*, was written before 1914 and about 20 appeared between then and 1962. His *Rome n'est plus dans Rome* (1951) portrays the self-examination of a professor and his wife who abandon France for Brazil under the stress of fear that Communism will overrun France. Children and their mental attitudes have a considerable part in this and other plays.

Marcel continued his *Journal métaphysique* for the years 1928–33 in his *Être et avoir* (1935; Eng. trans., *Being and Having*, 1949) and for 1938–43 in *Présence et immortalité* (1959). His

Gifford lectures at Aberdeen (1949–50) were published as *Le Mystère de l'être,* 2 vol. (1951; Eng. trans., *The Mystery of Being,* 1950–51). In *Homo Viator* (1945; Eng. trans., 1951) he developed a metaphysic of hope to expose the inadequacy of the theory expounded by Jean Paul Sartre that man chooses his own values, and later he became preoccupied with the dangerous effects of technocracy on human personality (*Les Hommes contre l'humain,* 1951; Eng. trans., *Man Against Mass Society,* 1952; *Le Déclin de la sagesse,* 1954; Eng. trans., *The Decline of Wisdom,* 1954; *Fragments philosophiques 1909–1914,* 1962).

Marcel became dramatic critic of *L'Europe nouvelle* in 1923, and in 1929 a perceptive criticism of a work by François Mauriac drew from Mauriac the question: "Why are you not one of us?" (*i.e.,* a professed Catholic). Marcel, whose philosophy had been tending toward religion, entered the Roman Catholic Church on March 23, 1929.

For Marcel the construction of a personality matters most. Fears and desires belong to the realm of having, while the loving collaboration with the liberty of another helps both agents to attain being, neither being used by the other as a means to emotional satisfaction or to self-discovery and the increase of self-love. Only within the divine Trinity is there perfect communication of being; creatures are distinct from God by the presence in them of the element of having.

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MARCELLINUS, SAINT (d. 304), pope from 296 to 304, was successor to Gaius. The *Liber Pontificalis* cites a now lost "Acts of St. Marcellinus" as saying that Marcellinus yielded to the persecutors under Diocletian, but repented and was martyred. St. Augustine wrote that since no proof of apostasy was offered, the charge should be rejected. Marcellinus is venerated as a saint, with his feast day on April 26, but proof of martyrdom seems to be lacking. (W. M. K.)

MARCELLO, BENEDETTO (1686–1739), Italian composer, born in Venice on Aug. 1, 1686, of a patrician family. He was intended by his father for the law but became a pupil of A. Lotti and F. Gasparini. In 1711 he was a member of the Council of Forty and in 1730 went to Pola (Istria) as governor. After eight years he retired to Brescia as chancellor, where he died on July 24, 1739.

Marcello is specially remembered for two works: the operatic satire *Il teatro alla moda* (1720), an important document in the early history of opera; and *Estro poetico-armonico* (1724–26), a setting for voices and instruments of the first 50 psalms in an Italian paraphrase by G. Giustini. An edition with English words was brought out by J. Garth and C. Avison in 1757. Marcello's other compositions include operas, oratorios, cantatas, concertos and sonatas. He was also a poet and translated John Dryden's *Timotheus* as a text for one of his own cantatas and wrote a libretto for G. Ruggieri's opera *Arato in Sparta* (1710). The celebrated Concerto in D minor (sometimes transposed into C minor) for oboe and strings, long attributed to Benedetto, is now known to have been composed by his brother Alessandro (1684–*c.* 1750). A catalogue of Marcello's works is given in *Monatshefte für Musikgeschichte,* vol. xxiii (1891).

See *Il teatro alla moda,* Eng. trans. by R. G. Paully in *Musical Quarterly,* vol. xxxiv–v (1948–49). (Cs. Ch.)

MARCELLUS, the name of two popes.

St. Marcellus I (d. *c.* 309), pope from *c.* 308 to *c.* 309, succeeded Marcellinus, after an interval of three or four years. The penances that he imposed on the Christians who had lapsed in the recent persecution led to rioting. Probably early in 309 he was banished from Rome by Emperor Maxentius and died shortly afterward. His feast day is Jan. 16. (R. E. McN.)

Marcellus II (Marcello Cervini) (1501–1555), pope in 1555, was born at Montefano near Macerata in the States of the Church on May 6, 1501. A model priest and a leader of the Catholic reform, he was also distinguished as a humanist and archaeologist. Cardinal in 1539, he proved an effective papal legate at the Council of Trent. He was elected pope on April 10, 1555, but died on May 1 of the same year. (E. A. R.)

MARCELLUS, a Roman plebeian family belonging to the *gens Claudia.* Its most distinguished members were:

Marcus Claudius Marcellus (*c.* 268–208 B.C.), one of the Roman generals during the Second Punic War and conqueror of Syracuse. He first served against Hamilcar in Sicily. In his first consulship (222) he was engaged, with Gnaeus Cornelius Scipio as colleague, in war against the Insubres and won the *spolia opima* (spoils won by a general who had killed an enemy chief in single combat) for the third and last time in Roman history by slaying their chief Viridomarus or Virdumarus. In 216, after Cannae, he took command of the remnant of the army at Canusium and, although he was unable to prevent Capua's going over to Hannibal, saved Nola and southern Campania. Consul for the third time in 214, he was sent to Sicily, where he stormed Leontini and besieged Syracuse, but the skill of Archimedes repelled his attacks. He took Syracuse after a two years' siege and set the example of carrying away the art treasures of a captured city. Consul again in 210, he took Salapia in Apulia, which had revolted to Hannibal; as proconsul, in 209, he attacked Hannibal near Venusia. In his last consulship (208), he and his colleague, while reconnoitring near Venusia, were surprised by the enemy, and Marcellus killed. His successes have been exaggerated by Livy, but the name often given to him, the "sword of Rome," was well deserved.

Marcus Claudius Marcellus (d. 46 B.C.), an inveterate opponent of Julius Caesar. During his consulship (51) he tried to remove Caesar from his army in March 49, but was outmaneuvered by Curio. He scourged a citizen of Novum Comum in order to flout Caesar's grant of privilege to the city. In Jan. 49 he vainly tried to put off declaring war against Caesar until an army could be got ready. He followed Pompey to Greece and, after Pharsalus, retired to Mytilene, where he practised rhetoric and studied philosophy. In 46 the senate successfully appealed to Caesar to pardon him, this being the occasion of Cicero's speech *Pro Marcello.* Marcellus left for Italy but was murdered in May by one of his own attendants, P. Magius Chilo, at Piraeus. Marcellus was a thorough aristocrat. He was an eloquent speaker and a man of firm character, although not free from avarice.

Marcus Claudius Marcellus (*c.* 42–23 B.C.), son of Gaius Claudius Marcellus and Octavia, sister of Augustus. In 25 he was adopted by the emperor and married to his daughter Julia. This seemed to mark him out as the heir to the throne. In 25 he accompanied the emperor to Spain but in 23, when a curule aedile, he died at Baiae. Great hopes had been built on the youth and he was celebrated by many writers, especially by Virgil in a famous passage in the *Aeneid.* He was buried in the mausoleum of Augustus, and Augustus himself pronounced the funeral oration. It was to this Marcellus that the theatre begun by Julius Caesar and completed by Augustus was dedicated (to the west of the Capitoline hill in Rome).

Bibliography.—For the first Marcellus, *see* Livy, xxiii, 14–17, 41–46; xxiv, 27–31, 35–39; xxv, 5–7, 23–31; xxvi, 26, 29–32; xxvii, 1–4, 21–28; Polybius, viii, 5–9; x, 32. For the second, *see* Cicero, *Letters, ad Familiares,* iv, 4, 7, 10, 12; viii, 1; *ad Atticum,* v, 11; Caesar, *Gallic War,* i, 2; Suetonius, *Caesar,* 28–29. For the third, *see* Horace, *Odes,* i, 12; Virgil, *Aeneid,* vi, 860 *et seq.;* Propertius, iii, 18; Dio Cassius, liii, 28, 30; Tacitus, *Annals,* ii, 41; Suetonius, *Augustus,* 63.

MARCH, EARLS OF, a title derived from the Marches or border regions between England and Wales and England and Scotland.

Welsh Marches.—In England the title was first held, between 1328 and 1425, by successive heads of the Mortimer (*q.v.*) family and afterward by the heir to their estates, Richard Plantagenet (d. 1460), duke of York. His son, Edward (d. 1483), later King Edward IV, was known as earl of March during his father's lifetime, and in 1479 this was among the titles which that king conferred on Edward (d. 1483), prince of Wales (afterward Edward V). In 1619 the earldom was revived for Esmé Stewart (1579–1624), duke of Lennox, and was held by his successors as dukes of Lennox and Richmond until 1672 (*see* Lennox, Earls and Dukes of). It then passed (1675) to Charles (Lennox), son of Charles II by the duchess of Portsmouth and ancestor of the

dukes of Richmond and Lennox (*see* RICHMOND, EARLS AND DUKES OF), in whose family it has since remained, being used as a courtesy title for the eldest son of the family during his father's lifetime. This English peerage must be carefully distinguished from the Scottish earldom of March.

Scottish Earls.—The Scottish earls of March were descended from CRINAN, father of Duncan, king of Scotland from 1030 to 1040, who was murdered by Macbeth. MALDRED, another son of Crinan, married Ealdgyth, daughter of Uhtred, earl of Northumberland, and of Elgiva, daughter of the Anglo-Saxon king Aethelred II. Maldred's son COSPATRIC or GOSPATRIC (d. *c.* 1075) was made earl of Northumberland (1067) by William the Conqueror, but he was deprived of this position (1072) and fled to Scotland where his cousin Malcolm III granted him Dunbar and adjoining lands. His son COSPATRIC (d. before Aug. 1139) witnessed the charter of Alexander I founding the abbey of Scone (*c.* 1115) and was perhaps killed fighting on the Scottish side at the battle of the Standard near Northallerton in Aug. 1138. His son, the third COSPATRIC (d. 1166) left two sons, the younger of whom was the ancestor of the earls of Home. The elder son, WALTHEOF or WALDEVE (d. 1182), was one of the sureties for the carrying out of the treaty of Falaise (Dec. 1174), arranging the release of the Scottish king William the Lion who had been captured by English forces while attacking Alnwick. The name of Dunbar, derived from the family estates, became a hereditary surname in the time of Waltheof's son PATRICK (d. 1232). This Patrick, styled 4th earl of Dunbar, was keeper of Berwick castle and married Ada, King William's illegitimate daughter. His son PATRICK (d. 1248) started out on the 7th crusade but died at Marseilles. His son PATRICK (d. 1289), the 6th earl, supported the Anglophile party in Scottish politics, helping to overthrow the "national" party led by the Comyns in 1255. In the same year he was nominated a guardian of the young king Alexander III.

PATRICK DUNBAR (d. 1308), 7th earl of Dunbar, was the first of his line to be called earl of March. He was referred to as *comes de Marchia* at the Brigham parliament of 1290. He claimed the crown of Scotland in 1291 in right of his great grandmother Ada, but soon withdrew and did fealty (1296) to the English king Edward I. In the subsequent wars he took the English side and was appointed (1298) commander of the English forces south of the Forth.

PATRICK DUNBAR (*c.* 1285–1368), 8th earl of Dunbar and 2nd earl of March, helped Edward II to escape after the English defeat at Bannockburn (1314) but then joined the Scottish patriots, fighting with them in 1332–33 at the battles of Dupplin and Halidon hill. His countess, known in Scottish history and romance as "Black Agnes," daughter of Thomas Randolph, earl of Moray, conducted a spirited defense of Dunbar castle when it was besieged (1338) by the earl of Salisbury. Both Earl Patrick's sons predeceased him; he therefore resigned his earldom to the crown and it was regranted to his greatnephew and heir male, GEORGE DUNBAR (d. *c.* 1416–20) who became the 9th earl. He was made warden of the marches (1372), accompanied James, earl of Douglas, on his foray into England and commanded the Scots after Douglas was killed at Otterburn (1388). Having been badly treated by King Robert III, by his son the duke of Rothesay and by the Douglases, he renounced his allegiance (1400) and fled to England, subsequently fighting on the English side at the battle of Homildon hill (1402). At the battle of Shrewsbury (1403) Dunbar fought against the Percys and Owen Glendower, with whom Douglas was now allied. He was forfeited but returned to Scotland (1409) after the death of Robert III and was restored to his earldom by the regent Albany.

His son GEORGE DUNBAR (d. *c.* 1455–57), 10th earl of Dunbar and 4th earl of March, was one of the negotiators (1423–24) for the release of James I from captivity in England; Dunbar was knighted at that king's coronation. But on the doubtful ground that the regent had had no power to reverse Patrick Dunbar's forfeiture, James II seized Dunbar castle in 1434 and the earl fled to England. The parliament at Perth (Jan. 1435) declared his lands and titles forfeited to the crown.

The earldom of March, thus forfeited, was conferred (1455) by James II on his second son ALEXANDER, afterward duke of Albany. But this prince later entered into correspondence with Edward IV of England and the earldom of March and the barony and castle of Dunbar were again (1487) annexed to the crown of Scotland.

The Scottish earldom of March was next held from 1580 to 1586 by ROBERT STEWART, second son of John, 3rd earl of Lennox. By another creation, the title was then conferred (1697) on WILLIAM DOUGLAS, 2nd son of William, 1st duke of Queensberry, and has been merged since 1826 with the earldom of Wemyss. *See* ALBANY, DUKES OF; LENNOX, EARLS AND DUKES OF; QUEENSBERRY, EARLS, MARQUESSES AND DUKES OF; WEMYSS, EARLS OF.

MARCH, AUSIÀS (1397–1459), the greatest poet of the Catalan language, and the most vigorous poetic personality of the 15th century in the Iberian peninsula, was born of a noble family, probably at Gandía, and died at Valencia. As a young man he accompanied Alfonso the Magnanimous of Aragon to Sardinia and Corsica, and took part in the Neapolitan and Sicilian campaigns and in the attack on Djerba in 1424. He retired at 32 to his own estates and at 40 married the first of his two wives, a sister of Joanot Martorell, author of the most important of Catalan novels, *Tirant lo Blanc* (*c.* 1460).

March's outwardly uneventful life contrasts with his tormented verses, which chronicle the conflict between his sensuality and his passionate idealism, issuing in anguished contempt for the flesh and for his own weakness and that of his mistress, Teresa Bou, in yielding to it. Except for Petrarch, all the formative influences on March's poetry and on his attitude to life—the Provençal troubadours, Scholastic philosophy and the *dolce stil nuovo*—place him as a writer of the middle ages rather than of the Renaissance: his apparent modernity lies in his highly personal expression of his dilemma in starkly abstract verse, almost devoid of imagery, and uncompromising in its intellectual and metaphysical subtlety, except when his implacably analytical probing into his own nature yields to an outburst of despair and self-loathing.

March's poems are by convention divided into *Cants d'amor* and *Cants de mort* (respectively before and after his mistress' death), *Cants morals*, and the great *Cant espiritual*, in which he at last attains to a measure of serenity in the face of death. His influence on the Castilian poetry of the golden age was as great as that of his Castilian predecessors on his own work had been negligible.

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MARCH, FRANCIS ANDREW (1825–1911), U.S. philologist, lexicographer and educator, whose special field of study was the English language, was born on Oct. 25, 1825, in Millbury, Mass. He graduated in 1845 from Amherst college, where his attention was turned to the study of Anglo-Saxon by Noah Webster. After teaching in secondary schools and at Amherst, he went in 1855 as a tutor to Lafayette college, Easton, Pa., where in 1857 he became professor of English language and comparative philology—the first chair of the kind established. In 1907 he became professor emeritus.

In 1865 he published *Method of Philological Study of the English Language*, and in 1870 *A Comparative Grammar of the Anglo-Saxon Language*, a monumental work, and *An Anglo-Saxon Reader*, both marking a new era in the study of English in America. To the "Douglass Series of Christian Greek and Latin Classics," which he edited, he contributed *Latin Hymns* (1874). In 1879–82 March was director of the American readers for the Philological Society's *New English Dictionary*. His article "On Recent Discussions of Grimm's Law" in the *Transactions and Proceedings* of the American Philological association for 1873 in large part anticipated Verner's law. With his son, Francis Andrew March (1863–1928), who was also a professor at Lafayette and a noted lexicographer, he edited *A Thesaurus Dictionary of the English Language* (1903). March died in Easton on Sept. 9, 1911. Peyton Conway March (*q.v.*) was also his son.

MARCH, PEYTON CONWAY (1864–1955), U.S. army officer who served as army chief of staff, 1918–21, was born at Easton, Pa., on Dec. 27, 1864, and attended that city's Lafayette college, where his father was a professor. After graduation in 1884 he entered the U.S. Military academy at West Point, N.Y., graduating in the class of 1888. March served in the Philippines during the Spanish-American War as an artillery officer. From 1903 to 1907 he served on the army general staff and was for a short time stationed in Manchuria as an observer of the Russo-Japanese War. During World War I he was put in charge of U.S. artillery forces in France and in May 1918 was named chief of staff, U.S. army, with the rank of general. In this position he had to deal with many difficult problems of army organization, training and demobilization. He retired from active duty on Nov. 1, 1921.

March received many decorations and awards from his own and other countries; in 1953 congress passed a joint resolution of thanks for his military services to the nation. He died in Washington, D.C., on April 13, 1955.

See Peyton C. March, *The Nation at War* (1932).

MARCH (Lat. *Martius*), the third month of the modern calendar, has 31 days. According to tradition the earliest Roman calendar, ascribed to Romulus, had only ten named months, March through December, the "dead season" of midwinter being left undesignated; to these ten January and February were later added by Numa Pompilius. Though the historical evidence for these early calendars is disputed, it is clear, if only from the names of the numbered months (*e.g.* December, "tenth month"), that March was originally the first month, the starting point for the annual cycle of religious festivals. It was only in or after 153 B.C., when Jan. 1 was finally fixed as the date for new magistrates to take office, that the civil calendar prevailed over the religious, and January thus came to be regarded as the first month. Since early spring was the season for renewed activity both in agriculture and in warfare, March was appropriately named for the god Mars, who seems to have been originally both a god of war and the protector of vegetation. (*See* also CALENDAR: *Western Calendar.*)

Memorable dates in this month include March 15 ("the Ides of March"), on which Julius Caesar was assassinated, and St. Patrick's day, March 17. Since the Council of Nicaea (A.D. 325) the date of Easter, the chief movable feast of the Christian calendar, has been calculated from the vernal equinox, reckoned as March 21. Until the passage of the 20th amendment to the Constitution, presidents of the United States were normally inaugurated on March 4. This amendment, adopted in 1933, modified the provisions of the 12th amendment and set the date for the inauguration on Jan. 20. (F. R. WN.)

MARCHAND, JEAN BAPTISTE (1863–1934), French general and explorer celebrated for his occupation of Fashoda in 1898, was born at Thoissey, Ain, on Nov. 22, 1863. After four years' service in the marines and at the military school of St. Maixent, he was commissioned sublieutenant in 1887. On active service in Senegal in 1889, when he was twice wounded, he was made a chevalier of the Legion of Honour. Appointed captain in 1892, he took part in expeditions to the western Sudan and to the hinterland of the Ivory Coast from 1893 to 1895. He was then entrusted by the French government with the task of crossing Africa from the west to the White Nile at Fashoda (Kodok), in order to prevent the British from linking Egypt to Uganda. Marchand left Brazzaville in Jan. 1897 with a small force and reached Fashoda in July 1898. The Fashoda crisis between Great Britain and France ensued (*see* EGYPT: *History*). He was subsequently promoted commander of the Legion of Honour.

After the outbreak of the Boxer rebellion in China in 1900, Marchand joined the French expeditionary force in Peking, of which he became chief of staff. He resigned from the army in 1904 with the rank of lieutenant colonel. Recalled to active service in World War I, he rose to be general of division (April 1917). He retired again from the army in 1919, receiving the grand cross of the Legion of Honour. Marchand died in Paris on Jan. 13, 1934.

See J. Delebecque, *Vie du général Marchand* (1936).

MARCHAND, JEAN HIPPOLYTE (1883–1941), French painter, was born in Paris on Nov. 22, 1883. He studied with Leon Bonnat and Luc Merson (1902–06), but deserted conventional styles, and exhibited at the Salon des Indépendants in 1908. He visited Russia and England on several occasions. Though Marchand came under the influence of Cubism between 1910 and 1912, his work was not greatly affected by it. His human forms are treated with power and discretion, while his landscapes and still life are tinged with an intense melancholy. He died in Paris on Oct. 10, 1941.

MARCHE (LA MARCHE), a province of France under the *ancien régime*, bounded in its ultimate form by Limousin in the south and southwest, by Poitou in the west, by Berry in the north, by Bourbonnais in the northeast and by Auvergne in the southeast, so that it corresponded, in terms of modern *départements*, to most of Creuse with a small fragment of Indre and much of northern Haute-Vienne (*qq.v.*).

In ancient times the country was part of Limousin (*q.v.*), from which it was detached in the middle of the 10th century to form a separate frontier countship, march or mark, to protect Poitou and the rest of the duchy of Aquitaine against invasion, whether by the French king's troops from Berry or by Norman raiders from the Loire valley. The first count, Boso the Old (recorded in 944), belonged to the Poitevin house of Charroux, but his direct male line died out in 1091, and the countship then passed to the house of Montgommery, which sold it in 1177 to Henry II of England. Henry's son John gave it to Hugh IX of Lusignan in 1199 (*see* LUSIGNAN). After the death of Hugh XIII of Lusignan (1303), the countship was confiscated by the French king Philip IV in 1308.

Meanwhile the frontiers of the countship had undergone changes. Charroux in the west remained a fief of Poitiers; Boussac in the northeast was gradually annexed to Berry; Combraille (the country round Chambon) in the east was taken by Auvergne in 1180; and the countship's only major acquisition was the viscounty of Aubusson, in the southeast (*c.* 1260). Moreover, a chain of fiefs depending directly on Poitiers, interspersed with ecclesiastical lordships, grew up to cut the countship practically into western and eastern halves, Basse Marche and Haute Marche. Basse Marche, on the middle Gartempe river, had Le Dorat and Bellac as its chief towns. Haute Marche, mainly on the Creuse, had Guéret, Ahun and eventually Aubusson.

Philip IV of France gave the countship to his third son, the future Charles IV, as an appanage in 1311 and made it a peerage for him in 1316. Charles in 1327 granted it to Louis I de Bourbon. It was held by a junior line of the Bourbons from 1342 to 1435, by a junior line of the house of Armagnac from 1435 to 1477, then by Pierre II de Bourbon (Pierre de Beaujeu) and by the constable Charles, duc de Bourbon. Confiscated by Francis I of France in 1527, it was granted successively to the widows of the French kings from 1574 to 1643. From the late 17th century to the end of the *ancien régime* the title was borne by sons of the princes de Conti.

Administratively, Basse Marche was from 1586 under the intendant of Limoges, but Haute Marche was under the intendant of Moulins (Bourbonnais). Judicially, the whole province depended on the *parlement* of Paris. The manufacture of tapestries at Felletin and at Aubusson dates from the 14th to the 16th centuries.

MARCHES, THE (Italian MARCHE), a region of central Italy, composed of the provinces of Ancona, Ascoli Piceno, Macerata and Pesaro-Urbino. Area 9,692 sq.km. (3,742 sq.mi.). Pop. (1961) 1,310,847. The Marches is a region of mountains and hills, the only pieces of level land being scattered along river valleys and on the Adriatic shore. Its mountain backbone is the Umbrian-Marchigian section of the Apennines; the administrative boundary between the Marches and neighbouring Umbria is the watershed between the Tyrrhenian and Adriatic slopes. The highest peak of the region is Monte Vettore (8,130 ft.). Except for the northernmost part, the hills of Montefeltro, the Marches is characterized by rivers running at right angles to the main Apennine crests out to the Adriatic, separated by low parallel ridges. The most im-

portant of these rivers are the Metauro, the Foglia, the Esino, the Potenza, the Chienti and the Tronto, the last named forming the boundary between the Marches and the Abruzzi. The upper valleys of these streams are narrow, often passing through deep gorges, while the lower sections are wider. The valley bottoms are thoroughly cultivated and most of the lower slopes are either in meadows or in well-tended fields.

The economy of the Marches is predominantly agricultural. Wheat and maize (corn) are the main cereals, and there are vineyards on all the sunny slopes, a white wine produced in the area being especially popular. The local type of cattle, beasts of burden rather than meat or milk producers, are known throughout Italy, and there are large numbers of horses, pigs, sheep and poultry. Fishing is important in several of the Adriatic ports, especially in Ancona and San Benedetto del Tronto. Industries are mostly small or medium sized and include shipbuilding in Ancona, paper in Fabriano, textiles in Iesi, musical instruments in Castelfidardo, pottery in Pesaro and Recanati. Ancona is the largest city and the only one with a natural harbour; Pesaro is the only other urban centre of any size on the seacoast. The other cities are hilltop settlements, like Urbino, Macerata and Ascoli Piceno, or valley centres, like Iesi and Fabriano. The main artery of north-west-southeast travel is the coast railroad, from Bologna through Rimini to Pesaro and Ancona and on to Foggia and Bari. Ancona also has a direct rail line to Rome. There are few secondary railroads, but a good network of roads links all settlements.

The Marches, originally inhabited by the Gauls and the Picenes, were incorporated early into the domain of Rome and became a single administrative unit as early as A.D. 292. During the early middle ages the southern part was ruled by the Lombards; the northern section, the so-called "Five Cities" along the Adriatic (Fano, Pesaro and others), was under the control of the Byzantine exarch of Ravenna. The name of Marches ("border province") appears during the 10th century; shortly afterward numerous "communes" constituted themselves into independent units. With the emergence of such powerful feudal families as the Montefeltro of Urbino and the Malatesta of Pesaro came turbulent times, aggravated by the desire of the popes to include the Marches in their domain. After the decline of the feudal lords, in the latter part of the 16th century, the Marches became part of the papal states, and remained thus until their incorporation in the kingdom of Italy in 1860. (G. Kh.)

MARCHESI, MATHILDE (née Mathilde Graumann) (1821–1913), German singer and teacher, was born at Frankfurt am Main on March 24, 1821. In 1845 she went to Paris to study with Manuel García. She made her debut as a singer in 1849 but in 1854 began her teaching career. She taught at the conservatories of Vienna and Cologne as well as in London and Paris. In 1852 she married the Italian baritone Salvatore Marchesi, cavaliere de Castrone and marchese della Rajata (1822–1908), who was also a well-known teacher. Marchesi published works on the technique of singing and in 1897 a volume of reminiscences, *Marchesi and Music*. She died in London on Nov. 17, 1913. Her daughter, Blanche Marchesi (1863–1940), was a Wagnerian singer and a teacher. She published *Singer's Pilgrimage* (1923).

MARCIAN (396–457), Eastern Roman emperor 450–457, was born in 396 in Thrace, the son of a soldier. He followed his father's profession, but during the Persian war of 421 he was still a private. He later entered the service of Aspar (*q.v.*) and fought under him in 431 in Africa, where he became a prisoner of the Vandals. It is said that even at this date Gaiseric, the Vandal king, predicted his future greatness. When Theodosius II died in 450, Marcian had risen high in Aspar's service; and Theodosius' sister Pulcheria, who then chose Marcian as her husband, and Aspar had him appointed emperor on Aug. 25. In foreign policy Marcian was a man of peace, although he adopted a stiffer attitude toward Attila than Theodosius II had done and although there were minor troubles with the Saracens on the eastern frontier. But he refused to become entangled in war with the Vandals in Africa. In religion he was strictly orthodox, and the greatest event of his reign was the meeting of the fourth ecumenical council, which opened at Chalcedon on Oct. 8, 451 (*see* Council: *Councils to the 9th Century*). In internal affairs Marcian was an energetic administrator. He saved money by refusing to pay tribute to the Huns, and he remitted taxation so far as he could, favouring the wealthier classes by abolishing the *follis*, the tax on the property of senators. He also confined the expensive office of the praetorship to senators resident in Constantinople. The result was that at his death he left a well-filled treasury, and his reign was looked back upon as a golden age. Marcian died at the beginning of 457, and with him the Theodosian dynasty came to an end. His daughter Euphemia was married to Anthemius (*q.v.*), later emperor of the west. Marcian's successor was Leo I (*q.v.*).

See J. B. Bury, *History of the Later Roman Empire*, vol. i (1923); E. Stein, *Histoire du Bas-empire*, vol. i (1959). (E. A. T.)

MARCION (fl. 2nd century A.D.), the leader of a vigorous heretical movement in early Christianity, the most striking tenet of which was the doctrine of two Gods: one the Creator and Judge, the other the God whom Jesus revealed. Since nothing from Marcion's hand has survived, and any information about him must be derived from the occasional and often biased comments of such orthodox opponents as Tertullian (*Against Marcion*) and St. Epiphanius (*Panarion*), scant knowledge of the man himself is available. Obviously a person of considerable originality and force, he hailed from Sinope (Sinop) in Bithynia-Pontus, where his father is said to have been the Christian bishop. He appears to have become a shipowner and a man of some wealth. His early life is altogether obscure but toward the middle of the 2nd century he emerged as an influential teacher in Rome. It is likely that this activity in the Roman Church followed upon similar activity farther to the east. It has been argued that Polycarp's epistle to the Philippians (*c.* A.D. 130) reflects the presence and influence of Marcion in Macedonia. Having reached Rome (*c.* A.D. 137), he was associated for a time with Cerdo, an important Gnostic teacher, and it is possible that some of the features of his thought are to be ascribed to Cerdo's influence. But Marcion was not a true or typical Gnostic despite his dualism and docetism (*q.v.*). He thought of himself as being a devoted disciple of Paul, who, he claimed, was the only true apostle. Because he looked upon the Jewish Scriptures, which were also at that time the Scriptures of the early church, as belonging to the inferior Creator-God, he repudiated them and set up in their place for his followers a new scripture consisting of a gospel (closely resembling that of Luke) and the Epistles of Paul. He also composed the *Antitheses*, a work in which the law and the Gospel were sharply contrasted. Marcion was a gifted organizer as well as a brilliant and persuasive teacher, and the movement he established became both widespread and powerful. The date of his death is unknown. *See also* Marcionites; Gnosticism.

See A. von Harnack, *Marcion: das Evangelium vom fremden Gott* (1921 and 1924). (J. Kx.)

MARCIONITES. Marcion (*q.v.*) exercised a major influence upon the development of Christianity in the 2nd century, an influence to be seen both in what the church took from him—especially a renewed attention to the writings of St. Paul—and in the measures adopted to oppose what was quickly perceived to be a dangerous perversion of the Gospel. Marcion was not merely an exponent of heresy or the leader of a school of thought verging on Christianity but also a founder of churches that were at first serious rivals to orthodox Christianity and kept themselves in being for centuries.

Marcion's theology centred upon his conviction that Christianity was something wholly new. Unable to reconcile the God revealed in Jesus with the God described in the Old Testament, he severed the Christian revelation from its roots in past history and taught that Jesus had come to reveal the true God, as yet wholly unknown, a God of pure love who had now for the first time acted in the material universe by sending His Son to redeem men from it. The Old Testament was not rejected as untrue; it was revelation of a kind. But the god whom it truly revealed, the god of the Jews, the demiurge (*q.v.*), was an inferior being who had fashioned the material universe, including man, and ruled it on the principle of law and obedience. He was powerful, but not omnipotent; at best, he was just, at worst, capricious, wrathful and

violent. Although not in himself the principle of evil, he was not the principle of good. The Messiah of the Old Testament was not identified with the Son of the true God. In redeeming men from sin and death, Jesus, the Son of God, was also rescuing them from the demiurge, who would eventually pass away together with his material universe. In all this Marcion was convinced that he had the support of St. Paul, indeed that he alone properly understood the apostle. In Paul he saw, above all else, the antithesis between law—the principle of the demiurge, of the Old Testament and of the Jews—and gospel—the principle of the God of love and of redemption in Jesus. With law went rewards and punishments, justification by works of obedience, while to gospel belong faith, liberty and grace. He also made the most (and more) of Paul's distinction between flesh and spirit. It cannot be doubted that Marcion was genuinely trying to interpret St. Paul; that the contemporary church was showing signs of a legalism contrary to the spirit of Paul and had an inadequate understanding of his profoundest teachings; or that Marcion was honestly facing real problems—in general, the problem of evil, and, in particular, the problem of the character of God as described in the Old Testament. He refused to adopt the method of allegorical exegesis which removed the latter difficulty for most Christians in an age which knew little of biblical criticism or "progressive revelation."

On the other hand, it is equally clear that Marcion perverted the teaching of St. Paul and that his own views had certain other sources. How Marcion's doctrine was related to gnosticism (*q.v.*) has often been a matter of controversy. He was unlike some leading gnostic teachers in that he eschewed all theories of aeons and emanations from God, had no fantastic mythology of redemption and did not so classify men by their natures that salvation was assured to one class and denied to another: for him, salvation was received by faith in Jesus Christ, indeed in Christ crucified. But it seems wrong to distinguish him from the gnostics on the ground that, while they were primarily philosophers, he was essentially religious; for the gnostic systems were normally offered as religions of redemption from evil and death. Marcion's kinship with gnosticism is inescapably evident in his attitude to matter and to the flesh; matter (at least according to his early critics) he treated as the principle of evil, and the flesh, if not intrinsically evil (as he probably believed), was for him unworthy of redemption. Hence his Christology was docetic; Christ had no true human nature (*see* DOCETISM). Though Marcion emphasized the place of the Cross and of suffering in redemption, it is doubtful whether he could consistently do this. Unlike Paul, he did not wrestle with the reconciliation of love and justice in one God, so that his doctrine of redemption, the core of his teaching, was after all shallow and un-Pauline. The same was probably true of his notion of faith and grace.

Marcion organized his followers into churches outwardly similar to those of the catholic church. They had an episcopal ministry, practised (illogically, his critics said) the sacraments of baptism and the eucharist and lived ascetically, renouncing marriage. Further, they possessed a Bible, the first fixed canon of Christian scriptures. Marcion accepted only St. Luke's Gospel and ten Pauline epistles (*i.e.*, he excluded the Pastorals and Hebrews); and these he mutilated, cutting out anything inconsistent with his own beliefs. Besides furnishing the epistles with prologues, Marcion gave his churches a guide to their interpretation in his *Antitheses*, a book that has not survived but that can be reconstructed in part from Tertullian's *Against Marcion*.

The existence of such churches compelled the catholic church to take Marcion very seriously. After the earlier skirmishers, such as Justin Martyr, Irenaeus attacked him, among the gnostics, in his *Against Heresies* (*c.* 185), as did Tertullian in his longest work, *Against Marcion* (*c.* 207), and elsewhere. It was easy to attack his arbitrary treatment of the text of those books which he himself accepted as Scripture, to press against him the argument from history and prophecy and to assert the necessary unity of the God of creation and redemption, the goodness of matter as God's creation and, therefore, the full reality of Christ's humanity (technically, Marcion's Christology was not only docetic but also modalist, the Son being conceived as no more than a manifestation of the Father); but also, if the church was to reject the dualism of good and evil (or imperfect) gods or of God and matter as the answer to the problem of evil, it had to develop its alternative solution. Hence the renewed emphasis upon the doctrine of the Fall evident in Irenaeus, Tertullian and Origen. Further, Marcion's misuse of St. Paul had to be countered by an even deeper interpretation of his essential message. This was largely provided by Irenaeus. Tertullian also emphasized the redemption of all creation (including the resurrection of the flesh) and brought out the continuity of sacred history: the good God had not been absent from his creation before the Incarnation. Marcion's canon produced a crystallization of the church's own, with apostolic authorship as the criterion. Paul, of course, was accepted, but so were Peter and John. Other Gospels with apostolic authority were set with St. Luke's; and further attention was drawn to the importance of the apostles by the inclusion of Acts. More generally, apostolicity was advanced as a principal mark of the true church in reply to Marcion and to other gnostics who took too little account of history and of tradition or who claimed to have secret revelations of their own. The church appealed to the apostolic writings and to the tradition preserved in churches of apostolic origin, seen in worship and in the apostolic rule of faith and guarded by the bishops in manifest succession of office in each local church—often, it was believed, from the days of the apostles themselves. Marcion did not create catholicism by causing a development, in reaction to himself, which would not otherwise have occurred: the concept of canonicity, respect for apostolic tradition, creeds and an authoritative ministry were none of them novelties. Rather he quickened the pace of the movement toward that presentation of "the catholic church" which is worked out in, for instance, Tertullian's *De praescriptione haereticorum*. That the dangers of excessive rigidity, traditionalism and institutionalism were not completely avoided is probable, and Montanism (*q.v.*) may be interpreted as in part a reaction from these aspects of catholicism. (*See* also GNOSTICISM.)

Marcionite churches spread rapidly through the empire, but the movement lost impetus in the west before the 3rd century was over. They probably merged into Manichaeism (*q.v.*). That they flourished longer in the east was shown by Cyril of Jerusalem (*c.* 350), who supposed that any city may contain a Marcionite conventicle; by Theodoret of Cyrrhus (in the middle of the 5th century), who converted many Marcionites in his diocese; and by Esnik's writings against those in Armenia. Clear traces of Marcionism proper were lost after the 7th century, but the dualism of the Marcionites, their suspicion of the flesh and their asceticism reappeared in other sects, such as the Paulicians and Bogomils, as well as in the Manichees. More modern tendencies among Christians to dismiss the Old Testament are often called Marcionism, while theologians who distrust natural theology and natural law sometimes express their understanding of the uniqueness of revelation in Christ in terms which recall those of Marcion himself.

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MARCOMANNI (MARCOMĂNI) were a German tribe who settled in the Main valley soon after 100 B.C. To escape Roman aggression in 9 B.C. they migrated east to Bohemia, where under their king Maroboduus they built an exceedingly powerful confederation of tribes. Tiberius was planning a major attack on them in A.D. 6, when he was recalled by revolt in Pannonia; but the kingdom broke up after a war with Arminius (*q.v.*) and in 19 Maroboduus became an exile in Roman territory. For many decades thereafter the Marcomanni and their neighbours the Quadi were clients of Rome, receiving frequent subsidies; and many Roman traders settled in their country. An attack by both tribes on Domitian in 88–89 was an isolated incident. But in 167 (probably) the Marcomanni with many allies invaded Pannonia

and penetrated into Italy. Marcus Aurelius expelled them, but was involved in war with them almost constantly till his death in 180, having apparently decided to annex their country. His plans were abandoned by his son Commodus, and from then on the Romans were on the defensive. The actual tribe is seldom mentioned again, but it doubtless formed part of the later "Alamannic" confederations.

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MARCONI, MARCHESE **GUGLIELMO** (1874–1937), Italian physicist, the inventor of a practical system of radiotelegraphy, was born in Bologna on April 25, 1874, the son of an Italian country gentleman who had married the daughter of Andrew Jameson of County Wexford, Ire. Educated first in Bologna and later in Florence, Marconi then went to the technical school of Leghorn, where he studied physics under Vincenzo Rosa and had every opportunity of investigating electromagnetic (or hertzian) wave technique, following the earlier mathematical work of James Clerk Maxwell and the experiments of Heinrich Hertz, Édouard Branly, Sir Oliver Lodge, Augusto Righi and others.

In 1894 Marconi began experimenting at his father's estate in Pontecchio, near Bologna, using comparatively crude apparatus: an induction coil with a spark discharger controlled by a Morse key at the sending end and a simple coherer at the receiver. After preliminary experiments over a short distance, he first improved the coherer and made it self-restoring in operation; then, by systematic tests, he showed that the range of signaling was increased by using a vertical aerial with a metal plate or cylinder at the top of a pole connected through the spark gap to a similar plate on the ground. In this way, the range of signaling was increased to about 1½ mi., and Marconi had convinced himself of the potentialities of this new system of communication. It was at this period also that he conducted some simple experiments with reflectors around the aerial to concentrate the radiated electrical energy into a beam instead of spreading it in all directions.

As he received little encouragement to continue his experiments in Italy, he went to England, and in Feb. 1896 he arrived in London and met William Preece, engineer in chief of the post office, who offered him assistance and encouragement. Marconi filed his first patent in England in June 1896 and, during that and the following year, he gave a series of successful demonstrations, in some of which he used balloons and kites to obtain greater height for his aerials. He was able to send signals over distances of up to 4 mi. on Salisbury plain and to nearly 9 mi. across the Bristol channel. These tests, together with Preece's lectures on them, attracted considerable publicity both in England and abroad; and, in June 1897, Marconi went to La Spezia, where a land station was erected and communication was established with Italian warships at distances of up to 12 mi.

There was, however, still much skepticism about the useful application of this means of communication and a lack of interest in its exploitation. But Marconi's cousin Jameson Davis, a practising engineer, financed his patent and was instrumental in the formation of the Wireless Telegraph and Signal Co., Ltd., the name of which was changed in 1900 to Marconi's Wireless Telegraph Co., Ltd. John Ambrose Fleming, who was to patent the first two-electrode thermionic valve in 1904, became scientific adviser to the company, the efforts of which for some time were devoted to assisting Marconi in his continuous endeavour to show to the full the possibilities of radiotelegraphy. A further step was taken in 1899, when a wireless station was established at South Foreland, Eng., for communicating with Wimereux in France, a distance of 31 mi.; in the same year British battleships exchanged messages at 75 mi.

In Sept. 1899 Marconi equipped two U.S. ships to report to newspapers in New York city the progress of the yacht race for the America's cup. This was another great success, arousing world-wide excitement and leading to the formation of the American Marconi company. The following year the Marconi International Marine Communication Co., Ltd., was established for the purpose of installing and operating services between ships and land stations. In 1900, also, Marconi filed the famous patent No. 7777 for "Improvements in Apparatus for Wireless Telegraphy." This was based on the earlier work of Sir Oliver Lodge in tuning wireless transmitters and receivers, enabling several stations to operate on different wave lengths without interference.

Marconi's great triumph was, however, yet to come. In spite of the opinion expressed by some distinguished mathematicians that the curvature of the earth would limit practical communication by means of electric waves to a distance of 100–200 mi., Marconi succeeded in Dec. 1901 in receiving at St. John's, Nfd., signals transmitted across the Atlantic ocean from Poldhu in Cornwall, Eng. This achievement created an immense sensation in every part of the civilized world; and, though much remained to be learned about the laws of propagation of radio waves around the earth and through the atmosphere, it was the starting point of the vast development of radio communications, broadcasting and navigation services that took place in the next 50 years, in much of which, moreover, Marconi himself continued to play an important part.

During a voyage on the U.S. liner "Philadelphia" in 1902, Marconi received messages from distances of 700 mi. by day and 2,000 mi. by night. He thus first discovered the fact that, because some radio waves travel by reflection from the upper regions of the atmosphere, transmission conditions are sometimes more favourable at night than during the day. It was in 1902 also that Marconi patented the magnetic detector, and during the next three years he developed and patented the horizontal directional aerial. Both of these devices improved the efficiency of the communication system. In 1910, assisted by H. J. Round, he received messages at Buenos Aires, Arg., from Clifden in Ireland over a distance of about 6,000 mi., using a wave length of about 8,000 m. Two years later Marconi introduced the timed-spark system of generating pseudocontinuous waves in place of the damped trains of waves produced by the older spark transmitters. This effected a considerable improvement in the selectivity of transmission and reception with a further gain in efficiency. The system was used for several years at many important long-distance stations, and Marconi used it to send the first messages ever transmitted by radio from England to Australia, in Sept. 1918.

In spite of the rapid and widespread developments then taking place in the various aspects of radio and its applications to communication, to navigation and to the safety of life at sea, Marconi's intuition and urge to experiment toward greater accomplishments were by no means exhausted. It was in 1916, during World War I, that he saw the possible advantages of using shorter wave lengths. For example, the shorter waves permitted the use of reflectors around the aerial, which in wartime minimized the interception of the transmitted signals by the enemy and also effected an increase in signal strength. After tests in Italy (20 years after his original experiments with reflectors), Marconi continued the work in Great Britain with C. S. Franklin and, on a wave length of 15 m., received signals over a range of 20–100 mi. In 1923 the experiments were continued with G. A. Mathieu on board the steam yacht "Elettra," which had been specially fitted up. From a transmitter of 1 kw. at Poldhu, signals were received at a distance of 1,400 mi., much louder than those from Carnarvon on a wave length several hundred times as great and with 100 times the power at the transmitter. Thus began the development of short-wave wireless communication which, with the use of the beam aerial system for concentrating the energy in the desired direction, constitutes the basis of nearly all modern long-distance radio communication. It was in 1924 that the Marconi company obtained a contract from the post office for the establishment of short-wave communication between England and the countries of the British Commonwealth.

A few years later Marconi returned to the study of still shorter waves and, with the aid of valve-oscillator technique, examined the range possibilities of wave lengths of about half a metre. At these very short wave lengths, a parabolic reflector of moderate size gives a considerable increase in radiated power in the desired direction. Experiments conducted off the coast of Italy on the

yacht "Elettra" soon showed that useful ranges of communication could be achieved with low-powered transmitters. In 1932 Marconi installed a radiotelephone system using very short wave lengths between the Vatican and the pope's palace at Castel Gandolfo. In later work, Marconi once more demonstrated that even radio waves as short as 55 cm. are not limited in range to the horizon or to optical distance between transmitter and receiver.

Marconi received many honours and several honorary degrees: he was created a knight of Italy (1902); made a freeman of Rome (1903); awarded the Nobel prize for physics, the Albert medal of the Royal Society of Arts and, in the United States, the Franklin and John Fritz medals (1909); appointed an honorary Grand Cross of the Victorian Order (1914); sent as plenipotentiary delegate to the peace conference in Paris (1919), in which capacity he signed the peace treaties with Austria and with Bulgaria; created *marchese* and nominated to the Italian senate (1929); and chosen president of the Royal Italian Academy (1930). Marconi died in Rome on July 20, 1937, and was accorded a state funeral by the Italian government. At his own wish, he was buried at his native town of Bologna. (R. L. S.-R.)

MARCUS, SAINT, pope in 336 (Jan. 18–Oct. 7) or, as other sources claim, from 337 to 340, is credited with having established the right of bishops of Ostia to consecrate new popes. He also is said to have founded the present church of S. Marco in Rome, and another over the catacomb of Balbina, but a letter alleged to have been sent by him to Athanasius is now regarded as spurious. His feast day is Oct. 7. (G. E. McC.)

MARCUS AURELIUS ANTONINUS (121–180), Roman emperor 161–180, was born on April 26, 121. His father's father was Annius Verus (three times consul, and prefect of the city), his mother's father Calvisius Tullus Ruso, his aunt the wife of Antoninus Pius. Thus he was related to, and inherited the wealth of, several families of the "new establishment" of Rome who had risen to power and influence under the Flavian emperors. His original name was Marcus Annius Verus; when Antoninus was adopted to be Hadrian's successor in 138 he in his turn adopted the young M. Annius, along with Lucius Ceionius Commodus, the son of Hadrian's original choice for the succession, and the youths were renamed M. Aelius Aurelius Verus and L. Aelius Aurelius Commodus, respectively. Marcus, intelligent and serious, became dissatisfied with the traditional education in Greek and Latin rhetoric and devoted himself to the Stoic philosophy and the law. He was consul in 140, 145 and 161, and worked untiringly at the side of Antoninus, learning the business of government. In 145 he married his cousin, Antoninus' daughter Annia Galeria Faustina.

On March 7, 161, Antoninus died, and Marcus (henceforth Imperator Caesar M. Aurelius Antoninus Augustus) became emperor; he associated Commodus with him in this position (as Imperator Caesar L. Aurelius Verus Augustus), and for the first time the Roman empire had two joint emperors of equal constitutional status and powers—but not equal *auctoritas,* for although L. Verus has suffered by comparison with Marcus it seems probable that the serious work of government was done throughout by Marcus. He was tragically unlucky in having to spend most of his principate fighting frontier wars and combating the effects of plague and demoralization.

In 161 there was an invasion of Syria by the Parthians. The war that followed (162–166) was nominally under the command of L. Verus, though its successful conclusion, and the overrunning of Armenia and Mesopotamia, were the work of subordinate generals, notably Gaius Avidius Cassius. The returning armies brought back with them a plague which raged the length and breadth of the empire for many years. In 167 or 168 (the chronology of the northern wars is subject to controversy) Marcus and Verus together set out on a punitive expedition across the Danube, and behind their backs a horde of German tribes invaded Italy in strength and numbers reminiscent of the days of Gaius Marius and besieged Aquileia. The military weakness of the empire stood revealed; desperate measures were adopted to fill the depleted legions and imperial property was auctioned to provide emergency funds. Marcus and Verus fought the Germans off with success, but in 169 Verus died. Three years of fighting were needed, with Marcus in the thick of it, to restore the Danube frontier, and three further years' campaigning in Bohemia were enough to bring the tribes beyond the Danube to peace, at least for a time. Egypt, Spain and Britain were at the same time troubled by rebellions or invasions. In 175 Avidius Cassius, who was virtually a kind of prefect of all the eastern provinces, took the occasion of a rumour of Marcus' death to proclaim himself emperor; he controlled Egypt. Marcus made peace in the north with those tribes not already subjugated, and prepared to march against Avidius, but Avidius was assassinated by his own soldiers. Marcus then took the opportunity to make a tour of pacification and inspection of the east, visiting Antioch, Alexandria and Athens —where, like Hadrian, he was initiated into the mysteries of Eleusis. During the journey the empress Faustina died, and was accorded honours similar to those paid to her mother (*see* Antoninus Pius).

In 177 Marcus proclaimed his son Commodus joint emperor, and in 178 the Danube wars were resumed. Marcus was determined to pass from defense to offense and further expansion of Rome's northern boundaries, and his determination seemed to be winning success when, on March 17, 180, he died suddenly at his headquarters, having just had time to commend Commodus to the chief advisers of the regime. Commodus very soon called a retreat, which may have been the right policy, though he is censured for it; certainly Marcus' expansionism had been called in question before he died, and the northern wars must have been costly.

Marcus had not much time or energy left to initiate original trends of civil policy. Many lines of development, some valuable, some pernicious, continued steadily as they had done ever since Flavian times. The emperor was now supreme legislative authority, and both the help given by the senate in running the empire and also the initiative of local governments had declined—the subjects of Rome had lapsed into a "paternalistic" frame of mind, in which all responsibility was laid on the emperor all the time, and this crushing burden could only with difficulty be sustained by one man. That there were now two equal Augusti is therefore not surprising; it needs only to be emphasized that constitutionally there was no territorial division—Marcus and Verus, and later Marcus and Commodus, were joint emperors over all, like the ancient consuls. The senate was treated with grave respect. It had changed its character in that many (perhaps half) of its members were non-Italian, making it a kind of universal club of administrators; as individuals, however, senators still held most of the important posts. The equestrian civil service continued to grow, and the role of permanent secretaries and praetorian prefects in the inner counsels of government was by Marcus' time very great.

The financial policy of Marcus is not easy to estimate. Antoninus Pius had left a substantial treasury surplus, and though the wars were expensive Marcus was not parsimonious; in 178 he followed Hadrian in granting an enormous remission of tax arrears, and like Antoninus he gave huge largesses. It is not certain therefore that his sales of imperial property were due to more than temporary stringency. There does not seem to have been a general increase in taxation, and though debasement of the silver content of the coinage was proceeding all the time it was not yet on a dangerous scale. On the other hand the financial structure of the empire was too rigid to meet emergencies; there was no real reserve.

The field of activity which was most congenial to Marcus, as to his predecessor, was the law. Numerous measures were taken and judicial decisions made, clearing away harshnesses and anomalies in the private law, improving the lot of the weak and helpless—widows, slaves, minors—and recognizing the claims of blood as against those of the agnatic family. Under Marcus that celebrated elementary handbook was written from which modern knowledge of the classical law of Rome is largely derived: the *Institutes* of Gaius; and works of interpretation and the beginnings of systematic treatment of administrative law were undertaken. Yet two anomalies must be mentioned. Firstly, it was in the

Antonine period that the law became a respecter of persons in a new way; the distinction was more and more sharply made between *honestiores* (upper class) and *humiliores* (lower class), and the sanctions imposed on them—harsher always for the *humiliores*. Secondly, in relation to Christianity: there was no systematic persecution of Christians under Marcus Aurelius; the legal situation remained as it had been under Trajan and Hadrian: Christians were *ipso facto* punishable, but not to be sought out, and if they ran into the embraces of martyrdom by their inflexible and deliberate stubbornness, that was their fault. This illogical position did little harm in times of general security and prosperity, but when and where security and prosperity were threatened the local population might rise against Christians, a governor might be forced to act and the central authority took the view that the law must take its course. Of this nature were the martyrdoms of Lyons in 177, and it appears that Christian blood flowed more profusely in the principate of Marcus Aurelius the philosopher than it had done before.

One of the world's famous and influential books is the *Meditations* or "soliloquies" of Marcus Aurelius. To what extent he intended them for eyes other than his own is uncertain; they are fragmentary notes, discursive and epigrammatic by turn, of his reflexions in the midst of battle and administration, by which he kept alive in himself the Stoic precepts learnt from his teacher in his youth, and so nerved himself for his enormous tasks. In no sense are they original philosophy, but they give a valuable picture of what Stoicism as a practical way of life meant to a high-minded Roman of the 2nd century. Perhaps the most interesting thing about them is that they—the inmost thoughts of a Roman emperor—are written in Greek; to such an extent had the union of cultures become a reality. There is no reason to doubt that Marcus' *Meditations* reflect his life, which was noble and self-sacrificing.

Apart from the *Meditations* the most enduring monument of Marcus is the column erected to his memory which now stands in Piazza Colonna in Rome, a worthy successor to that of Trajan, with a spiral frieze in very high relief telling (whether chronologically or not) the story of the Danube wars in a brutally realistic and dramatic style.

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MARCY, WILLIAM LEARNED (1786–1857), U.S. politician, state governor and cabinet member, was born in Southbridge, Mass., on Dec. 12, 1786. He graduated from Brown university, Providence, R.I., in 1808, studied law, was admitted to the bar in Troy, N.Y., and began practice there in 1810. During the War of 1812 he served as captain of volunteers and took part in the storming of the British post at St. Régis, Que., on Oct. 22, 1812. As editor of the *Troy Budget* he was a vigorous supporter of Martin Van Buren (then a member of the New York senate), and when Van Buren's followers acquired control of the legislature in 1821 Marcy became adjutant general of the New York militia. From 1823 to 1829 Marcy was comptroller of the state and became a leading member of the Albany regency, a group of powerful Democratic politicians at the state capital. After serving as an associate justice of the New York supreme court in 1829–31, he entered the U.S. senate in Dec. 1831. In a senate speech defending Van Buren against an attack by Henry Clay, Marcy made the remark that, "to the victor belong the spoils of the enemy," and thereby became known as a champion of the "spoils system," the policy of removing political opponents from office and replacing them by political friends. He resigned from the senate in Jan. 1833 to become governor of New York, serving in that capacity for six years.

In 1844 Marcy was recognized as one of the leaders of the "Hunkers," or regular New York Democrats, and an active opponent of the "Barnburners" under Van Buren. He was secretary of war in President Polk's cabinet in 1845–49, ably discharging his duties during the Mexican War. From 1853 to 1857 he served as secretary of state in the cabinet of President Pierce.

As secretary of state, Marcy issued the "Dress Circular" of 1856 which recommended that, whenever practicable, U.S. diplomatic agents abroad should "appear in the simple dress of an American citizen." In 1867 this recommendation was enacted into law by congress. In 1853 Marcy secured approval of the Gadsden treaty which adjusted the boundary dispute between Mexico and the United States and added a substantial area to the federal domain. His diplomatic capabilities were put to an even greater test the following year by the Black Warrior case in which he prudently avoided war with Spain. Marcy was not averse to obtaining Cuba in an honourable manner, and it was at his suggestion that James Buchanan, J. Y. Mason and Pierre Soulé, ministers respectively to Great Britain, France and Spain, met at Ostend and Aachen in Oct. 1854 to discuss the Cuban question. But the resulting Ostend Manifesto (*q.v.*) was too extreme and Marcy promptly disavowed it. In domestic affairs Marcy was a shrewd but honest partisan; in diplomacy he was a broadminded, patriotic statesman, endowed with vigour rather than brilliancy of intellect. He died at Ballston Spa, N.Y., on July 4, 1857.

See S. F. Bemis *et al.* (eds.), *The American Secretaries of State and Their Diplomacy* (1927–29). (N. A. G.)

MAR DEL PLATA, Argentine coastal city, primarily important as a seaside resort and known to Argentines as the "Pearl of the Atlantic," located 250 mi. S. of Buenos Aires, in Buenos Aires province. Pop. (1960) 203,093. Settled in the 1850s as site for a meat-salting plant, Mar del Plata did not become a resort area until the early 20th century. Extensive beaches, a pleasant climate, night clubs and a government-controlled casino add to the tourist attraction. The harbour is an important port for the Argentine fishing fleet, and large canneries have been built to process the catch. (Js. R. S.)

MARDI GRAS: *see* Carnival; Shrove Tuesday.

MARDIN, the capital of the *il* (province) of Mardin in southeastern Turkey, lies about 30 mi. N.W. of Nusaybin on a branch line of the Istanbul-Baghdad railway. Pop. (1960) 27,390. It is situated on the southern slopes of a broad highland, rising to an altitude of 3,450 ft., and overlooks extensive limestone plateaus. The Mardin highland receives relatively more rainfall than its lower surroundings. Summer is very hot and the temperature may reach 42° C. (108° F.); in winter the average January temperature is 3° (37°). On a nearby hill are the remains of a citadel, founded in Roman times and refortified during the medieval period. The town is an active trading centre of local importance and on the caravan route between east and west. A main road leads west to Urfa and so to Aleppo in Syria via Gaziantep; a good highway runs northwest to Diyarbakir. Another road runs southeast through Nusaybin to the Tigris and connects with Mosul and Baghdad in Iraq.

Mardin Il (pop. [1960] 353,411; area 4,921 sq.mi.) is bounded on the south by Syria. It is agriculturally rich, the principal products being wheat, barley and sesame. Some wool is produced and there is a small cotton and woolen weaving industry. The population is mixed and includes (in addition to Turks) Arabs, Kurds and a medley of Asians, including "Jacobites" or members of the Syrian Monophysite Church.

(N. Tu.; E. Tu.; S. Er.)

MARDONIUS (d. 479 B.C.), Persian general who was nephew of King Darius I (*q.v.*) and married to Darius' daughter Artazostra. In 492 he was sent to succeed Artaphernes in the settlement of Ionia with a special commission to attack Athens and

Eretria. Contrary to the usual Persian policy, he restored democracies in Ionia. After this he crossed the Hellespont and invaded Thrace and Macedonia. His fleet was wrecked off Athos with enormous loss; because of this setback he was deprived of his command. According to Herodotus, Mardonius was, from motives of ambition, one of Xerxes' instigators in the invasion of Greece. After the Persian defeat at Salamis he persuaded Xerxes to return to Asia and himself stayed behind with a large army. He was defeated by Pausanias and killed at Plataea in Sept. 479. *See* GRECO-PERSIAN WARS.

MARDUK, the chief god of the city of Babylon and the national god of Babylonia. (As such he was eventually called simply Bel, "lord"; *see* BEL.) His name, probably Sumerian, is of uncertain meaning: "calf of the sun," "young buffalo of the sun," "infant sun" (*i.e.,* of spring). Theophoric names of the early 2nd millennium B.C. contain the element "Marduk." Marduk's name predominates in official inscriptions of the reign of Ammiditana, the third successor of Hammurabi. In Hammurabi's own reign (*c.* 1800 B.C.), Marduk is styled "son of Ea" (Sumerian Enki, "Lord of the Earth"), the god of the fresh-water ocean and of wisdom. Marduk's "Enlilship" or lordship over the great gods of heaven, the Igigi, is attributed to Anu, god of the sky, and to Enlil, god of the atmosphere. A poem, known from its opening words as *Enuma Elish,* and probably dating from the end of the 2nd millennium B.C., relates Marduk's rise to such pre-eminence that he is the god of 50 names, each one that of a deity or of a divine attribute. Because it is his mission to conquer the monster of primeval chaos, Tiamat, to him are given all the powers and prerogatives of all gods. He becomes "lord of the gods of heaven and earth, king of the gods of heaven and earth, king of all gods and kings and lord of all lords." All nature, including man, owes its existence to him; the destiny of kingdoms and subjects is in his hands. He is the source of law and civilization (*see* also CREATION, MYTHS OF).

Deities whose functions Marduk appropriates retain their place and prestige, however. His own chief cult centre as national god is the capital city of Babylon; while his son Nabu (*q.v.*) reigns supreme at nearby Borsippa. In the heart of Babylon were the temples Esangila, "the abode of the lord of Babylon, the supreme god Marduk," and Etemenanki, which was a storied tower or ziggurat, with a shrine of Marduk on the top; and subsidiary buildings (*see* BABYLON). In Esangila the poem *Enuma Elish* was recited every year at the New Year festival.

In poems and hymns Marduk is celebrated as "benefactor" and "merciful." A poem, whose contents have caused it to be named "the poem of the righteous sufferer," expresses thanks to him for his saving intervention. As god of medicine, equal in knowledge to his father, Ea, he is much invoked in incantations and exorcisms.

The lady of Marduk is Sharpanit (Sarpanitum), "brilliant as silver," who "shines resplendent among the stars." Her name is also written Zerbanitu, "who created seed." Other goddesses also are named as ladies of Marduk: Gula, Ishtar, Nana, Shala. His star is Jupiter, under various names: Shulpae, Sagmegar, Nebiru. He is also identified with the sun, the moon and other heavenly bodies. Animals sacred to him are horses, dogs and especially the so-called dragon with forked tongue which adorns his city's walls. On the oldest monuments Marduk is represented holding a triangular spade or hoe, interpreted as an emblem of the fertility and vegetation which are his gifts. He is also pictured on foot, walking or on his war chariot. His tunic is adorned with stars; in his hand is the sceptre and for armour he carries bow, spear, net or thunderbolt. An image of Marduk survives on a great lapis-lazuli inscription of the 9th century B.C., found at Babylon.

Kings of Assyria, too, do honour to Marduk and Sharpanit on inscriptions. Sargon II (722–705 B.C.) claims the consent of Marduk to his victorious entry into Babylon and is lavish with gifts to his shrine. Other Assyrian kings follow suit. An acrostic hymn in the dialect of Assyria in honour of the god and his spouse was composed in the name of King Ashurbanipal (669–630). Cyrus II the Great of Persia claimed that he was called by Marduk to overthrow Nabonidus of Babylon (556–539) because that king had preferred some other god to Marduk. Under Cyrus and the Seleucids, temples of Marduk were rebuilt. *See* BABYLONIA AND ASSYRIA: *Religion: Assyro-Babylonian Pantheon; see* also references under "Marduk" in the Index.

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MARE CLAUSUM and **MARE LIBERUM** (Lat. for "closed sea" and "free sea"), in international law terms associated with the historic controversy which arose out of demands on the part of different states to assert exclusive dominion over areas of the open or high sea. Thus Spain and Portugal laid claim to exclusive dominion over whole oceans, Great Britain to the narrow seas, and so on. These claims gave rise to vigorous opposition by other powers and led to the publication of Hugo Grotius' work *Mare liberum* (1609). In *Mare clausum,* written in 1617–18 and published in 1635, John Selden asserted "that the sea by the law of nature or nations is not common to all men but capable of private dominion or property as well as the land." A formula was found, on the other hand, by Cornelis van Bynkershoek in his *De dominio maris* (1702), for the restriction of dominion over the sea to the actual distance which could be protected by cannon range; *i.e.,* three marine miles (*see* WATERS, TERRITORIAL).

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MAREDSOUS, the first Benedictine abbey established in Belgium after the 1830 Revolution, was founded near Namur in 1872 by the family of Desclée de Tournai and colonized by monks from Beuron in Germany under a young Belgian, Hildebrand de Hemptinne. In 1878 the foundation was erected into an abbey. From the beginning it has been an active centre of Benedictine life and learning, with special interest in liturgical and historical studies. *Le Messager des Fidèles,* first published at Maredsous in 1884 as a liturgical review by Gerard van Caloen, was enlarged in scope to become the *Revue Bénédictine* in 1890. Among its most distinguished historians were Germain Morin, Ursmer Berlière and Philibert Schmitz. Columba Marmion, abbot 1909–23, wrote outstanding works on spiritual discipline. Daughter houses of Maredsous are Mont-César in Louvain (founded 1899), Glenstal in Ireland (1927) and Gihindamuyaga in Rwanda (1959).

(M. M. CH.)

MAREE, LOCH, a fresh-water loch in the county of Ross and Cromarty, Scot. Its name commemorates St. Maelrubha or St. Maree, who in 671 founded a monastery at Applecross and a chapel on Isle Maree. The lake is 12½ mi. long from Kinlochewe, at the head of the dam erected in the 16th century (or earlier) by the iron smelters of the Cheardach Ruardh, or Red Smiddy, on the river Ewe, by which it drains to the sea. Its greatest breadth is just over 2 mi. at Slattadale, and the greatest depth 367 ft. There are more than 30 islets, covering an area of nearly 1 sq.mi. and lying mostly north and east of Slattadale. The largest is Eilean Subhainn, or St. Swithin's Isle, which contains two small lakes. For two-thirds of its length the loch is flanked by mountains. On the northeast the principal heights are Ben Slioch (3,217 ft.), Ben Lair and Benn Airidh Charr, and, on the southwest, the peaks of Ben Eay, four of which exceed 3,000 ft. Sea trout and salmon are taken in the loch. The National Nature reserve at Kinlochewe was the first of its kind established in Great Britain.

MARÉES, HANS VON (1837–1887), German painter, was born at Elberfeld on Dec. 24, 1837. In 1853 he went to Berlin, where he studied for two years under Steffeck. For the next eight years he worked chiefly in Munich, coming under the influence of the historical school, and in 1864 he went to Italy, where he lived for about 20 years. He also traveled in Spain and France and spent some time in Berlin. In 1873 he received his most important commission, the painting of frescoes in the library of the Zoological museum at Naples. Although ambitious, Marées lacked self-confidence, and in the latter part of his life ceased to

exhibit his work. He died in Rome on June 5, 1887, a disappointed and practically unknown man. When his works were collected at the Munich exhibition in 1891, their value became apparent, as in "The Oarsmen," a subject he often painted.

MAREMMA, a district of central Italy along the Tyrrhenian coast, largely within the Tuscany region, includes the coastal stretch from south of Leghorn to the Campagna di Roma, as well as the Apennine foothills overlooking the coast. In Etruscan and Roman times the Maremma was well settled and famed for its farms, which were drained by subterranean canals. Among the Etruscan towns situated on hilltops, Populonia, Cosa, Tarquinii and Caere were the largest, and several ports handled Etruria's foreign trade. During the later years of the empire the region declined rapidly, drainage was neglected, malaria became endemic and the Maremma, until the early 20th century, served only as a winter grazing ground for herds from the Apennines. Beginning in 1951 the Maremma Land Reform agency spent considerable sums on the region, and new farms, roads and rural service centres were built, changing the face of the Maremma beyond recognition.
(G. Kh.)

MARENGO, BATTLE OF, a battle fought $4\frac{3}{4}$ mi. E.S.E. of Alessandria in Piedmont, Italy, between the French under Napoleon Bonaparte and the Austrians under Michael Melas on June 14, 1800, early in the Napoleonic Wars (*q.v.*). Having brought his army into Italy via the St. Bernard pass in May, Bonaparte moved westward to threaten the Austrians' rear. A number of oversights in the execution of his fundamentally sound strategy immediately before the battle came very close to causing the destruction of Bonaparte's army, for they enabled Melas to concentrate 30,000 men and more than 100 guns with which to launch an unanticipated attack on the French army's 19,000 men and 14 cannon early on June 14. By late afternoon the French, who resisted stubbornly, had been obliged to yield considerable ground. The Austrians' advance, however, was too deliberate, and gave Desaix time to march a division to Bonaparte's support. When he arrived the Austrians were forming a large column to press home their advantage. About 5 P.M. Desaix's men came into action against the head of the column; Desaix fell in the attack that drove back the leading Austrian troops, whose confusion was completed when Kellermann's 400 cavalry charged their flank. The Austrians were given no time to recover their balance, and surprise soon yielded to panic. The French now assumed the offensive along the entire front, and by nightfall the Austrians were in full rout. Next day Melas signed a convention by which the Austrians evacuated northern Italy west of the Mincio river. The French had lost about 4,000 men, the Austrians 9,500. (J. H. N.)

MARENZIO, LUCA (1553/54–1599), the greatest Italian madrigalist of his generation, was born in Coccaglio. He may have served as a choirboy in the nearby town of Brescia. By 1578 he was in service with Cardinal Luigi d'Este in Rome, where he remained until 1586. In 1588 he went to Florence, where he worked with the circle of musicians and poets associated with Count Giovanni Bardi, and later returned to Rome to serve Cardinal Cinzio Aldobrandini. In 1594 he visited Sigismund III of Poland, was in Rome in the summer of 1595 but returned to Poland in 1596. In 1598 he was in Venice, and was later appointed musician at the papal court. He died in Rome, Aug. 22, 1599.

Marenzio published a large number of madrigals and villanelle and five books of motets. His sacred works are colourful and impressive, but he is best known for his madrigals. Marenzio's early works are influenced by M. Ingeneri, but he soon developed an individual technique rarely surpassed in elegance and expressiveness. His extended forms depend upon subtle contrasts of emotional tension. He liked writing for high voices but varied his brilliance with sentiment and gravity. He was a daring harmonist: his chromaticism occasionally leads to advanced enharmonic modulations, and he sometimes leaves dissonances unresolved for dramatic effect. He exerted a strong influence on C. Monteverdi, C. Gesualdo and H. L. Hassler, and was much admired and imitated in England, where his works were first printed in N. Yonge's *Musica Transalpina* (1588).

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(B. L. Tr.)

MARE'S-TAIL, the popular name for an aquatic herb known botanically as *Hippuris vulgaris,* which forms the family Hippuridaceae. It is little cultivated, being of some interest in the bog or pond gardens. Some botanists divide the family into several species. Mare's-tail grows on margins of lakes, ponds and similar localities and has a submerged stout creeping rootstock, from which spring many jointed cylindrical stems bearing numerous narrow leaves close set in whorls. The minute greenish flowers are borne in the leaf axils. Like many fresh-water plants it has a wide distribution, occurring in arctic and temperate regions in the northern hemisphere and in southern South America.

MARET, HUGUES BERNARD, Duc de Bassano (1763–1839), French diplomat and statesman of the Napoleonic period, was born in Dijon on July 22, 1763. He embarked on a career as a lawyer; but from July 1789, in the early stages of the French Revolution, he and Maurice Méjean began publishing the debates of the Constituent Assembly in the *Bulletin de l'Assemblée.* In Jan. 1790 this *Bulletin* was merged in C. J. Panckoucke's *Moniteur universel,* for which Maret continued to provide impartial reports of debates until the dissolution of the assembly in Sept. 1791. Though he was a member of the moderate club of the Feuillants, he was brought into the diplomatic service by Dumouriez, then minister of foreign affairs, in 1792 (probably in April).

After the withdrawal of the British legation from Paris, Maret was sent on a mission to London in Nov. 1792 and had two sympathetic but fruitless interviews with Pitt in December. Another mission after Louis XVI's execution was also unsuccessful: Maret arrived in London on Jan. 30, 1793, and the Convention in Paris declared war on Feb. 1. Sent in July 1793 to take up a post as French diplomatic agent in Naples, Maret was captured on his way by the Austrians in the territory of the Graubünden (Grisons) and detained till Jan. 1796. He took part in the French negotiations with the British at Lille from July 1797, but these were broken off after the *coup d'état* of Fructidor (Sept. 4).

When Napoleon Bonaparte returned from Egypt, Maret became one of his supporters. After the *coup d'état* of Brumaire (Nov. 1799) he was appointed secretary to the consuls and then secretary of state; and in 1804 his post was raised to the rank of ministry. He had the official section of the *Moniteur* under his control, accompanied Napoleon on all his campaigns of 1805–09 and was created duc de Bassano in 1809.

On April 17, 1811, Maret replaced J. B. Nompère de Champagny as minister of foreign affairs and was thus responsible for the treaties with Prussia (Feb. 1812) and with Austria (March 1812) which preceded the French invasion of Russia. He followed Napoleon as far as Vilna in 1812 and was also with him in the campaign of 1813. In Nov. 1813, however, he was replaced by Armand de Caulaincourt as minister of foreign affairs. He then resumed his post as minister-secretary of state, which he lost on Napoleon's fall in 1814 but held again in 1815 during the Hundred Days.

Exiled on the second Bourbon Restoration, Maret lived in Friuli and then at Trieste till he was allowed to return to France in Jan. 1820. After the revolution of July 1830 Louis Philippe made him a peer of France. Finally, on Nov. 10, 1834, Maret took office as prime minister and minister of the interior; but his cabinet lasted only five days. He died in Paris on May 13, 1839.

Maret was upright, hard-working and completely devoted to Napoleon, but some have blamed him for submissively adopting his master's foreign policy without explaining its dangers to him.

See A. A. Ernouf, *Maret, duc de Bassano* (1878); C. P. M. Miles (ed.), *The Correspondence of W. A. Miles,* 2 vol. (1890).
(C. E. Du.)

MAREY, ÉTIENNE JULES (1830–1904), French physiologist and inventor, was born March 5, 1830, at Beaune (Côte-d'Or). After receiving his bachelor's degree at Beaune in 1849, he studied medicine in Paris, where he received the M.D. degree in 1859. In 1860 he invented the sphygmograph, an instrument for recording graphically the features of the pulse and the varia-

tions in blood pressure. In 1867 he was appointed to the chair of natural history in the Collège de France. He wrote extensively on the circulation of the blood, cholera, terrestrial and aerial locomotion, experimental physiology and graphic methods in physiology. He also was a pioneer in the development of the motion picture. In order to study the flight of birds, in 1882 he invented a photographic camera with magazine plates that took a series of photographs; the pictures could be combined to represent movements. In 1894 he adapted the motion-picture camera to the microscope. He died in Paris on May 16, 1904. (T. E. K.)

MARGARET, SAINT, a virgin martyr and one of the 14 Auxiliary saints or Holy Helpers, who, according to the purely fictitious legend, rejected marriage with the prefect Olybrius at Antioch and was beheaded in consequence, after undergoing trials of remarkable extravagance. Her feast day is July 20. The story is substantially that of St. Marina of Antioch in Pisidia (July 17 in the Greek calendar). The name Marina is the Latin equivalent of the Greek name Pelagia, and the St. Margaret legend is one of the family of pious romances whose starting point seems to have been the historical St. Pelagia (*q.v.*); among the others are those of SS. Eugenia, Theodora of Alexandria and another Marina (or Mary). It is accordingly very doubtful whether this St. Margaret ever existed.

See H. Delehaye, *The Legends of the Saints* (1962). (D. Ar.)

MARGARET, SAINT, OF SCOTLAND (*c.* 1045–1093), queen consort of Malcolm III (Canmore; *see* MALCOLM), granddaughter of the Anglo-Saxon king Edmund Ironside, daughter of Edward Aetheling and sister of Edgar (*q.v.*) the Aetheling. She was brought up at the Hungarian court, where her father was in exile. After the battle of Hastings, the widow and children of Edward fled for safety to Scotland, and *c.* 1070 Margaret married Malcolm, in spite of her leanings toward a religious life. Through her influence over her husband and his court, she promoted the interests of the English population conquered by the Scots in the previous century, as well as those of the church in conformity with the Gregorian reform. She died in Edinburgh on Nov. 16, 1093, and was canonized by Innocent IV in 1249. Some early calendars have her feast on Nov. 16, others on June 19, but it was fixed eventually on June 10. *See* also SCOTLAND: *History*.

See the account of her by her chaplain and confessor, Turgot, afterward bishop of St. Andrews, *Acta Sanctorum*, vol. ii of June (1867), Eng. trans. by W. Forbes-Leith (1884); R. L. G. Ritchie, *The Normans in Scotland* (1954). (Pl. Gn.)

MARGARET (1353–1412), queen of Denmark, Norway and Sweden, was born in 1353, the daughter of Valdemar IV of Denmark. She was married in 1363 to Haakon VI of Norway. On her father's death in 1375 she procured the election of her infant son Olaf as king of Denmark; and in 1380 Olaf also succeeded Haakon as king of Norway. After Olaf's death (1387) Margaret, who had ruled both kingdoms in his name, was in 1388 chosen "sovereign lady and ruler" of Norway and Denmark. She then turned to Sweden, where the nobles, in arms against their unpopular king Albert of Mecklenburg, appealed to her for help.

At a conference held at Dalaborg castle in March 1388, the Swedes were compelled to accept all Margaret's conditions, elected her "sovereign lady and ruler" or regent and engaged to accept from her any king that she chose to appoint. On Feb. 24, 1389, Albert, who had returned from Mecklenburg with an army of mercenaries, was taken prisoner at Aasle near Falköping and Margaret was now the mistress of three kingdoms. Only Stockholm, then almost entirely a German city, still held out; fear of Margaret induced both the Mecklenburg princes and the Wendish towns to hasten to its assistance; and the Baltic and the North sea swarmed with the privateers of the *Viktualien brödre* or *Vitalianer*, so called because their professed object was to revictual Stockholm. Finally the Hanseatic league intervened, and by the compact of Lindholm (1395) Albert was released by Margaret on promising to pay 60,000 marks within three years. The Hanseatic league meanwhile was to hold Stockholm in pawn. Since Albert failed to pay his ransom within the stipulated time, the league surrendered Stockholm to Margaret in Sept. 1398, in exchange for confirmation of all its commercial privileges.

It had been understood that Margaret should, at the first convenient opportunity, provide the three kingdoms with a king who was to be her nearest kinsman, and in 1389 she proclaimed her infant cousin, Eric of Pomerania, king of Norway. In 1396 homage was also rendered to him in Denmark and Sweden, Margaret reserving to herself the office of regent during his minority. To weld the three kingdoms still more closely together, Margaret summoned a congress of the three councils of state and other magnates to Kalmar in June 1397; and on Trinity Sunday, June 17, the joint coronation of Eric united the kingdoms. The terms of a perpetual union also were discussed, and a draft is still extant. This much-discussed Kalmar document, the clauses of which tended to prevent amalgamation by insisting that each country should retain its own laws and customs and be administered by its own dignitaries, was never ratified. Considering its restriction of the royal power, Margaret probably rejected the proposal, but she avoided every appearance of an open rupture.

Eric was declared of age in 1401, but Margaret remained the real ruler of Scandinavia. As long as the union was insecure, Margaret had tolerated the presence near the throne of "good men" from all three realms (the *rigsraad*, or council of state, as these councilors began to be called); but their influence was always insignificant. In every direction the royal authority remained supreme. The Danish national assemblies had already fallen into disuse after 1377; the offices of high constable and earl marshal were left vacant; and Margaret ruled through her court officials acting as superior clerks. Margaret also recovered for the crown all the landed property which had been alienated since the 1360s in Denmark and Sweden. This so-called "reduction," or land-recovery, was carried out with the utmost rigour, and hundreds of estates fell to the crown. Margaret also reformed the Danish currency. In foreign politics she maintained a clever system of neutrality but she spared no pains to recover lost Danish territory. Gotland she purchased from its actual possessors, Albert of Mecklenburg and the Livonian Order, and the greater part of Schleswig was regained in the same way. Margaret died suddenly on board her ship in Flensborg harbour on Oct. 28, 1412.

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(R. N. B.; A. E. Cn.)

MARGARET (THE MAID OF NORWAY) (1282 or 1283–1290), queen of Scotland, was the only child of Eric II, king of Norway, and Margaret, daughter of Alexander III, king of Scotland. Eric's wife died in 1283, soon followed by her only surviving brother, and the Scottish magnates accepted Margaret as heir to the throne (1284). After the death of Alexander III on March 18–19, 1286, she was proclaimed queen (July 1286). Edward I of England, her greatuncle, arranged a marriage between her and his son Edward, papal dispensation for which was granted on Nov. 16, 1289. The marriage treaty (July 18, 1290, confirmed by Edward on Aug. 28) included some safeguards of Scotland's independence. On the voyage from Norway, Margaret fell ill, and died in Orkney, then still Norwegian territory, late in Sept. 1290. The bishop of Bergen returned with her body to Bergen, where she was buried. In 1301 a woman from Lübeck who claimed to be Margaret was burned near Bergen as an impostor. By Margaret's death an ancient line became extinct. A court presided over by Edward I chose as her successor (1292) her distant cousin John de Balliol, and for more than 20 years Scotland suffered foreign domination and civil war.

See A. O. Anderson, *Early Sources of Scottish History A.D. 500 to 1286*, vol. ii (1922); A. Lang, *History of Scotland*, vol. i, 5th ed. (1929).

(M. O. An.)

MARGARET (MARGARET TUDOR) (1489–1541), queen consort of James IV of Scotland, was the eldest daughter of Henry VII, king of England, and was born at Westminster on Nov. 29, 1489. She married James IV of Scotland on Aug. 8, 1503, but the scanty dowry given by her father wrecked any chance of improved relations between the two kingdoms, despite the treaty of perpetual peace which accompanied the marriage. The rest of Margaret's life was an unending series of intrigues, first with one

political faction, then with another, her conduct being mainly influenced by considerations affecting her pocket.

Margaret was crowned in Edinburgh in March 1504. Between 1507 and 1510 she gave birth to two sons and a daughter, all of whom died in infancy. She gave birth to a son in 1512 who succeeded his father as James V and in 1514 she bore a posthumous son, Alexander, created duke of Ross, who died within two years. A dispute over a legacy with her brother, Henry VIII, was a contributory cause of the war that ended at Flodden, where James IV was killed in Sept. 1513. By his will Margaret was appointed sole guardian of the infant king, James V. At this time Scotland was divided mainly into two parties: one in favour of alliance with England and the other with France. The leader of the pro-French party was John Stewart, duke of Albany (*see* ALBANY, DUKES OF), next heir to the crown of Scotland after Margaret's sons. Margaret herself generally inclined to the English faction; and when Albany returned to Scotland from France on the invitation of the Scottish parliament in the spring of 1515, the conflict verged on civil war. Margaret's marriage to Archibald Douglas, earl of Angus (*see* ANGUS, EARLS OF), on Aug. 6, 1514, had alienated many of the nobility, especially the earls of Arran and Home, and made her entirely dependent on the house of Douglas. It also furnished the parliament with a pretext, in July 1515, for removing her from the offices of governor and tutor in favour of Albany. She fled to England in September, where she bore to Angus a daughter, Margaret (afterward countess of Lennox), who was the mother of Lord Darnley.

In 1516 Margaret went to her brother's court in London, while Angus, much to his wife's displeasure, returned to Scotland, where he made peace with Albany, was restored to his estates and formed a liaison with a daughter of the laird of Traquair. The rivalry between the French and English factions in Scotland was complicated by the struggle of Arran and Angus for supreme power in the absence of Albany in France (1517–21), where at the instance of Henry VIII he was detained by Francis I. Margaret, quarreling with her husband, at first sided with Arran and began to agitate for a divorce from Angus. In this she was probably aided by Albany, who found an unexpected ally in Margaret who was temporarily alienated from the English party by Henry VIII's opposition to her divorce. When Albany returned to Scotland in 1521 his association with Margaret gave rise to the accusation that it was with the intention of marrying her that he favoured her divorce from Angus. As Albany was strongly supported by the Scottish parliament, Angus found it necessary to withdraw to France till 1524. During these years there was constant warfare between the English and the Scots on the border but in May 1524 Albany was obliged to retire finally to France. Henry VIII continually aimed at securing possession of his nephew, the king of Scots, but he was proclaimed king in July 1524. Margaret married Henry Stewart, second son of Lord Avondale, immediately after her divorce from Angus in 1527. With her new husband, who was created Lord Methven in 1528, she became for a time the ruling influence in the counsels of James V. But when her desire to arrange a meeting between James and Henry VIII in 1534 was frustrated by the clergy and the council, Margaret in her disappointment revealed certain secrets to Henry which led to her being accused by her son of betraying him for money and of acting as an English spy. She died at Methven castle on Oct. 18, 1541.

(G. S. P.)

MARGARET OF ANGOULÊME (1492–1549), queen consort of Navarre from 1527 and one of the outstanding figures of the French Renaissance both as the patron of humanists and reformers and as the author of the *Heptaméron*, was born at Angoulême on April 11, 1492, the daughter of Charles de Valois-Orléans, comte d'Angoulême, and Louise of Savoy. Though her first marriage (1509), to Charles, duc d'Alençon, was not very satisfactory, she became the most influential woman in France, next to her mother, when her brother acceded to the kingdom as Francis I (1515). Widowed in 1525, she was next married, in 1527, to Henry II of Navarre (Henry d'Albret). Her brother could not fulfill his promise of recovering Navarre south of the Pyrenees for the couple from the Spaniards, but his generosity enabled Margaret to keep small courts at Nérac in Gascony and at Pau in Béarn and to continue her distinguished patronage of artists and writers.

Margaret extended her protection both to men of purely literary genius and to the advocates of doctrinal and disciplinary reform in the church. François Rabelais, Clément Marot, Bonaventure des Périers and Étienne Dolet were all included in her circle. Any sympathy that she may have had with Lutheranism can only have come from her attachment to St. Paul's teaching, on which she accepted the views of Jacques Lefèvre d'Étaples and Guillaume Briçonnet; and she was certainly not a Calvinist. On her deathbed she asserted that she had supported the Reformers, not because she agreed with all their beliefs, but out of "pure compassion." Her personal religious inclinations seem to have been toward a sort of mystical pietism, which she carried to such extremes that her correspondence with Briçonnet is barely intelligible. She wanted reform within the Catholic Church. Having always sought to dissuade Francis I from intolerant measures, she disapproved of the persecution launched after the "affair of the Placards" in 1534 (*see* FRANCE: *History;* HUGUENOTS). When Francis intensified the persecution of heretics and freethinkers, Margaret could do nothing to save Des Périers, Dolet or Marot.

By her first husband she had no children; but by Henry II of Navarre she had a daughter, Jeanne d'Albret (1528–72; mother of the future Henry IV of France), and a son who died in infancy. She soon became estranged from Henry II and could not maintain a happy relationship with her Calvinist daughter. Her brother was her cynosure, and she survived him by less than three years, dying at Odos-en-Bigorre on Dec. 21, 1549.

Of Margaret's literary works, the most important is the *Heptaméron*, constructed on the lines of Boccaccio's *Decameron* and consisting of 72 short stories (out of a planned 100) told by a group of travelers delayed by a flood on their return from a Pyrenean spa. Originally published in 1558 under the title *Histoire des amants fortunez*, it was reissued in 1559 by Claude Gruget, who gave it the name *Heptaméron*. Its dedication to Jeanne d'Albret, together with internal evidence, left no room for doubt as to its authorship, but it is very likely that Margaret engaged members of her court to collaborate with her on it. The stories, illustrating the triumphs of virtue, honour or quick-wittedness and the frustration of vice and hypocrisy, with a strong element of satire against licentious and grasping monks and clerics, may be taken as characteristic of the atmosphere of Margaret's court. The best edition is by A. Le Roux de Lincy (4 vol., 1880), from which J. S. Chartres prepared an English translation (5 vol., 3rd ed., 1928).

A devotional poem of Margaret's, the *Miroir de l'âme pécheresse* (1531), was translated by Elizabeth of England as *A Godly Meditation of the Soul* (1548). The *Marguerites de la marguerite des princesses* (1547; modern ed. F. Frank, 4 vol., 1873) are miscellaneous poems and farces, mostly artificial and elaborate in style. Her best verse is to be found in *Les Dernières Poésies*, first published by A. Lefranc (1896) and including *Les Prisons* (a long allegory) and *Le Navire* (a remarkable expression of her despair at Francis I's death; *cf.* the later edition of this by R. Marichal, 1956). There is also an edition of her *Lettres* by F. Génin (4 vol., 1841–42).

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MARGARET OF ANJOU (1429–1482), queen consort of Henry VI, king of England, was the daughter of René I of Anjou, the titular king of Naples, and was born on March 23, 1429, at the Chateau Keure in her father's duchy of Lorraine. She was brought up in Anjou by her grandmother, Yolande of Aragon, and was betrothed to Henry in 1444 as part of a truce between England and France. They were married at Titchfield abbey on April 23, 1445. At this time she had the assets of youth, beauty and an amenable husband. But she had come to England bringing, not a dowry, for her father was penniless, but the shame of surrender; for her marriage had been bought by a secret promise to cede the English holds in Maine. Furthermore, as the match had

been negotiated by the earl of Suffolk, she regarded him as her best friend in England. But he was fast becoming a controversial figure, and the queen, who had a vigorous and passionate nature, fell into the blunder of regarding his allies, the Beauforts, as her allies, and his enemies, the dukes of Gloucester and York, as her foes. The result was that she quickly became involved in the party struggles herself; and the popular hatred of her was increased by the disasters in France and by her covetous and imperious behaviour. Perhaps inspired by her husband's example, she founded in 1448, with Andrew Docket, Queens' college, Cambridge; but as a childless queen her influence was limited, in spite of her talents and ambition. However, on Oct. 13, 1453, she bore her only son, Edward, and from that moment she threw all her tireless energies into the defense of his rights. To her indomitable spirit the cause of Lancaster owed much of its endurance; to her implacable determination it owed much of its failure.

It was her misfortune that a few months before her son was born her husband went mad. The natural head of the government in these circumstances was the duke of York whose ambitions Margaret suspected. By persistently treating him as a foe she finally made him one. By 1455 he was convinced that Margaret and the head of the Beauforts, the duke of Somerset, were plotting his destruction. The result was the first battle of St. Albans (May 1455), the death of Somerset, the capture of the king, and York's control of the government. But Margaret was tireless in opposition, and in 1456 succeeded in ousting him and his friends from the government. Thenceforward relations deteriorated until in 1459 the war for which both sides had been preparing broke out. After a Yorkist defeat at Ludlow Margaret embittered the struggle by a wholesale proscription of her opponents in the parliament of Coventry. When the Yorkists had won the battle of Northampton (July 1460), she refused to accept the compromise by which York was declared heir to the throne. Instead she sought help in Scotland, which lost her much support in England. She forfeited even more when, after the death of the duke of York at the battle of Wakefield (Dec. 1460), she marched south with wild Scottish and northern troops who pillaged even altar vessels. Hatred of her was increased by the vindictive executions which she instigated after the second battle of St. Albans (Feb. 1461). After the disaster of Towton in March no course was left but for her, with her son and husband, to take refuge in Scotland.

But she refused to accept defeat. A year later she went to France, obtained help for a temporarily successful expedition to Northumberland, but finally had to seek refuge in the family possessions in Bar. There young Edward was educated to be king of England. To this end Margaret was prepared in 1470 to be reconciled with her former bitter enemy, the earl of Warwick, and agreed to marry her beloved son to his younger daughter Anne; but she did not trust Warwick and after his success and Henry's restoration she still remained in France. At last on April 14, 1471, she was induced to land with her son at Weymouth, the very day that Warwick was killed by Edward IV's forces at Barnet. Her last hope was to reach Wales and there raise Lancastrian supporters, but Edward IV foresaw the danger and caught up with her army at Tewkesbury. In the crushing defeat of her forces there on May 4, 1471, her son was killed and she was captured; less than three weeks later her husband was murdered in the Tower of London. She was now a broken woman, with nothing left to live for. Louis XI ransomed her under the treaty of Picquigny in 1475 and she returned to France in Jan. 1476. She lived for six years in Bar and Anjou, in poverty and dependent for sustenance on Louis XI, who in return made her surrender her claims to her father's inheritance. She died near Saumur on April 25, 1482, and was buried in Angers cathedral.

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MARGARET OF FRANCE (MARGUERITE DE VALOIS) (1553–1615), queen consort of Navarre, famous as LA REINE MARGOT, was born at St. Germain-en-Laye on May 14, 1553, the daughter of Henry II of France and Catherine de Médicis. From the moment when she took her place at court in 1569 she played a part in the Wars of Religion: her relations with her brothers, Charles IX and the duc d'Anjou (later Henry III of France), were often strained, and she had an early liaison with Henry, duc de Guise. On Aug. 18, 1572, she was married, in Paris, to the Protestant Henry de Bourbon, king of Navarre (the future Henry IV of France), in order to seal the peace between Catholics and Protestants; but six days later the massacre of St. Bartholomew's day began. Subsequently, refusing to be parted from Henry of Navarre, she promoted the understanding between him and her youngest brother, François, duc d'Alençon, a leader of the moderate Catholics. Her role in the ensuing conspiracies cost the life of her lover, the seigneur de La Môle (Joseph de Boniface), in 1574. Later Henry III of France banished her to the inaccessible castle of Usson in Auvergne (1586); but with Guise's help she made herself mistress of the place. The collapse of the League in Auvergne left her unable to maintain herself against her husband; but when he demanded the annulment of their childless marriage so that he could marry Gabrielle d'Estrées, she withheld her consent till Gabrielle was dead (1599). Henry then married Marie de Médicis (1600), but Margaret retained her royal title. Five years later she was allowed to return to Paris, where she lived in magnificent style, free to pursue her amours, till her death on March 27, 1615. Her brilliant *Mémoires* (composed at Usson *c.* 1595–96), her poems and her letters were edited by L. Lalanne (1858). She was naturally the idol of Brantôme, but many lampoons were written against her, notably *Le Divorce satirique*.

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MARGARET OF PROVENCE (*c.* 1220–1295), queen consort of Louis IX of France, was the eldest daughter of Raymond Berengar V (IV), count of Provence. She was married to Louis at Sens on May 27, 1234, and crowned the next day. Though the young king's mother, Blanche of Castile, had arranged the marriage, she was jealous of her daughter-in-law, whom she supervised strictly; Jean, sire de Joinville, tells several stories of Blanche's separating the royal couple, and Louis himself seems sometimes to have behaved brusquely to Margaret.

Margaret accompanied Louis on the seventh crusade (1248–54) and showed great courage at Damietta, reinspiring the crusaders after the defeat at Mansurah (Feb. 1250), where Louis was captured by the Muslims. Blanche died in 1252, and Margaret, after returning to France, tried occasionally to meddle in politics. Though she was usually checked by the king's intransigence, she may have done something to improve relations between Louis and Henry III of England, who in 1236 had married her sister Eleanor. On the other hand she resented the fact that her father, who died in 1245, had by his will of 1238 left Provence to her youngest sister Beatrice, who in 1246 was married to Charles of Anjou, a brother of Louis IX (*see* CHARLES I of Naples). After Louis IX's death (1270) she did all that she could to thwart Charles's ambitions. She survived Louis, to whom she had borne 11 children, by 25 years, dying near Paris on Dec. 21, 1295.

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MARGARET OF AUSTRIA, princesses who governed the Netherlands for their Habsburg kinsmen in the 16th century.

MARGARET OF AUSTRIA (1480–1530), duchess of Savoy from 1501, was born in Brussels on Jan. 10, 1480, the daughter of the Austrian archduke Maximilian (*see* MAXIMILIAN I, Holy Roman emperor), by his consort Mary of Burgundy. She was betrothed in June 1483 to the dauphin, later Charles VIII of France, but he repudiated her in 1491 and sent her back to the Netherlands in 1493. Next, in April 1497, she was married to the infante Don John of Aragon, heir apparent to the Spanish kingdoms; but in

Oct. 1497 he died. Finally, in Dec. 1501, she was married to Philibert II, duke of Savoy; on his death (Sept. 1504), she caused a splendid tomb to be built at Brou, in Bresse. After her brother Philip's death (1506), Maximilian in March 1507 named her regent of Netherlands for the infant Charles (*see* CHARLES V, Holy Roman emperor). She pursued a strongly pro-English policy and avoided hostilities against France till England, as well as Maximilian and Spain, undertook them. Charles was declared of age to rule in Jan. 1515, but reappointed Margaret to the government of the Netherlands by a series of acts of 1518–20. It was she who, with her sister-in-law Louise of Savoy, negotiated the "Ladies' peace" of Cambrai between Charles and the French king Francis I (1529). Margaret died at Mechelen in the night of Nov. 30–Dec. 1, 1530.

MARGARET OF AUSTRIA (1522–1586), duchess of Parma from 1550, was born at Oudenarde in Flanders in summer 1522, the natural child of the emperor Charles V and Johanna van der Gheenst. She was married on Feb. 29, 1536, to Alessandro de' Medici, duke of Florence, who was murdered in Jan. 1537. She was next married, in Nov. 1538, to Ottavio Farnese, whose claim (1547) to the duchy of Parma was allowed by the papacy in 1550 but obstructed by Philip II of Spain (the power occupying Piacenza) till 1556. In May 1559, however, Philip named Margaret governor general of the Netherlands. As the revolt of the Netherlands gathered strength, Margaret tried in vain to conciliate the nobility. When the duque de Alba arrived with a Spanish army (Aug. 1567), she offered her resignation. Philip soon accepted it, and she left Brussels for Italy in Dec. 1567. While her son Alessandro Farnese was commander in chief in the Netherlands, Philip in March 1580 entrusted Margaret with the civil administration there again; but in Dec. 1581 Alessandro was officially named governor general, and in July 1583 Margaret was finally relieved of her functions. She left for Italy again in Sept. 1583 and died at Ortona on Jan. 18, 1586.

See, for the elder Margaret, Jane de Iongh, *Margaret of Austria . . .*, Eng. trans. (1953); for the younger, F. Rachfahl, *Margaretha von Parma . . .* (1898).

MARGARET OF CARINTHIA (called MAULTASCH because her mouth [*Maul*] was like a pocket [*Tasch*]) (1318–1369), countess of Tirol, was the daughter of Henry, duke of Carinthia and count of Tirol. In Sept. 1330 she was married to the nine-year-old John Henry of Luxembourg, son of King John of Bohemia and younger brother of the future Holy Roman emperor Charles IV. On her father's death (1335) she inherited Tirol, but Carinthia had to be ceded to the house of Habsburg (1336). Her marriage, however, was unhappy, and the Tirolese disliked the way in which Charles governed the country for his brother; so she and the Tirolese estates expelled John Henry in 1341. The Wittelsbach emperor Louis IV the Bavarian upheld her, annulled her marriage on the ground of John Henry's impotence (Feb. 1342) and gave her instead to his own son Louis, margrave of Brandenburg, regardless of their being within the prohibited degrees of affinity. These proceedings infuriated at once the papacy (which ought to have been consulted about the new marriage) and the Habsburgs (who still coveted Tirol), as well as the aggrieved house of Luxembourg. The Tirolese also rose against their rulers, but Margaret withstood them till her husband had suppressed the rebellion. Finally Charles of Luxembourg, secure in the German kingship after Louis IV's death (1347), left Louis of Brandenburg in possession of Tirol. Louis, however, died in 1361, and his and Margaret's only son, Meinhard III, in 1363. Then the Habsburg Rudolf IV of Austria induced Margaret to cede Tirol to himself (Sept. 29, 1363). Retiring to Vienna, she died there on Oct. 3, 1369.

MARGARINE (OLEOMARGARINE) has been variously defined during its history. In the U.S. it is defined in the standard of identity promulgated under the federal Food, Drug and Cosmetic act as a plastic food prepared from one or more vegetable and animal fats intimately mixed with one or more variations of cow's milk together with table salt and several other permitted optional ingredients in small quantities. It may also be defined as a plastic, solid, fat food consisting of 80% (U.S. legal minimum) edible fat, which carries dispersed in it the balance of the product, namely, an aqueous portion consisting primarily of skim milk and salt.

The ingredients in margarine, then, are those found in its edible fat portion and in its milk portion. The edible fats used have varied widely since the 1870s when the manufacture of margarine began, the trend having been from the animal fats predominantly in use earlier to the vegetable fats predominantly in use by the mid-20th century in the U.S.; these are principally cottonseed, soybean, peanut and corn oils. In European countries whale oil has been and is widely used, but it was never common in the U.S.

Usually there are such ingredients as vitamins A and D, vegetable lecithin, emulsifiers and similar materials dissolved in the liquid fats used in making margarine, while in the milk portion there are dissolved the salt and other ingredients readily mixable with milk. These two portions are then thoroughly mixed to produce an emulsion which is chilled to a solid, kneaded to a suitable mass and packaged.

Margarine was developed in the late 1860s by the French chemist Hippolyte Mège-Mouriès, who not only received recognition for his achievement in France and other European countries, but was also granted a U.S. patent in 1873. Out of Mège-Mouriès' early experience and process, which was unduly complicated, there grew the generally simple process in the 1870s and 1880s in the U.S. of churning the melted margarine fat blend with milk and salt, solidifying the churned mixture by chilling with cold water, working mechanically (kneading) the chilled mass to a plastic consistency and packaging, all by means of typical butter-working equipment of the time.

Primarily as a result of the efforts of competitive industries, margarine was subjected in the United States and elsewhere to severe restrictive legislation. The Oleomargarine act of 1886 was the earliest significant U.S. legislation on the subject. This law, together with subsequent amendments to it (1902, 1930), imposed a prohibitive tax on yellow margarine, levied high licence fees on all manufacturers, wholesalers and retailers of the product, and in other respects subjected the manufacture and sale of this food to numerous restrictions. The result was not only to prevent margarine from reaching its normal consumption level but for a very long time to prevent the sale of any yellow margarine. There was also a wave of similar state legislation, in which practically every state took part.

An important development in margarine processing occurred in the mid-1930s. Before that time, most vegetable fat margarine was made from imported oils, such as coconut, palm and palm kernel oils. While these oils were perfectly wholesome, the anti-margarine groups used this situation to support the continued restrictions on margarine and even to advocate additional ones on the basis that such use of foreign oils was inimical to the best interests of the U.S. farmer. After considerable research, manufacturers of margarine in the U.S. finally found in the mid-1930s how to make a satisfactory margarine from domestic vegetable oils. The resultant increase in the use of cottonseed and soybean oils stimulated the interest of cottonseed and soybean farmers and processing groups in the elimination of discriminatory restrictions on margarine; in the 1940s consumer groups in the U.S. also became interested in the elimination of this legislation.

The efforts of domestic, agricultural and consumer groups to have margarine freed from what they considered unfair legislation culminated in success in 1950, when congress repealed all the federal taxes and licence fees on margarine made in the U.S. This action was followed by similar action of state legislatures, and within a relatively short time thereafter, most of the state prohibitions against yellow margarine were repealed.

In addition to the development of the use of domestic vegetable fats in margarine, other improvements by modern scientific methods were made. In 1923 it was first fortified with vitamins A and D. In 1941, following extensive public hearings, the United States Food and Drug administration established a definition and standard of identity for margarine which, in turn, were revised and brought up to date in 1952. This standard prescribed the mandatory and the optional ingredients to be used in the manufacture of margarine, and served not only as government recognition of the

wholesomeness of the product, but also as a protection to the consumer. As a result of these developments and other scientific advances, margarine has been accepted by the U.S. public to an extent comparable with its acceptance in many European countries.

Nutritionally, the value of margarine as a food fat is primarily as a source of food fuel (calories) and of other nutritional factors. From the early 1950s, all margarine manufactured in the U.S. was fortified with at least 15,000 U.S.P. units of vitamin A to the pound. In the late 1950s (mostly 1956–60) there developed an increased interest in the relation of polyunsaturated fat to health. This resulted in a marked shift in the fat ingredients of margarine to include such fats (*see* OILS, FATS AND WAXES: *Physical and Chemical Properties* and *Hydrogenation*).

See also references under "Margarine" in the Index.

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MARGARITA, CLEMENTE SOLARO, CONTE DELLA (1792–1869), Piedmontese statesman who stood for the old order during the Italian Risorgimento, was born at Mondovì on Nov. 21, 1792. He entered the diplomatic service of Sardinia-Piedmont in 1816 and went to Naples. From 1826 to 1834 he was minister plenipotentiary in Spain. He was appointed minister of foreign affairs by King Charles Albert in 1835.

Della Margarita's policy was to keep his country neutral, avoiding alliance either with France or with Austria. In home affairs he protected the church and refused to support liberal reforms. When agitation for constitutional reform grew too strong, Charles Albert dismissed him in Oct. 1847.

Della Margarita, whose *Memorandum storico-politico* (1851) was an apologia for his administration, opposed projects for a united Italy as he felt that the sacrifice of Piedmontese independence was too great a price to pay. From 1854 to 1860 he was deputy for San Quirico in the Piedmontese parliament and led the clerical opposition to Cavour. Not elected to the first parliament of the new kingdom of Italy, he retired from politics in 1860 and died in Turin on Nov. 12, 1869.

See M. Monaco, *Clemente Solaro della Margarita* (1955).

MARGARITA ISLAND (ISLA DE MARGARITA), also known as the Isle of Pearls, is the largest of 70 islands making up the state of Nueva Esparta (*q.v.*) in Venezuela, and is about 12 mi. N. of the peninsula of Araya. Of the 89,492 persons in the state in 1961, nearly 75,000 were on the island. Margarita is about 40 mi. long from east to west, has an area of 414 sq.mi. and a coast line of 198 mi., with many natural harbours. It is in reality two islands joined by a low, narrow isthmus. The highest elevation on the island is the peak of Macanao, 2,493 ft. After 1950 the government enlarged its road-building program, and in 1957 the official claim was that the island had 200 mi. of improved roads. There is an airport at Porlamar. Water is a fundamental problem of the island population; drinking water is brought from the mainland. Farming and grazing is carried on but the island is a net importer of foodstuffs.

La Asunción (pop. [1961] 5,541), on the eastern end of the island, is the capital of the state. It was founded in 1524 by Marcelo Villalobos. Porlamar (pop. [1959 est.] 22,763), is the most important city. It is the centre of a pearl fishing industry that dates back to the early 16th century and which is closely controlled by the government in order to guarantee its continuance. Pampatur (pop. [1959] 1,823), the leading port, is located on a protected bay. Juangriego (pop. [1959] 4,718), located on the north side of the island, is a major fishing centre; its canned products are sold throughout the nation.

Tile and ceramics are manufactured on the island. Shoes and hats made from sisal, produced locally, have a national market. The building of fishing boats is an established industry, as is the manufacture of salt. After World War II Margarita won favour as a tourist area.

The island of Margarita was discovered by Columbus in 1498 on his third voyage. The pearl industry of Margarita and the surrounding islands sprang up soon thereafter. The life span of the Indian divers was short and the raiding of the mainland for replacements led to bloody reprisals by the natives. In 1561 the crazed Lope de Aguirre ravaged the island before menacing the mainland. Fifteen years later (1576) it was visited by British pirates. In 1662 Pampatar was razed by the Dutch. For a long time Margarita was attached to Cumaná, but in the 18th century it was made administratively independent. Its traders rendered invaluable assistance to the revolutionists in the wars of independence; Simón Bolivar used the island as a base of operation in 1816, and the Spanish general Pablo Morillo was driven from its shores in 1817. In recognition of its contribution to the independence movement Margarita, with the surrounding smaller islands, was renamed Nueva Esparta ("New Sparta").

The population of Margarita is predominantly indigenous; the Spanish ancestry is traceable chiefly to the Canary Islands. Since 1920 the island has attracted immigrants from abroad, but at the same time many islanders have migrated to the mainland in search of favourable employment. There are on the island a *liceo* (high school) and three institutions which provide commercial instruction. (J. J. J.)

MARGATE, a municipal borough and seaside resort of Kent, Eng., lies at the southeast end of the Thames estuary 16 mi. N.E. of Canterbury by road. Pop. (1961) 45,708. During the summer it is served by pleasure steamers from London. The municipality owns 9 mi. of sea front with its fine sands, and has built promenades along almost the whole distance, which includes Cliftonville and Westbrook, Westgate-on-Sea and Birchington and provides concert pavilions and winter gardens, tidal bathing pools and many other means of recreation for the huge influx of summer visitors who provide the town's chief source of income. The jetty is 1,240 ft. long and the pier 760 ft. There is a small harbour and some fishing is carried on. A large industrial estate for light industry has been developed south of the town.

Margate was originally known as St. John's, Thanet, and the flint church of St. John the Baptist, founded in 1050, contains some portions of Norman architecture and many brasses. The port was an ancient and senior noncorporate limb of Dover, and at the time of the siege of Calais it contributed 15 ships of small tonnage. A pier existed before 1500 but, the amount of grain shipped being small, the *droits* (dues) were insufficient to keep it in repair. In 1750 Margate became known as a bathing place with fine sands and in 1777 the pier was rebuilt. The stone pier, badly damaged in the storms of 1953 when the harbour light (1829) was destroyed, has been repaired. In 1835 the town was still a liberty of Dover and no right of citizenship could be acquired. In 1857 it was incorporated, and the borough was extended to include the resorts of Westgate-on-Sea, Birchington and the parish of Garlinge in 1935. Margate suffered considerably from air raids and cross-channel bombardment in World War II. The early 15th-century gateway of the manor house of Daundelyon, now Dent-de-Lion farmhouse, remains between Margate and Westgate. The foundation of a Roman villa was discovered at Tivoli, south of Margate, in 1924. At Quex park is the Powell-Cotton museum of natural history and ethnography.

MARGAY (*Felis wiedii*), an American wildcat found from far southwestern Texas to Paraguay, east of the Andes. It is 2 ft. long, with tail 18 in., resembling the larger ocelot in colour, but with more elongate spots and a longer tail. The head is more rounded. The name tiger cat is applied loosely to the margay and several other American wildcats. (J. E. HL.; X.)

MARGELAN, a town in the Fergana *oblast* of the Uzbek Soviet Socialist Republic, U.S.S.R., is situated in the southwest of the Fergana valley 1½ mi. from Gorchakovo station on the

Andizhan-Kokand railway and 5 mi. N. of Fergana city. Pop. (1959) 67,990. It has been celebrated for its silk since the 10th century and is now the most important silk spinning and weaving centre in the U.S.S.R. Margelan is famous for a type of brightly coloured iridescent silk used for women's clothes all over central Asia. It was called Stary (Old) Margelan (1876–1907) as opposed to Novy (New) Margelan (subsequently renamed Fergana). (G. E. Wr.)

MARGGRAF, ANDREAS SIGISMUND (1709–1782), German chemist whose name is especially associated with the discovery of sugar in beetroot, was born at Berlin, March 3, 1709. He studied chemistry at Berlin and Strasbourg, medicine at Halle, and mineralogy and metallurgy at Freiberg, and returned to his native city in 1735 as assistant to his father, who was chief apothecary at the court. In 1738 he was elected to the Berlin Academy of Sciences, which in 1754 put him in charge of its chemical laboratory and in 1760 appointed him director of its physics class. He died in Berlin, Aug. 7, 1782. Marggraf's discovery of beet sugar in 1747 led to development of the beet sugar industry. He introduced the microscope as an aid to chemical inquiry and used this instrument to detect the presence of minute sugar crystals. In another research dealing with the nature of alum, he showed that one of the constituents of that substance, alumina, is contained in common clay, and that it is quite distinct from lime. He explained and simplified the process of obtaining phosphorus from urine, and made some observations on phosphoric acid; but though he noted the increase in weight that attends the oxidation of phosphorus he remained an adherent of the phlogistic doctrine. For his time he was a skilful chemical analyst.

His papers were presented to the Berlin academy, and with the exception of a few of the latest were collected in two volumes of *Chymische Schriften* in 1761–67.

MARGHILOMAN, ALEXANDRU (1854–1925), Rumanian statesman noted for his role in World War I, was born at Buzău on July 4, 1854. After studying law and political science in Paris he returned to Rumania and was elected deputy in 1884. He first became a member of the government in 1888. One of the Junimist group of young conservatives, Marghiloman believed that Rumania's interests demanded co-operation with Germany and Austria-Hungary; but on the outbreak of war in 1914 he advocated neutrality. In 1916, as leader of the Conservative party, he was offered a seat in Ion Brătianu's cabinet, but he refused it because he could not endorse Rumania's declaration of war on the Allied side. He remained in Bucharest during the German occupation and, as president of the Rumanian Red Cross, was able to act as mediator between the occupying authorities and the population. He rejected German proposals that, in order to conclude peace, he should form a government in Bucharest, in rivalry to King Ferdinand's government in Iaşi. After Rumania's surrender in March 1918, however, he went to Iaşi and at the king's request took office as prime minister to sign a peace treaty with the Central Powers (May 7, 1918; never ratified). His cabinet fell on Nov. 8, 1918, with the defeat of the Central Powers, and he played no further part in Rumanian politics. He died at Buzău on May 10, 1925. His memoirs appeared in 1927. (B. Br.)

MARGIN, a term in finance meaning the amount by which the value of collateral provided as security for a loan exceeds the amount of the loan. This excess represents the borrower's equity contribution in a transaction that is partly financed by borrowed funds; thus it provides a "margin" of safety to the lender over and above the collateral that is pledged. The size of the margin that is required varies with the type of collateral, the stability of its market price, expectations with regard to its future price and the credit standing of the borrower.

The term margin is used especially in connection with transactions in securities and commodity futures. When securities are purchased "on margin" the buyer supplies only a percentage, or margin, of the purchase price and borrows the remainder from his broker, pledging the security as collateral for the loan. A fall in the price of the security subsequent to the purchase reduces the margin available to the lender and the customer may be called upon to restore his margin to a prearranged level. This level is determined by the lending broker, but may not be below minimum levels stipulated by the organized exchange in which the transaction takes place.

In addition, minimum initial margin requirements on loans made for the purpose of purchasing securities are required in the United States by the federal reserve board under authority granted by the Securities Exchange act of 1934. The purpose of the margin requirement is to prevent excessive use of credit for speculation in stocks. Dealings on margin are not allowed on British stock exchanges. (Ea. S.)

MARGINAL GROUPS. This term is used in two ways by sociologists: one refers to certain racially mixed groups; the other to a group leaving one cultural background but not yet accepted by a second cultural community. In societies throughout the world there are people of mixed or uncertain genetic origin who are not recognized as members of the dominant racial group and who refuse to accept racial classification among a socially subordinate group, or minority. These become the "marginal groups." Ohio State university sociologist and anthropologist Brewton Berry, author of *Almost White* (1963), has identified the Melungeons (in Tennessee), the Guineas (West Virginia), the Jackson Whites (New York–New Jersey), the Keating Mountain group and the Pools (Pennsylvania), the Croatans (Georgia and the Carolinas), the Dominickers (Florida) and other groups throughout the U.S. south and in New England. In other countries there are the métis in Canada and the mestizos (*q.v.*), or cholos, in Bolivia, Colombia, Ecuador and other Latin-American countries.

Commonly in the United States, a Negro is socially defined as anyone who has any known trace of Negro ancestry, despite the many legal definitions that specify one-fourth or one-eighth Negro ancestry as defining a Negro (*see* Negro, American). With the extensive intermingling that has gone on for over 350 years in North America, practically all socially defined Negroes have varying degrees of admixture of white ancestry, and a great number have some American Indian ancestry. Appearance is not a perfect guide, either to the actual amount of genetic intermingling or to the public acceptance of a given person as being of a specific race. Only one thing is certain: if a community *defines* a person as a Negro, he is treated as a Negro.

The phenomenon of *group self-hatred* is well known among certain minority groups who are considered as proper objects for prejudice and discrimination by the majority group (*see* Minorities). That is, there are individuals who despise themselves because they are members of despised minorities, yet they cannot break away from the group because of their physical appearance, their social obligations or their public identification. Some of the American Negroes who have group self-hatred also have been living together as a group in the same community for many generations. They have developed distinctive traditions and a way of life characteristic of a community of people living together and more or less isolated from the larger society over a period of time. One of their most important characteristics is their group self-hatred, which manifests itself in a vigorous denial that they are Negro. In one important way they are right, since they are not predominantly Negro in a scientific, biological sense. But they are partly Negro, and are socially defined as Negro by the majority of the population, and of these things they are very much aware. They are thus marginal—accepted neither by whites nor by Negroes, while they themselves refuse the racial identification which both of the other groups give them as Negroes.

Another such group is the Cajuns of Louisiana and Alabama. They claim ancestry, probably accurately, from the French Acadians (Cajun is a corruption of Acadian) who were driven out of Canada by the English in the 18th century and who took up residence in the French colony of Louisiana. What they fail to acknowledge is that their French ancestors amalgamated with Negroes and probably also with American Indians. They insist that they have pure Caucasoid ancestry, which neither the whites nor the Negroes of their communities accept. So the Cajuns live an isolated existence: the whites will not associate with them, and they will not associate with the Negroes. What makes their situation ironic is that many of the French-descended "whites" of

Louisiana who call themselves "Creoles" also have some admixture of Negro ancestry. But the Creoles have managed to get themselves publicly identified as white, while the Cajuns have not.

The Croatans of Georgia and the Carolinas are another such group, with ancestry predominantly a mixture of Indian and Negro. They reject a Negro ancestry and insist on being called Indians. The whites and the Negroes in their communities know of their Negro ancestry, but because of their aggressive refusal to be treated like the other Negroes, they occupy a distinctive, but segregated, position in the community. In other nations where race identifications are very important socially (as in South Africa and Southern Rhodesia) the mixed bloods are accorded a legal status, as "Coloureds," different from that of the pure-blooded Negroes, and therefore have a recognized, though inferior, position in the society (*see* CAPE COLOUREDS). In the United States, where practically all Negroes are mixed bloods and where the dominant whites identify anyone with any known Negro ancestry as Negro, the mixed bloods must either identify themselves as Negro or else become a "marginal group"—calling themselves something which nobody else recognizes to be true.

Marginal groups have also been defined by sociologists Robert E. Park and Everett Stonequist to be those in transition between two cultures, regardless of their genetic characteristics. Members of an immigrant group, for example, having abandoned the society of their ancestors, are still not fully accepting of, or accepted in, the host society into which they have moved. The character of being marginal is even more keenly defined for the children, who feel completely alienated from the society of their ancestors but are still not fully accepted into the society where they now dwell. The main studies of these "marginal men" have been among the offspring of European immigrants to the United States, but the problem has been observed, too, among migrants from the rural south to the industrial cities of the north, where they have been disparagingly classified as "hillbillies." Group self-hatred usually characterizes these cultural marginal groups just as it does the racial ones. In all cases, they are between two larger groups, but part of neither.

See also SEGREGATION, RACIAL; INTERRACIAL RELATIONS; CLASS, SOCIAL.

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MARGOLIOUTH, DAVID SAMUEL (1858–1940), British Arabic scholar who enjoyed an almost legendary reputation among the Islamic peoples and the oriental scholars of Europe, was born in London on Oct. 17, 1858, the son of an Anglican missionary to the Jews. Educated at Winchester and New college, Oxford, he devoted himself to Arabic studies and in 1889 became Laudian professor of Arabic at Oxford. He took an active part in the Royal Asiatic society, was awarded its triennial gold medal in 1928 and was its president, 1934–37. He held many other honours. In addition to several works on the history of Islam, which became the standard English treatises on the subject, he edited and translated many important Arabic texts, including the *Letters* of Abu al-'Ala (1899), Yakut's *Dictionary of Learned Men*, six volumes (1907–27) and (with H. F. Amedroz) *The Eclipse of the 'Abbasid Caliphate*, seven volumes (1920–21). He died in London on March 22, 1940.

See the *Proceedings of the British Academy*, vol. xxxvi (1940).

MARGRAVE (Ger. MARKGRAF), originally the count (*q.v.*) at the head of a mark or march, one of the great military zones of command established by Charlemagne and his successors on the frontiers of the Frankish empire; *e.g.*, the Breton march, the Spanish march, the march of Gothia, the march of Friuli. The German kings of the Saxon dynasty, Otto I, Otto II and Otto III, created a new system of marks in the 10th century, giving particular attention to their eastern frontier. A margrave was expected not only to secure the frontier but also to push it forward into Slav or pagan territory, as did Gero, the Billungs, the margraves of Meissen and Albert I the Bear (*qq.v.*). Some of the margraviates grew into hereditary principalities; thus the Bavarian Ostmark became the duchy of Austria, the Steiermark became the duchy of Styria, the Saxon Nordmark became the electorate of Brandenburg. Later, however, the margraves of Baden were so styled simply because their ancestor had held the mark of Verona in 11th-century Italy; the Hohenzollern margraves of Ansbach and of Bayreuth likewise echoed their ancestor's title to Brandenburg. (C.-E. P.)

MARGUERITE, the popular name for several plants of the family Compositae, especially *Chrysanthemum frutescens*, a shrubby perennial with smooth leaves cut pinnately into narrow segments and flower heads two or three inches across produced singly in summer and autumn on slender erect stalks. The ray florets, which may be white or pale yellow, surround a yellow disk. It is a native of the Canary Islands, and a favourite for decoration and for greenhouse cultivation, window boxes and open ground in the summer. The golden marguerite or yellow camomile (*Anthemis tinctoria*) has golden yellow flowers and somewhat woolly stems and leaves. The plant is propagated from cuttings taken in autumn from old plants and placed in sandy loamy soil in cold frames. In England marguerite, moon-daisy or oxeye daisy indicates *Chrysanthemum leucanthemum*. The African subshrub *Felicia amelloides*, known in cultivation as blue daisy, is also called the blue marguerite. In France *la marguerite* is applied to the common daisy (*q.v.*).

MARGUERITTE, PAUL (1860–1918) and **VICTOR** (1866–1942), French novelists, both born in Algeria, where their father, Gen. Jean Auguste Margueritte (1823–1870), who later distinguished himself at the head of the 1st Cavalry division and met his death near Sedan in Sept. 1870, was commanding a garrison. Paul, who was born at Laghouat on Feb. 1, 1860, recalled his Algerian childhood in *Le Jardin du passé* (1895). Educated at the free school for officers' sons at La Flèche, he worked at the ministry of education from 1881 to 1887. He published his first book, *Mon Père*, in 1884 and was originally one of the Naturalist group of writers, but broke with them when he signed the manifesto of "the Five" against Émile Zola's *La Terre* in 1887. He had already published *Tous quatre* (1885), *La Confession posthume* (1886) and *Maison Ouverte* (1887); there followed *Pascal Géfosse* (1887), *Amants* (1890), *La Force des choses* (1890), *Sur le Retour* (1892), *Ma grande* (1892), *La Tourmente* (1894), *Âme d'enfant* (1894) and *L'Eau qui dort* (1896). In 1896 he began his collaboration with his younger brother Victor (born at Blidah on Dec. 1, 1866), who, after serving as a lieutenant in a dragoon regiment, left the army to devote himself to literature. The two brothers published jointly *Pariétaire* (1896), *Poum, aventures d'un petit garçon* (1897) and *Une époque*, a series of four novels on the events of 1870–71, comprising *Le Désastre* (1898), *Les Tronçons du glaive* (1901), *Les Braves Gens* (1901) and *La Commune* (1904). Besides these historical novels, they wrote novels on moral questions and pamphlets on marriage and the emancipation of women, including *Femmes nouvelles* (1899), *Deux vies* (1902) and *Le Prisme* (1905). Their collaboration ceased in 1907.

Paul Margueritte was one of the first members of the Académie Goncourt, having been nominated for a seat in Edmond's will (*see* GONCOURT). Among his later books were *Souvenirs de jeunesse* (1906–08), *La Flamme* (1909), *La Faiblesse humaine* (1910), *L'Embusqué* (1916) and *Jouir* (1918). He died at Hossegor (Landes) on Dec. 30, 1918.

Victor published by himself *La Prostituée* (1907), *Jeunes filles* (1909), *La Garçonne* (1922) and *Ton corps est à toi* (1927). The last two provoked an indignant moral outcry, as also, for different reasons, did his books on the war, *Les Criminels* and *Appel aux consciences* (both 1925). He died at Monestier, Isère, on March 23, 1942. (R. DL.)

MARI, an ancient Syrian city marked by the site of TALL HARIRI, was situated on the right bank of the Euphrates about 7 mi. N.N.W. of Abu Kemal near the frontier with Iraq. Excavations directed by A. Parrot were initiated in 1933 and were still in progress in the 1960s. The periods at which the city was occupied range from the Parthian and Sasanian (2nd century B.C.–

7th century A.D.) through the Neo-Babylonian and Assyrian back to Hammurabi, 18th century B.C., when the place, ruled over by a local king named Zimri-Lim, enjoyed a glorious period of prosperity for about 30 years. It was then destroyed by the Babylonians who, after defeating Rim-Sin of Larsa, deemed it necessary to control the important trade routes which ran along this stretch of the middle Euphrates.

A series of buildings, many of them on a grand scale, were continuously re-erected between 3000 and 2000 B.C. They include a ziggurat, temples to Ishtar, Nin-har-sag and Dagan. Remains of the Jamdat Nasr period (*c.* 3100 B.C.) have also been found, and still earlier occupations probably remain to be discovered.

Associated with the temples was an important series of statuary in alabaster and calcite, of the period known as Early Dynastic III, mostly inscribed with Semitic names of kings, viziers, priests and other dedicants. It is, however, the great palace at Mari, founded in the 19th century B.C., which has been the most remarkable of the many discoveries at that site. It occupied an area of about five acres and contained nearly 300 rooms within which were concentrated all the most important administrative offices. The royal apartments and the approaches to the throne room were decorated with painted murals, of which the most striking was a huge "canvas"—a painting in mud plaster which depicted the king being invested with the royal insignia from the goddess Ishtar. Many hundreds of small objects were found as well as some splendid statuary of which the most remarkable was a lifesize figure of a goddess holding a vase, so arranged that the life-giving waters could be poured through her and issue from a vase held between her hands. Nothing however was more valuable than the discovery of many thousands of archives in various scribal chambers. These consisted of diplomatic correspondence and reports sent in from all parts of the realm, as well as historical archives and letters exchanged between King Shamshi-Adad I of Assyria and his two sons shortly before 1800 B.C. Economic and legal texts were also abundant, and dispatches from local governors have added greatly to the knowledge of Syrian and Assyrian geography. These documents, of which many hundreds have already been published, give a graphic picture of life at this period, both of the town dwellers and of the Bedouin.

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MARIA, the name of two queens of Portugal.

Maria I (1734–1816), queen of Portugal from 1777 to 1816, was born in Lisbon on Dec. 17, 1734, the daughter of the future king Joseph I. In 1760 she married her uncle who, as king consort after Maria's accession (Feb. 1777), was styled Pedro III. Her prosperous and peaceful reign followed the dictatorial administration of the marquês de Pombal, part of whose handiwork she repudiated. A treaty of alliance was signed with Spain (1778), after an agreement to map the common frontier in South America. Deaths in the royal family in 1786 and 1788, combined with news of the excesses of the French Revolution, so affected Maria that she became mentally deranged. Her third surviving son and heir apparent (afterward John VI) assumed power in Feb. 1792 for the duration of his mother's illness, and when this was declared incurable, became regent (1799). Maria accompanied the court to Brazil in 1807 and died in Rio de Janeiro on March 20, 1816.

Maria II (1819–1853), queen of Portugal from 1834 (regarded by some as queen from 1826) to 1853, was born in Rio de Janeiro on April 4, 1819, the daughter of Pedro, eldest surviving son of John VI. When John died (1826), Pedro, already emperor of Brazil, succeeded to the Portuguese throne but quickly made a conditional abdication in favour of Maria, the proviso being that she should marry her uncle, Dom Miguel (*q.v.*). However, before Maria arrived in Europe (Sept. 1828), Miguel had renounced his allegiance to her and to Pedro and had been proclaimed king. As a result, Maria did not actually become queen until 1834 when Miguel was defeated (*see* Portugal: *History*). Her reign was characterized by the continuing struggle between liberals and conservatives, and by foreign intervention. Maria married in 1835 Augustus, duke of Leuchtenberg, who died the same year, and in 1836, Ferdinand of Saxe-Coburg, by whom she had 11 children. She died in Lisbon on Nov. 15, 1853. (M. Ca.)

MARÍA CRISTINA, the name of two queens of Spain.

María Cristina I (1806–1878), queen consort of Ferdinand VII from 1829 to 1833 and queen regent from 1833 to 1840, was born at Naples on April 27, 1806, the daughter of Francis I, king of the Two Sicilies. Spanish liberals hoped that her marriage to Ferdinand would moderate the persecution to which they were subject, and this hope was in fact realized whenever the queen exercised political power. In 1830, the queen being pregnant, Ferdinand VII confirmed the *pragmática* issued in 1789, which re-established the right of females to succeed to the throne in default of male heirs. This was opposed by supporters of the claims to the succession of the king's brother, Don Carlos (1788–1855). Within a few days of the death of Ferdinand VII (1833), when María Cristina was named regent during the minority of her daughter Isabella, the first Carlist War began. The war was terminated only by the convention of Vergara in 1839 and by this time María Cristina had lost much support because of her morganatic marriage with Fernando Muñoz. She resigned her regency in 1840 and went to Marseilles, but returned to Spain in 1843, after Gen. Ramón Narváez's *coup d'état.* Isabella II was then declared of age and María Cristina again took part in political life, but she was forced to go into exile again in 1854. She died at Saint-Adresse in France on Aug. 23, 1878. (R. S. Ll.)

María Cristina II (1858–1929), queen consort of Alfonso XII from 1879 to 1885 and queen regent from 1885 to 1902, was born at Gross Seelowitz on July 21, 1858, the daughter of the archduke Charles Ferdinand of Austria. She married Alfonso XII on Nov. 29, 1879. He died on Nov. 25, 1885, leaving her two daughters and a posthumous son, born on May 17, 1886, who immediately succeeded to the throne as Alfonso XIII, under the regency of his mother. María Cristina discharged her long and difficult regency with a tact and dignity that won general respect, even though the war of 1898 against the United States was a disaster for Spain. She contributed greatly to the strengthening of the monarchy, to the appeasement of political struggles and to the steady, though slow progress of Spain from the lowest point of its decadence. After Alfonso XIII's coming of age (May 17, 1902), María Cristina devoted the remainder of her life to social and charitable work. She died in Madrid on Feb. 6, 1929. (R. M. N.)

MARIANA, JUAN DE (1536–1624), Spanish historian and Jesuit whose chief work, the *Historiae de rebus Hispaniae,* is esteemed for its learning and its flowing prose style, was born at Talavera. In 1561 he went to teach theology in Rome, to Robert Bellarmine (*q.v.*) among others, then passed into Sicily, and in 1569 was sent to Paris, where his expositions of the writings of Thomas Aquinas attracted large audiences. He returned to Spain in 1574.

The *Historiae de rebus Hispaniae* first appeared in 25 books at Toledo in 1592; ten books were added (1605), and the author completed it to the accession of Philip IV in 1621. Mariana later translated it into Spanish (1601). Of his other writings the most interesting is the treatise *De rege et regis institutione* (1599; Eng. trans., *The King and The Education of The King,* 1948). Mariana's conclusion in this work that it may be lawful to overthrow a tyrant brought much odium upon the Jesuits, especially after the assassination of Henry IV of France in 1610. Mariana died in Toledo on Feb. 16, 1624.

See G. Cirot, *Études sur les historiographes espagnols: Mariana, historien* (1905); J. Laures, *The Political Economy of Juan de Mariana* (1928).

MARIANA ISLANDS, a series of volcanic mountain peaks and uplifted coral reefs in the Pacific ocean forming a chain from Guam to Japan, extending from latitude 12° to 21° N. and longitude 144° to 146° E. They are divided politically into Guam, a territory of the United States (*see* Guam), and the islands north of Guam which are part of the United States Trust Territory of the Pacific Islands, administrated as a trusteeship from the United Nations since 1947. The northern Marianas have a total area of

approximately 184 sq.mi. of which 47 are on Saipan, 39 on Tinian and 33 on Rota. The climate is mild, tropical and frost-free. On Saipan temperatures range from 21° to 29° C. (70° to 85° F.) and the annual rainfall averages 82 in.

The northern Marianas had a population of 8,290 in 1958 with the Rota district, administrated by the interior department since 1951, having a population of 969 and the Saipan district, administrated by the U.S. navy since 1953, having a population of 6,654. The population is descended from the pre-Spanish Chamorros with considerable intermingling of Spanish, Mexican, Philippine, German and Japanese blood. Spanish cultural traditions are strong.

After Ferdinand Magellan's discovery in 1521, the Mariana Islands were visited frequently but not occupied permanently by the Spanish until 1668. The name was changed from Ladrones Islands (Islands of Thieves) to Mariana Islands to honour Queen Marie Anne (Mariana), then regent of Spain. Guam was ceded to the United States following the Spanish-American War and the northern Marianas were sold to Germany in 1899. They were occupied by Japan in 1914 and became a Japanese mandate from the League of Nations until seized by the United States in World War II.

The economy is largely self-sufficient agriculture with some income from copra and services to military bases. (C. A. MR.)

MARIANAO, a city in Havana province, Cuba, adjacent to the western city limits of Havana. It is situated in a slightly hilly section along the northern coast. Although founded in 1726 it did not grow much until after 1900. Having only 9,000 inhabitants in 1907 it then grew extremely rapidly as a residential and industrial suburb of Havana; its 1953 population was 219,278. Exclusive residential sections have been developed near Marianao beach and in the country club area. The principal manufactures are beer, pharmaceuticals, paper products, cloth and tobacco. The chief military encampment of Cuba, Camp Columbia, is in Marianao. (D. R. D.)

MARIANISTS (SOCIETY OF MARY; SOCIETAS MARIAE; S.M.), a religious congregation of the Roman Catholic Church founded by William Joseph Chaminade at Bordeaux, France, in 1817, and canonically approved Aug. 11, 1865. The congregation comprises about 3,200 clerical and lay members—in 11 provinces throughout western Europe, the Americas, Asia, Africa and Australia—engaged primarily in Christian education. It is governed by an elected general superior, resident in Rome. American Marianists constitute 45% of the total membership, in four provinces centring at Dayton, O., St. Louis, Mo., Santa Cruz, Calif., and Chester, Pa. (J. A. EL.)

MARIANSKE LAZNE (Ger. MARIENBAD), a small spa in the West Bohemia region, Czech., lies on the edge of the wooded Cisarsky Les hills, 39 km. (24 mi.) S.W. of Karlovy Vary. Pop. (1961) 16,456. The mineral springs which made it famous as a spa were long the property of Tepl abbey (12th century) about 14 km. (9 mi.) from the town. Josef Nehr, the abbey's doctor (1779–1820), demonstrated the therapeutic properties of the peat and springs. The settlement took its German name, Marienbad, in 1808 and received its town charter in 1868. Special features of the springs are the high iron content of the Ambrozuv *pramen* (spring) and the strength of the alkaline-saline waters of the Krizovy *pramen*. In the last years of the Austrian empire the popularity of the cures and the beauty of the surroundings attracted wealthy visitors from all over Europe; the spa is now a centre for international congresses and symposia. (H. G. S.)

MARIANUS SCOTUS (originally named MOEL-BRIGTE, "Servant of Bridget") (1028–1082), Irish monk whose Latin chronicle, written in Germany, is notable for its challenge to the traditional calendar. Born in Ireland, he became a monk in 1052 and was taught by Tigernach, abbot of Clonmacnoise. Soon, however, he began to travel. He was in Cologne in 1056 and went from there to Paderborn and then to Fulda. Ordained priest at Würzburg in 1059, he returned at once to Fulda to be walled up as a recluse. In 1069 he was summoned to Mainz; but there he was again walled up. He died there on Oct. 22, 1082. He is not to be confused with the Marianus Scotus who died in 1081 as abbot of St. Peter's in Regensburg.

Marianus wrote a universal chronicle to 1082, the first part of which, down to 1073, is extant in his manuscript. Its main interest lies in its chronological calculations: Marianus maintained that Dionysius Exiguus, whose Easter tables determine the Christian calendar, dated the birth of Christ 22 years too early. Book iii of the chronicle is edited by G. Waitz in *Monumenta Germaniae Historica*, series *Scriptores*, vol. v and xiii (1844, 1881).

See A. D. von den Brincken, "Marianus Scotus," in *Deutsches Archiv*, 17 (1961). (K. RE.)

MARIA STELLA (1773–1843), Italian adventuress who claimed to be a French princess of the house of Bourbon-Orléans, was born at Modigliana, near Forlì, on April 16, 1773, and registered as the daughter of Lorenzo Chiappini, constable of Modigliana, and his wife Vincenzia Viligenti. Trained as a singer and dancer, she went on the stage in Florence. She was married in 1786 to Thomas Wynn, 1st Baron Newborough, who died in 1807; and in 1810 to a Russian count, Edward Ungern-Sternberg.

When Lorenzo Chiappini died in 1821 he left a letter stating that Maria Stella's real father was not he but a nobleman who had exchanged her for Chiappini's son and had later died. Finding that in 1773 a couple traveling under the name of comte and comtesse de Joinville had been at Modigliana, Maria Stella built up the story that these two were the duc and duchesse de Chartres (Louis Philippe Joseph, later duc d'Orléans and named Louis Philippe Égalité, and his wife Adélaïde de Bourbon-Penthièvre) and that the duc had exchanged a daughter for Chiappini's son in order to keep the Penthièvre inheritance in his own house. The son whose parentage was thus contested was Louis Philippe, then duc d'Orléans and later king of the French. The ecclesiastical court of Faenza in 1824 accepted Chiappini's story but rejected the identification of the nobleman with the duc de Chartres.

Maria Stella's apologia, *Maria Stella ou un échange d'une demoiselle du plus haut rang contre un garçon de plus vile condition*, first appeared in 1830, coinciding with Louis Philippe's accession to the French throne. Its publication may have been arranged by partisans of the duchesse de Berry as a counterblast to pamphlets (supposedly of Orleanist inspiration) casting doubt on the legitimacy of her son, the duc de Bordeaux. The book was reprinted in 1839 and in 1849. Maria Stella died in poverty in Paris on Dec. 28, 1843.

See R. P. Gallwey, *The Mystery of Maria Stella, Lady Newborough* (1907); M. Vitrac, *Philippe Égalité et Chiappini* (1907).

MARIA THERESA (1717–1780), consort of the Holy Roman emperor Francis I, in her own right archduchess of Austria and queen from 1740 of Hungary and Bohemia, was born in Vienna on May 13, 1717, the eldest daughter of the emperor Charles VI and Elizabeth of Brunswick-Wolfenbüttel. Her father's only son having died in earliest infancy, she was the presumptive heiress to the Habsburg succession, but nothing was done to prepare her personally for the tasks before her. On Feb. 12, 1736, she was married to Francis Stephen of Lorraine, who the next year became grand duke of Tuscany in compensation for renouncing his duchy of Lorraine. Charles VI, meanwhile, had hoped to secure her peaceful accession to the entire Habsburg inheritance by inducing the great powers and the German princes to recognize the pragmatic sanction (*see* AUSTRIA, EMPIRE OF; HABSBURG); but after his death on Oct. 20, 1740, the War of the Austrian Succession (*q.v.*) broke out. Frederick II of Prussia, the elector Charles Albert of Bavaria and, after several months of hesitation, the French all attacked the Habsburg territories.

The young queen found very little support either in her husband or among the majority of her principal counselors; she needed "the heart of a king" not to lose courage. Charles Albert entered Prague and had himself elected king of Bohemia in Dec. 1741; and at Frankfurt in Feb. 1742 he was crowned Holy Roman emperor as Charles VII. His fortunes soon fell when Bavaria was overrun by the Austrians; he died in Jan. 1745; and finally Francis Stephen was elected emperor instead, as Francis I (Sept. 1745). Still, Maria Theresa had to cede Silesia to Frederick at the treaty of Dresden (Dec. 1745) in return for his recognition of Francis. This cession, which was confirmed in the general peace of Aix-la-Chapelle at the end of the war (1748), impaired Austria's position

vis-à-vis the other German states and reduced the Germans in the lands of the Bohemian crown to a minority as against the Slavs.

Naturally Maria Theresa resented the loss of Silesia and hoped to regain that rich province in a new war. To prepare for this, she had to mobilize the potentialities of the ancient Habsburg realms and to transform that mass of territories into a compact state. This implied reducing the power of the estates of the various countries, which were hotbeds of particularist feeling. With the help of Friedrich Wilhelm, Graf von Haugwitz (1700–65), she succeeded, by radical administrative reforms, in reshaping the constitutions of the individual lands. The administrative functions of the estates were largely superseded by centrally appointed bodies; and by overriding the juridical distinction between the lands of the Bohemian crown and the Austrian territories the nucleus of a consolidated Austrian monarchy was brought into being. Moreover, the estates were forced to grant higher taxes. Even so, this great administrative reform was limited to the countries west of the Leitha river, as Maria Theresa was too circumspect to touch the Hungarian constitution so fiercely defended by the Magyar nobility. Her diplomatic ability, however, succeeded in drawing Hungary nearer to the unified monarchy.

It was not enough merely to reorganize the monarchy if Silesia was to be reconquered. A change in Austria's external policy was also necessary, and for this task Maria Theresa found a guide of the highest diplomatic skill in Wenzel Anton von Kaunitz. Kaunitz convinced the empress that she would never defeat Prussia if she relied only on the allies that she had had in the war of the Austrian Succession, namely Great Britain and the United Provinces of the Netherlands; instead he wanted to break the Franco-Prussian alliance and to win the French alliance for Austria. This "diplomatic revolution," at first considered almost impossible, was actually achieved; an Austro-French defensive alliance was concluded on May 1, 1756. This was changed into an offensive alliance a year later, when the Seven Years' War (*q.v.*) had already begun. When the Russian empress Elizabeth joined the anti-Prussian front, Frederick's fate seemed sealed. The Austrian diplomats, however, had overestimated France's power and willingness to wage war, had not taken into account the hesitancies of the Russian leadership and could not match Frederick's military genius—though L. J. von Daun and E. G. von Laudon were outstanding generals. The peace of Hubertusburg (Feb. 1763) left Silesia with Prussia.

The emperor Francis I died in 1765; Maria Theresa never ceased to mourn him. Her son Joseph II then succeeded Francis as emperor and became co-ruler with her over the Austrian dominions. Joseph and Kaunitz tried to compensate for the loss of Silesia by acquiring Bavarian territory, but this policy, which they pursued against the wishes of Maria Theresa, was frustrated by the Prussian king. The War of the Bavarian Succession (*q.v.*) brought no glory to either contestant; though the peace of Teschen (May 1779) gave the Innviertel to Austria, the real victor was Frederick of Prussia. On the other hand Joseph and Kaunitz were luckier with their eastern policy, which brought eastern Galicia and Lodomeria to Austria at the first partition of Poland (1772). Maria Theresa, however, agreed only after a hard fight to participate in this piece of banditry, for she held firmly that the concepts of private law and ethics ought also to govern the dealings of states with one another, whereas Joseph and Kaunitz followed the utilitarian conceptions of enlightened despotism.

Maria Theresa's last years were rendered happy by the reforms that she inaugurated after the Seven Years' War. While she and Joseph did not always see eye to eye, both strove to promote the welfare of their people. In fact, the monarchy became notably more prosperous from 1763 onward. Mercantilist ideas, now fully applied, stimulated economic life and created new wealth; and Maria Theresa's social policy improved the lot of the serfs, whose services and labour were appreciably lightened. Especially close to Maria Theresa's heart was the reform of education; some primary schooling was made compulsory, higher education was modernized, and universities were plentifully endowed and brought up-to-date. The empress, who gave protection, help and opportunities to those who had to work for their living, deserved indeed to be called "the universal and first mother" of her peoples. She died at Schönbrunn on Nov. 29, 1780.

See also references under "Maria Theresa" in the Index.

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MARI AUTONOMOUS SOVIET SOCIALIST REPUBLIC of the Russian Soviet Federated Socialist Republic in the U.S.S.R., lies in the basin of the middle Volga, covering an area of 14,416 sq.mi. Almost all the republic lies on the northern, left bank of the Volga and is drained by its tributaries, the Vetluga, Bolshaya (Greater) and Malaya (Lesser) Kokshaga, and Ilet. Only in the west does a small area extend on to the right bank, where the northern end of the Volga upland comes up to the high bank of the river. The surface of the main left bank area consists of a level, often swampy, plain of boulder clay, derived from glacial ground moraine and sands of fluvioglacial origin. Toward the east this plain rises gently to the low hills of the Vyatka upland (Vyatski Uval), which reach a maximum height of 902 ft. The climate is markedly continental. Winters are lengthy and cold, with January average temperatures of −13° C. (9° F.). During the not infrequent invasions of cold arctic air masses, temperatures may fall as low as −42° C. (−43° F.). Summers are warm, with July averages about 20° C. (68° F.) and maxima in the thirties (C.) or nineties (F.). Precipitation is about 18 in. a year, with a summer maximum, but there is possibility of wide variation. Annual totals as low as 8 in. and as high as 29 in. have been recorded. The republic lies at the southern limit of the taiga zone, with dense coniferous forest. Spruce and birch are ubiquitous, while sandy areas are usually in pine. Toward the northeast, fir is common. In the extreme south and the Volga right bank area the mixed forest zone begins and some oak is found. Originally forests covered almost all the republic, but much has been cleared in the course of centuries and they now cover just over half the surface. Clearing has been particularly extensive on the Vyatka upland and the right bank area, where conditions are drier. Flood plain meadows line the Volga and other rivers usually subject to annual flooding in spring. There is a great deal of surface water; the republic has 476 rivers although 426 of these are less than 15 mi. long. There are also many areas of peat bog, reed and grass marsh and swampy forest, scattered over the boulder clay plain. Apart from the swamp and river meadow areas, soils nearly everywhere are podzols.

The population of the Mari republic numbered 647,680 by the 1959 census. Of these the bulk were rural dwellers (72% of the total, or 465,214). This is well above the U.S.S.R. figure of 52%. The remaining urban inhabitants live in three towns, Yoshkar-Ola, the capital, with 88,744 people, and Volzhsk and Kosmodemyansk, both on the Volga. There are nine urban districts ("settlements of town type"). The rural population, and especially the Mari, live for the most part in small villages, with less than 250 inhabitants. The Mari or Cheremis (*q.v.*) are a Finno-Ugrian people, related to the Udmurts and Mordvinians. In 1959 they numbered 504,205 in the Soviet Union as a whole and 498,066 in the R.S.F.S.R. In Yoshkar-Ola there is an institute for the study of the Mari language, literature and culture, as well as a Mari theatre. The rest of the population are mostly Russians, but there are also some Turkic peoples, Tatars and Chuvash. In general the Russian population is concentrated in and round the towns and in the main cleared areas. The Mari are found chiefly in the forested areas. Russian colonization dates from the 16th century when, after the fall of Kazan to Ivan IV, the Terrible, the land along the middle Volga passed to Russia. The territory was constituted an autonomous region in 1920 and was raised to an autonomous republic in 1936.

The leading role in the economy is taken by exploitation of the forest wealth. Timber cutting is widespread, the logs being

floated down to the Volga, where they are made up into rafts and sent downstream to Kazan, Kuibyshev, Volgograd and the Donets basin (Donbass). Much of the timber cut is used for pit props and railway sleepers. Since the Revolution, timber processing industries have been established in the Mari republic. Sawmilling is chiefly concentrated along the Volga and the railway running through Yoshkar-Ola. Most other timber working is to be found along the railway, the making of prefabricated houses at Krasnogorski and Suslonger, furniture at Yoshkar-Ola and paper and pulp at Volzhsk. Wooden barges are built on the Volga at Pokrovskoye, while there are ship repair yards at Zvenigovo. The wood-chemical industry, producing turpentine and alcohol, is important. An old established industry is glass making, for which the main centre is Krasny Steklovar. Brick making is carried on at several places, but other industry, chiefly food processing, is concentrated at Yoshkar-Ola. A handicap to more rapid industrial development is the deficiency of all-weather communications. Apart from the Volga along the south of the republic, the only important line of communication is the branch railway from Zelenodolsk in the Tatar Autonomous Soviet Socialist Republic to Yoshkar-Ola and on to its terminus at Golovinski in the north. Good roads are almost non-existent.

Despite the predominance of rural population, agriculture is not well developed. Only 28% of the area is arable and this is found mainly along the Volga and in the northeast on the Vyatka upland. Grains occupy almost 70% of the cropped area, largely rye and oats, with some spring wheat and buckwheat. Flax, potatoes and other vegetables and maize (corn) for silage are also grown. Numbers of livestock are not great. By the early 1960s the number of cows had scarcely attained the pre-Revolutionary level of about 90,000. Pig-keeping has developed steadily and there are more than 250,000 head of sheep and goats. (R. A. F.)

MARIAZELL, a town in Styria, Aus., lies in the valley of the Salza surrounded by the north Styrian Alps. Pop. (1961) 2,191. By road it is 140 km. (87 mi.) S.W. of Vienna, with which it is connected by rail. It is the most famous place of pilgrimage in Austria and is also a summer resort and a winter-sports centre. On the main square is the Gnadenkirche (founded 1157, rebuilt 1644–83), in which is enshrined a 12th-century limewood statue of the Virgin Mary (2 ft. high). The church is visited annually by about 150,000 pilgrims, some of whom attribute favours to the Virgin through the instrumentality of the statue.

MA'RIB, a town and a district of eastern Yemen in the *liwa'* (province) of San'a', 55 mi. N.N.E. of San'a' city, famous in history for its dam. The small modern town stands among the extensive ruins of the old Sabaean capital and is the headquarters of the *'amil* of the district. The fort contains many antiquities found in the ruins. There is a Shafi'i majority in the district, which includes numerous *sharifs* formerly powerful, under their amir of the al-Qeisi family. Rock salt is mined in the district, which is now desert, but good horses are bred. *See* also ARABIA: *Archaeology;* SABAEANS. (W. H. Is.)

MARIBO, an *amt* (county) of Denmark, centred on the small town of Maribo in Lolland and embracing that island, Falster and several islets. Area 694 sq.mi. Pop. (1960) 131,699. It forms the southernmost part of the Danish archipelago, being separated from Germany by Fehmarn Belt. Its gently undulating morainic surface with fertile clay loams forms an important mixed farming district. The principal town and port of Falster is Nykøbing (pop. [1960] 17,850); that of Lolland is Nakskov (16,639). (HA. T.)

MARIBOR (Ger. MARBURG), a town of the Maribor *srez* (district), Socialist Republic of Slovenia, Yugos., is a popular summer resort and tourist centre, picturesquely situated on the Drava river near the Austrian frontier, 105 km. (65 mi.) N.E. of Ljubljana. Pop. (1961) 82,387. The principal buildings are the cathedral of St. John the Baptist, dating from the 12th century, but with many later additions, among them a 17th-century tower 136 ft. high; the 15th-century castle famous for its sculptures; and the Madeleine church built in 1288, destroyed and rebuilt in 1788. There was a settlement at Maribor in Roman times but the present town grew up in the 10th century. In 1282 it was a Habsburg trade centre, controlling a vast district. After the Turkish invasions and during the anti-Reformation struggles, the importance of the city declined. Mercantilism at the end of the 18th century and the building of the Vienna-Trieste railway brought new life to the town, which is situated in the midst of a fertile fruit- and wine-growing district. Maribor is one of the largest industrial cities in Yugoslavia, with iron and tinware, automobile and railway car works. A system of hydroelectric power stations is built on the Drava river nearby. More than 14,000 people are employed in industry.

During World War II Maribor was occupied by German troops who tried ruthlessly to germanize the Slovene population of the town and district. Thousands of intellectuals were forcibly deported from Slovenia. In 1945 Maribor was liberated by the Yugoslav partisans. (V. DE.)

MARICOPA, a Yuman-speaking Indian tribe originally driven from the lower Colorado river area by intertribal warfare, like the Halchidhoma and Kohuana whom they absorbed between 1825 and 1838. The date of the Maricopa removal is not known. In 1775 they numbered 1,500–2,000. In the 1960s the Maricopa shared reservation lands with the Pima (*q.v.*) tribe on the Salt and Gila rivers. Their combined population was about 7,700, including less than 200 Maricopa.

Their mode of life was like that of the lower Colorado tribes (*see* COCOPA; MOHAVE). Houses were flattish hemispheres of timber and earth. Dress was scanty: willow-bark breechclouts for men and short, thick skirts for women. Manufactures included considerable pottery, both for cooking and general containers, but little basketry; cotton blankets and bands were woven by men. Subsistence depended largely on gathering wild mesquite beans and hunting small game, augmented by two minor crops of corn each year. Corresponding to this, a calendar of six lunar months was repeated in a year.

Maricopa political organization was loose in spite of strong tribal unity; chiefs were primarily advisors. Deliberation in the meetinghouses was in a formal, oratorical style when annals were recounted. Threading through the society were male-linked lineages thought to be mystically associated with food plants and with animals. Women alone were called by the lineage name or given personal names referring to the lineage totem.

Wars were frequent, especially with the lower Colorado tribes; club wielders and bowmen formed separate military companies. Pitched battles involving large numbers of warriors were arranged, when champions met in combat and massed fighters stood clubbing away until the losing side was nearly annihilated.

All success among the Maricopa was held to depend on dream contact with spirit birds and animals. The dream narrative, which paralleled Maricopa myths, revealed songs that were believed to give power. Ceremonial consisted in long cycles of songs (essentially myth narratives), each appropriate to a life crisis. The dead were cremated; of the four souls held to belong to each person, the principal soul was said to be reborn four times in the land of the dead. *See* also YUMAN.

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MARIE (MARIE DE MÉDICIS; Italian MARIA DE' MEDICI) (1573–1642), queen consort and, from 1610 to 1614, regent of France, was born in Florence on April 26, 1573, the daughter of Francesco de' Medici, grand duke of Tuscany, and Joan of Austria. Henry IV of France, having had his childless marriage to Margaret of France annulled, chose Marie as his next consort because a Medici dowry would serve to restore the French finances. The marriage was celebrated at Florence, with Henry's proxy, on Oct. 5, 1600. Between 1601 and 1609 Marie bore the king six children (*see* BOURBON: Table II: *The Bourbon Kings of France*); but Henry's infidelities and Marie's devotion to her Florentine favourite Concini and his wife Leonora Galigaï (*see* ANCRE, CONCINO CONCINI, MARQUIS D') brought perpetual turmoil into their relationship. Marie, however, secured her own coronation as queen on May 13, 1610, the very day before Henry was assassinated.

Consequently she could be named as regent for her young son Louis XIII, even though members of her entourage were suspected of complicity in the assassination.

As regent, the queen mother reversed Henry IV's policy for France: whereas Henry had resisted Spain, she admitted the Spanish ambassador to her council; and she squandered the revenue and made humiliating terms with rebel princes (*see* FRANCE: *History*). Though Louis XIII came of age in Sept. 1614, Marie continued to govern for him, capitulating again to the princes (1616), until, on the eve of a third rebellion, Louis had the marshal d'Ancre assassinated on April 24, 1617. Marie was then exiled to Blois; but in Feb. 1619 she escaped from there and began a revolt. Her principal adviser, the future cardinal de Richelieu (*q.v.*), then bishop of Luçon, negotiated the peace of Angoulême with the royal government for her, after which she was allowed to set up her court at Angers; and he won good terms for her again after the defeat of a further rebellion (Aug. 1620). Readmitted to the king's council in 1622, Marie obtained the cardinal's hat for Richelieu (Sept. 1622) and finally appointment as the king's premier minister (Aug. 1624). She also began the building of the Luxembourg palace in Paris, with decorations by Rubens.

By 1628 the queen mother was Richelieu's worst enemy: his services to Louis XIII appeared to her as an ungrateful betrayal of her past causes; and she stood with the *parti dévot*, which wanted a French understanding with Spain and Austria for Catholic solidarity against the Protestants. In the crisis known as the Day of Dupes (Nov. 10–12, 1630) she and her friends thought that they had persuaded Louis to dismiss Richelieu, but their attempt turned to Richelieu's advantage. Banished to Compiègne, Marie fled to Brussels in the Spanish Netherlands in July 1631, never to return to France. She died destitute at Cologne on July 3, 1642.

See L. Batiffol, *La Vie intime d'une reine de France au XVIIe siècle: Marie de Médicis* (1906; Eng. trans. 1908); P. Erlanger, *Louis XIII* (1946), *L'Étrange mort de Henri IV* (1957). (P. ER.)

MARIE (MARIA LESZCZYNSKA) (1703–1768), queen consort of Louis XV of France, was born at Breslau (Wroclaw) in Silesia on June 23, 1703, the daughter of Stanislaw Leszczynski, who was elected king of Poland in 1704 as Stanislaw I. After her father's withdrawal from Poland, Marie was brought up by him in straitened circumstances until the proposal that she should marry the king of France came as a great stroke of good fortune.

The marriage was arranged by Louis XV's premier minister, Louis Henri, duc de Bourbon, who after the rupture of the project for marrying the king to a Spanish infanta, was looking for a suitable Catholic princess. The duc's mistress, the marquise de Prie (Agnès de Pléneuf), encouraged him to choose someone unlikely to be a formidable rival at court; Marie was chosen and the marriage took place at Fontainebleau on Sept. 5, 1725.

Louis quickly lost interest in his queen, who angered him by her objection to the dismissal of the duc de Bourbon in 1726; and his long series of mistresses caused her great unhappiness. However, she bore the king nine children between 1727 and 1737. The marriage contributed to France's involvement in the War of the Polish Succession and to the French acquisition of Lorraine. Marie died at Versailles on June 24, 1768.

See P. de Nolhac, *La Reine Marie Leczinska* (1900); A. Leroy, *Marie Leczinska* (1940).

MARIE (1875–1938), queen consort of Rumania from 1914 to 1927, was born in England at Eastwell Park, Kent, on Oct. 29, 1875, the eldest daughter of Queen Victoria's son Alfred, duke of Edinburgh, and Maria, daughter of the Russian emperor Alexander II. On Jan. 10, 1893, she married Prince Ferdinand of Hohenzollern-Sigmaringen, nephew and heir of King Carol I of Rumania. Her early years in Bucharest as crown princess were acutely unhappy. Accustomed to English life, she was constrained by the strict formal discipline imposed by King Carol and felt the atmosphere of Rumania to be alien. Yet she grew to love the country and its people and became greatly beloved for her beauty and warmth of heart. For her six children *see* HOHENZOLLERN: Table V: *The Swabian Line*.

On Carol I's death in Oct. 1914, Ferdinand became king of Rumania. Keenly loyal to Great Britain, the young queen played an important part behind the scenes in stiffening the pro-Allied faction in Rumania during World War I, and she rejoiced when the country joined the Allied cause in 1916. She was then active as a Red Cross nurse and also in maintaining morale at Iaşi, where the government set itself up after the German occupation of Bucharest. Her popularity with the troops was high. When a greater Rumania had been established after the war, the long-delayed coronation of the king and queen took place at Alba Iulia on Oct. 15, 1922. Queen Marie visited the United States in 1926.

On King Ferdinand's death on July 20, 1927, Queen Marie, already alienated from her eldest son Carol (who had just renounced his rights of succession), was disappointed at not being made a member of the regency for her grandson Michael. Accordingly she withdrew from active participation in Rumanian political life and devoted her time to writing and to the creation of a beautiful house and garden at Balcic on the Black sea (Balchik in the Bulgarian Dobruja after 1940). She died at Sinaia on July 18, 1938, and was buried at the church of Curtea de Arges, her heart being interred at Balcic. Queen Marie's published works include *The Country That I Love* (1925); *Crowned Queens: a Tale From Out of the Past* (1929); *Masks*, a novel (1935); and *The Story of My Life*, three volumes (1934–35). (B. BR.)

MARIE, PIERRE (1853–1940), French neurologist who was the first to describe several neural and endocrine diseases, was born Sept. 9, 1853, in Paris. There he became a pupil of C. J. Bouchard and J. M. Charcot (*q.v.*), received his M.D. degree in 1883 and two years later became director of neurological service at the Bicêtre and Salpêtrière hospitals. His clinical lectures on diseases of the nervous system made him internationally known. In 1886 he published the first description of acromegaly (enlargement of the nose, chin, hands and feet); this paper and a second one (1889) on the same subject, which together form the origins of modern endocrinology, describe in detail the causes of the disease; *i.e.*, a tumour and functional disturbances of the pituitary gland. In 1893 Marie published a paper on a hereditary disease of the cerebellum that leads to serious disturbances of the equilibrium (hereditary cerebellar ataxia: Marie's ataxia). A certain type of progressive muscular atrophy is named jointly for Marie and his teacher (Charcot-Marie type). Marie's revolutionary papers on aphasia were opposed to the localization of symptoms at a specific area of the brain (as had been suggested by Paul Broca) and paved the way for the modern concept of aphasia. He died in Paris on April 13, 1940.

MARIE AMÉLIE DE BOURBON-SICILES (1782–1866), queen of Louis Philippe, king of the French, was born at the palace of Caserta, near Naples, on April 26, 1782, the daughter of King Ferdinand IV of Naples (afterward Ferdinand I of the Two Sicilies) and of his consort the archduchess Maria Carolina. She was piously educated, mainly at Palermo in Sicily, where the Neapolitan royal family took refuge (1798–99, 1806–14) during the French occupation of the mainland. Her marriage (Nov. 25, 1809) with the exiled Louis Philippe (*q.v.*), then duc d'Orléans, helped him to improve his relations with the senior branch of the French royal family. With him she went to France during the first Restoration (1814) and took refuge in England during the Hundred Days (1815). After the second Restoration she lived at the Palais Royal in Paris or at Vernon, Neuilly-sur-Seine or Eu, absorbed in bringing up her children (*see* BOURBON: Table IV: *The House of Orléans from 1830*). When Louis Philippe was king (1830–48), she took no part in political affairs, being always afraid of a new revolution. At the revolution of Feb. 1848 she accompanied Louis Philippe to England, where they settled at Claremont, Esher, Surrey. Widowed in 1850, Marie Amélie died at Claremont on March 24, 1866. Her *Journal* was edited by Henriette of Belgium, duchesse de Vendôme, in two volumes (1938–43).

See A. Trognon, *Vie de Marie Amélie, reine des Français* (1872); the duchesse de Vendôme, *La Jeunesse de Marie Amélie, reine des Français* (1935). (JE. V.)

MARIE ANTOINETTE (1755–1793), the Austrian queen consort of Louis XVI of France, was born in Vienna on Nov. 2,

1755, the 11th daughter of the Holy Roman emperor Francis I and Maria Theresa. Her name is associated with the decline in the moral authority of the French monarchy in the closing years of the *ancien régime;* with the courtly extravagance that was erroneously held to be the cause of the financial disorders of the French state at the same period; and also, more correctly, with the policy of court resistance to the progress of the French Revolution, which finally led to the overthrow of the monarchy.

In more senses than one, however, Marie Antoinette was the victim of circumstance. In her youth she was a pawn on the diplomatic chessboard in that her marriage to the French dauphin on May 16, 1770, was intended to strengthen the Austrian alliance with France. The stigma of being the representative of Austria when the connection with Vienna was unpopular in France remained with her throughout her life. She was unfortunate also in her husband, since his frigid behaviour and initial inability to produce an heir drove her to seek companionship and distraction among favourites and discreditable companions whom she might have avoided if her family life had been more satisfactory. It was her husband's personal weakness and political nullity that forced her to play such a prominent political role during the Revolution.

The influence that Marie Antoinette exerted on French internal and foreign policy between the accession of Louis XVI in May 1774 and the outbreak of the Revolution in 1789 has probably been much exaggerated. Her efforts, for example, to secure the return to power of the duc de Choiseul in 1774 were unsuccessful; and the fall of Turgot in 1776 must be attributed to the hostility of Maurepas and to the differences that arose between Turgot and Vergennes over French participation in the American Revolution rather than to the direct intervention of the queen. Marie Antoinette was not, at that time, interested in politics except as a way of securing favours for her friends, and her political influence never exceeded that formerly wielded by the royal mistresses of Louis XV. In foreign policy she encountered the opposition of both Louis XVI and Vergennes in her efforts to advance Austrian interests, and it is certain that her brother, the emperor Joseph II, was gravely disappointed at her lack of success. Even her deference to the persistent requests of her favourites, such as the comtesse de Polignac (Yolande de Polastron), did not entail a great drain on the treasury. More serious was the frivolity of her own behaviour, her close association with the more dissipated sections of the French court and, above all, the suspicion of immorality and corruption she incurred as a result of the "Affair of the diamond necklace" (*see* DIAMOND NECKLACE, AFFAIR OF THE) in 1785–86. This incident was all the more unfortunate for the queen's reputation because, since the birth of her daughter Marie Thérèse Charlotte in Dec. 1778 and of the dauphin Louis in Oct. 1781, she had led a quieter and more conventional life. Her second son, the future Louis XVII, was born in March 1785. Her most intimate friend from this time onward was the princesse de Lamballe.

Though the queen had supported Jacques Necker's return to power at the end of Aug. 1788 and had approved of the concession of double representation to the third estate, her unpopularity was at its height when the estates-general met at Versailles in May 1789 (*see* FRANCE: *History;* FRENCH REVOLUTION). This was because she was regarded, though without justification, as an associate of the reactionary coterie of the king's brother Charles, comte d'Artois (*see* CHARLES X, king of France) and because of the aspersions cast on her moral character by the duc d'Orléans (Louis Philippe [1747–93] the future Égalité). At the end of May she seemed to have intervened little in politics, as she was distracted by the illness of her elder son, who died early in June. After the fall of the Bastille the queen was deprived of the company of some of her most intimate friends, as they emigrated; but in the October days, when the court was transferred to Paris and she herself was the main target of popular resentment, she displayed high personal courage that sustained the royal family both then and throughout its later disasters.

Because of Louis XVI's irresolution at this period Marie Antoinette was to play an increasingly important part in the secret intrigues to liberate the royal family from its virtual captivity in Paris. However, the queen's aversion to Mirabeau, who became the paid secret adviser of the court in May 1790, and the king's refusal to contemplate a resort to civil war ensured the rejection of Mirabeau's initial plans for an escape to the interior of France and an appeal for royalist support in the provinces. After Mirabeau's death in April 1791, the queen turned for help chiefly to her friends outside France; and it was with the assistance of the Swedish count Hans Axel Fersen, the baron de Breteuil (L. A. Le Tonnelier) and F. C. A. de Bouillé that the plans were laid for the flight of the royal family to Montmédy, on the eastern frontier.

When the royal family was stopped at Varennes on June 21, 1791, and brought back to Paris, the queen was forced back on further secret intrigues. This time she plotted with the leaders of the constitutional monarchists in the Constituent Assembly, namely Antoine Barnave and Alexandre and Théodore de Lameth, who were anxious to check the progress of republicanism and to bring the Revolution to a close. The basis of their secret understanding with the queen was that, after the constitution had been revised so as to bolster up the executive power of the king, it should be loyally accepted and implemented by Louis XVI. In foreign policy the aim of the constitutionalists was to persuade the *émigrés* to return and to prevent the emperor Leopold II (Marie Antoinette's brother) from being committed to a counter-revolutionary crusade against France. Marie Antoinette, however, distrusted Barnave and his associates, and though she acquiesced in the king's acceptance of the constitution in Sept. 1791, she warned the emperor that she was not in favour either of their domestic or foreign policy. Instead she urged the necessity of an armed congress of the powers to negotiate from strength for the restoration of the royal authority. This duplicity paralysed the pacific policy of Barnave and did not dissuade the *émigrés* from their more aggressive designs for the restoration of the *ancien régime.* After France had declared war on Austria on April 20, 1792, the queen was naturally suspected of being the prime mover of the counterrevolutionary coalition, and popular resentment against her was one of the factors that led to the storming of the Tuileries palace and the overthrow of the monarchy on Aug. 10. For the rest of her life the queen was a prisoner, at first together with the rest of the royal family in the Temple and, after Aug. 1, 1793, in solitary confinement in the Conciergerie. Throughout this period, even after the execution of the king on Jan. 21, 1793, her courage remained unshaken. She herself was placed on trial before the Revolutionary tribunal on Oct. 14, 1793, after several unsuccessful attempts had been made to secure her escape. Sentenced to death, she was guillotined in the Place de la Révolution in Paris on Oct. 16.

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MARIE DE FRANCE (fl. late 12th century), the earliest known French woman poet, whose verse narratives and simple handling of Aesopic and other fables are works of considerable charm and talent, and were probably written in England. What little is known about her is taken or inferred from her writings and from a possible allusion or two in contemporary authors. From a line in the epilogue to her fables: "Marie ai nun [= name], si sui de France" Claude Fauchet in his *Recueil de l'origine de la langue et poesie françoise* (1581) drew the name by which she has since been known. The same epilogue tells us that her *Fables* were translated from, or based on, an English source, for a Count William, usually identified as William Longsword, earl of Salisbury (d. 1226), or sometimes as William Marshal, earl of Pembroke (1146–1219). Her *Lais* were dedicated to a "noble" king, presumably Henry II of England (1154–89), though it is sometimes claimed that this was Henry's son, the Young King (d. 1183). Her version of *L'Espurgatoire seint Patriz* was based on the Latin text (*c.* 1185) of Henry of Saltrey. Every conjecture about her, her identity (was she Marie, the half-sister of Henry II, who became abbess of Shaftesbury?), the chronological order of her works (*Lais* before 1167?, *Fables* about 1180?, *Espur-*

gatoire after 1189?) and the sources of the most attractive of her works, the *Lais*, have been hotly debated. She claims that her 12 narrative *Lais*, in octosyllabic rhymed couplets, varying in length from the 118 lines of *Chevrefoil*, an episode in the Tristan story, to the 1184 lines of *Eliduc*, a story of the devotion of a first wife whose husband brings a second from overseas, were based on Breton lays; but of these nothing is known. Her treatment of them is fascinating; she develops her analyses of love problems with great skill against varying backgrounds of realism and fairy tale. Here, and in some of her fables, she displays a keen interest in contemporary affairs and manners.

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MARIE LOUISE (1791–1847), second consort of the French emperor Napoleon I and later duchess of Parma, was born an Austrian archduchess on Dec. 12, 1791, the eldest daughter of the Holy Roman emperor Francis II (later Francis I of Austria) and Maria Theresa of Naples-Sicily. The niece of the unhappy queen of France, Marie Antoinette, she was brought up to detest the French Revolution and its consequences. Her marriage to Napoleon seems to have been suggested by the Austrian statesman Metternich shortly after the Franco-Austrian peace of Oct. 1809, at a moment when Napoleon, having already decided to dissolve his marriage with the childless Joséphine, was tentatively negotiating with the Russian emperor Alexander I for the hand of his daughter Catherine. Joséphine's marriage was annulled by the church on Jan. 12, 1810, and while the Russian negotiations were being prolonged for political reasons Napoleon in February asked for Marie Louise in marriage. She was married to his proxy in Vienna on March 11, 1810, and to him in person in Paris on April 1–2. Delighted at this alliance with the Habsburg dynasty, which linked his empire, born of the Revolution, with the "legitimate" sovereigns of the old Europe, Napoleon showed extreme affection for Marie Louise during their honeymoon at Compiègne; and on March 20, 1811, she bore him the long-desired heir, the king of Rome and future Napoleon II (*see* REICHSTADT, NAPOLÉON FRANÇOIS JOSEPH CHARLES, Duke of).

Marie Louise accompanied Napoleon to Dresden in May 1812, where he conferred with Francis of Austria and Frederick William III of Prussia before launching his disastrous attack on Russia. Subsequently she was regent for him in Paris (with his brother Joseph Bonaparte as lieutenant general) during his absences. After his first abdication (April 6, 1814), however, she made her way back to Austria with her son, escorted by Adam Albert, Graf von Neipperg (1775–1829). The treaty of Fontainebleau (April 11, 1814) awarded to her the formerly Bourbon duchies of Parma, Piacenza and Guastalla in full sovereignty, with the succession to them for her son. She ignored Napoleon's entreaties to join him in Elba and was completely estranged from him by his threat of forcible abduction. During the Hundred Days (1815) she remained in Austria, showing no desire for the success of Napoleon in France. The congress of Vienna ratified her accession to Parma, Piacenza and Guastalla, despite Bourbon opposition; but her son's right of succession was overruled (1817), the duchies being secured to her for her lifetime only. She went to Parma without her son, who was given the title of duke of Reichstadt in 1818.

Marie Louise had a daughter, Albertine (1817–67), by Neipperg before Napoleon's death, but Napoleon in exile on St. Helena excused her infidelity and mentioned her with tenderness in his will. In Aug. 1821, after Napoleon's death (May), she bore Neipperg a son, Wilhelm Albrecht, later prince of Montenuovo (d. 1895); and in Sept. 1821 she married Neipperg morganatically. Together they governed the duchies more liberally than most other princes of the Restoration in Italy: some Napoleonic institutions were preserved, equal rights for women in inheritance were established (1817), and a civil code was promulgated (Jan. 1820). Josef von Werklein, however, who became secretary of state in Parma after Neipperg's death, pursued a more reactionary policy, and in 1831 a rising in Parma forced the duchess to take refuge with the Austrian garrison in Piacenza. Restored to power by the Austrians, she ruled thenceforward in accordance with their prescriptions.

In 1832 Marie Louise visited the dying duke of Reichstadt in Vienna. In Feb. 1834 she contracted a second morganatic marriage, with Charles René, comte de Bombelles (1784–1856). She died in Parma on Dec. 17, 1847, and was buried in the Capuchin church in Vienna.

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MARIE THÉRÈSE (MARIA TERESA DE AUSTRIA) (1638–1683), queen consort of Louis XIV of France, was born on Sept. 10, 1638, in the palace of the Escorial, the daughter of Philip IV of Spain and Elizabeth of France. The treaty of the Pyrenees in 1659 stipulated that she should marry the French king, at the same time renouncing any claim to the Spanish succession. She was married in June 1660, in ceremonies at Fuenterrabia and at St. Jean-de-Luz on the Franco-Spanish frontier. Though he made use of her claims to the Burgundian inheritance of the Spanish Habsburgs—as if these were not covered by her renunciation—in order to justify the War of Devolution after Philip IV's death, Louis soon lost interest in his queen, and she was overshadowed by his series of mistresses. The marquise de Maintenon (*q.v.*) finally arranged a reconciliation between her and Louis, but the queen died on July 30, 1683, at Versailles. Of her six children only one survived her, the dauphin Louis, who died in 1711.

MARIETTA, a city of Georgia, U.S., the seat of Cobb county, is located 20 mi. N.W. of Atlanta, in the Blue Ridge foothills at an altitude of 1,118 ft. Founded in 1833, when Cobb county was formed from Cherokee land, it was chartered as a city in 1852. The state-owned Western and Atlantic railroad, completed from Atlanta to Marietta in 1845, and subsequent railroad connections stimulated the town's growth.

In 1942 an aircraft-manufacturing plant was located 3 mi. S., where B-29s (the Superfortresses of World War II) were fabricated; the plant was reopened in 1951. As many as 15,000 workers have been employed there in the manufacture of jet aircraft.

Adjacent are the Atlanta naval air station and Dobbins air force base, centre for U.S. southeastern air defenses. A variety of small industries including furniture, textiles and stone antedated aircraft.

The Kennesaw Mountain National Battlefield park, 2½ mi. N.W., which marks the site of an important American Civil War battle, is situated at Kennesaw mountain (1,808 ft.). On June 27, 1864, entrenched Confederate forces under Gen. Joseph Eggleston Johnston repulsed a frontal assault by invading Federal troops under Gen. William Tecumseh Sherman. Federal losses exceeded 2,500. A flanking movement finally forced a Confederate retreat across the Chattahoochee river into the environs of Atlanta. More than 10,000 Federal soldiers are buried in the Marietta National cemetery.

For comparative population figures *see* table in GEORGIA: *Population.* (J. C. WA.)

MARIETTA, a city of southeastern Ohio, U.S., the seat of Washington county, is located on the Ohio river, at the mouth of the Muskingum, 45 mi. S.E. of Zanesville. Its history dates from 1785, when Ft. Harmar was constructed there. Permanent settlement, the first in Ohio, began April 7, 1788, with the arrival of Gen. Rufus Putnam (*q.v.*) and his pioneer group, the Ohio Company of Associates, and it was named in honour of Queen Marie Antoinette of France. On July 15, 1788, Arthur St. Clair was installed there as first governor of the Northwest territory. The first years were difficult, because of the Indian War of 1791–

95. For many years thereafter Marietta was noteworthy in the flatboat trade in agricultural produce down river to New Orleans. During the steamboat era it was a typical river town. For a generation after the American Civil War it was the centre of an important oil and gas area.

There was still a considerable production in the 1960s, mostly on a secondary-recovery basis. Certain favourable peculiarities of soil and climate contributed to the growth of truck farming in the surrounding countryside, but much of the best land has been taken over for industry or housing. The chief products of the local and nearby factories are chemicals (especially plastics), metal alloys and office equipment.

Marietta is the seat of Marietta college (related to the Congregational Christian Church and chartered in 1835), the library of which has the original records of the Ohio company and the 20,000-volume Rodney M. Stimson collection relating chiefly to the Ohio and Mississippi valleys. Worthy of note are Conus, a large and perfect Indian mound in the Mound cemetery; "The Start Westward of the United States," a memorial in Muskingum park, dedicated by Pres. Franklin D. Roosevelt in 1938; and the Campus Martius museum, operated by the Ohio Historical society. The museum houses the land office of the Ohio company, the home of Rufus Putnam, a "river museum," and the Charles Goddard Slack collection of prints and autographs. A great tourist attraction, the "W. P. Snyder, Jr.," a river towboat of a type long obsolete, which is moored in the Muskingum river, also belongs to the museum.

For comparative population figures *see* table in OHIO: *Population.* (R. L. J.)

MARIETTE, AUGUSTE (1821–1881), French egyptologist and a pioneer of excavation in Egypt, was born on Feb. 11, 1821, at Boulogne. He was educated at the Collège de Boulogne and became professor there in 1841. In 1849 he joined the Egyptian department of the Louvre and the following year was sent to Egypt on a government mission to find and purchase Coptic, Syriac, Arabic and Ethiopic manuscripts. Soon after his arrival, however, Mariette discovered the ruins of the Serapeum at Memphis and he remained in Egypt for four years to continue his excavations. He dispatched most of the archaeological treasures to the Louvre and on his return he was appointed assistant curator.

In 1858 Mariette accepted the position of conservator of Egyptian monuments to the former khedive Ismail Pasha, and moved with his family to Cairo. He studied the pyramid fields of Memphis and Saqqarah, the necropolis of Meydum and those of Abydos and Thebes, and disinterred the great temples of Dendarah and Edfu. Important excavations were carried out at Karnak, Medinet-Habu and Deir al Bahri; Tanis (the Zoan of the Bible) was partially explored in the Delta; and even Gebel Barkal in the Sudan. The museum at Bulaq, Cairo, was founded to house his discoveries. The Sphinx was bared to the rock level, and the famous granite and alabaster monument miscalled the "Temple of the Sphinx" was discovered. Mariette was raised successively to the rank of bey and pasha. He died at Cairo on Jan. 19, 1881. (*See* also EGYPT: *Archaeology.*)

His chief published works are: *Le Sérapéum de Memphis* (1857–64); *Dendérah* (1873–75); *Abydos* (1869); *Karnak* (1875); *Deir-el-Bahari* (1877); *Listes géographiques des pylônes de Karnak* (1875); *Catalogue du Musée de Boulaq*, 6th ed. (1864–76); *Aperçu de l'histoire d'Égypte* (1874); *Les Mastabas de l'ancien empire* (ed. by G. Maspéro) (1889).

See G. C. C. Maspéro, *Notice biographique sur Auguste Mariette* (1905). (W. R. D.)

MARIGNANO, BATTLE OF (Sept. 13–14, 1515), the Franco-Venetian victory over Swiss mercenaries in the first Italian campaign of Francis I of France, won near the village of Marignano (the modern Melegnano, on the Lambro river, 10 mi. S.E. of Milan).

Francis I was determined to conquer the duchy of Milan, his predecessor Louis XII having been unable to make good the French claim to it. He had the alliance of Venice and could expect some Genoese help; but Massimiliano Sforza, the duke in possession, not only had the support of the Holy Roman emperor Maximilian I, Pope Leo X and Ferdinand II of Aragon but also was the protégé of the Swiss confederacy. The Swiss, whose mercenary soldiers were reputedly the best in Europe, were being encouraged to take an actively anti-French policy in Italy by the bishop of Sion, Matthäus Cardinal Schiner.

The Swiss controlled the more practicable passes over the Alps; but in Aug. 1515 the main French army crossed the Col de l'Argentière (Col de Larche or Maddalena) by a route hitherto unexploited. Having taken Novara, it then turned southeastward to establish communication with the Venetians under Bartolomeo d'Alviano. The papal and Spanish forces lay farther to the south, and the French could now easily have taken Milan if the Swiss had agreed to be bought off. The Swiss, however, though they had not received their subsidies, were reinforced from Switzerland and were finally persuaded by Schiner to reject France's overtures and to move southward to the defense of Milan.

In the afternoon of Sept. 13 the Swiss (between 25,000 and 30,000 strong, with 10 guns) advanced against the position that the French (about 40,000, with 72 guns) had taken up near Marignano. A stream, with channels, ran through marshy ground between the opposing armies; and despite heavy losses under artillery fire the Swiss moved across this ground—over which the French heavy cavalry could not operate—to fall upon Francis I's *lansquenets* (*Landsknechte* or mercenary light infantry from Germany). By midnight, however, when fighting was suspended, the Swiss had had to withdraw somewhat. Next morning they sent their right and left against the French flanks, and the issue was uncertain for eight hours until Alviano and the Venetian cavalry arrived from Lodi. A final drive by Francis made the Swiss give way; but the French, who had lost about 8,000 men, did little to harass the orderly Swiss retreat. The battle put an end to Schiner's policy and won Milan for the French king.

MARIGNOLLI, GIOVANNI DE' (fl. 1338–1357), a Franciscan, one of four ecclesiastics appointed by Pope Benedict XII as his legates to the court of the great Khan, was born, probably before 1290, in Florence. His family is long extinct, but a street near the cathedral (Via de' Cerretani) formerly bore the family name.

The Catholic mission left Avignon in Dec. 1338 and joined the Tatar envoys at Naples. The combined embassies traveled via Constantinople and the Black sea to the court of Mohammed Uzbeg, khan of the Golden Horde, at Sarai on the Volga. He entertained them during the winter of 1339–40 and sent them across the steppes to Armalec, Almalig or Almaligh (*i.e.*, Kuldja, 44° 00′ N., 81° 00′ E.), the northern seat of the house of Chaghatai. There the legates built a church and baptized several persons. Leaving Armalec in 1341 they reached Peking in May or June 1342. They were well received by the reigning khan, the last of the Mongol dynasty in China. There Marignolli stayed for three or four years, leaving via Zayton or Amoy in Dec. 1347. He reached Columbum (Kollam or Quilon in Malabar) in Easter week, 1348, and found there a Catholic church (probably founded by Jordanus of Severac). He visited the shrine of St. Thomas (near Madras), the kingdom of Saba (which he identified with the Sheba of the Bible, but which seems to have been Java) and Ceylon where he was detained. From Ceylon, his route appears to have been by Ormuz, Baghdad, Mosul, Aleppo, Damascus and Jerusalem. In 1353 he reached Avignon and delivered a letter from the great khan to Pope Innocent VI. In 1354, the emperor Charles IV made Marignolli one of his chaplains. Shortly afterward he became bishop of Bisignano. In 1356 he was an envoy to the pope from Florence, and in 1357 he was at Bologna. The date and place of his death are unknown.

Marignolli inserted notes of his Asian travels in his *Annals of Bohemia*, compiled for Charles IV. These fragments were not noticed until they were included by Father G. Drobner in *Monumenta historia Bohemiae nunquam antehac edita* (1768). *Fontes rerum bohemicarum*, ii, 49–604 (1882) contains the best text.

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MARIGNY, ENGUERRAND DE (*c.* 1260–1315), a prominent minister of the French king Philip IV, belonged to the minor nobility and was born at Lyons-la-Forêt in Normandy. Equerry to Hugues de Bouville (Philip IV's chamberlain), he became in 1298 chief bread bearer to the queen, Joan (Jeanne) of Navarre, whose goddaughter, Jeanne de Saint-Martin, he married. After 1302 Marigny's rise was rapid. Knighted and later created comte de Longeville, he became grand chamberlain to the king, was sent to preside over the Norman exchequer in 1306 and subsequently became *surintendant des finances et des bâtiments* and *capitaine* of the Louvre. His power reached its zenith in the years 1313–14 when he was in charge of the royal treasury and of the newer auditing department, the *chambre des comptes*, imposing on them a unified rule. On Aug. 1, 1314, he addressed an assembly at Paris on the financial difficulties arising from Philip's renewal of war with Flanders. Generally unpopular both with the nobility and with the *bourgeoisie* and associated with the policy of heavy taxation and debasement of the coinage, Marigny also incurred the special enmity of the king's brother, Charles of Valois. In the last few months of Philip's reign a commission was nominated to examine Marigny's administration of the finances. After the accession of Philip's son Louis X the membership of the commission was changed to include many of Marigny's enemies, including Charles of Valois. Nevertheless the accounts were found to be in order. Charles of Valois then made further similar charges against Marigny, who was arrested and confined successively in the Louvre, the Temple and the keep of Vincennes. King Louis was inclined merely to banish Marigny, but Charles of Valois then accused the minister of sorcery, and immediate execution was ordered. Marigny was hanged on the public gallows at Montfaucon, just outside the city wall, to the northeast of Paris, on April 11 or 30, 1315. In 1317 his body was taken down and buried in the Chartreux at Paris. The legend that Marigny himself had erected the gallows is untrue.

See P. Clément, *Trois Drames historiques* (1857).

MARIGOLD, a common name given to several plants, of which the following are the best known: *Tagetes erecta*, the African marigold; *T. patula*, the French marigold; *Calendula officinalis*, the pot marigold; and *Chrysanthemum segetum*, the corn marigold. These all belong to the family Compositae, but the marsh marigold (*q.v.*), *Caltha palustris*, belongs to the Ranunculaceae (buttercup family). (*See* also Ice Plant for the fig marigold.)

To the gardener the name marigold most commonly indicates species of the genus *Tagetes* and especially the developed varieties of *T. erecta* and *T. patula*. Contrary to the origins indicated by their common names, these are native to America, from Mexico to the Argentine. These hardy annuals, from the tiny (one to one and one-half foot) French types to the giant (three to four feet) Africans, have finely cut strong-scented foliage, except for a few later-developed unscented varieties. Besides the above species, *T. lucida*, sweet-scented marigold, and *T. tenuifolia*, striped marigold, are grown. The flowers of yellow, orange and red to red-brown are popular in the garden in beds, borders and massed groups, and are excellent as cut flowers. Seed sown in the spring in any garden soil—poor to average, wet or dry—in sun or partial shade will give a profusion of blooms from midsummer to frost. The plants require little attention and transplant readily.

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POT MARIGOLD (CALENDULA OFFICINALIS)

The pot marigold (*Calendula officinalis*), a familiar garden plant up to two feet in height, with unscented foliage and orange-coloured blossoms, is probably not known in the wild state. Single and double varieties have been in cultivation for at least 300 years; John Gerard in his *Herball* (1597) mentions a proliferous form, the "fruitful marigolde," in which small flower heads proceed from beneath the circumference of the flower. He remarks that it is called *Calendula* "as it is to be seene to flower in the calends [first] of almost everie moneth." *Calendula officinalis* is one of the easiest of annuals to grow; seed sown in spring in any average soil in full or partial sun will produce flourishing plants which bloom from late spring to frost. Smaller plants, cut back in fall and potted, will bear flowers indoors for several weeks.

The Eurasian corn marigold (*Chrysanthemum segetum*) is a weed common in fields in England and throughout the eastern part of North America. The cape marigold (*Dimorphotheca aurantiaca*) is a South African perennial, much cultivated for ornament.

MARIJUANA (Marihuana), an intoxicating excitant drug, used illegally in the United States and elsewhere usually in cigarette form, is obtained from the top leaves and flowers of the Indian hemp plant (*Cannabis sativa*), which grows in most parts of the world. Since ancient times people have used its products for stimulation and intoxication, under the names hashish, bhang, ganja, kef, etc. Improper use of marijuana is a serious medical and social problem in various countries. Many emotionally unstable persons known to be associated with major crimes prove to be marijuana users. Marijuana intoxication may be accompanied by such physical and psychic manifestations as thirst, hunger, craving for sweet foods, nausea, dizziness, abdominal pain, drowsiness, irritability, delusions of grandeur or persecution, uncontrollable hilarity, talkativeness, apprehension, mental confusion, prostration, depression, inarticulate speech and delirium. Mental dullness ordinarily increases with continued use of marijuana and psychoses may develop. Some persons have suffered very disagreeable effects a short time after smoking one marijuana cigarette.

Withdrawal of marijuana does not cause the extreme physical discomfort seen in opiate withdrawal. Addiction to heroin or morphine (*qq.v.*) is a common sequel to the use of marijuana, especially among young persons.

Marijuana, formerly used in medicine as an analgesic and sedative, was considered to have so little medical value that it was removed from the United States pharmacopoeia. The federal Marihuana Tax act of 1937 prohibited its use. It was placed under international control because of its increased abuse throughout the world. The World Health organization undertook a project to develop a strain of the hemp plant devoid of intoxicating resins.

See Drug Addiction; Hashish; Hemp.

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MARILLAC, SAINT LOUISE DE (1591–1660), cofounder with St. Vincent de Paul (*q.v.*) of the Daughters of Charity, better known as Sisters of Charity of St. Vincent de Paul, was born either in Paris or Ferrières on Aug. 12, 1591, and educated by Dominican nuns at Poissy and in a lay boarding school in Paris. Her delicate health, which proved lifelong, prevented her from joining the strict order of Poor Clares, and in 1613 she married Antoine le Gras, secretary to Queen Marie de Médicis, by whom she had a son before his death in 1625. Vincent de Paul, whom she had chosen as her spiritual guide, moderated her zeal and encouraged her to undertake charitable works. Receiving into her home a few country girls sent by him, she trained them in the spiritual life and taught them to assist the Ladies of Charity in visiting, feeding and nursing sick poor. Their number increased, and in 1633 Vincent founded the Daughters of Charity with Louise as their superior. He would not have them called nuns or have them enclosed. He thus pioneered in bringing religious women into the service of God and man outside the cloister. The rest of Louise's life was uneventful. She died in Paris on March 15, 1660. She was canonized in 1934, and her feast day is March 15.

See biographies by Alice Lady Lovat (1916) and Sister Bertrande Meyers (1956). (J. LD.)

MARIMBA, a xylophone (*q.v.*) with resonators below the keys that originated in Java. It was taken to Africa where it spread across the centre of the continent and was taken thence by the slave trade to Central America. In the U.S. the name has been applied to an orchestral xylophone, with large keys and soft beaters, used mainly for light music. In the Javanese instrument the keys are of bronze and the resonators of bamboo. Elsewhere the keys are of wood and the resonators are gourds or wooden boxes (except in the orchestral instrument, which has brass tubes). In South African mining compounds marimbas are made from floor boards and tin cans. In Africa and Central America the resonators usually have a hole near the bottom covered by a membrane which adds a buzz to the tone. The instrument is invariably played with soft beaters. The tuning always follows the two original Javanese scales, the pentatonic *sléndro* and the heptatonic *pélog* (*see* GAMELAN). The marimba was used in 20th-century works by C. M. Loeffler, D. Milhaud and P. Creston.

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MARIN, JOHN (1872–1953), U.S. painter, whose great contribution was a dynamic expression of vivid perceptions, best known for his water colours, was born in Rutherford, N.J., on Dec. 23, 1872. (His full name, never used, was John Cheri Marin III.) His mother died a few days after he was born, and he was brought up by her relatives. After some practice of architecture, Marin studied painting at the Pennsylvania academy in Philadelphia and the Art Students league in New York. In 1905 he went to Europe for six years and returned permanently to the United States in 1911. In Europe he was influenced by Whistler in both etching and water colour; there, too, commenced his association with Alfred Stieglitz, so important to them both. Marin's technical experimentation found direction after he saw European work at Stieglitz's "291" gallery and at the New York Armory show (1913). In 1914 he married Mary H. Hughes, who died in 1945. Their permanent home was at Cliffside Park, N.J.

Marin's financial success was achieved through Stieglitz's handling of his output; his artistic stature was established for the general public by the retrospective exhibition at the Museum of Modern Art, New York, in 1936. His technique in water colour by 1920 was brilliant, as in "Lower Manhattan" (privately owned). Eventually he attained an equivalent intensity in oil. In 1948 he received the Fine Arts medal of the American Institute of Architects. He died at Addison, Me., on Oct. 1, 1953.

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, THE ALFRED STIEGLITZ COLLECTION, 1949

"LOWER MANHATTAN FROM THE RIVER, NO. 1," JOHN MARIN, WATER COLOUR. IN THE METROPOLITAN MUSEUM OF ART

BIBLIOGRAPHY.—Tributes by William Carlos Williams *et al., John Marin* (1956); Herbert J. Seligmann (ed.), *Letters of John Marin* (1931); Dorothy Norman (ed.), *Selected Writings of John Marin* (1949). (VL. B.)

MARINDUQUE, an island and, together with several offshore islets, a province of the Philippines, located south of central Luzon and east of Mindoro. Area 355 sq.mi. Pop. (1960) 114,586. Over 30% of the total land is in farms. Coconuts, for copra production, and rice are the leading crops. The provincial capital is Boac (pop. [1960] 26,712). An iron mine at Mogpog, 3 mi. north of Boac, provides employment for about 500 persons and is the leading nonagricultural industry. (R. E. HE.)

MARINE BIOLOGY is the science that deals with animals and plants that live in the sea. It also deals with air-borne and terrestrial organisms that depend directly upon bodies of salt water for food and other necessities of life. In the broadest sense it attempts to describe all vital phenomena pertaining to the myriads of living things that dwell in the vast oceans of the world. Some of its specialized branches concern natural history, taxonomy, embryology, morphology, physiology, ecology and geographical distribution. Marine biology is closely related to the science of oceanography because of the relationship of the physical features of the oceans to the living organisms that dwell in them. It aids in the understanding of marine geology through the study of those organisms that contribute their skeletal remains to the floors of the oceans, or that elaborate the vast coral reefs of the tropic seas.

Knowledge of marine biology is essential to certain aspects of human welfare. Intelligent regulation of the commercial marine fisheries would be impossible without a thorough understanding of the biology of commercial fishes. The prevention of fouling of ships depends on the knowledge of factors that interfere with biological processes of fouling organisms. Survival at sea by means of life rafts and lifeboats often depends on the utilization of various kinds of marine life for both food and water. The rapid increase in the human populations of the world has indicated a need for greater use of the marine products, which may be made more easily available through contributions of the knowledge gained in the study of marine biology.

THE MARINE COMMUNITY

Environment

The great oceans and adjacent seas comprise approximately 70% of the surface of the earth, with a volume of more than 1,000,000,000 cu.km. The greater part of this vast marine environment is suitable for the existence of large numbers of living organisms; and no part, not even the blackest, coldest depths, has been discovered to be completely devoid of life. The upper layers of the oceans, effectively illuminated with sunlight to depths as great as 200 m., support the existence of pigmented plants that elaborate primary food materials by photosynthesis. Mineral salts are available for the use of living material during growth, the relative concentration of these salts approximating those of the body fluids of most marine organisms. Oxygen is present in concentrations sufficient for respiration in all but a few zones of the oceans; but even the oxygen-deficient zones are inhabited by organisms that exist by anaerobic respiration.

The temperature ranges of −2° to 30° C. (about 28° to 86° F.) are well within the limits favourable to most living organisms. In addition the density and viscosity of sea water are such that it affords an ideal flotation medium for the numerous organisms, large and small, that dwell within it. *See* OCEAN AND OCEANOGRAPHY.

Organisms

The sea contains a vast assortment of living things, including the smallest and the largest that inhabit the world. Discounting the submicroscopic bacteriophages (viruses that attack bacteria) that have been isolated from coastal waters, the smallest forms that can definitely be called living are bacteria. Invertebrate animals range in size from tiny protozoa, barely visible under the highest power of an ordinary optical microscope, to the giant

deep-sea squid *Architeuthis*. Vertebrates range from tropical fishes less than 1 in. long when mature to the great blue whale, which may attain 100 ft. in length and 150 tons in weight.

Plants.—*Bacteria.*—Many bacteria in the sea perform the important function of decomposing the dead bodies of larger organisms to release their elementary substances as primary nutrients for plant growth. These bacteria are generally scant in the open waters but become numerous near the coast lines, where organic matter is abundant, and also on the surface of the sea bottoms, where detritus accumulates. Terrestrial bacteria, especially those of human origin, often become abundant in bays and estuaries. These bacteria are not marine in the strict sense because they are unable to grow and reproduce in the marine environment. However, since they are able to survive in the sea for long periods of time, may be dangerous pollutants and are continually replenished in large supply from the land, they are given an important place in the marine community. (*See* also BACTERIOLOGY.)

Algae.—Most of the marine plants belong to the algae, a collection of primitive phyla characterized by the absence of a vascular system, and by a reproductive mechanism that does not require the formation of flowers and seeds. The largest and most diverse group of plants consists of microscopic unicellular forms that abound everywhere in the illuminated upper waters of the oceans, where they synthesize the greater part of the primary food that supports the marine community. Reproduction is accomplished by simple cell division. When conditions are unfavourable, resting spores are formed which germinate when the situation improves. The rate of reproduction of algae depends to a large extent on the availability of nutrient salts of nitrogen and phosphorus, which, however, are most abundant in the deep unlighted waters where they cannot be utilized. Consequently, the greatest production of unicellular plants occurs where there is upwelling of the deep, nutrient-rich water; the primary food synthesized in these localities often provides the basic supply for prosperous commercial fisheries.

The macroscopic marine plants are represented by seaweed—certain red, green and brown algae—with flowering plants being represented by the eelgrasses and the salt-marsh grasses. The three groups of seaweed are generally anchored to the bottom or some solid structure by rootlike holdfasts that perform the sole function of attachment and do not extract nutrients from the soil as do the roots of the higher plants. Seaweeds often form dense accumulations in shallow water; but their restricted zonation along the margins of the seas, where the depth is 50 m. (about 165 ft.) or less, detracts from their importance as primary food producers.

One group of red algae, the Corallinacae, contributes in the formation of coral reefs. Members of this group form resistant encrustations on the seaward surfaces of reef corals. A green alga, *Halimeda,* also contributes to the formation of coral atolls by depositing its platelike calcareous skeleton on the floors of lagoons. (*See* also ALGAE; CORAL REEF.)

Higher Plants.—The eelgrasses and saltmarsh grasses, marine representatives of the angiosperms, have true roots, and obtain their nutrients from the mud and sand in which they grow. Both groups reproduce by forming true flowers that are pollinated and produce seeds. These grasses have an important effect on the formation of geological structures in bays and estuaries, where they entrap water-borne sediments, thus forming mud flats, sand bars and marsh banks. Marsh grasses, growing at or near the high-water level on coasts where the sea level is constantly rising, build up layers of peat, some of which are several metres thick.

It is curious that few animals browse directly upon the larger marine plants. However, the sea hare, *Tethys,* some other gastropods and a few kinds of fishes feed on seaweed, and the manatees, or sea cows, eat other large plants. In general the importance of the larger plants in the marine communities depends upon their providing hiding places and means of attachment for animals. After death they contribute to the organic content of the sea as detritus.

Animals.—The animal kingdom presents a spectacular array of forms and sizes in the sea. It is represented by all the major divisions (phyla), of which five are exclusively marine, namely, the Ctenophora (comb jellies), Echinodermata (starfish and allies), Chaetognatha (arrowworms), Brachiopoda (lamp shells) and Phoronida (tufted tube worms).

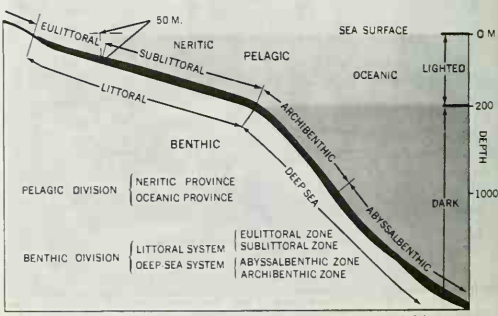
Vertebrates.—All classes of vertebrates except the Amphibia are represented in the marine community. The fishes are numerous and diverse. The reptiles include the true sea snakes and turtles. Certain birds, such as the penguins, have no power of flight and spend the major part of their lives swimming in or waddling near the sea. Others, such as the albatross, soar over the oceans for long periods of time and only return to land to nest. The fish-eating cormorants are powerful underwater swimmers that pursue their prey to considerable depths below the surface of the sea. The principal mammals that are exclusively marine are whales, porpoises and sea cows; these are so specialized for the aquatic environment that they cannot leave the sea at any time. Others, including the seals, sea lions and sea otters, normally live in the sea but are able to move on land for breeding purposes.

Invertebrates.—The forms and modes of life of the marine invertebrates are extremely diverse. The mud and sand of the ocean's bottom teem with burrowing worms, mollusks and crustaceans. The surface of the sand may be covered with starfish, brittle stars, sea urchins and sand dollars where conditions are favourable. Certain coelenterates and bryozoans form vast colonies, free floating or attached to solid surfaces. Extreme specialization occurs in the siphonophore coelenterates in which individual members of the colony are modified for such diverse tasks as swimming, flotation, food catching, ingestion and reproduction. The gigantic coral reefs of the tropical seas are, to a large degree, formed from the skeletal secretions of colonial corals, also coelenterates.

The Crustacea (*q.v.*) are probably the most numerous and diverse group in the marine habitat. The vast majority swim freely in the upper waters, feeding on phytoplankton and organic detritus, and in turn providing the primary source of food for such pelagic fishes as the herrings and mackerels. Certain crustaceans, such as crabs, lobsters and crayfish, inhabit the bottom as scavengers, feeding on dead organisms. Others, such as the barnacles, have adopted a completely sedentary mode of life in the adult condition: they become firmly cemented to solid surfaces, their legs being modified into food-gathering organs that sweep the adjacent waters for organic detritus and small organisms.

ZONATION

The marine environment is divided into arbitrary zones for means of convenience (*see* diagram), and the organisms are classified into categories determined by habitat and locomotive behaviour. The two main divisions of the sea are the benthic and the pelagic, the former comprising the entire sea bottom and the latter, all the overlying water. All organisms that burrow through the mud, attach to solid surfaces or crawl on the bottom are ecologically classified as living in the benthos. Organisms inhabiting the pelagic division are classified as nekton if they are strong, active swimmers and as plankton if they are weak swimmers or pas-



FROM SVERDRUP, JOHNSON AND FLEMING, "THE OCEANS" (PRENTICE-HALL, INC.)

THE MAIN DIVISIONS OF THE MARINE ENVIRONMENT

sive drifters. Planktonic plants such as diatoms, photosynthetic dinoflagellates and other floating algae are known as phytoplankton. Planktonic animals, which include a host of drifting forms, comprise the zooplankton.

The scheme of marine zonation followed in this article is a time-honoured one; other classifications, found in the articles ANIMALS, DISTRIBUTION OF, and ECOLOGY, ANIMAL, are also widely used.

Sea Floor.—The benthic division may be divided into a littoral system that extends from the shore to a depth of 200 m. and a deep-sea system extending down to the greatest depths. The littoral system may be further subdivided into a eulittoral zone, extending from the high-tide mark to the 50-m. contour, and a sublittoral zone, to the edge of the continental shelf. (The 50-m. depth is chosen because it represents approximately the greatest depth at which attached plants can grow.)

The kinds of things that grow in the littoral system depend to a considerable extent on the type of bottom and on the degree of exposure to wave action. Exposed sandy coasts generally develop sparse populations, especially between the tide lines. Also the few organisms inhabiting wave-swept rocky shores are generally firmly cemented to the substratum. Protected bays and inlets often develop rich populations. Protected rocky shores are generally covered with seaweeds, mussels, barnacles, etc., and with various kinds of crabs and worms crawling among them. Sandy and muddy bottoms teem with burrowing mollusks, worms and echinoderms in localities where headlands and projections protect the environment from violent wave action. The sublittoral zone, which receives a considerable amount of organic matter from the shoreward area and from the waters above, is particularly rich in animal life; it is there that important ground fisheries are located.

More than 90% of the ocean bottom is included in the deep-sea system. A detectable amount of light penetrates the shallower (archibenthic) zone, but it is in such reduced amounts that no plant growth can occur. Beyond the 1,000-m. contour the abyssal-benthic zone remains in perpetual darkness. The entire deep-sea system depends on food produced in the upper lighted zones; this food drifts downward in limited quantities, restricting the numbers and kinds of animals which can depend upon it for existence. Most deep-sea animals are therefore small and inconspicuous.

Open Water.—The pelagic division may be divided into the neritic province, which overlies the littoral area, and the oceanic province, which occurs over the deep-sea system. The entire neritic province receives sunlight and may develop rich blooms of phytoplankton, aided by contributions of nutrient salts from the nearby land and the shallow bottom. The zooplankton, which feeds on the phytoplankton, is characterized by the presence of a number of temporary forms, including the larval stages of benthic animals. These are scarce in the oceanic province because of their distance from adult populations and also because of the scarcity of such animals in the deep-sea system.

The upper illuminated section of the oceanic province is termed the upper pelagic. There the phytoplankton may develop in abundance in places where oceanographic features bring up nutrient salts from the deeper waters below. Animal life may become so abundant that important tuna and other pelagic fishing may be profitably pursued. In the unlighted abyssal-pelagic zone the animal populations become sparse. The fishes of this region are generally small, dark in colour and often equipped with light-producing organs.

ADJUSTMENTS TO LIFE IN THE SEA

The principles of general physiology of marine organisms are essentially the same as those that apply to fresh-water and terrestrial organisms. All living things extract substances from their surroundings to provide materials for growth and for energy to maintain the living processes.

Reproductive Patterns.—*Bacteria and Algae.*—In the plant kingdom the marine bacteria and microscopic algae reproduce by simple cell division. Favourable conditions may increase the rate of reproduction to such an extent that dense local accumulations known as "blooms" may occur. Abnormal blooms of certain poisonous dinoflagellates (*q.v.*) are not uncommon in the warmer seas where, as "red tides," they colour the water and kill vast quantities of fish with their toxic secretions. These substances are of such virulence that shore resorts are at times made uninhabitable because respiratory irritations result when these poisonous substances are transferred to the air by breaking waves. The macroscopic algae typically reproduce by spores that germinate into inconspicuous male and female plants, called the gametophyte generation. Fertilization then takes place and the new sporophyte generation is produced (*see* ALGAE: *Structure and Reproduction*).

Animals.—The life histories of marine animals are remarkably varied. Most sedentary forms reproduce sexually by liberating eggs and sperm into the water, where fertilization takes place. Typically this is followed by a larval stage with the swimming larva quite unlike the adult. After a free-swimming existence, a period of days or weeks, the larva undergoes metamorphosis and assumes the adult form. Fertilization is internal among the majority of the crustaceans. The young grow by molting or shedding their shells, and pass through a number of successive larval stages before the adult form is attained.

As a rule, the reproductive and developmental patterns of marine animals fall into one of three general categories: (1) internal fertilization, with parental protection of the early stages of development, the offspring numbering in the hundreds or less, as in certain gastropods; (2) internal or external fertilization, with some provision for the early helpless stages, the offspring numbering in the thousands, as in many bottom-dwelling crustaceans; and (3) external fertilization, with no provision for protection during the early stages, the offspring numbering in the millions, as in most mollusks, echinoderms and many fishes.

The type of fertilization determines to a considerable degree the extent to which populations of any animal may fluctuate from time to time. Certain snails lay small numbers of eggs in resistant capsules that protect the embryos until they become well enough developed to cope with their environment. Populations of such snails tend to remain relatively constant, with only gradual fluctuations over long periods of time. Many of the bottom-dwelling crustaceans fertilize the eggs internally and attach the fertilized eggs to special appendages. The eggs are then carried on the mother through the early stages of development and are finally hatched as free-swimming larvae in an advanced stage. To ensure some survival in the subsequent precarious free-swimming existence, the eggs usually number from the hundreds to the tens of thousands. Populations of animals with this kind of life history fluctuate to a considerable extent, depending on how the conditions of the environment favour survival during the free-swimming period. Most mollusks, echinoderms and many commercial species of fish produce millions of eggs per female. These are fertilized externally and then are abandoned to fend for themselves, through a prolonged period of helpless developmental stages. Survival during this period depends on the presence or absence of predators, the strength and direction of currents, and the suitability of the physical and chemical factors of the environment. So many factors or combinations of factors may influence the survival of each generation that populations of organisms with this mode of reproduction tend to exhibit extreme variations from one year to the next. Occasionally circumstances may permit such a high degree of survival of a single generation that its constituents may outnumber all other members of the population for several years. Such a generation is known as a dominant-year class and is of considerable importance to the commercial fisheries.

Salt-Water Balance.—Composition of living matter must be maintained within narrow limits with respect to the water content and to the concentration of various mineral salts. The problems of maintaining the required composition are accomplished by marine organisms in a number of ways.

Most naked or thinly-covered marine organisms have little difficulty in coping with their environment because the composition of their blood approximates that of sea water with respect to the major salts. They are thus able to carry out their living processes without expending large amounts of energy in concentrating or eliminating water and mineral substances.

The blood of many of the fishes, however, is less concentrated (hypotonic) than sea water, and special mechanisms are necessary to prevent loss of water through the body membranes by osmosis (*see* also FISH). In most fishes the walls of the digestive tract are permeable to solutions of mineral salts, so that sea water (with its salts) ingested by these species can pass into the blood stream. Special organs on the gills extract the excess mineral salts from the blood and excrete them into the waters outside the body. The salt concentration of the blood is thus reduced to an optimal level.

Certain species of cartilaginous fishes (sharks, skates and rays) accomplish the task of regulating their salt concentrations in a different fashion. Instead of expending energy in secreting salts against the osmotic gradient, they conserve their nitrogenous wastes in the form of urea, which is retained in the blood in concentrations sufficient to make it the osmotic equivalent of sea water.

A number of crustaceans that invade the variable dilute waters of the estuaries are faced with the problem of surviving in a medium that is less concentrated than their blood. Consequently water flows into their bodies by osmosis. These forms are generally protected over most of the body surface by impermeable shells; and the excess water entering through the reduced permeable area is eliminated with considerable expenditure of energy by means of special kidneylike organs.

The cellular fluids of many marine plants differ considerably from the surrounding sea water in their relative concentrations of sodium and potassium. In effect, these plants appear to concentrate potassium, and in doing so must eliminate sodium in order to maintain the total salt concentration of the cellular fluid at a level equal to that of sea water. The elimination of excess sodium is accomplished by means of a "sodium pump," which operates in some unknown manner but which may be stopped by substances that inhibit the organism's utilization of energy-supplying substances.

Oxygen Levels and Metabolism.—Organisms that live between the tide lines, such as clams and oysters, are deprived of oxygen-bearing water at each low tide. The end products of metabolism, formed during this period of anaerobiosis, are acidic. These are temporarily prevented from injuring the organism by being neutralized by the calcium carbonate of the shell, at which time the organism incurs an "oxygen debt." This temporary debt is paid off by an increase in oxygen consumption when the oxygen-rich waters flow over the organism at high tide, the accumulation of metabolic products then being eliminated by oxidation.

Periodicity.—Certain tidal organisms exhibit rhythms in behaviour, or rates of metabolism, which correspond to tidal periods. These peculiarities persist even when the organisms are transferred to situations where there is no tide. The oxygen consumption of some mollusks varies as much as tenfold with the phases of the tide. This variation continues in a rhythmic manner even when the organisms are maintained under constant conditions in laboratory aquariums. Such organisms collected from separate localities where the phases of the tide differ will maintain their intrinsic rhythm. Fiddler crabs that live in the intertidal zone and alter their colour patterns as the tides rise and fall, for example, continue to exhibit the same rhythmic colour variations under constant conditions in the laboratory.

Brittle stars, sea cucumbers and other voracious animals dwell on the sea bottom in dense accumulations. They require such enormous quantities of food that each generation of immature food organisms would be entirely exhausted if eaten immediately after settling to the bottom. To make efficient use of their food supply, the brittle stars and cucumbers enter a quiescent stage during the period when the food organisms are settling, and maintain their metabolic activities at a low rate until the food organisms have increased in volume through growth. In this way the food supply is extended, eliminating starvation.

Other Adaptations.—Most marine animals are heavier than the surrounding sea water; therefore, special adjustments have appeared among the various forms to offset the tendency to sink. Among these adjustments are the flotation processes of diatoms and dinoflagellates; the oil droplets in the protoplasm of many protozoa; the gas traps in some radiolarians, some jellyfishes and notably in some large seaweeds; and the swim bladder in some fishes.

Many larger marine animals actively swim about by adaptations of appendages (fishes, whales and seals) or by ejecting water (octopods, scallops and some jellyfishes); those confined to the bottom may flip about, creep and swim to some extent, but some are sedentary, like sea anemones, corals and many large seaweeds attached to intertidal rocks. The great bulk of living substance of the sea, however, is passively adrift as plankton (*q.v.*). *See* also ANIMALS, DISTRIBUTION OF; LOCOMOTION, ANIMAL.

THE FOOD WEB OF THE SEA

Cycle of Food.—The marine environment is essentially a closed system in which life proceeds in a cycle determined by the nutritional requirements of the various kinds of organisms. The marine plants undergo continual grazing by hordes of herbivorous animals. Since the bulk of the plant material produced in the sea is included in the phytoplankton, the majority of the herbivorous animals are filter feeders, endowed with special structures for straining the tiny plants out of the water. The planktonic Crustacea possess filter nets of closely spaced bristles on the appendages adjacent to the mouth. Clams, oysters and mussels strain their food out of the water by means of their gills. Some worms employ mucous nets capable of extracting particles of extremely minute size from the water. These herbivorous animals, which perform the important function of converting plant materials into animal substance, are in turn subject to predation by the primary carnivores.

This group includes a vast array of forms from the tiny arrowworms, which snap at individual organisms with their formidable jaws, to the great baleen whales, which strain vast numbers of organisms for food by means of their whalebone plates. Beyond the primary carnivores are successive levels of carnivorous forms ending with the top predators. When the latter die they are decomposed by bacteria, thus releasing the elementary substances for the use of the photosynthetic plants, and completing the food cycle.

Within this general cycle of life there are a number of events that make the system complex. Death and decomposition occur at every phase of the cycle. Phytoplankton drifting down into the deep, unlighted zones of the oceans may die and decompose. Their elementary substances are then beyond the reach of their photosynthetic relatives until such time as turbulence or upwelling may return the nutrients to the illuminated water. Shrimp, fishes and other forms dying from causes other than direct predation may sink to the bottom to be eaten by scavengers such as crabs and worms before bacterial decomposition is completed. Incomplete decomposition of any dead organism may result in the production of organic detritus, which is particulate matter of indeterminate nature included in the diet of many filter-feeding species. Lastly, the general system is made complex by the fact that the metabolic activities of all organisms continue to release elementary substances through respiration and excretion, thus helping to maintain the supply of basic nutrients for the photosynthetic plants.

The great demands for energy made by living organisms, in order to maintain the fundamental living processes, necessarily limit the amount that is available to be transferred from one step to the next in the food cycle. In general every organism uses 90% or more of its food intake merely to sustain its metabolic activities and transfers less than 10% into its own substance during growth. Thus the rate of production of marine life depends upon the position of a particular species in the cycle with respect to the primary source of supply, the photosynthetic plants.

In the pelagic division the tiny herbivorous copepods and euphausiid shrimps are produced at a rate fast enough to support the feeding requirements of the giant baleen whales. Mussels, clams and oysters, which are also herbivorous filter feeders, have proved to be a dependable source of food for coastal peoples throughout the ages.

The bulk of the world's catch of commercial fishes consists of

certain pelagic species, including the herrings, mackerels and menhaden, all primary carnivores, which subsist on small crustaceans and other similar organisms. At the other extreme, the very large fishes and other top predators seldom reproduce and grow at a rate fast enough to permit catches of a size approaching those of the herrings and mackerels.

Sources of Human Food.—Man has depended on the sea for part of his food supply since prehistoric times. Human preferences have tended toward the larger fishes because they are relatively easy to capture by means of both primitive and advanced types of fishing gear. However, these larger fishes are generally one or more levels removed from the primary source of food and are therefore produced at a reduced rate, as already described. As a typical example, it has been shown that the yield of a single population of haddock to the commercial fisheries represents less than one-thousandth of the total quantity of living material synthesized by the plants growing in the waters over the fishing grounds.

The increasing need for human food has stimulated interest in making more efficient use of the productivity of the oceans. Preliminary estimates showed that the yearly production of primary food materials approximated three tons per acre when measured as dry plankton. However, two major difficulties prevented extensive use of this enormous crop for human food. The vast majority of the photosynthetic plants and the herbivorous zooplankton that subsist on them are exceedingly minute—seldom more than of microscopic size. The problem of separating such organisms from the waters is vastly more complicated than that of netting even such small fishes as sardines or anchovies. In addition, the cycle of life in the sea proceeds at such a rapid rate that the phytoplankton are consumed by the zooplankton about as fast as they grow. The herbivorous zooplankton in turn are limited constantly by the continual predation by larger forms. The final result of this rapid turnover is a low standing abundance of the groups of organisms that are produced at the highest rate, the phytoplankton. It thus appears that man must continue to depend on the larger carnivorous fishes even though they represent an infinitesimal fraction of the total amount of food produced in the sea.

Some progress was made during World War II in the use of zooplankton as an emergency source of food for survivors on lifeboats and rafts. Various kinds of zooplankton were tested as to their nutritive value and palatability. The results of these tests indicated that the commonest forms would sustain life for some time and that the taste and consistency was generally acceptable.

Considerable attention has been given to the possibility of increasing the production of such herbivorous mollusks as mussels, clams and oysters, by modifying local conditions to favour the desired species. These species are so close to the primary source of food that their production, in limited localities, surpasses that of any other kind of edible animal material. Oysters and mussels have been farmed for centuries by providing suitable surfaces for attachment and by eliminating predators and competitors.

In a few instances it has been possible to apply principles of marine biology to the deep-sea fisheries in order to locate new supplies and to regulate the degree of exploitation that would maintain the optimal sustained yield. Knowledge of the hydrographic features along the borders of the equatorial currents of the Pacific ocean has made it possible to discover productive tuna populations. An understanding of the population dynamics of Pacific halibut has made it possible for the interested nations to regulate the total catch by international agreement and thus to prevent the wide fluctuations in the availability of this species that result from overfishing. Similarly, a number of nations whose fishermen depend on the haddock resources of the northwest Atlantic agreed to regulate the size of the mesh of the trawls employed in this fishery. In this way the young haddock are allowed to escape so that they may grow to marketable size in greater numbers. This regulation was enacted after years of study of the biology of the haddock, the extent of the resource and the effect of various fishing methods.

See also FISHERIES; FISH CULTURE: *Regulation of Fishing for Best Yield.*

RESEARCH METHODS

During the last half of the 19th century, when emphasis was placed mainly on the collecting and cataloguing of marine organisms, the methods employed in marine biology were directed toward the capture and preservation of specimens for study. Various kinds of dredges and trawls were used to collect specimens from the bottom; and hoop nets of different sizes were employed in securing pelagic specimens. The vast multitude of marine species has made it necessary to continue to employ such methods up to modern times. The first half of the 20th century, however, saw a shifting of the emphasis toward quantitative and dynamic aspects of the science, for which refined methods and the use of more complex tools were required.

Equipment to determine the physical features of the marine environment was developed with a considerable degree of precision. Among the instruments devised were thermometers to determine the temperature at any desired depth and containers that close automatically to bring water samples to the surface for analysis. New analytical methods made possible immediate determinations for salinity, oxygen, nutrient salts and plant pigments on shipboard. Also developed were photoelectric devices for measurements of light penetration and a variety of coring instruments for collecting bottom sediments.

Even the collecting apparatus underwent a high degree of refinement. Qualitative hoop nets gave way to quantitative samplers that may be lowered in a closed position to any desired depth, opened, towed and closed again. The exact amount of water filtered through the fine silk netting is accurately determined by propellers and counters. Continuous sampling is accomplished by a filtering device whereby a band of fine netting is moved across an opening and then is rolled up in a tank of preservative. Such samplers may be towed long distances behind commercial vessels and require only a small amount of attendance by unskilled personnel.

Direct observation of marine organisms in their natural habitats has been made possible by underwater cameras, television and improved diving equipment. Cameras have been devised that function in the greatest depths by means of light produced by commercial photographic flash bulbs or xenon-gas discharge tubes. Underwater television provides the observer with a continuous picture of events that occur within the field of his submerged camera. The development of self-contained diving equipment made it possible for the investigator to inspect personally marine organisms in their natural habitat.

The rate of production of primary foods by the photosynthetic plants is determined by dark and light bottle experiments and by the use of radioactive isotopes of various elements. Dark and light bottles filled with sea water of known oxygen concentration and containing a normal population of organisms are suspended in the sea for a given time. Photosynthesis that occurs in the light bottles is determined by the increase in oxygen. A comparison is made between the oxygen concentration in the water in the light bottle, determined after a finite time, with that of the water at the time of filling; the result gives an indication of the amount of food produced.

Corrections for losses of oxygen by respiration are determined from the oxygen content of the dark bottle. More direct determinations of this primary productivity are made with the aid of radioactive isotopes. Light bottles filled with water containing normal populations are supplied with small quantities of salts of radioactive carbon and suspended in the sea. After a period of photosynthesis, the organisms are filtered off and the amount of carbon fixed in their bodies is determined by Geiger-Müller counters.

The properties of isotopes have also been used to determine climatic conditions in earlier times. It was discovered that the ratio of the commonest isotope of oxygen, O^{16}, to O^{18} in the calcium carbonate of shell-forming organisms is influenced by the surrounding temperature at the time of the formation of the shell. Therefore the climate in which a number of prehistoric organisms lived is determinable by analysis of their fossil remains.

Morphological and taxonomic studies of marine organisms are

generally performed on preserved materials in connection with the work in museums and universities. Physiological and embryological investigations requiring the use of living material are generally pursued at biological stations. These are situated on the seacoast, thus facilitating the rapid transfer of specimens to the laboratory where they may be maintained in sea water provided by special circulating systems.

See also OCEAN AND OCEANOGRAPHY; ZOOGEOGRAPHY; ZOOLOGICAL COLLECTING; and references under "Marine Biology" in the Index.

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Among the most useful journals for marine biology are the *Journal of the Marine Biological Association of the United Kingdom; Journal of Marine Research; Journal of the Fisheries Research Board of Canada; Deep Sea Research; Ecology; Ecological Monographs.*

(H. J. T.; X.)

MARINE ENGINEERING, the branch of engineering that is concerned with the design, construction and administration of machinery installations afloat. The title marine engineer usually designates the men ashore who are occupied with such installations in technical or administrative capacities. It does not normally refer to the activities of the officers and crew who are responsible for the daily operation of their vessel's machinery; they are usually called engineer officers and engineers to distinguish them from deck officers and deck hands.

Marine engineering and naval architecture are often used together to comprehend the entire engineering function involved in design and construction of ships. The demarcation between the responsibilities of the naval architect and the marine engineer is not rigid, but in general the primary responsibility of the marine engineer is the propulsion machinery of the ship, while her form and structure are in the hands of the naval architect. Auxiliary machinery of various kinds may be assigned to either one or the other, and in some shipyards and design offices the electrical installations are the province of an electrical engineer who is not responsible directly to either the marine engineer or the naval architect.

As in other disciplines of engineering, those who practise the profession of marine engineering may have prepared themselves either by formal university-level training or by practice and experience. The number of those who have been formally educated as marine engineers in the English-speaking countries is not large. In Great Britain, marine-engineering education has been mainly a branch of mechanical engineering. In the United States it has usually been administered as part of a program called naval architecture and marine engineering in the few institutions that offer courses in this field.

In any case, the core of the professional area of the specialty is the main propulsion machinery of the ship. Most installations in large ocean-going vessels transform the energy delivered by the power plant to thrust by means of one or more screw propellers at the stern of the ship. The propellers may be connected with the driving engine by direct lines of shafting, by mechanical gearing or, less commonly, by electrical transformation. The number of shafts is usually determined primarily on the basis of maximum unit engine power which can be produced and handled. In general, the smaller the number of screws the higher the propulsive efficiency.

Propulsive efficiency is the efficiency with which power delivered by the shafting (shaft horsepower, s.h.p.) is transformed into the power absorbed by the ship in uniform forward motion alone under towed conditions; *i.e.,* without the disturbances caused by the propellers (effective horsepower, e.h.p.). Single-screw propulsion may give propulsive efficiencies of 70%–80%, while quadruple-screw propulsion may show only 55%–60%. Operating costs will generally be lower with single-screw installations largely because fewer man-hours are required for operation at sea and for upkeep. However, conditions other than efficiency may favour multiple-screw propulsion. Even when the total power required for propulsion could be delivered by a single unit, the corresponding propeller diameter may be too large for the geometry of the stern. Vulnerability to damage of a single-engine shaft and screw favours the multiple-screw installation. A lesser consideration, except in special circumstances, is the feature of maneuverability, which clearly favours multiple screws.

TYPES OF POWER PLANTS

For large ocean-going vessels the two principal types of conventional power plants are the diesel engine and the steam turbine. Each type has a variety of forms and applications. The diesel installation may be connected directly to the propellers, or it may transmit power through mechanical gears or electrical transmission; the steam turbine, because of its high inherent speed, is always connected to the propellers through mechanical or electrical speed reduction. Nuclear propulsion has proved entirely feasible from the engineering standpoint and has displaced the conventional power plant in some special types of ships. The gas turbine, operated either with a conventional combustion system or with free-piston gasifiers, has also attracted considerable attention as a marine power plant.

The choice of power plant for a specific ship depends on many factors. Because of the obvious conditions of use, the factor of reliability is always paramount. Other factors, some or all of which may be governing in any particular design, are: power requirements and the availability and first cost of a power plant of proved form and size to meet these requirements; weight and space characteristics; fuel economy; maintenance costs; noise; vibration; personnel requirements; auxiliary compatibility; and other special features.

First cost is seldom a deciding consideration. Both the older conventional types have survived in active competition with each other, and their costs do not differ greatly. But availability of a proven plant may often decide the issue. After the decision to build a ship has been made, there is seldom time to develop completely new designs of machinery to fit her. In large vessels, bulkhead arrangements dictated by other considerations usually make space requirements a secondary matter, except in very fast, high-powered ships.

Weight characteristics, expressed usually in pounds of machinery weight per shaft horsepower, vary widely. In smaller powers the diesel usually has the advantage; in large powers, such as are needed for high-speed liners or most naval vessels, the geared turbine usually offers weight advantage. Fuel economy is related to fueling ports on the proposed itinerary of the vessel, to the proportion of time at which full power will be used and to the proportion of time spent in stand-by condition. Most merchant vessels operate normally at or near full power; naval ships cruise normally at only a fraction of full power. For continued operation at or near full power the diesel usually offers fuel-economy advantages in all sizes. Maintenance costs are determined by the estimated reliability of the plant and the cost of labour for maintenance work. The latter factor has sometimes placed the diesel at a disadvantage in American vessels, where labour costs have been much higher than elsewhere, because the diesel usually requires more maintenance than a steam plant.

Numberless other factors may influence the choice of a particular type of power plant. The experience of the proposed owners, tradition and past practice exert powerful influences. European owners have shown preferences for diesel installations in circumstances where American owners have chosen steam turbines, and the proportion of diesel installations in ocean-going vessels has accordingly been higher in European practice than in American.

DIESEL-ENGINE DRIVE

Engine Types.—Diesel engines for marine use are divided into two general types, the four-stroke and the two-stroke, sometimes called the four-cycle and the two-cycle. In the four-stroke engine the cycle of events required for operation is completed in four strokes of the piston or in two revolutions of the crankshaft.

The events are: compression on the first upstroke; combustion and expansion on the first downstroke; exhaust on the next upstroke; and aspiration or induction of air on the last downstroke.

The two-stroke cycle, as its name implies, is completed in one revolution of the crank, and, usually, the revolution is divisible into three approximately equal periods, viz., compression, combustion and expansion, and exhaust and scavenge. Fig. 1 shows the sequence of events diagrammatically. Only insignificant fractions of the expansion and compression strokes are lost, because the exhaust and scavenge periods occur and are completed as the piston is approaching and leaving the bottom dead centre. Every downstroke of the main piston is a power stroke. Scavenging air is supplied by a blower, mechanically or independently driven; and the cylinder may be scavenged longitudinally, transversely or in a looped direction.

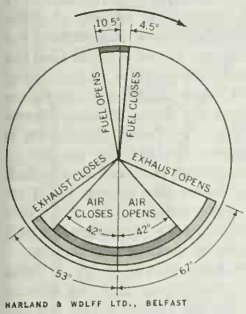


FIG. 1.—SEQUENCE OF EVENTS IN TWO-STROKE CYCLE ENGINE

Engines are of the trunk-piston or crosshead types. In the first the crank is connected to the piston directly through the connecting rod, so that reaction to the horizontal force component of the rod results in side pressure against the cylinder wall. To reduce unit value of this side pressure the piston is elongated, or trunked, and from this derives the name trunk-piston type. Alternatively a piston rod connects the piston to a crosshead, which in turn is connected to the crank by a connecting rod, so that the horizontal force component is resisted by the crosshead pressure on its guide, which is connected to the engine frame.

Engines are characterized as single-acting or double-acting, depending on whether a pressure cycle is operative on only one end of the piston or on both ends alternately. A further distinction arises when the exhaust valves are arranged as pistons returning energy to the crankshaft. Such an arrangement is called an opposed-piston engine. When air is forced into the cylinder under pressure instead of being aspirated in at atmospheric pressure, the engine is referred to as being pressure-charged or supercharged.

During the first 15 years of marine application, the most successful engine type was the four-stroke, single-acting, crosshead design. The transverse-scavenged, two-stroke single-acting engine was next in popularity. As a pressure-charged unit the four-stroke single-acting engine persisted for many years more. In the mid-1920s the double-acting four-stroke engine was introduced for higher-powered vessels, but, after a few years, it was discarded as being too complicated for ready overhaul. At this time the double-acting, two-stroke uniflow-scavenged engine followed. The design was very successful in service, but the time and labour needed in port for overhaul precluded its wide acceptance.

Out of this long period of evolutionary activity in several countries and as the result of the independent experience of many builders, the pressure-charged, longitudinally scavenged, single-acting two-stroke engine has emerged as a widely favoured type.

Fig. 2 shows a section through a cylinder of such an engine, made by Harland and Wolff in powers from 3,000 to 8,000 brake horsepower. The bore and stroke of the cylinders are fixed in conjunction with the number of cylinders, ranging from four to eight per engine. The crankcase is isolated from the cylinder, a feature which is important when burning heavy fuels of high sulfur content. There are two pistons in each cylinder, and the scavenging is longitudinal; *i.e.*, on the so-called uniflow principle. The lower, or main, piston controls the admission of the scavenging air through tangential ports arranged near the bottom of the cylinder liner; the upper, or exhaust, piston controls the egress of the combustion gases through radial ports located near the top of the cylinder liner.

Each exhaust piston is operated by a pair of eccentrics, located one on each side of the associated crank. Each eccentric is con-

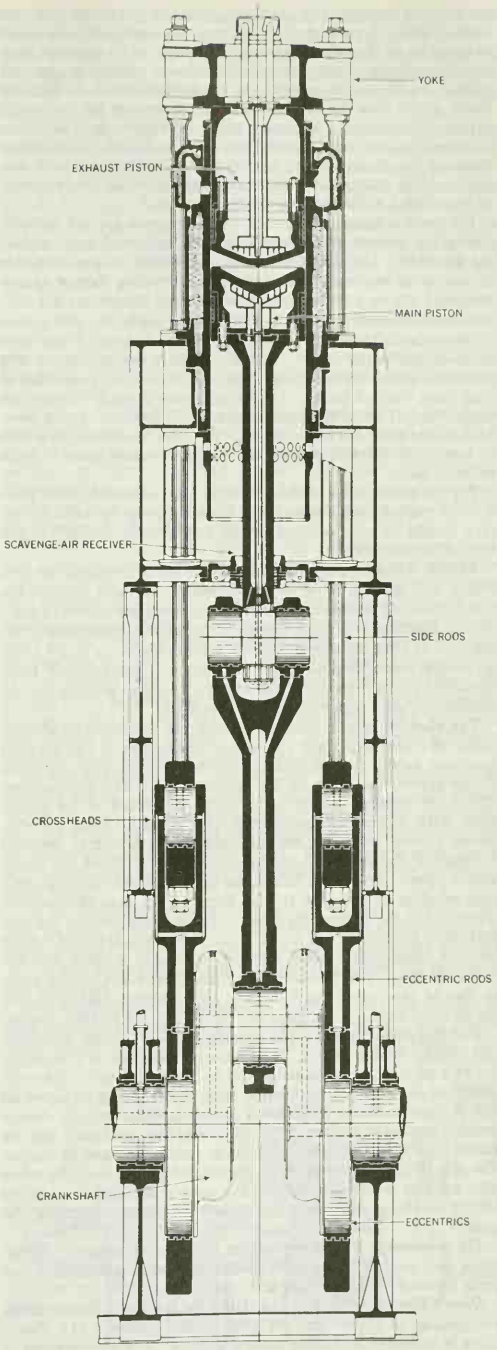


FIG. 2.—LONGITUDINAL SECTION THROUGH ONE CYLINDER OF A HARLAND AND WOLFF SINGLE-ACTING TWO-STROKE ENGINE

nected to a crosshead through an eccentric strap and rod, and each crosshead is connected by two rods to a cast-steel yoke bolted to the skirt of the exhaust piston. Although, as its primary function, the exhaust piston controls the exhaust periods, it also contributes to the engine output; the working stroke is, in fact, the crank stroke plus the eccentric stroke. Scavenge air is supplied to the cylinders, in a normally aspirated engine, by two rotary blowers that are chain-driven from the crankshaft. The advantages of the eccentric-type engine are its compactness and simplicity. The crankshaft is short and stiff; there are no "criticals" to be avoided in the running range.

For certain types of ships, crosshead engines are not suitable, chiefly for reasons of height and weight, and trunk-type engines are installed. The first cost of a trunk engine is less than that of an equivalent crosshead engine, but a telling factor against the trunk engine is its higher consumption of lubricating oil.

Geared Diesel Engines.—The claims made for the geared drive are as follows: (1) It is more reliable because it has more than one engine per screw. (2) One or more engines can be shut down when the ship is running light, the others being operated at their most efficient rating. (3) Maintenance is easier because the engines are of more manageable size. (4) Engines can be overhauled, one after the other, at sea. (5) The machinery of a fleet of vessels of different powers can be standardized upon a single cylinder size.

For the geared diesel engine to be in a strong competitive position the engines should run at four times the propeller revolutions; they should be of crosshead design and be able to burn heavy fuel oil successfully.

Elastic Couplings.—An elastic coupling is provided between engine and gearing to serve as a cushion that will prevent the transmission of detrimental torque pulsations from engine to gearing; to function as a quick-disconnecting clutch, when maneuvering; and to limit the transmissible torque to about 1.5 to 2.5 times its normal value, thus obtaining a measure of protection if there should be a seizure in one of the engines. Such a coupling may be mechanical, electrical, hydraulic or pneumatic.

The electromagnetic coupling in wide use resembles an electric motor in construction and operation. It consists of two rotating members, axially aligned, with one inside the other, one connected to the engine, the other to the pinion shaft of the gear system. The outer member consists of a spider connected to the pinion shaft, with salient field poles projecting inwardly from the rim. Direct current from the ship auxiliary supply activates the field windings of these pole pieces, consuming about 1% of the transmitted power. Inside the field is the inner member, with squirrel-cage winding comparable to the rotor of an induction motor, connected to the engine crankshaft. The air gap between the two parts may be from 0.2 to 0.4 in. The field when actuated causes the two members to rotate together, with only a small slip between the two. The r.p.m. of the pinion shaft is always the same as that of the engine shaft less the slip, which normally should not be more than 1% for large powers, or 2% for smaller powers.

Reduction Gearing.—The gearing is always single reduction and usually double helical. The ratio of reduction is frequently 2.5 to 1 or 2 to 1; occasionally it is as low as 1.5 to 1. The efficiency of the energy transmission from diesel engine to propeller hub is approximately 92% for a geared installation; for direct-coupled engines it is about 97%. Between the crankshaft and the tunnel shafting there is a loss both in revolutions and in torque. The slip in revolutions between engine and pinion must be taken into account when determining the gear ratio, and the loss of torque at the gearing must be considered when computing the powers.

Fig. 3 shows a typical two-engine geared arrangement. Sometimes four engines are coupled to one gear-wheel shaft, with two units forward of the gearbox and two abaft of it.

Diesel-Electric Drive.—The claims for the diesel-electric drive are similar to those for the geared diesel drive: (1) Reliability is increased by having several engines. (2) Maintenance is easier, the engines being of relatively small size, with interchangeable parts. (3) One or more engines can be shut down at sea for overhaul. (4) With the ship running slowly or in ballast, the necessary units can generate power at their most efficient load. (5) The total installation weight is less, and the engine-room height is much reduced. (6) The propeller and engine revolutions can be made to suit the respective requirements. (7) By varying the number of cylinders per engine and engines per ship, one or two cylinder sizes can cover the range of likely powers.

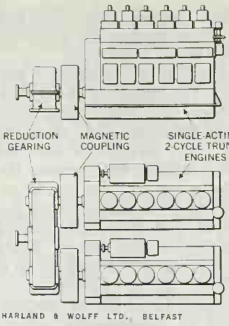


FIG. 3.—GEARED DIESEL ENGINE ARRANGEMENT

Certain additional claims are made for the alternating-current drive: (1) Power distribution is flexible, because any number of engines per shaft can be installed. (2) The engines can be located anywhere, the motors being arranged aft. (3) The engines are nonreversible. (4) Complete bridge control can be obtained. (5) A quicker turn-round in port can be arranged, based upon a system of running overhauling.

The operating excellence of a diesel-electric drive utilizing direct current cannot be gainsaid. Notwithstanding the varying requirements of ship speed and power, the engines rotate steadily under the most favourable conditions; maneuvering and reversing affect only the propulsion motor; being nonreversible, the engines are spared the wear and tear which normally occur during maneuvering. But, except for small powers, direct-current machinery is too heavy and expensive to compete with other types. Alternating current and high voltages, however, are accompanied by certain problems. The diesel engines must always run in synchronism. For steady running this is not difficult to achieve, as speed governing within close limits is possible; also the alternators, being electrically linked, can drag the engines into synchronism. But, when maneuvering, the engine revolutions must rise and fall with those of the propeller, and at the same time synchronism must be maintained among the engines. In reversing, the engine revolutions are reduced to their minimum and then, immediately before reversing the propulsion motor, the load is completely taken off the engines. Immediately afterward, when the load is restored, the back torque transmitted from the propeller to the propulsion motor—caused by the ways on the ship—may much exceed what the engines are capable of at the low speed at which they may be running at the moment.

STEAM TURBINES AND BOILERS

There is much more scope for variation in design with steam installations than there is with internal-combustion engines. The variables include: levels of steam pressure and temperature; capacity, number and type of steam generator; superheater arrangements; number and kind of turbines; reduction gear ratios and assembly; arrangements for economizers, air preheaters, feed heating, water distillation; and so on. The economics of a steam plant are relatively more in evidence and receive more attention because, at all points, decisions must be based on careful equating of thermal gains against monetary outlay.

Pressures and Temperatures.—During World War II, steam conditions in most merchant vessels were in the range of 450–600 lb. per square inch (p.s.i.) and 750°–825° F.; a few vessels operated with more advanced conditions of 850 p.s.i. and 910° F. In the years following World War II there was a general tendency to increase both pressures and temperatures, and there were many installations in the 600 p.s.i., 800° F.; 600 p.s.i., 850° F.; and 850 p.s.i., 850° F. ranges, as well as some in the 650 p.s.i., 1,025° F. and 925 p.s.i., 1,000° F. categories. The bulk-cargo steamship "Hugo Stinnes," delivered in 1957 by the Nordseewerke, Emden, Ger., was equipped with a notable post-World War II turbine installation, employing steam at 1,200 p.s.i. and 950° F.

Steam Generators.—From about 1860 to the early 1900s the Scotch boiler was in common marine use and represented the opti-

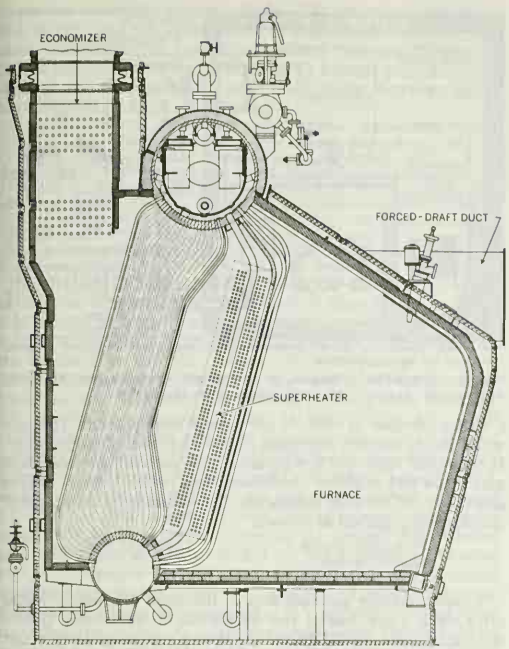


FIG. 4.—BABCOCK AND WILCOX MARINE WATERTUBE BOILER, INTEGRAL FURNACE TYPE

mum development of the fire-tube boiler. In this type, the water space was pierced by many tubes through which the combustion gases passed, transferring their heat to the water. For marine propulsion such boilers were almost entirely superseded by the watertube boiler, though the Scotch boiler persisted in some auxiliary boilers for special marine use. In the watertube boiler, water circulated within the tubes; combustion gases were outside. Two general types of such boilers were in common use in the marine field, the sectional-header and the drum (express) type.

The sectional-header boiler had certain fundamental advantages. The tubes were straight and of only a few sizes. Each tube was accessible for inspection and replacement independently of any other tube. Maintenance costs were inherently less than with the drum-type boiler, and inspection procedures were easier. However, the headers, the elements of the boiler into which the tubes fitted, limited design pressures to about 850 p.s.i., since the increased thickness required for higher pressures increased the spacing between tubes in adjacent headers.

Compared with the header type, the drum type offered the important advantage of reduction in weight and space requirements. Such a boiler is shown in fig. 4. The drum type was particularly suitable for high-powered naval vessels and fast merchant ships, where power plants of large horsepower had to be installed in minimum space and where weight was of special importance. Its design pressure was not generally subject to practical limitations with welded drums and radial tube holes. However, the tubes were usually bent and were of many different lengths. The tubes could not be independently removed nor easily inspected. Drum-type boilers could not be located with the longitudinal axis of the drums athwartship because of possible tube failure during a roll; header-type boilers did not suffer from this limitation.

Steam Turbines.—The earliest geared turbines were of all-reaction design. Later the high-pressure turbine embodied an impulse wheel, reducing its length. For powers of about 6,000 s.h.p. and above per screw, the standard unit became a three-turbine arrangement, in which the high-pressure turbine was impulse reaction, with end-tightened blading; the intermediate-pressure and low-pressure turbines were all-reaction; the high-pressure and low-pressure astern turbines of impulse design were respectively fitted to the intermediate-pressure and low-pressure ahead turbines; the gearing was single reduction. The astern power was nominally 60%–65% of the ahead power.

In due course, higher turbine revolutions and double-reduction gearing brought about a further improvement in the steam-consumption rate. Under the influence of land practice, all-impulse high-pressure turbines superseded impulse-reaction designs. The standard arrangement became a two-turbine set, with an all-impulse high-pressure turbine and an all-reaction low-pressure turbine; the preferred form for the latter became a double-flow design, wherein the steam entered the turbine at mid-length and flowed toward each end, reducing the low-pressure blade lengths. The high-pressure astern turbine was overhung on the high-pressure ahead turbine, and a low-pressure astern turbine was incorporated in the low-pressure ahead turbine. Many single-screw designs had only one astern turbine, which was arranged on the low-pressure ahead turbine, the astern power being nominally 40%–50% of the ahead power.

The next evolutionary step was the introduction of the single-cylinder impulse turbine. For powers between about 1,000 s.h.p. and 10,000 s.h.p. per shaft this single-casing turbine was very satisfactory, being simple and reliable. The ahead and astern turbines were arranged on a common rotor, using a single pressure casing for both turbines, with steam entering near the middle of the casing and exhausting outward.

Gearing.—Double-reduction gearing arrangements are classified as articulated, interleaved or locked-train. Fig. 5 shows the principle of the articulated gear. The high-pressure and low-pressure turbines drive separate pinions, which mesh respectively with separate primary wheels, driving the secondary pinions through quill shafts. The secondary pinions mesh with the main wheel, driving the propeller. Articulated gearing has advantages over the interleaved type. A much stiffer gear case is obtained; the flexible quills between the first and second reduction trains reduce the inertia forces on the secondary pinion teeth, which arise from inaccuracies in gear cutting; and the accurate mutual alignment required by all gearing is confined to pairs.

In the locked-train arrangement the pinion meshes with two primary wheels which are bolted at their aft ends to quill shafts; the quills pass through the secondary pinions and drive them through fine-tooth couplings. The power is transmitted from the secondary pinions to the main wheel. Great care is necessary in setting up locked-train gearing, to ensure the proper sharing of tooth loads.

In the single-reduction geared turbine the ratio of reduction may be from 12 to 1 to 20 to 1, if the best over-all results are to be obtained; *i.e.*, if there is to be an efficient, slow-moving propeller at one end of the line and an economical, fast-moving turbine at the other end.

For double-reduction gearing the usual ratio of reduction for the high-pressure turbine may be approximately 40 to 1 and, for the low-pressure turbine, 30 to 1; but the high-pressure turbine ratio

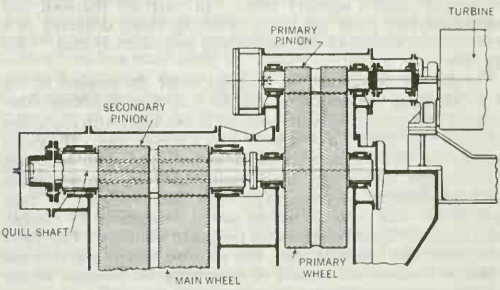


FIG. 5.—DOUBLE-REDUCTION GEARING; ARTICULATED TYPE

can be as high as 60 to 1. All gearing teeth are of involute form. For primary pinions and primary wheels the teeth are $\frac{6}{10}$ in., and for secondary pinions and main wheels they are $\frac{8}{10}$ in. The propeller revolves usually about 110–120 r.p.m. for twin-screw ships and 95–100 r.p.m. for single-screw vessels.

Turbo-Electric Drive.—The turbo-electric drive presents fewer problems than the corresponding diesel-electric arrangement. The greatest power required for one propeller is obtainable from a single turboalternator. For a twin-screw installation each propeller motor is driven by its turboalternator normally, but at reduced power only one turboalternator need be used, the current being divided between the motors. Turboalternators can be run at much higher rotational speeds than geared turbines; being nonreversible, they can be simpler.

NUCLEAR POWER

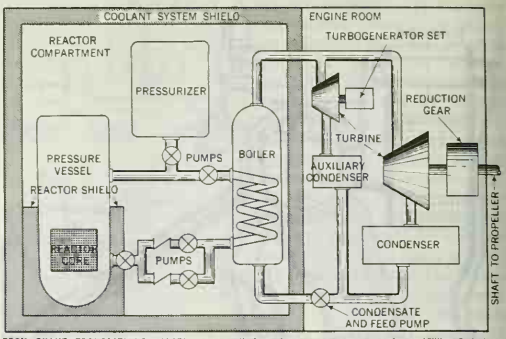
From the standpoint of the marine engineer, nuclear power means utilizing the process of nuclear fission in a reactor as the source of heat, with nuclear fuel replacing conventional fuel. The differences in fuel weight are enormous. One pound of U^{235} produces as much heat as 2,300 tons of coal or 300,000 gal. of fuel oil. The weight of the nuclear fuel itself is an almost inconsequential part of the weight of a nuclear power plant. The amount of energy that may be released within a reactor is almost unlimited, and thus the power produced is approximately independent of the size of the reactor. Any amount of power within very wide limits may be produced from any size reactor if the energy can be removed from it. The limitations on the power of the reactor are, consequently, those imposed by the engineering problems in the heat-removal process.

A large number of reactor types have been studied and analyzed from the standpoint of suitability for mobile marine use. The installation in the first nuclear submarine, the U.S.S. "Nautilus," and the plant developed and engineered for the first commercial nuclear merchant ship, the NS "Savannah," were both based on the pressurized water, heterogeneous, enriched fuel, thermal reactor type. These terms are used to identify the principal features of the system. Pressurized water describes the type of coolant-moderator material. Other coolants proposed or used include boiling water, organic liquid, gas and sodium. Heterogeneous indicates the physical separation of fuel, coolant and moderator elements, in contrast to the homogeneous type in which they are mixed. Enriched fuel means that the natural uranium, which contains only 0.7% U^{235}, the remainder being U^{238}, is enriched in the U^{235} isotope for use in the plant. In a thermal reactor the neutrons are greatly slowed from their initial high energy by a moderator; if no moderator is used the reactor is called fast.

The submarine thermal reactor plant installed in the U.S.S. "Nautilus" consisted of a reactor in which U^{235} fissioned as a result of the absorption of thermal neutrons into the nucleus. Heat was transferred from the reactor into the steam generator or boiler by ordinary water (primary coolant) under pressure high enough to prevent boiling. This primary coolant water was circulated through the reactor and boiler in a closed loop by canned-rotor-type pumps. The boiler, essentially a shell and tube heat exchanger, utilized ordinary boiler feed water on the shell side at considerably lower pressures, producing steam delivered to a conventional marine-turbine condensing propulsion system. (*See* fig. 6.)

In the NS "Savannah," as designed under the auspices of the U.S. Maritime administration and the U.S. Atomic Energy commission, the primary system consisted of two loops with one steam generator and two main circulating pumps in each loop. The steam generators were of the natural circulation type, with bent-tube U-shell-type boilers that could supply both the main turbines and the auxiliary turbogenerator units simultaneously or independently. The main circulating pumps were driven by canned-rotor constant-speed motors with two-speed windings. The major portion of the reactor system was enclosed within a sealed and shielded containment capable of containing the products of any possible rupture in the reactor system during operation.

The power plant of the "Savannah" was designed to operate at



FROM SNAME TRANSACTIONS (1957); REPRODUCED BY PERMISSION OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

FIG. 6.—SCHEMATIC DIAGRAM OF A TYPICAL PRESSURIZED NUCLEAR-PROPULSION PLANT. RELATIVE SIZES NOT INDICATED

a steam pressure of 480 lb. per square inch absolute (p.s.i.a.) with $\frac{1}{2}$ in. Hg vacuum, delivering 22,000 s.h.p. to a single propeller. It comprised high- and low-pressure main turbines and reduction gear, main and auxiliary condensers, feed water system, turbine generators and the usual auxiliaries. The estimated gross weight of the complete plant was as follows:

Propulsion system	1,150 long tons
Reactor system	600 " "
Containment and shielding	1,900 " "

A conventionally powered ship of the same dimensions would carry about 2,300 tons of fuel oil instead of the reactor system and containment, would deliver the same s.h.p., could carry about 500 tons less cargo and would be limited to 13,000 mi. without refueling. The nuclear-powered ship would have a corresponding radius of 350,000 mi. before renewal of fuel became necessary.

GAS-TURBINE PROPULSION

The gas-turbine system, eliminating steam as a transfer medium and leading the exhaust products from a combustion system direct to a turbine, obviously has interesting possibilities for marine propulsion. The gas-turbine ship "John Sergeant," converted from a Liberty ship in 1956, was the first ocean-going vessel to be propelled by a single-unit, mechanical-drive gas turbine. The gas turbine installed was an open-cycle, two shaft regenerative machine with a 14-stage axial-flow compressor, a combustion system, a single-stage high-pressure turbine driving the compressor, and a single-stage low-pressure turbine driving a controllable-pitch propeller through a reduction gear. Maximum rating was 6,600 s.h.p. at a propeller r.p.m. of 114. The vessel on trial easily developed 7,500 s.h.p. A fuel rate of 0.523 lb. per shaft horsepower-hour at normal power was attained.

In the free-piston, gas-turbine type of propulsion, a bank of free-piston engines constitutes both the combustion system and the compressor system for a gas-turbine drive. The free-piston engine, or gasifier, is essentially an opposed-piston, two-stroke, uniflow diesel engine. Each piston is composed of a power piston and a compressor piston. Firing is by compression ignition. There is no crankshaft, the pistons being free to oscillate except for a connecting linkage to maintain phase relationship.

A free-piston engine was conceived and built in the early 1920s, but it was not until World War II, when the German navy employed free-piston air compressors in submarines, that the type achieved operating success. By 1957 over 100 free-piston gasifiers of approximately 1,000 brake horsepower (b.h.p.) each were in service throughout the world in various applications. Two small French coasters, the "Cantenac" and "Merignac," each employing two such units, went into service in 1953 between Bordeaux and Hamburg. They achieved a high degree of reliability and economy. The first British ship designed with free-piston machinery was the ore carrier of the Ormsary class. The conversion of the Liberty ship "William Patterson" to free-piston, gas-turbine drive was

completed under the auspices of the U.S. Maritime administration in 1957 and the vessel placed in transatlantic service. The plant consisted of six free-piston gasifiers connected in parallel to two turbines which were connected to a single propeller shaft through reduction gearing. *See* NAVAL ARCHITECTURE; SHIPBUILDING (MERCHANT AND NAVAL).

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MARINE INSURANCE, a means of financial protection against loss or damage that is available to those having an insurable interest in property exposed to maritime perils. Marine insurance is thought to have been introduced into Great Britain by the Lombards in the 15th century. With the passage of time it became increasingly important in the conduct of international trade, and British practice was followed by many other countries. The Marine Insurance act of 1906 (6 Edw. VII, c. 41), which codified the law relating to marine insurance, defined a contract of marine insurance as a "contract whereby the insurer undertakes to indemnify the assured, in manner and to the extent thereby agreed, against marine losses, that is to say, the losses incident to marine adventure." Such a contract may, by its express terms or by usage of trade, be extended to protect the assured against losses on inland waters or even on land if the risk is incidental to a sea voyage. Subject to the provisions of the act, every lawful marine adventure may be the subject of a contract of marine insurance. A marine adventure exists whenever: (1) any ship, goods or other movables are exposed to maritime perils—such property being referred to as "insurable property"; (2) the earning or acquisition of any freight, passage money, commission, profit, or other pecuniary benefit, or the security for any advances, loans or disbursements, is endangered by the exposure of insurable property to maritime perils; (3) any liability to a third party may be incurred by the owner of, or other person interested in or responsible for, insurable property, by reason of maritime perils. This marine insurance safeguards shipowners, merchants, bankers, mortgagees and others who risk their property, money or credit in ventures of a maritime nature.

Legislation.—In Great Britain marine insurance was the subject of sporadic legislation up to the end of the 19th century. In 1601, during the reign of Elizabeth I, an act was passed (43 Eliz., c. 12) setting up a court of policies of insurance to arbitrate in cases of dispute, but by 1720 this court had fallen entirely into disuse and arbitration had taken its place. In 1745 the Marine Insurance act of that year (19 Geo. II, c. 37) prohibited the making of policies of marine insurance in the subject matter of which the assured had no interest, and was intended to prohibit speculative insurances. This statute was repealed by the act of 1906, the provisions of the earlier act with regard to "no interest" policies being re-enacted in sec. 4 of the 1906 act. From the act of 1745 until that of 1906 there appears to have been no legislation of importance affecting marine insurance except certain finance acts dealing with policy duties. In the intervening period, however, Lord Mansfield, who became lord chief justice in 1756, trained a competent body of special jurors to try marine insurance and other commercial suits and founded the principles on which the comprehensive, though not exhaustive, act of 1906 is based. This act was followed in 1909 by the Marine Insurance (Gambling Policies) act (9 Edw. VII, c. 12), which imposed certain criminal responsibilities on parties to contracts of marine insurance effected by way of gaming or wagering on loss by maritime perils.

Practice.—Marine insurance is transacted through the medium of brokers who, by their expert knowledge, can select the best market in which to place their clients' risks and obtain the terms most suitable for the adventure to be insured. In Great Britain, the London market, which consists of Lloyd's (*q.v.*) and the marine insurance companies, occupies the premier position and is regarded as the leading world market, though important markets exist in the United States and in Scandinavia and other European countries.

On receipt of instructions from his client to effect insurance, the broker will prepare a "slip" or memorandum of the risk, giving the essential particulars in abbreviated form, for submission to various underwriters. Where large values are involved, several insurers will be approached and each underwriter willing to participate in the risk will indicate on the slip the amount for which he is prepared to accept liability and append his initials to his "line." The contract is then deemed to be concluded though it cannot be legally enforced until it is embodied in a properly stamped policy. Where a valid policy is in existence, however, reference may be made to the slip for the purpose of establishing the intention of the parties to the contract. In the case of Lloyd's underwriters, an underwriting agent is appointed to represent a particular syndicate or syndicates of underwriting members who share between them the liabilities undertaken on their behalf by the agent so appointed. The liability of members is personal and extends to their assets and in this respect their position differs from that of a company underwriter.

Only authorized Lloyd's brokers may place insurances at Lloyd's, but an assured may have direct contact with the companies. Where the insurance is effected through a broker, he is directly responsible to the insurers for the payment of the premium and the insurer is directly responsible to the assured for the amount which may be payable for losses. On the other hand, the broker has a lien on the policy for the amount of the premium and his charges for effecting the policy.

Disclosure and Representation.—The contract of marine insurance is based upon the utmost good faith, and the act of 1906 lays down in sec. 17 that, if the utmost good faith be not observed by either party, the contract may be avoided by the other party. So that the underwriter may make a just appraisal of the risk offered for insurance, the assured must disclose to the insurer before the contract is concluded every material circumstance of which he is aware and, according to the act, the assured is deemed to know every circumstance that in the ordinary course of business ought to be known by him. In the absence of inquiry, certain circumstances—such as any circumstance that diminishes the risk—need not, however, be disclosed (sec. 18 [3]). Similarly an agent employed to effect an insurance on behalf of his principal is under an obligation to disclose every material circumstance that the assured is bound to disclose unless it comes to the latter's knowledge too late to communicate it to the agent (sec. 19). The act further provides that every material representation made by the assured or his agent to the insurer during the negotiations for the contract and before the contract is concluded must be true; if it be untrue the insurer may avoid the contract. Representations may be either as to matters of fact or as to matters of expectation or belief: in the former case they must be substantially correct, while in the latter they are deemed to be true if made in good faith.

The Policy.—Policies are prepared on the basis of the details contained in the slip and the lines accepted by the various insurers participating in the risk. Before World War II each company issued its own form of policy, but in Nov. 1939 a plan was devised to save time and labour whereby the Institute of London Underwriters was empowered by member companies to execute a combined companies' policy, on the basis of the slip, on behalf of all companies concerned in the particular insurance. Similarly, in the case of Lloyd's underwriters, the execution of policies on their behalf is undertaken by Lloyd's policy-signing bureau and only one policy is issued for all syndicates concerned in a risk. The details that a policy must specify, as prescribed by sec. 23 of the act of 1906, were, as from Aug. 1, 1959, restricted by sec. 30(5) of the Finance act, 1959 (7 & 8 Eliz. II, c. 58), to the name of the assured or of some person who effects the insurance on his behalf. The Finance act of 1959 also repealed the former ad valorem basis of computing stamp duty on marine policies and substituted a flat rate of 6*d.*, thereby bringing marine business into line with other branches of insurance. At the same time it

removed the restriction that time policies may not exceed 12 months, though it had the effect of making it obligatory to stamp contracts of reinsurance. In practice, marine policies follow standardized lines; the hull form, applicable to the insurance of vessels generally, differs little from the cargo form, except in respect of the clauses attached to the policy. The basic form, in most cases, remains the same and is substantially identical with that incorporated in the schedule to the act of 1906 which, in turn, is based on the old common form adopted by Lloyd's in 1779, known as the S.G. form. Policies may be effected on either a time or a voyage basis, it being customary to insure hulls and allied interests for a period of 12 months, while goods are normally covered for the duration of the particular voyage.

Substantially the same basic form of policy is made to apply to the particular interest insured by the attachment of suitable clauses such as the institute hull clauses that have been drawn up by the Institute of London Underwriters and generally adopted by the market. Certain commodities, however, such as timber and rubber, have their own trade clauses. Marine policies may be either "valued" or "unvalued." A valued policy is one that specifies the agreed value of the subject matter insured which, in the absence of fraud, is binding on the insurers and represents the extent of their liability in the event of total loss. An unvalued policy, seldom encountered in practice because of the disadvantages to which it is subject, does not specify the agreed value of the subject matter but merely the sum insured and, in the event of loss, makes it necessary to ascertain the insurable value in accordance with sec. 16 of the act of 1906. Broadly speaking, the insurable value is the value of the interest at the inception of the risk plus incidental charges, including insurance. So far as goods are concerned, the disadvantage is that the insurable value does not include any margin for profit on the transaction.

Policy Proof of Interest Policies.—It is made clear by sec. 4(1) of the act of 1906 that every contract by way of gaming or wagering is void and that included in this category are policies effected "interest or no interest," or "without further proof of interest than the policy itself," or subject to any other like term. Though void, such policies are not illegal and do not constitute a breach of the Marine Insurance (Gambling Policies) act of 1909 unless the assured procures a policy without having a genuine interest or expectation of acquiring interest. Other types of policies in common use are: construction risks policies, covering the construction of a vessel from the laying of the keel to delivery to the owners; port risks policies, confined to the insurance of vessels while in the confines of a particular port; and floating policies, used for the insurance of goods where regular shipments are made, which describe the insurance in general terms and leave the name of the ship or ships and other particulars to be defined by subsequent declaration.

Warranties.—In marine insurance a warranty is some particular thing that the assured undertakes shall or shall not be done—an undertaking that some condition shall be fulfilled, or the affirmation or negation of a particular state of fact. Warranties must be complied with exactly; otherwise the insurer is discharged from liability as from the date of the breach of warranty. The following are examples of warranties: the assured warrants that a vessel meets safety requirements on a certain date; he warrants that a vessel shall not proceed on certain voyages; he warrants that he is uninsured for a specified proportion of the amount at risk. These are "express warranties" and must be included in, or written upon, the policy, or contained in some document incorporated by reference into the policy. In hull insurance, where, as is customary in Great Britain, the institute hull clauses apply, the policy is made subject to a disbursements warranty restricting the sums that the assured may insure on such interests as freight and disbursements, commission and profit, on a 12 months' basis.

Besides express warranties, there are implied warranties, such as, for example, that the ship shall be seaworthy at the commencement of the voyage. The assured also impliedly warrants that the adventure in respect of which he has effected insurance is a lawful one. There is, however, no implied warranty of seaworthiness in a time policy, but if, with the knowledge of the assured, the vessel is sent to sea in an unseaworthy condition, the insurer is not liable for any loss attributable thereto. Breach of warranty is excused, under the Marine Insurance act of 1906, when, because of change of circumstance, the warranty ceases to be applicable to the circumstances of the contract, or where compliance with the warranty is rendered unlawful by any subsequent law. A breach of warranty may be waived by the insurer, and in practice it is customary, in the case of some warranties, to make provision in the policy to the effect that in the event of breach the risk is "held covered" either at a specific premium or at a premium "to be arranged." Where a warranty is broken, the assured cannot avail himself of the defense that the breach was remedied and the warranty complied with before loss.

Assignment.—The Marine Insurance act of 1906 provides that a marine policy is assignable unless it contains terms expressly prohibiting assignment and that it may be assigned either before or after loss. Where a marine policy has been assigned so as to pass the beneficial interest in such policy, the assignee of the policy is entitled to sue thereon in his own name; and the defendant is entitled to make any defense arising out of the contract that he would have been entitled to make if the action had been brought in the name of the person by or on behalf of whom the policy was effected. Policies may be assigned by endorsement or in any other customary manner. In practice, hull policies may not be so assigned unless the insurer has consented in writing to a transfer of the cover granted, the reason being that the standard of ownership or management is an integral factor in the rating of hull risks.

The Insured Perils.—In the body of the standard form of policy there appears a list of perils against which the underwriters agree to insure the subject matter. These include: perils of the seas; men-of-war; fire; enemies; pirates; rovers; thieves; jettisons; surprisals; takings at sea; arrests, restraints and detainments by all kings, princes and people; barratry of the master and mariners; and all other perils, losses and misfortunes (these latter not to be construed literally, as they embrace only perils similar in kind to those expressly mentioned). These perils are augmented, in the case of hull insurance, by the incorporation in standard clauses of a collision clause and a negligence clause. The former protects the assured, in the event of a collision between the vessel insured and another vessel or vessels, to the extent of three-fourths (subject to a limit of three-fourths of the amount insured) of any sum which the assured has to pay to the owners of such other vessel or vessels, by way of damages, in consequence of such collision. The negligence clause embraces loss or damage to the subject matter insured directly caused by: accidents in loading, discharging or shifting cargo or fuel; explosions on shipboard or elsewhere; bursting of boilers, breakage of shafts or any latent defect in the machinery or hull; contact with aircraft; negligence of the master, officers, crew or pilots; and breakdown of or accident to nuclear installations or reactors on shipboard or elsewhere. Observations on the scope of certain of the perils insured by the policy are contained in the rules for construction of policy appended to the Marine Insurance act of 1906.

Exclusion of War Risks.—For very many years it has been the practice for marine policies to incorporate the "free of capture and seizure" clause in their text. The effect of this clause is, broadly speaking, to exclude from the cover such losses as are directly attributable to hostilities or warlike operations, civil war, revolution, rebellion, insurrection and piracy. Legal decisions have proceeded on the basis that "hostilities" does not mean the existence of a state of war, but means acts of hostility or operations of hostility, while "warlike operations" would include almost any movement of the combatant forces in the course of their combatant duties while exercised in the area of war. The insurance of so-called "war risks" may be placed separately in the open market or with mutual war risk insurance associations. The latter, however, confine their operations to the mutual insurance of British vessels and are largely reinsured by the British government. Whenever war risks are covered, the frustration clause becomes operative, whereby the policy is "warranted free of any claim based upon loss of, or frustration of, the insured voyage or

adventure caused by arrests, restraints or detainments of Kings, Princes, Peoples, Usurpers or persons attempting to usurp power." The frustration clause counteracts the decision of the court of appeal in *Sanday* v. *British and Foreign Marine Insurance Co. Ltd.* (1916) 1 A.C. 650, in which it was held that goods prevented by arrests or restraints from reaching their insured destination entitled the assured to claim the sum insured, on the ground of "loss of voyage" even though the goods are undamaged and remain under the control of the assured.

Generally, the insurance of shipowners' liability to third parties is the special province of protecting and indemnity associations that operate on a mutual basis by sharing their liabilities equally among their members. Such associations also undertake the insurance of the one-fourth collision liability excluded by the standard collision clause in hull policies.

Measure of Indemnity for Loss or Damage.—In marine insurance terminology, loss and damage are almost synonymous, for damage is often described as partial loss. The distinction to be made is between actual or absolute total loss and partial loss. According to the Marine Insurance act of 1906 there is an actual total loss where: (1) the subject matter is destroyed by a peril insured against; or (2) so damaged as to cease to be a thing of the kind insured; or (3) the assured is irretrievably deprived of the possession of the subject matter insured. In such cases, upon proof of the claim, the assured is entitled, in the case of a valued policy, to the sum insured by the policy, or to the insurable value of the subject matter insured, as defined by sec. 16 of the act of 1906, in the case of an unvalued policy. An insurance against total loss, without further qualification, includes a constructive, as well as an actual, total loss unless a different intention appears from the terms of the policy. Constructive total loss is peculiar to marine insurance and has no counterpart in other branches. It implies one of two things: first, the impracticability of repairing damage sustained by an insured peril because of the prohibitive cost of repairs in that the expenditure required would exceed the value of the property when repaired; or second, the deprivation of the property by reason of insured perils coupled with the unlikelihood of salvage or recovery within a reasonable time. In such an event, if the assured is desirous of claiming a constructive total loss—whereby, if substantiated, payment would be made by the insurer on the basis of a total loss—it is essential that he give to the insurer, on receipt of reliable information of the loss, a notice of abandonment, indicating, in unequivocal terms, his intention unconditionally to abandon to the insurer his entire interest in the subject matter insured. Failure to tender notice of abandonment will result in the claim's being adjusted on a partial or "particular average" loss basis. In hull insurance, a clause in the institute hull clauses provides, in effect, that a constructive total loss may not be demonstrated unless the cost of repairing the damage (including other admissible items) exceeds the insured or agreed value of the subject matter, as distinct from the actual value when repaired. In the case of vessels reported missing, after the lapse of a "reasonable" time—varying according to the class of ship and nature of the voyage—an actual total loss may be presumed.

Particular Average.—The Marine Insurance act of 1906 defines a particular average loss as a partial loss of the subject matter insured, caused by a peril insured against, and which is not a general average loss. In this context, the word "loss" includes damage. Particular average thus includes all forms of partial loss or damage fortuitously caused by an insured peril, such as stranding, collision or heavy weather damage, all of which examples come within the scope of "perils of the seas." With certain reservations, particular average losses under hull policies are subject to a 3% "franchise"; that is to say, losses below 3% of the insured value (or, in the case of separate valuations for different items of the vessel, below 3% of the appropriate valuation for the particular item) are not recoverable. If, however, the damage be occasioned by stranding, fire or collision, the 3% franchise does not apply and the claim is recoverable in full irrespective of amount. The standard franchise may be, and commonly is, replaced by agreement by a fixed sum to be deducted from all particular average claims, either singly or from the aggregate of all such claims occurring on a round voyage. (*See* also AVERAGE.)

Measure of Indemnity.—The Marine Insurance act of 1906, sec. 69, provides that where a ship is damaged, but is not totally lost, the measure of indemnity, subject to any express provision in the policy, is as follows: (1) where the ship has been repaired, the assured is entitled to the reasonable cost of the repairs, less the customary deductions, but not exceeding the sum insured in respect of any one casualty; (2) where the ship has been only partially repaired, the assured is entitled to the reasonable cost of such repairs, computed as above, and also to be indemnified for the reasonable depreciation, if any, arising from the unrepaired damage, provided that the aggregate amount shall not exceed the cost of repairing the whole damage, computed as above; (3) where the ship has not been repaired and has not been sold in her damaged state during the risk, the assured is entitled to be indemnified for the reasonable depreciation arising from the unrepaired damage, but not exceeding the reasonable cost of repairing such damage, computed as above. The reference to customary deductions, which signifies an allowance to be made because of the replacement of old material by new, is no longer of importance as standard clauses provide for the payment of both particular average and general average without deduction "new for old." The reasonable cost of repairs will include all necessary expenses such as towage and dry dock dues incurred in order to effect the repairs. Unlike other branches of insurance, the sum insured by the policy is not reduced by reason of claims paid and therefore does not have to be reinstated to provide a continuation of full cover; in marine insurance the insurer is liable for successive losses during the currency of the policy, up to the limit of the sum assured in each case.

Similar principles apply in respect of particular average on cargo, but there are also important differences. The Marine Insurance act of 1906 provides that, where the whole or any part of the goods or merchandise insured has been delivered damaged at its destination, the measure of indemnity is such proportion of the sum fixed by the policy, in the case of a valued policy, or of the insurable value in the case of an unvalued policy, as the difference between the gross sound and damaged values at the place of arrival bears to the gross sound value. In other words, the measure of depreciation has to be ascertained by comparison between the gross sound and damaged values at destination, and the percentage thus obtained applied to the insured value of the goods in order to ascertain the liability of insurers. The application of the franchise in cargo insurance is more complicated, in that certain goods are warranted free from particular average entirely unless the ship be stranded, sunk or burned; others free from particular average under £5% (*i.e.*, £5 per £100) unless the ship be stranded, sunk or burned; and all other goods free from particular average under £3%. In practice, however, the effect of this basic wording is considerably modified by the attachment of institute cargo clauses which make the insurer liable to pay, without reference to the franchise, the insured value of any package which may be totally lost in loading, transhipment or discharge; loss of or damage to the interest insured which may reasonably be attributed to fire, explosion, collision or contact of the vessel with any external substance; or to discharge of cargo at a port of distress. Where the institute all-risks clauses are used, no franchise applies whatever and claims are payable irrespective of percentage unless the loss or damage is due to delay, or to the inherent vice or nature of the subject matter insured, which would, by virtue of special provision in the clauses, exonerate the insurer from liability therefor.

General Average and Salvage.—General average is a doctrine of equity having its roots in the old Rhodian laws and exists apart from insurance. The fundamental principle involved is that, where a sacrifice of someone's property is made in time of peril to save the common adventure, the owners of property saved by the sacrifice shall contribute, according to the value of their property, to make good the loss sustained by the owner of the sacrificed property. In the course of time, uniformity of practice in the treatment of cases of general average became an imperative need, for many countries evolved their own codes of law pertaining to this subject. Since 1890 standard practice has largely been

ensured by an international set of rules known as the York-Antwerp rules. The York-Antwerp rules of 1950 govern the adjustment of general average and provision for their application is made in the vast majority of bills of lading and contracts of affreightment. These rules embody the basic principles of a general average act and enumerate various circumstances in which allowances in general average may be made. So far as insurance is concerned, the marine policy protects the assured against his liability to contribute in general average and, if it should so happen that the property of the assured himself has been sacrificed, then the insurer is liable to indemnify him to the full extent of the sacrifice and, in turn, recoup himself, by way of contribution, from the other parties to the adventure. Where the insurer is called upon to reimburse a general average contribution, due from the property insured, he is liable for the full amount of that contribution only if the subject matter insured has been insured for the full value upon which it has been made to contribute in general average and, generally speaking, the value for contribution to general average is the value obtaining at the final port of discharge from the ship.

The definition of a general average act given in the York-Antwerp rules of 1950 is to the effect that there is a general average act only when any extraordinary sacrifice or expenditure is intentionally and reasonably made or incurred for the common safety for the purpose of preserving from peril the property involved in a common maritime adventure. Among examples of general average may be quoted: (1) jettison of cargo carried in accordance with the custom of the trade; (2) damage sustained by a vessel in refloating, at the risk of damage, from a stranded position; (3) expenses incurred in entering and leaving a port of refuge to which resort is made either for the common safety or to enable necessary repairs to be effected; and (4) loss of freight arising from loss of cargo in the course of discharging or reloading at a port of refuge to enable such repairs to be effected.

Salvage.—Salvage, strictly speaking, connotes the remuneration payable to third parties for rendering meritorious services to maritime property in distress, especially in cases where human life is endangered. It has to be borne in mind, however, that the mere saving of life does not entitle the salvor to reward, but if property is saved as well the award will be increased by reason of the saving of life. Salvors who render such services are entitled to an appropriate reward; in Great Britain the reward is decided by the admiralty court unless a fixed amount, or, alternatively, resort to arbitration, has already been decided upon. Before an award may be made, however, some property must be saved, for it is upon the property that the salvors have a lien in law for their claim. Under a marine form of policy, insurers undertake to reimburse the amount of salvage due from the interest insured, subject to a comparison of insured and contributory values as is made in cases of general average. The position is considerably simplified by an agreement that, in practice, salvage under agreement—as distinct from voluntary salvage in the case of an abandoned vessel—shall be treated as general average.

Subrogation.—Subrogation is the principle whereby an insurer who has paid for a loss is entitled to participate in any recovery effected by the assured from a third party in respect of that loss, thus preserving the principle of indemnity which underlies the contract of insurance. Where the insurer pays for a total loss, he is entitled to take over the interest of the assured in whatever may remain of the subject matter so paid for and is thereby subrogated to all the rights and remedies of the assured in and in respect of that subject matter as from the time of the casualty causing the loss. Where the insurer pays for a partial loss, he acquires no title to the subject matter insured, or to such part of it as may remain, but he is thereupon subrogated to all rights and remedies of the assured in and in respect of the subject matter causing the loss, in so far as the assured has been indemnified, according to the Marine Insurance act, by such payment for the loss.

Reinsurance.—Reinsurance is the indemnification of one insurer by another in respect of liabilities that the former has incurred in the course of business. The Marine Insurance act of 1906 gives the reinsured an insurable interest in his risks, but stipulates that, unless the policy provides, the original assured has no right or interest in respect of such reinsurance. Reinsurance may be either facultative, which is the reinsurance of specific individual risks, or by treaty. A treaty of reinsurance is an agreement by one insurer to accept a stated proportion of the whole, or any specified part, of the business accepted by another, it being customary to place limits as to the maximum amount that may be ceded under the treaty. The Finance act of 1959 eliminated the former difficulty applying to the stamping of such treaties, and there appears to be no reason why they should not be duly stamped and enforced in law as valid contracts of marine insurance.

Market Institutions.—In marine insurance, the institutions that exist for the purpose of furthering and protecting the interests of underwriters play a very prominent part. In Great Britain, the oldest of these institutions is the Liverpool Underwriters' association, founded in 1802. The leading body in Great Britain is the Institute of London Underwriters, founded in 1884, and composed of the majority of companies transacting marine business in London, including the London branches of companies in Liverpool and other provincial cities. This body formulates and issues the clauses to which reference has been made. Also, through the medium of the Joint Hull committee, on which Lloyd's underwriters and the Liverpool market are represented, it deals with such matters as the framing of agreements with regard to hull rates and values, the drafting of warranties governing voyages and seasons and similar matters. Lloyd's Underwriters' association is another important market institution to which practically all the active underwriting members of Lloyd's belong, and which works in close collaboration with the Institute of London Underwriters on matters of principle and sometimes on matters of practice. Lloyd's Brokers' association is a body representative of the brokerage side of the business at Lloyd's while the Corporation of Insurance Brokers represents brokers in all parts of Great Britain. The Chartered Insurance institute, largely educational in function, holds examinations in marine insurance. The Association of Average Adjusters, founded in 1872, is a body concerned with the profession of average adjusting (*i.e.*, the adjustment of marine insurance claims), and from time to time it lays down rules of practice for the guidance of members to ensure uniformity in the practice of average adjusting.

Market Institutions in Other Countries.—Elsewhere there are, in most markets, local or national institutions concerned with the regulation and government of business, such as the Central Underwriters' association of Norway, the Association for the Improvement of Marine Insurance in the Netherlands, the Verband, or Union of Underwriters, in Germany and the Union des Syndicats in Paris. These are similar in many respects to the Institute of London Underwriters and are in constant communication with that body and with each other. There is also the International Union of Marine Insurance with headquarters in Berlin, in which the majority of national markets are represented by leading companies. This institution holds an annual conference at which matters of common interest are discussed and it has been the means of producing a number of agreements, the most important of which is that concerning dangerous drugs. By this agreement underwriters are pledged to incorporate in all policies on drugs a clause making it imperative that all claims shall be accompanied by a certificate from the government of the country of origin authorizing the shipment in respect of which the claim is made. This agreement, made in the first place at the instance of the British foreign office, has proved effective in checking the trade in opium, cocaine and other drugs referred to in the various international conventions relating thereto. (C. L. Ro.)

UNITED STATES

Marine insurance in the United States is divided into two classifications, ocean marine and inland marine. Ocean marine insurance is related to the protection of ships and cargoes, whereas inland marine insurance has to do with protection of goods in transit on land and of movable property that is of such a nature that its location is indefinite. The line of demarcation between ocean marine and inland marine is not precise. Small boats, for

example, may be insured under either category, depending upon the practices of individual insurance companies.

There are federal and state laws concerning marine insurance, but the business is regulated primarily by the states. Each state has a definition of marine insurance in its statutes, couched in general terms. In most states the general definition is supplemented by the adoption of the nationwide marine definition, a document recommended by the National Association of Insurance Commissioners. This definition is intended to distinguish marine insurance from other kinds of insurance, but it does not distinguish between ocean marine and inland marine.

Ocean marine law and practice relating to the contract, and regarding insurable interest, insurable value, disclosure and representation, measure of indemnity, warranties, double insurance and reinsurance are substantially the same as in Great Britain. There is no federal nor any generally enacted state statute comparable to the British Marine Insurance act of 1906. The result is that some variations in practice in the United States have grown up, largely as a result of court decisions. One difference in practice relates to over-insurance. In the United States if there is double insurance, the policy with the earliest effective date is considered to be the primary insurance. A company whose policy has a later effective date is liable only if the amount of the first policy is insufficient to cover the loss.

Ocean marine insurance in the United States is placed largely in U.S. insurance companies or in U.S. branches of alien companies. Members of Lloyd's of London may participate either by means of direct insurance or by means of reinsuring the policies of insurance companies. Groups or syndicates of insurance companies have been formed in order to provide adequate amounts of insurance and to encourage uniformity in the underwriting of certain types of ships and cargoes. There are also groups that develop uniform policy forms and clauses. Some insurance companies place the underwriting of their ocean marine business in the hands of marine managers who operate for several companies in a group. This is done partly to save expense and also to permit the use of experts.

Rates for ocean marine policies are set by each insurance company or group manager without review or approval by any governmental official. Such rates are specifically exempt from regulation under both federal and state laws. This is considered necessary so that U.S. insurance companies may compete successfully with alien insurers.

Subrogation practices are similar for ocean and inland marine insurance. An insurer having paid a loss to a policyholder acquires the rights of the policyholder to the extent of the payment against any third party who may have caused the loss.

While inland marine is a direct outgrowth of ocean marine insurance in the United States, its practices differ in many respects. These policies primarily cover property in the United States. Property that is insurable under inland marine policies consists generally of personal property of substantial value that may be carried about by its owners, cargo being shipped by railroad, motor truck or airplane, and equipment of contractors or others who must use the equipment at many different locations. It is also customary to insure fixed property such as bridges and tunnels, and neon signs under inland marine policies, but this has come about because marine underwriters generally are the only insurers who are willing to write the broad insurance coverages desired by the owners of such property.

Rates for many inland marine policies are made by rating bureaus that serve hundreds of insurance companies. Federal and state laws permit insurance companies to act in concert for the making of rates where combined actuarial data are advantageous in determining the probabilities of loss. However, rates are made by the companies individually for those properties where the risks of loss vary greatly between policyholders. (W. H. Ro.)

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(C. L. Ro.)

MARINE RAILWAY: *see* SLIPWAY.

MARINES are troops specially recruited, trained and organized for service at sea and in land operations incident to naval campaigns. The use of marines goes far back in history. Herodotus and Thucydides refer to *Epibatai*, or "heavy-armed sea soldiers" in the Greek fleets, while Polybius describes *milites classiarii* ("soldiers of the fleet"), a category of Roman soldier organized and specially armed for duty aboard warships, usually the quinqueremes. During the middle ages, ordinary soldiers were frequently embarked aboard ship to provide a fighting backbone, but it was not until the naval wars of the 17th century that the distinct and organized role of marines was almost simultaneously rediscovered by the British and Dutch, who raised the first two modern corps of marines, in 1664 and 1665. The U.S. marine corps, organized in 1775, was originally patterned on the British model. It has retained many of its inherited characteristics but has evolved along independent lines to become the most famous organization of its kind.

U.S. MARINE CORPS

The U.S. marine corps is a military service within the department of the navy. Side by side with the navy, the marine corps comes directly under the secretary of the navy. Its commandant, a four-star general, is responsible to the secretary of the navy for the readiness, administration and performance of the corps as a whole. The commandant also sits as a member of the joint chiefs of staff (*q.v.*) when matters of concern to the marine corps are under consideration.

The primary missions of the marine corps are to provide fleet marine forces of combined arms, including aviation, for seizure and defense of advanced bases; to conduct land operations incident to naval campaigns; and to develop the doctrines, tactics, techniques and equipment for U.S. landing forces in amphibious operations. In addition, the marine corps is responsible for providing detachments for service aboard certain types of naval vessels as well as security forces for naval shore installations and for United States embassies and consulates. Finally, the corps is required by law to be instantly ready to perform such other duties as the president may direct.

The two fleet marine forces are the expeditionary part of the corps, and are required by law to be maintained at a minimum strength of three combat divisions, three air wings and supporting units. One fleet marine force is assigned to the Atlantic fleet and the other to the Pacific fleet. To provide and support the marine operating forces, the marine corps supporting establishment includes on each coast of the United States, one recruit depot, one major ground forces base, one supply centre and one or more air stations. Officer training, and all marine development activities, are centralized at marine corps schools, Quantico, Va. Marine corps headquarters is in Washington, D.C. The marine corps reserve, upon which the corps draws to augment its strength in time of large-scale emergency, embraces units and individuals in more than 150 cities. The peacetime strength of the regular marine corps does not usually exceed 200,000.

Marine aviation is primarily trained and equipped to render close air support of ground forces and to conduct expeditionary operations. In addition, it reinforces carrier-based naval aviation. Since marine assault concepts demand the closest air-ground teamwork, marine aviation is integrated in every possible way with ground forces and with the corps as a whole.

Ranks of marine officers are the same as those of the U.S. army, but certain of the noncommissioned officer titles have varied tra-

ditionally and are distinctive to the marine corps. (*See* INSIGNIA, MILITARY.) Young men between the ages of 17 and 28 who are physically and mentally qualified may enlist in the marine corps for three, four or six years. Although the corps was compelled to accept draftees during World Wars I and II and the Korean War, it is traditionally made up only of volunteers. Every marine recruit undergoes several weeks of rigorous but carefully supervised recruit training at Parris Island, S.C., or San Diego, Calif., followed by a shorter period of advanced training in infantry weapons and small-unit tactics at Camp Lejeune, N.C., or Camp Pendleton, Calif. The corps obtains officers from a wide variety of sources, including the naval academy, military academy, civilian colleges, the marine aviation cadet program and meritorious noncommissioned officers. With few exceptions, newly commissioned marine officers, regardless of source or previous training, are sent through the marine corps basic school at Quantico.

The marine corps includes women marines, both regular and reserve. In peacetime approximately 2,000 women—2% of the authorized strength of the corps—serve as U.S. marines at posts in continental United States and Hawaii, as well as overseas. Women marines perform such duties as personnel administration, communications, aerology, food services, photography and disbursing. The director of women marines, a colonel, supervises the women marines and is on the commandant's staff at marine corps headquarters.

Single young women of good character who are physically and mentally qualified and between the ages of 18 and 30 are eligible for the marine corps. Women recruits undergo ten weeks' training at Parris Island, while women officer candidates (who must be college graduates or equivalent) train for 18 weeks at Quantico. Although the women marines were not authorized as a permanent regular component of the corps until 1948, they were first enlisted for war service in World War I as Marinettes, and in World War II as women reservists.

History and Traditions.—On Nov. 10, 1775, the date usually given for the origin of the U.S. marine corps, the Continental Congress ordered that two battalions of marines be raised for service as landing forces with the fleet. For an infant maritime power this was a natural requirement and it has continued to exist. In addition to projecting naval power ashore, however, it has also been a recognized function of the marine corps to provide mobile, immediately ready, professional military units to serve as national forces-in-readiness. The first commandant of the corps was Capt. Samuel Nicholas of Philadelphia.

Marines have participated in all wars of the United States, being in most instances first, or among the first, to fight. In addition, marines have executed more than 300 landings on foreign shores and served in every major U.S. naval action since 1775.

The marines' first battle was the expedition against Nassau, in the Bahamas, in 1776. After the American Revolution, the Continental marines, together with the navy, were inactivated; on July 11, 1798, congress re-established the marines as a separate corps. During the following century marines fought in the naval war with France (1798–1801), Tripolitan War (1801–05), War of 1812, Creek and Seminole wars (1836–42), Mexican War (1846–48) and the American Civil War (1861–65). During the Civil War, marines fought at Bull Run, on the Mississippi river and in all amphibious landings of the U.S. navy along the Confederate coast. The Confederacy organized its own marine corps on March 16, 1861; this was a smaller but virtually identical copy of the U.S. marines, and the Confederate marines—largely officered by former U.S. marine officers of southern birth—performed similar duties throughout the war.

Between wars in the 19th century, marines landed in the South seas, China, Japan, Korea, Panama, Uruguay, Paraguay, Egypt, Mexico, Cuba, the arctic, Formosa, Argentina, Chile, Greenland, Haiti, Nicaragua and the Samoa Islands.

Following the Spanish-American War (1898) the corps entered an era of professional development and expansion. It saw active service in the Philippine insurrection (1899–1902), Boxer uprising (1900), Cuba (1906–09), Nicaragua (1912), Veracruz (1914), Haiti (1915–34) and the Dominican Republic (1916–24). After the United States entered World War I, the 4th marine brigade in France fought at Belleau wood, Soissons, St. Mihiel, Blanc Mont and the Meuse-Argonne.

In 1921, foreseeing the eventuality of a naval war in the Pacific, the marine corps began its development of modern amphibious warfare. For the next two decades, with a strength that never exceeded 18,000, it worked closely with the navy to evolve the amphibious assault doctrines ultimately used by the United States in World War II. These doctrines were proven by marines on Guadalcanal (first American offensive in World War II), Bougainville, Tarawa, Roi-Namur, Eniwetok, New Britain, Saipan, Tinian, Guam, Peleliu, Iwo Jima, and Okinawa. By 1945 the marine corps included six divisions, four air wings and supporting troops. Its top strength in World War II was 485,113, of whom more than 90% served overseas in combat.

Immediately after the war, the marine corps became convinced that the challenge of modern weapons, especially the atom bomb, required a far more flexible, widely dispersed and rapid landing attack than had been possible in the past. Between 1946 and 1950, the marine corps therefore developed an amphibious "vertical envelopment" concept using assault helicopters—pioneered by the corps—as landing craft, and aircraft carriers as transports. This was subsequently adopted, like the earlier marine concepts of the 1920s and 1930s, as standard U.S. navy and marine doctrine.

After outbreak of war in Korea (1950), marines were the first reinforcements dispatched from the United States to the aid of the U.S. forces retreating on Pusan. Here the corps flew helicopters in combat for the first time in history. Subsequently marines executed the Inchon landing and carried out the epic winter withdrawal from the Changjin reservoir down to the sea. From 1951 to 1953, marine ground and aviation units played a major part in the hard-fought but indecisive battles along the 38th parallel. (*See* KOREAN WAR.)

The marine corps emblem is the western hemisphere superimposed on a fouled anchor and surmounted by a spread eagle. The corps motto is *Semper Fidelis* ("Always Faithful"), which is also the title of the corps march, composed by John Philip Sousa when he was leader of the U.S. marine band. Perhaps even more familiar is "The Marines' Hymn" beginning with the words, "From the Halls of Montezuma to the shores of Tripoli . . ." The marine band, the oldest musical organization in the U.S. armed forces, is known as "The President's Own" because of its privilege of performing at all state functions at the White House. The official colours of the corps are scarlet and gold, but forest green enjoys semiofficial recognition. The distinctive dress blue uniform of marines, with its standing collar, is well known, whereas the forest green service uniform bespeaks the original status of the corps as light infantry (*see* UNIFORMS). From the standing collar—descended from the tall leather neckpiece of the 18th- and 19th-century uniform—comes the traditional nickname for marines of "leathernecks"; the equivalent slang term for British marines, from the same origin, is "boot-necks." In naval formations, marines have the privilege of forming on the right of line or at the head of column, the traditional places of honour and seniority.

ROYAL MARINES (GREAT BRITAIN)

The Royal Marines were founded by an order in council on Oct. 26, 1664, as the duke of York and Albany's maritime regiment of foot—1,200 "land Souldgers prepared for sea service," administered by the admiralty. The modern Royal Marines remain under the admiralty, and the commandant general, Royal Marines, a lieutenant general, reports to the board of admiralty. His headquarters, the Royal Marine office, is in London. A member of the royal family serves as captain general of the corps.

The missions of the Royal Marines are to: (1) supply detachments for her majesty's ships; (2) provide bands for the navy; (3) man minor landing craft; (4) provide commando (amphibious raiding) units; (5) serve as a link between the navy and the army during landing operations. Since World War II, the peacetime strength of the Royal Marines has approximated 10,000.

The marine establishment in the U.K. is divided into the Portsmouth and Plymouth groups, each under a major general. Ports-

mouth group, with headquarters at Royal Marine barracks, Eastney, directs the seagoing training of the corps, as well as the amphibious school at Poole, Dorset, which operates in conjunction with the Joint Services School of Amphibious Warfare at the same place. Plymouth group, with headquarters at Stonehouse barracks, Plymouth, co-ordinates the military training of Royal Marines. Plymouth group's two most important subordinate activities are the commando school, Bickleigh, Devon, and the infantry training centre, Lympstone, Devon. The latter also includes the Officers' School Royal Marines, where subalterns receive basic instruction. Recruits are trained at Deal, Kent. While women serve with the Royal Marines, they are assigned from the Women's Royal Naval service (WRENS).

Aside from ships' detachments, the commando brigade—Britain's permanent commando force—is the principal operating unit of the corps. After World War II, when marines assumed the commando role, the brigade served in Hong Kong, Palestine, Malaya and Cyprus. At Suez (1956) the brigade formed the amphibious spearhead; one unit conducted its assault on Port Said by helicopters landed from an aircraft carrier in accordance with the U.S. marine vertical envelopment concept.

History and Traditions.—From 1664 until 1755 the various marine regiments went through reorganizations, disbandments and fluctuations between army and admiralty control. The most distinguished episode of the period was the capture and subsequent defense of Gibraltar by marines in 1704–05, for which the corps still bears on its colours the single battle honour, *Gibraltar*. In 1755 the corps of marines was reorganized into 50 independent companies under complete admiralty control, and grouped into three "divisions" at Portsmouth, Plymouth and Chatham, an organization which, with slight changes, lasted until 1947.

Marines served in the Seven Years' War (1756–63), American Revolution (1775–81) and Napoleonic Wars (1792–1815), winning the designation "royal" in 1802. Three years later a fourth division was established at Woolwich, and an artillery company was added to each existing division. In 1855, the infantry companies were designated "Royal Marines, light infantry," and, in 1862, the artillery companies were grouped as "Royal Marine artillery." This separation continued until 1923, when the corps was reconstituted as the Royal Marines.

In World World I marines saw service widely at sea and as infantry and artillery. The most notable action of the corps was its raid on Zeebrugge in 1918. In World War II, the corps initially organized one marine division and two mobile naval base defense organizations, and attained a top strength of 78,000. A reorganization in 1944 converted most of the Royal Marines into commandos and landing craft detachments. Outstanding among many feats of the corps in the war were the defense of Crete (1941) and assault on Walcheren (1945). One commando was sent to Korea in 1950 and served with the U.S. 1st marine division thoughout the Changjin reservoir campaign.

The Royal Marines' badge is the globe (conferred in 1827 by King George IV), surrounded by a laurel wreath won in 1761 for the storming of Belle Isle, surmounted by the lion and crown of a royal regiment, and an anchor. *Per Mare, Per Terram* ("By Sea and by Land") is the corps motto, and the corps colours are yellow, scarlet, green and blue. The uniforms of Royal Marines are not unlike those of the U.S. marine corps.

OTHER MARINES

In addition to the United States and Great Britain, 19 other nations maintain marines or units which perform similar duties. Oldest of these is the Royal Netherlands *korps mariniers*, established on Dec. 10, 1665, as part of the Netherlands navy. The *korps mariniers* saw immediate action against England, France and Spain, and played a conspicuous part in the Dutch amphibious raid up the Medway (1667). Subsequently the corps was mainly employed to police and protect the Dutch empire. During World War II it was reorganized and trained by the U.S. marine corps. The motto of the corps is *Qua Patet Orbis* ("To the Ends of the World").

Other countries having marines or some type of "naval infantry" are: Argentina, Brazil, Cambodia, Chile, Colombia, France, Indonesia, Iran, Mexico, Nationalist China, Philippine Republic, Republic of Korea, Spain, Thailand, U.S.S.R., Venezuela, Vietnam and Yugoslavia.

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MARINETTI, FILIPPO TOMMASO (1876–1944), Italian writer, the founder of the literary Futurist movement, was born at Alexandria, Egy., Dec. 22, 1876, and educated in Paris. He published the original Futurist manifesto in the Paris *Figaro* on Feb. 20, 1909. His most characteristic work was the *Mafarka le futuriste* (1910). In 1914 he wrote the extraordinary *Zang-tumb-tuum* on the Balkan War. His *Guerra sola igiene del mondo* (1915) advocated Italian intervention in World War I. In *Futurismo e fascismo* (1924) he expressed support of Fascism, under which he enjoyed official backing.

Marinetti described himself as a "mystic of action"; but his technical devices (*e.g.*, "words in their freedom") and noisy agitations were essentially sterile. His war against all forms and patterns of ideas of the past, though expressive of a revulsion against literary tradition, created a rhetoric of its own. His Futurism also numbered Italian painters among its followers, with some success. Marinetti died at Bellagio, Dec. 2, 1944. (U. L.)

MARINI, MARINO (1901–), Italian sculptor, was born in Pistoia, Feb. 27, 1901, and was academically trained in Florence. From 1929 to 1940 he taught art in Monza and after 1940 in Milan; from 1942 to 1946 he lived in Switzerland. Marini's talent lay in seizing upon strong gestures that convey great strain or distress, as in the horse and rider series beginning in the 1930s, or taking a passively posed body and imparting to its surface great richness of colour and texture. He was deeply aware of older and primitive art, and his taste was for strongly shaped sensuous masses, which in his sculptures of women were given a graceful lightness. Marini's humanism expressed itself in his striking portrait of Igor Stravinsky (1950), and his series dealing with the peasant on his horse, menaced by war. While searching for elementary forms, Marini wanted his surfaces to reveal the spiritual substratum of his subjects. He worked with few themes, refining and re-exploring, so that often the differences between his sculptures are extremely subtle. Marini also worked in other media.

See Carola Giedion-Welcker, *Contemporary Sculpture*, 3rd ed. (1960). (A. E. EL.)

MARINIDS (BANU MARIN), a Berber dynasty which established its rule over Morocco, and temporarily over other parts of northern Africa, during the 13th–15th centuries A.D. A tribe of the Zenata group, they had been established in eastern Morocco for over a century when in 1248 their ruler Abu Yahya captured Fès (Fez) and made it the Marinid capital. The defeat of the last of the Almohads (*q.v.*) and the capture of Marrakech in 1269 made the Marinids under their ruler Abu Yusuf Yakub masters of Morocco. They would have been wise to have eschewed foreign adventure and to have concentrated on consolidating their power in Morocco, for the Marinids could not draw on the same strength as either of their predecessors, the Almohads or the Almoravids, nor were they the leaders of any religious cause. Being ambitious, however, to fulfill the duties of Muslim sovereignty and to acquire religious prestige, they were often at war with the Christian kings of Castile in south Andalusia. They could not attempt the reconquest of former Muslim Spain but gave valuable assistance to the Nasrid kingdom of Granada and up to the mid-14th century slowed down the advance of the Christians to the Strait of Gibraltar.

In Africa the Marinids tried to re-establish the Almohad empire and, driving to the east, attacked their kinsmen the Abd-al-Wadids of Tlemcen. The greatest of the Marinid sultans, Abu'l Hasan, captured Tlemcen in 1337 and then seized much of Tunisia.

He was defeated however at Kairouan in 1348 and driven from the country. His successor Abu Inan met with a similar fate: after capturing Tunis in 1357 he was compelled to flee the country. These adventures absorbed the resources of the dynasty and diverted their attention from the grave problems which they had to solve in Morocco. The Bedouin Arab tribes which had settled there had ruined the ancient economy of the country by their depredations and by the development of nomadism. In the 15th century much of the country was in a state of rebellion. Further, the Marinids had not succeeded, in spite of the foundation of religious schools, in controlling the religious evolution of the country. Sufism, which spread everywhere, degenerated into maraboutism and in the 15th century anarchy ensued in which the Marinid dynasty foundered. The towns of the Maghreb, especially Fès and Tlemcen, owe to the Marinids some splendid monuments which, though often of small dimensions, display a refined luxury.

See H. Terrasse, *Histoire du Maroc*, vol. ii (1950). (H. L. E. T.)

MARINKOVIĆ, VOJISLAV (1876–1935), Yugoslav statesman, foreign minister in 1924 and from 1927 to 1932 and prime minister for three months in 1932, was born in Belgrade on May 13 (new style; May 1, old style), 1876. Having graduated as doctor of laws in Paris (1901), he entered parliament as a Progressist (1906), represented Serbia at the Paris conference (1913) for the financial settlement of the Balkan Wars and became minister of national economy (1914–17). The leader of the Serbian Progressist party from 1915, he took part in the drafting of the Corfu declaration of 1917 and the Geneva agreement of 1918 and became the first Yugoslav minister of trade. He brought the Progressists into the new Democratic party in 1919. As minister of the interior (1921–22) he organized the electoral law. He served twice as minister of foreign affairs (1924, 1927–32) and was prime minister from April 4 to July 29, 1932. He died in Belgrade on Sept. 18, 1935.

During his five years as foreign minister Marinković signed a treaty of friendship with France (1927), ratified the Nettuno conventions concluded with Italy (1928), represented Yugoslavia at the assemblies of the League of Nations and was a member of the League council (1929–32; he was president of the council in 1930). He took part in the negotiations for the agreement establishing the Balkan entente and for the new statute of the Little entente, but both were signed after his resignation. (*See* YUGOSLAVIA: *History*.)

An eloquent speaker, well-known at Geneva for his courage in saying what many thought but kept unsaid, Marinković's most important part was played in 1931 when Germany and Austria attempted to conclude an *Anschluss:* it was mainly because of his energetic stand that the Austrians had to disavow their signature. At home he favoured coalition governments. A great and imaginative parliamentarian, he was respected by members of all parties.

See K. S. Pavlović, *Vojislav Marinković . . .*, 5 vol. (1955–60). (K. St. P.)

MARINO (MARINI), **GIAMBATTISTA** (1569–1625), Italian poet, the foremost of the *secentisti* (*see* ITALIAN LITERATURE), was born at Naples on Oct. 18, 1569. After a riotous youth, he secured the powerful patronage of Cardinal Piero Aldobrandini, whom he accompanied from Rome to Ravenna and to Turin. His early poems, *Le rime*, were published in 1602, and under the title *La lira*, in 1608 and 1614. At Turin (1608–15) he enjoyed the duke of Savoy's protection, but Marino eventually had to leave Italy because of resentment at his satirical writing and at his disorderly life. He then took refuge in Paris (1615–23) where he was favourably recognized by Marie de Médicis and by Louis XIII. Marino died at Naples on March 25, 1625.

Marino's *Adone* (1623; new ed. by R. Balsamo-Crivelli, 1922) tells the story of Venus and Adonis, with many digressions, in 45,000 lines. The poem contains many passages that still impress by their brilliance and shows a consummate mastery of technique; but it remains episodic, failing to come to life as a whole.

Marino's avowed purpose as a stylist was novelty at all costs, in order to dazzle the reader; and his licence, extravagances and conceits impressed his contemporaries and led many to imitate him. "Marinism" was the Italian manifestation of that cult of artifice and ornament which characterized western European literature in the 17th century.

Other publications by Marino include *La strage degli Innocenti* (1632; Eng. trans., by R. T., *The Slaughter of the Innocents*, 1675); *Lettere* (1627; critical ed. by A. Borzelli and F. Nicolini, *Epistolario;* 1912). Selections of his works were published in *Poesie varie*, ed. by B. Croce (1913), *Le più belle pagine di Giambattista Marino*, ed. by R. Balsamo Crivelli (1925) and *Prose e poesie*, ed. by C. Culcasi (1930).

See G. F. Damiani, *Sopra la poesia del cavalier Marino* (1899); C. Culcasi, *G. B. Marino* (1932). (U. L.)

MARINUS, the name of two popes, sometimes erroneously called Martin (*q.v.*).

MARINUS I (d. 884), pope from 882 to 884, a Tuscan, succeeded John VIII in Dec. 882. He had been deacon and treasurer of the Roman church and bishop of Caere and had been sent on missions to Constantinople by Nicholas I, Adrian II and John VIII. Marinus carried on the discussions with Photius begun under Nicholas. Owing to the researches of F. Dvornik it is now widely doubted that Marinus ever condemned Photius. Marinus died on May 15, 884.

MARINUS II (d. 946), pope from 942 to 946, a worthy man of whom little is known except that he was ruled by Alberic, prince and senator of the Romans. He died in April or May 946. (C. P. L.)

MARINUS, Neoplatonist philosopher, came from Neopolis (Shechem) in Samaria and was a convert from Samaritan Judaism to the old Greek religion. He succeeded Proclus as head of the Neoplatonic school at Athens in A.D. 485. His thought, like that of his predecessor and teacher, was a strange mixture of sober scholarship, acute reasoning (he was keenly interested in mathematics) and fantastic superstition. Marinus' chief surviving work is a biography of Proclus, ed. by J. F. Boissonade (1814), Eng. trans. in L. J. Rosan, *The Philosophy of Proclus* (1949). (A. H. Ac.)

MARIO, stage name of GIOVANNI MATTEO DE CANDIA (1810–1883), one of the famous Italian tenors of the 19th century, was born of a noble family at Cagliari on Oct. 17, 1810. While serving as an officer in the Sardinian army he fled to Paris to avoid arrest for his connection with Giuseppe Mazzini and the Young Italy party. There, on the advice of Meyerbeer, he studied singing under L. A. Ponchard and G. M. Bordogni and made his debut in 1838 at the Opéra in Meyerbeer's *Robert le Diable*. In 1839 he sang with Giulia Grisi at Her Majesty's theatre in London and later in the year they sang at the Théâtre Italien in Paris. In 1843 he created the part of Ernesto in *Don Pasquale*. Married to Giulia Grisi in 1839, he soon won a European reputation and sang regularly in Paris and at Covent Garden, where in 1847 he took part in that theatre's first season of Italian opera. He is said to have had a voice of unrivaled softness and richness and he was also considered a fine actor. He died in Rome in reduced circumstances on Dec. 11, 1883.

MARION, FRANCIS (1732–1795), American soldier in the Revolutionary War, nicknamed "the Swamp Fox" by the British because of his elusive tactics, was born in 1732 at Winyah, Berkeley county, S.C. His first military experience was against the Cherokee Indians in 1759. For the next 14 years he was a hunter and farmer in South Carolina. After serving as a member of the South Carolina provincial congress in 1775, Marion was commissioned a captain, and he recruited patriots to fight the British. Promoted to the rank of major in 1776, he took part in defending Charleston harbour and in nine months had become a lieutenant colonel. After the surrender of Gen. Benjamin Lincoln to the British at Charleston in 1780, Marion slipped away to the swamps. He was ordered to burn boats and generally harass the enemy. In 1781 he was appointed a brigadier general by Gov. John Rutledge, and after the disastrous defeat of Gen. Horatio Gates at Camden, Marion gathered around himself a band of intrepid guerrillas whom he trained to ride and fight hard while living off the land. Though Marion could not swim, he was at home in the watery swamps and often defeated larger bodies of British

troops by surprise and rapidity of movement. Even the dreaded Col. Banastre Tarleton could not find Marion, saying, "As for this damned old fox, the devil himself could not catch him." But he did appear and united his men with those of Gen. Nathanael Greene in engagements at Georgetown and Eutaw Springs. For a daring rescue of Americans surrounded by a British force at Parker's Ferry, Marion received the thanks of congress. After the war he served in the senate of South Carolina from 1782 to 1790 and died on his estate in Berkeley county on Feb. 27, 1795.

See R. D. Bass, *Swamp Fox* (1959); J. R. Alden, *The South in the Revolution* (1957). (No. C.)

MARION, city and seat of Grant county, Ind., U.S., is located 65 mi. N.E. of Indianapolis on the Mississinewa river.

In the 1880s and 1890s it experienced booms in gas and oil, supplies of which failed after the turn of the century. Its industry, rapidly expanding by mid-20th century, is diversified but tends toward automotive parts domination. Other products include plastics, glassware, castings, television tubes, paper products, wire and cable, electrical parts and dairy products. Corn, oats and pigs are important in the local economy. Wheat and beef and dairy cattle are also produced and the county ranks high in soybean and tomato production.

A veterans administration hospital cares for about 1,650 psychiatric patients in more than 60 buildings. Taylor university (1846) is at nearby Upland. Matter park includes a zoo and historical museum. U.S. troops fought Miami Indians nearby at the battle of Mississinewa in 1812. The community was founded in 1831 as the county seat, chartered in 1889, and named for Gen. Francis Marion (*q.v.*). For comparative population figures *see* table in INDIANA: *Population.* (R. S. St.)

MARION, a city of Ohio, U.S., and seat of Marion county, is located 44 mi. N. of Columbus in the midst of fertile farming and grazing lands. Laid out in 1821 (or 1820) on a natural travel route between Columbus and Lake Erie, the site first was called Jacob's Well after Jacob Foos, who had dug for water just south of the original plat (now within the city limits). The settlement was officially named for Gen. Francis Marion (*q.v.*) of Revolutionary War fame, in 1822; it was incorporated as a village in 1830 and became a city in 1890.

The city's location and transportation facilities contributed to its prosperity, and its pre-eminence in the manufacture of excavating machinery earned for it the sobriquet "Shovel City." Other major industries include road-construction machinery, home laundry dryers, metal products, refrigeration equipment, racing sulkies, brass bushings, burial vaults and overhead garage doors.

At Marion are the Harding house and museum and the Harding memorial, honouring the nation's 29th president, Warren G. Harding (*q.v.*). The city is also the location of a U.S. army engineer storage depot. For comparative population figures *see* table in OHIO: *Population.* (J. S. St.)

MARIONETTES: *see* PUPPETS AND MARIONETTES.

MARIOTTE, EDME (*c.* 1620–1684), French physicist, co-discoverer of Boyle's law, (*q.v.*), which is known by Mariotte's name in France, spent most of his life at Dijon, where he was prior of St. Martin-sous-Beaune. He was one of the first members of the Academy of Sciences founded at Paris in 1666. He died at Paris on May 12, 1684. The first volume of the *Histoire et mémoires de l'Académie* (1733) contains many original papers by him upon a great variety of physical subjects, such as the motion of fluids, the nature of colour, the notes of the trumpet, the barometer, the fall of bodies, the recoil of guns and the freezing of water.

His *Essais de physique,* four in number, of which the first three were published at Paris between 1676 and 1679, are his most important works, and form, together with a *Traité de la percussion des corps,* the first volume of the *Oeuvres de Mariotte* (2 vol., 1717). The second of these essays (*De la nature de l'air*) contains a statement of Boyle's law, which Mariotte discovered independently.

MARIPOSA LILY, the name given to the genus *Calochortus,* tuliplike perennial plants of the lily family (Liliaceae), comprising about 40 species native to western North America, about 25 of which are found in California. They have simple or somewhat branched stems, one-half foot to four feet tall, rising from coated corms and bearing a few narrow leaves and showy white, yellow, lilac or bluish flowers, often spotted or marked in the centre. The three large broad petals, one to two inches long, usually bear a conspicuous basal gland. Several species are in cultivation.

See SEGO LILY.

MARIS, JACOB (1837–1899), Dutch landscape painter, the eldest of three brothers all of whom became artists, was born at The Hague on Aug. 25, 1837. He first studied at the Antwerp academy, and subsequently in Antoine Hébert's studio in Paris from 1865 till 1871. He is best known for his scenes from the Netherlands countryside, of bridges and windmills, old quays, massive towers and level banks, against misty skies or chasing clouds. In all his works, whether in water or oil colour, and in his etchings, the subject is always subordinate to the atmospheric effect, as in the "Grey Tower, Old Amsterdam," "Landscape Near Dordrecht," "Sea-weed Carts, Scheveningen," "A Village Scene" and numerous other pictures. He died at Karlsbad (Karlovy Vary, Czech.) on Aug. 7, 1899.

MATTHEW MARIS (1839–1917), younger brother of Jacob, was born at The Hague on Aug. 17, 1839. He received a royal subsidy and for some time lived and worked with his brother Jacob, on whom his more spiritual and mystical nature had a refining influence. There is a touch of medievalism in many of his figures. "Souvenir of Amsterdam," "Bride of the Church," "The Four Mills" and "Girl Feeding Chickens" are among his most successful works. In 1885 he went to London to design windows. He died in London on Aug. 17, 1917.

WILLIAM (WILLEM) MARIS (1844–1910), youngest of the brothers, was born at The Hague, Feb. 18, 1844. He developed under the influence of Jacob and Matthew and lived for the greater part of his life in London. His paintings of cattle grazing, the most famous of which is "Cows Beside a Ditch," are modern in treatment and have charm of colour and feeling. He died in London in 1910.

MARISCO (MARSH), **ADAM DE** (d. *c.* 1258), English Franciscan and theologian, known as *Doctor illustris,* was born in the last years of the 12th century, probably in Somerset, and educated at Oxford, where he was important in the early organization of the university. His uncle, Richard Marsh, bishop of Durham, gave him the benefice of Wearmouth, but the young priest soon joined the Franciscans, who had recently come to England. Adam Marsh first pursued his studies, especially of theology and mathematics, at Oxford (from a date between 1226 and 1230), under Robert Grosseteste, and was the first Franciscan lecturer at the university (*c.* 1238). A devoted friend of Grosseteste, he became the spiritual director of Simon de Montfort as well as a counselor of King Henry III and his queen, and of Archbishop Boniface of Canterbury. Thus enabled to guide the policy both of the opposition and of the court party in matters affecting the interests of the church, he was inclined to avoid official charges in his own order and elsewhere and contented himself with exercising an important influence unhampered by administrative duties. As chancellor of Lincoln, he accompanied his bishop, Grosseteste, to the Council of Lyons in 1245 and refused an invitation to take the chair in the University of Paris lately occupied by Alexander of Hales and John of La Rochelle. Both Henry III and Archbishop Boniface were anxious to secure for him the see of Ely in 1256, but the opposition of the monks defeated their intention, and he died shortly afterward.

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MARIST BROTHERS (LITTLE BROTHERS OF MARY; INSTITUTUM FRATRUM MARISTARUM A SCHOLIS; F.M.S. or P.F.M.), a Roman Catholic congregation of teaching brothers founded in 1817 by Marcellin Champagnat (1789–1840), who was beatified in 1955. The congregation was approved Jan. 9, 1863, and it has grown to be one of the largest orders of men. The brothers, scat-

tered all over the world, are devoted entirely to the education of youth. The general mother house is at St. Génis Laval, France. *See* also Orders and Congregations, Religious.

MARIST FATHERS (Society of Mary; Societas Mariae; S.M.), a Roman Catholic religious congregation founded in 1822 in the diocese of Belley, France, by Jean Claude Colin to undertake all ministerial works, parochial educational and missionary, while stressing the virtues of the Virgin Mary. The congregation has establishments in 20 countries; members number about 2,300. Its foreign missions, the acceptance of which was the chief reason for its approval by the Holy See (April 29, 1836), embrace the islands of the South Pacific (the congregation's original mission field), Japan, Algeria, Peru and Venezuela. Stemming from the Marist Fathers are the Marist Brothers, the Marist Sisters, the Missionary Sisters of the Society of Mary and the Blessed Sacrament Fathers. (Jo. L. W.)

MARITAIN, JACQUES (1882–), French philosopher internationally respected both as an interpreter of the thought of St. Thomas Aquinas and as a profound and far-reaching thinker in his own right, was born in Paris on Nov. 18, 1882. Brought up in an atmosphere of liberal Protestantism, he went to the Sorbonne and fell briefly under the spell of teachers who held that the natural sciences alone could provide all the answers to the questions tormenting the human mind. At the Sorbonne also, however, he met Raïssa Oumansoff, a Russian Jewish student who was to share his quest for truth. Soon disillusioned with the scientism of the Sorbonne, the two began to attend the lectures of Henri Bergson (*q.v.*), who liberated in them "the sense of the absolute." They were married in Nov. 1904 and were received into the Roman Catholic Church on June 11, 1906.

Having graduated in philosophy (1905), Maritain spent two years at Heidelberg studying biology (1906–08). He then returned to Paris and took up the study of Thomism. In 1913 he began teaching at the Institut Catholique, where he was professor of modern philosophy from 1914 to 1939. From 1932, moreover, he gave yearly courses at the Institute of Mediaeval Studies, Toronto. Sent to the United States by the French government in 1939, he was visiting professor at Princeton (1941–42) and at Columbia (1941–44). After World War II he was French ambassador to the Holy See (1945–48) and then professor of philosophy at Princeton (1948–55).

Maritain's thought is based on the principles of Aristotle and St. Thomas Aquinas, but incorporates many insights found in other philosophers, both classical and modern, and also profits from data supplied by such sciences as anthropology, sociology and psychology. Dominant themes are: (1) that there are different ways of knowing reality—science, philosophy, poetry, mysticism, etc.—each with its own proper legitimacy and prerogatives; (2) the transcendence of the human person with respect to the political community; (3) knowledge of natural law by inclination; (4) the need for moral philosophy to take into account the data of revelation and theology as to the existential state of man; and (5) the pluralistic co-operation among men of different beliefs in the pursuit of the common good of political life. A Jacques Maritain centre was established at the University of Notre Dame, Notre Dame, Ind., in 1958.

Among Maritain's most important works are *Art et scolastique* (1920; 2nd Eng. trans., *Art and Scholasticism*, 1930); *Distinguer pour unir, ou les degrés du savoir* (1932; Eng. trans., *The Degrees of Knowledge*, 1937; new trans. 1959); *Frontières de la poésie . . .* (1935; partial Eng. trans., *Art and Poetry*, 1943); *Humanisme intégral* (1936; Eng. trans., *True Humanism*, 1938); *Sept leçons sur l'être . . .* (1934; Eng. trans., *A Preface to Metaphysics*, 1939); *Man and the State* (1951); *Creative Intuition in Art and Poetry* (1953); and *La Philosophie morale: examen historique et critique des grands systèmes* (1960; Eng. trans., *Moral Philosophy: an Historical and Critical Survey of the Great Systems*, 1964).

(J. W. Ev.)

MARITIME ADMINISTRATION, U.S., an agency of the federal government established in May 1950, along with the federal maritime board, to replace the United States maritime commission. The Maritime administration was made a part of the department of commerce. Both the board and the administration were established to foster the growth of a U.S. merchant marine sufficient to meet the needs of national defense and of foreign and domestic commerce. The guiding principles for their operation remained those set forth in the Merchant Marine act of 1936.

The Maritime administration is responsible for administering shipbuilding, shipping, port development and related programs authorized by law. It determines the ocean services, routes and lines needed for the nation's foreign and domestic commerce, and the types of ships required to provide adequate service. It recommends the terms of subsidy contracts to be awarded by the federal maritime board to U.S. shipping companies and shipyards. The Maritime administration provides insurance on private loans and mortgages for ship construction, arranges for war risk insurance and pays the cost of national defense features added to ships. It conducts a research and development program to improve the efficiency and economy of operations of the U.S. merchant marine, including study of nuclear-powered ships. It maintains a national defense reserve fleet of government-owned ships, maintains several shipyards in inactive condition for use in a national emergency, and operates warehouses for the storage of marine equipment that might be required in an emergency. It also operates radar training schools and the U.S. Merchant Marine academy at Kings Point, N.Y.

The federal maritime board is composed of three members appointed by the president by and with the advice and consent of the senate. One of the three members is designated as chairman of the board and also serves as head of the Maritime administration. The board is a regulatory agency and as such is independent of the secretary of commerce. Its functions include the regulation of rates, services, practices and agreements of common carriers by water. It may enter into subsidy contracts relating to construction and operating costs to help U.S. shipyards and shipping companies meet the competition of foreign countries. It makes its determinations with regard to such contracts in accord with the provisions of the Merchant Marine act of 1936.

The history of efforts by the federal government to develop and maintain a strong merchant marine and to regulate water carriers in foreign and interstate commerce goes back many years. In 1916 the U.S. shipping board was established with these goals in mind. It played an important role in World War I but during the postwar years the U.S. merchant fleet was in a far from healthy state. The Shipping board was abolished in 1933 and in 1936 new legislation created the U.S. maritime commission. The 1936 act authorized new types of subsidies to help U.S. shipping firms meet competition from low-wage countries which also offered subsidies to their merchant marines. (M. S. Bl.)

MARITIME LAW, or admiralty law, is the body of legal rules, partly substantive, partly procedural, which has grown up around the shipping industry. As transportation of goods and passengers by water is one of the earliest forms of commercial activity of which there is record, references to the law of the sea abound in the sources which have come down from antiquity and, after the revival of a commercial society in Europe, from the middle ages. It is easy to exaggerate both the completeness of the ancient and medieval sea codes and their relevance to modern law. The 6th-century Byzantine compilation known as the *Digest* of Justinian includes a mass of references which are often confused and contradictory, obscure in meaning and of uncertain date, authority and integrity. The largely mythical body of law attributed to the Rhodian mariners has been constructed from a few scattered references in the *Digest*. A number of medieval collections of local maritime customs have survived, the earliest extant editions or copies going back to the 13th and 14th centuries; the best known of these are the *Consolat de Mar* or "Consulate of the Sea" (Barcelona, 1494), the Laws of Oléron and the Laws of Visby (or Wisby), which are of uncertain date. Many of these medieval sea codes, so-called, were reproduced in the influential 17th-century French treatise by Étienne Cleirac, *Les Us et Coutumes de la mer* (1647). The great 19th-century collections were made by Jean Marie Pardessus, *Collection des lois maritimes antérieures au XVIIIe siècle* (6 vol., 1828–45), and by Sir Travers

Twiss in his edition of the *Black Book of the Admiralty* (4 vol., 1871–76).

Development of English Admiralty Jurisdiction.—The material just mentioned is of great historical interest but is no longer relevant to a discussion of modern maritime law, since each major change in the technology underlying the shipping industry has resulted in a major change in the inarticulate bases of the law. Furthermore, England, the United States and other countries whose legal systems derive from that of England were affected by the peculiar development of the English court system.

By the end of the 16th century the English admiralty courts, of which the most important was the high court of admiralty (founded in 1360), had come to exercise an extremely wide jurisdiction, reaching far beyond salt-water transportation into many areas of commercial law. But during the first half of the 17th century the judges of the common-law courts succeeded in divesting their competitors in the admiralty of their commercial jurisdiction and in restricting them to the adjudication of "things done upon the sea." This restriction of jurisdiction was accomplished through writs of prohibition issued by the common-law courts under the vague authority of a series of long-ignored statutes, the earliest of which was dated in the reign of Richard II (13 Rich. II, c. 5 [1389]). The common-law courts do not seem to have had, or to have won, the confidence of the merchants; there ensued a hiatus of nearly 200 years in the development of English commercial law during which mercantile disputes were rarely settled in court. During the second half of the 18th century, under the vigorous leadership of Lord Mansfield, the common-law courts, stimulated, no doubt, by the novel needs of a society in full course of industrialization, created a new series of legal rules for dealing with mercantile disputes. Meanwhile, the courts of admiralty were cut off from the main streams of commercial activity and of legal thought; an entry in Pepys's diary for March 17, 1663, gives a vivid description of the admiralty judge contriving, with much solemnity, to make a little business go a long way. Not until the 19th-century reorganization of the English court system was there re-established by statute (3 & 4 Vict., c. 65 [1840]; 13 & 14 Vict., c. 26 [1850]; 24 & 25 Vict., c. 10 [1861]) a court of admiralty with extensive though incomplete jurisdiction over the problems peculiar to the shipping industry. The admiralty court became part of the new high court of justice created by the legislation of 1873–75, forming with the historically related courts of probate and divorce a division of that court; certain county and other inferior courts were also to some degree invested with admiralty jurisdiction in 1868–69; the admiralty jurisdiction of certain other local courts, *e.g.*, in the Cinque ports, was not interfered with. The jurisdiction of the main courts of admiralty has been considerably widened in the 20th century, notably by the Administration of Justice act, 1956, and the County Courts act, 1959. The former high court of admiralty and the modern high court have had exclusive jurisdiction in England and Wales in prize (*q.v.*), except in prize appeals, for several centuries, and the vice-admiralty courts and their successors exercised this jurisdiction in the colonies, dominions and similar territories.

American Developments.—The development in the American colonies followed a different line. During the pre-Revolutionary period vice-admiralty courts exercised, without successful challenge, a jurisdiction much wider than that left to the English admiralty courts. The judges of the vice-admiralty courts were appointed by the crown and, following the tradition of the royal or prerogative courts, sat without juries; for these reasons, and perhaps because of their unsympathetic attitude toward smuggling offenses, the vice-admiralty courts were not popular during the period of ferment which preceded the American Revolution.

Art. iii of the federal constitution, which defines the "judicial power of the United States," provides in sec. 2 that "the judicial power shall extend . . . to all Cases of admiralty and maritime Jurisdiction. . . ." Little is known of the genesis of this notably obscure provision, whose meaning was left to be supplied by congress and the courts. In the Judiciary act of 1789 congress translated the constitutional ambiguity into an equally glaring statutory ambiguity by providing that "the [federal] district courts . . . shall also have exclusive original cognizance of all civil causes of admiralty and maritime jurisdiction . . . saving to suitors, in all cases, the right of a common law remedy, where the common law is competent to give it; . . ." Several times amended, most recently in connection with the revision of the Judicial code in 1948, the substance of the act of 1789 now appears, in slightly different language but with, apparently, no change in meaning, as sec. 1333 of Title 28 of the United States code.

At the outset, the congressional enactment, far from clarifying the situation, served merely to introduce an additional element of confusion; the riddling words of the second branch of the jurisdictional provision came to be known as "the saving-to-suitors clause." The courts, and particularly the U.S. supreme court, were therefore charged with the task of determining the scope of the jurisdictional grant ("all civil causes of admiralty and maritime jurisdiction") as well as that of figuring out a meaning for the saving-to-suitors clause.

The resolution of the saving-to-suitors clause question furnished one of the distinctive features of U.S. admiralty practice. The judicially determined meaning of the clause was this: although a cause of action is within the "admiralty and maritime jurisdiction" and thus (under the first branch of the statutory provision) within the "exclusive original cognizance" of the federal courts (sitting "in admiralty"), the same cause of action may be sued on in a nonadmiralty court (that is, a state court or a federal court sitting, not "in admiralty," but as a civil court of law and equity). What developed therefore was not a body of law, federally created and administered exclusively by the federal courts, but a body of law administered and to some degree inspired by both state and federal sources. State courts developed systems of admiralty law which were quite independent of general or federal maritime law, and the legislatures of many states enacted comprehensive maritime codes. This process was halted by the supreme court's decision in the case of *The Moses Taylor*, 71 U.S. (4 Wall.) 411 (1867), holding unconstitutional a state statute which authorized an *in rem* proceeding against a vessel in a state court. Such a proceeding, it was held, could be brought only in the federal court in admiralty and was not a "common-law remedy" under the saving-to-suitors clause. *The Moses Taylor* decision made it clear that to some extent admiralty was an exclusively federal domain, but it continued to be thought that in actions brought outside the admiralty court under the saving-to-suitors clause, state courts would apply their own rules of substantive law (for example, that plaintiff's contributory negligence bars an action in tort) even where those rules were inconsistent with the "general maritime law" (under which plaintiff's contributory negligence may cause damages to be divided or apportioned but is not a bar to the action). Considerable doubt was cast on the principle that state courts apply their own law in maritime causes of action by *Southern Pacific Co.* v. *Jensen*, 244 U.S. 205 (1917), in which the supreme court, holding a state workmen's compensation statute unconstitutional as applied to a longshoreman engaged in work aboard ship, included in its opinion language which suggested that state law is invalid if it "works material prejudice to the characteristic features of the general maritime law or interferes with the proper harmony and uniformity of that law in its international and interstate relations." Thereafter, in a series of cases decided during the 1940s and 1950s the supreme court seemed to be elaborating what might be called a theory of maritime-law supremacy. The supremacy theory was expressed principally in cases involving actions by seamen and other maritime workers for death or personal injuries. The court was closely divided on these issues, and shifts in its membership in the late 1950s led to a series of decisions (*e.g.*, *The Tungus* v. *Skovgaard*, 358 U.S. 588 [1959]) which indicated that the supremacy theory might be confined within its present limits if not curtailed.

Jurisdiction of Admiralty Courts.—In addition to their civil jurisdiction, admiralty courts in England and the United States have long exercised a jurisdiction over crimes committed on shipboard. This jurisdiction passed to the ordinary courts in England in 1834. The general theory is that a national court has jurisdiction to try crimes committed in its own territorial waters as well

as crimes committed by its own nationals or citizens or on ships flying the national flag on the high seas or within the territorial waters of another nation. Applicable principles of international law and comity will determine the extent to which a national court is entitled to assert, or will assert, jurisdiction over crimes committed on foreign ships within its territorial waters.

For several centuries the law of prize has been a distinctive feature of the practice of admiralty courts in wartime. A captured enemy ship may be brought into port and, if adjudicated as lawful prize by the admiralty or vice-admiralty court exercising the prize jurisdiction, will be sold by the court, with the proceeds being divided among the state and the captors. The hope of prize money no doubt stimulated the efforts of privateers who, until the middle of the 19th century, might act with official permission as adjuncts to the regular naval fleets in wartime. During the 19th century, warships became bigger, more expensive and more destructive, and privateering was outlawed by international agreement. The opportunity for amateurs to turn a state of war into a profitable commercial venture on the high seas was thus lost, and naval warfare became a matter for professionals. The institution of prize became a matter in which only states and naval personnel could profit.

In both Great Britain and the United States the admiralty courts exercise a limited jurisdiction over maritime causes of action. Only admiralty courts have power to entertain a proceeding *in rem* against a ship to enforce maritime and similar liens. The admiralty courts sit in civil cases without juries, except that in the United States a special statute confers a right of jury trial in Great Lakes cases; they have traditionally followed a simple, flexible and nontechnical procedure. Since access to these specialized courts, with their special powers, depends on the existence of a maritime cause of action, much attention has been given to the dividing line between what is, in a legal sense, maritime and what is nonmaritime. In general, British and U.S. law are in substantial agreement on the demarcation; indeed, to a considerable degree this body of law is supranational and world-wide.

One basis of admiralty jurisdiction is territorial: the occurrence on navigable waters of some event of a maritime nature which relates to a vessel or to her cargo. Under this branch of the jurisdiction fall crimes (including piracy), torts such as collisions, injuries to crew members and passengers, damage to cargo and salvage, which is *sui generis*, being based neither on tort nor on contract (though there may be a salvage contract). In England the jurisdiction was restricted to the high seas up to the middle of the 19th century. In the United States, no doubt because of the great economic importance of the inland waterway system, the English limitation was abandoned at about the same time (*The Genesee Chief* v. *Fitzhugh*, 53 U.S. [12 How.] 443 [1851]); all inland waterways, whether they be lakes, rivers or canals, which are in fact navigable in interstate or foreign commerce, and in England virtually all waters and their shores, are within the jurisdiction. The requirement that some kind of floating structure which constitutes a "vessel" be involved leads to occasional litigation about odd objects which, by accident or design, find their way into navigable waters. The older cases, both English and American, took the vessel limitation seriously, with the result that such things as navigation beacons and dry docks which had broken loose from their moorings were held not to be subject to the maritime rules of salvage (*q.v.*). Recent cases in the U.S. have taken a less restrictive approach, while statute has widened the jurisdiction in Britain.

The other principal basis of admiralty jurisdiction is contractual: a dispute arising out of a contract which is considered to be maritime in nature. It was this branch of the jurisdiction that was withdrawn from the English admiralty courts during the 17th century, as noted above, and restored by statute toward the middle of the 19th century.

In the United States a broad contractual jurisdiction was at all times maintained, following the precedents of the colonial vice-admiralty courts. Justice Joseph Story, who was at all times an apostle of federalism, was the most influential exponent of the concept of a broad admiralty jurisdiction; his learned opinion in *De Lovio* v. *Boit*, 7 Fed. Cas. 418 (C.C.D. Mass. 1815), holding a contract of marine insurance within the jurisdiction, became the classic statement of that approach. In Britain, marine insurance is still not within the admiralty jurisdiction.

The line between maritime and nonmaritime contracts was eventually drawn to include within the admiralty jurisdiction most contracts which would be popularly thought of as closely connected with the business of shipping: contracts for transporting passengers or cargo, for chartering ships, for services and materials furnished to a ship (supplies, repairs, towage, pilotage, wharfage, etc.), for maritime employment, for marine insurance (in the U.S. only), and so on. There are, however, some strange exclusions: contracts to build or sell ships are nonmaritime and, apart from statute, so are mortgages of ships. In lieu of mortgages, maritime law recognized two security interests known as bottomry bonds and respondentia bonds. Bottomry was a loan on the security of a ship, respondentia on the security of a cargo. Both are now obsolete. The peculiar feature of both was that if the ship or the cargo failed to complete the voyage (having been, for example, lost at sea) the lender lost not merely his security but his right to repayment. Any attempt to give the lender a claim that would survive the loss of the ship or cargo was held to convert the bond into a nonmaritime mortgage. In both Great Britain and the United States statutes have conferred maritime status on ship mortgages that comply with the requirements that the statutes impose; these are complex in U.S. law.

Liens.—Many types of maritime claims, whether based on contract, tort or salvage, give rise to maritime liens against the ship or its cargo. In admiralty terminology, the pleading which initiates a proceeding is known as a libel in the U.S., a writ in Britain. Proceedings may be brought either *in personam*, against the shipowner, or *in rem*, against the ship, cargo or proceeds of sale. *In personam*, the decree, if the libelant or plaintiff is successful, is a money judgment against the shipowner. *In rem*, the ship is arrested and kept in the custody of the court unless the owner secures her release by posting a bond for indemnity or, in Britain, by giving bail. If judgment goes for the libelant or plaintiff in an *in rem* action, the ship will be sold by order of the court or there will be recovery on the bond if the owner does not pay. The sale of a ship by an admiralty court acting *in rem* is said to divest or "execute" all liens against the ship—not merely those liens which may have come into the proceeding in which the ship was sold but all liens everywhere in the world. (By way of contrast, the holder of an *in personam* judgment against a shipowner can, like any judgment creditor, have the ship sold on execution. But such a sale, unlike the admiralty sale *in rem*, does not divest existing liens; the ship, in the hands of the purchaser at the execution sale, remains subject to all existing liens.) Thus, the procedure *in rem* has decisive advantages over the procedure *in personam*, and these advantages become even more striking when the shipowner is insolvent or when, typically following some maritime disaster, the aggregate of claims far exceeds the value of the offending ship. Possession of a claim with maritime lien status has a twofold importance: (1) with some statutory exceptions in Great Britain, only the holder of a maritime lien may bring an action *in rem*; (2) when funds are distributed following judgment in an *in rem* action in which several parties have filed libels or issued writs or have been allowed to intervene, maritime lien claims are paid in full, with priority over claims which are maritime but do not have lien status as well as over-all nonmaritime claims. In Britain, liens are classified as maritime, statutory or possessory; the first two always confer a right to proceed *in rem*.

All maritime torts for which a ship is responsible give rise to liens. Examples of such torts are collisions due to negligent navigation, and injuries to persons or damage to property caused by the negligence of the ship's personnel or by the ship's unseaworthiness. The breach of most types of maritime contracts also gives rise to liens: contracts of affreightment or passage; charter parties; employment contracts of officers and crew; contracts for repairs, supplies and various types of maritime services such as towage, pilotage and wharfage. Breach of a contract, however, gives a lien only when at the time of breach the contract has been to some

degree executed or performed—as by delivery of cargo on board ship or by delivery of a ship under a charter party. In the United States, breach of a contract while it is wholly executory—for example, the refusal of a ship to accept cargo which it has agreed to carry or to receive a passenger to whom a ticket has been sold, or the failure to deliver a ship under a charter—creates a maritime claim, but such a claim does not enjoy lien status. A few types of concededly maritime claims have at one time or another, usually for no discernible reason, been denied lien status; examples are the claim of an insurance company for unpaid premiums on a marine insurance policy and the claim of a general agent for advances.

Maritime liens are also given for several types of peculiarly maritime transactions or services. Among these are liens for salvage and, in the U.S., for contributions made to a general average (*see* AVERAGE).

The ship may have a lien against the cargo. Typically, the lien against cargo is asserted for nonpayment of freight, but it could support a claim for damage caused the ship by the cargo. For enforcement of such a lien the cargo may be proceeded against *in rem* and sold by the admiralty court, just as in cases of *in rem* actions against ships. The peculiarity of the lien against cargo under U.S. law is said to be that it depends on possession and is lost by a voluntary delivery of goods to the consignee.

Under general maritime law there is a complex hierarchy of maritime liens; that is to say, in a proceeding which involves distribution of an inadequate fund to a number of lien claimants, liens of a higher rank will be paid in full in priority over liens of a lower rank. Liens are ranked according to two quite different criteria: the time when they arise and the nature of the transaction or event which gives rise to the lien. (*See* also LIEN.)

The general rule in the U.S. is that liens rank in inverse order of creation; that is, existing liens are subordinated to liens subsequently created. However, liens of the same class which accrued on the most recent voyage all share equally, and all enjoy priority over the liens which accrued on the preceding voyage. With respect to class, the highest priority goes to seamen's claims for wages. Since the criteria of time and class are quite different, it is obvious that clarity and predictability in the law are, even theoretically, impossible. Indeed, for a hundred years commentators have regularly bemoaned the extraordinary degree of confusion which marks the question of lien priorities. From the fact that the confusion has been allowed to persist, it may be concluded that a certain vagueness or formlessness in the legal categories, which leaves ample room for judicial maneuver, meets the needs of the situation. Without much exaggeration, it can be said that a trial judge, in decreeing the distribution of an inadequate fund among competing lien claimants, can find authority and precedent for almost any distribution which appears to him to be reasonable. Furthermore, appeals from decrees of distribution are rarely taken, so that, in the absence of authoritative statements by appellate courts, the law becomes progressively more unsettled and parochial.

In Britain, similarly, the priorities of various kinds of liens have always been a matter of difficulty. It is said that, subject to special priorities of payment accorded to court fees and, by certain statutes, to various harbour authorities, *e.g.*, for dock dues or wreck raising, there are two cardinal principles: (1) that liens arising from contract or for salvage rank in the inverse order of their attachment and (2) that tort liens rank before contract claims. Claimants having similar liens tend to be ranked together pro rata. Decisions as to priorities are nearly always reserved by the court until all claims have been adjudged. Priorities are governed by the law of the court in which the action is brought.

Limitation of Liability.—A distinctive feature of maritime law is the privilege accorded to a shipowner and certain other persons, *e.g.*, charterers, to limit their liability, under certain circumstances, in respect to both tort and contract claims. In the United States the limit, with some exceptions (*see* below), is the value of the ship. The basic condition of the shipowner's privilege is that he must be free from "privity or knowledge"; this formula (which is common in the limitation law of maritime countries) means, roughly, that the shipowner is not liable for losses caused by faulty navigation but may be liable for losses caused by the ship's unseaworthiness which could have been corrected before the voyage. In a sense the limited liability of shipowners may be compared to the limited liability that any investor may now achieve by incorporating his enterprise. However, the limited-liability idea in maritime law long antedates the emergence or invention of the modern corporation or limited company; its early appearance in maritime law may be taken as a recognition of the extraordinary hazards of sea-borne commerce and the need to protect the adventurous shipowner, before even the most primitive forms of insurance became available, from a crushing burden of liability. Modern commentators have often suggested that the peculiar features of maritime limitation of liability have outlived their usefulness; the development of insurance and of the modern limited liability company has radically altered the conditions out of which the shipowner's privilege originally grew. Although no maritime country has yet gone to the length of abolishing limitation of liability, shipowning interests appear to have become concerned about the possibility of such a development. The Brussels convention of 1957 on limitation of liability proposed a limitation fund substantially larger than that previously available in many countries. The convention was promptly ratified by Great Britain and given statutory force by the Merchant Shipping (Liability of Shipowners and Others) act, 1958. In the United States it was suggested that it would be unwise to submit any kind of limitation legislation to congress on the ground that, once the subject was opened, the result might quite possibly be the abolition of limitation entirely. The U.S. has not adopted the 1957 convention.

In most maritime countries the principle of limitation of liability was considered to be a part of the general maritime law. As it developed in continental Europe the idea, generally stated, was that a shipowner entitled to limitation could satisfy his liability by abandoning the ship (and its pending freight) to claimants. Since the privilege of limitation was, and is, typically invoked following a large-scale maritime disaster, the abandonment theory meant that claimants got the value of the ship as it was following the disaster. If the ship had sunk or was a total loss with no freight pending, the claimants got nothing. This theory was carried over into the law of many South American countries.

A number of European countries, as well as Brazil, adopted a modification of the abandonment theory proposed by a Brussels convention of 1922. Under the convention the owner retains the privilege of abandoning his ship in full satisfaction of claims but may, as an alternative, retain the ship and limit his liability to £8 per ton of the ship's registered tonnage (plus an amount for freight) in respect of property claims, with additional provision being made for death and personal injury claims. The convention was described as a happy compromise between British and continental theories of limitation but was, in fact, more favourable to the shipowner than either the British system or the previous continental system.

Great Britain and the United States were the only maritime countries that refused to admit the principle of limitation as part of the general maritime law. In both countries, however, the competitive needs of the shipping industry compelled its reintroduction by statute.

The first British limitation act was passed in 1733 (7 Geo. 2, c. 15), but this related solely to the thefts of cargo by master or crew. The next act, of 1786 (26 Geo. III, c. 86), extended the right to thefts by other persons and loss by fire. Limitation of liability in cases of loss by collision was created by an act of 1813 (53 Geo. III, c. 159), and many others have followed. Until after the middle of the 19th century, English limitation law, much less favourable to shipowners than the continental abandonment theory, set the limitation figure at the value of the ship at the beginning of the relevant voyage—*i.e.*, before the disaster—plus pending freight. In 1854 (17 & 18 Vict. c. 104) it was provided that in case of death and personal injury claims the value of the ship should be taken as not less than £15 per ton. Thereafter in 1862 the actual value of the ship was abandoned as a measure of

liability, and limitation was fixed in all cases at £15 per ton in cases of death and personal injury and £8 per ton in case of property damage alone. These provisions were incorporated in the Merchant Shipping act of 1894 and remained in force until amended by the Merchant Shipping (Liability of Shipowners and Others) act, 1958. In the 20th century, particularly after the end of World War II, soaring costs deprived these figures of any relation to reality.

U.S. shipowners apparently did not become concerned about the question of limitation of liability until the middle of the 19th century. The Limitation of Liability act of 1851 was closely modeled on the British statute then in force and was supported in congress as a measure designed to restore U.S. shipowners to a position of competitive equality with British shipowners. The act fixed the maximum liability of a shipowner entitled to limitation at the value of the ship plus pending freight, but gave no indication whether that value was to be calculated after the disaster (the European "abandonment" theory) or before (the English theory under the statute then in force). The legislative history of the act suggested that it should be construed according to British law, but the U.S. supreme court eventually decided (*Norwich & N.Y. Transportation* v. *Wright,* 80 U.S. [13 Wall.] 104 [1871]) that the principle of limitation was a part of the general maritime law, which the act had merely restored to vitality, and elected to follow the European theory. Thereafter the court decided that a shipowner entitled to limitation could keep for his own benefit any insurance recovery and did not have to put that money into the limitation fund (*The City of Norwich,* 118 U.S. 468 [1886]). These holdings left U.S. limitation law at the end of the 19th century in a state much more favourable to the shipowning interests than was the corresponding British law. However, as ship values continued to increase, the U.S. formula, in cases where the ship was not a total loss, opened the way to recoveries substantially larger than were available under the British formula, tied to the increasingly unrealistic figures of 1862.

The U.S. act of 1851, consistent with its purpose to restore the U.S. mercantile fleet to a position of equality with the British fleet, had excluded from its coverage vessels used on the inland waterways; in 1886, however, the act was extended to "all vessels used on lakes or rivers or in inland navigation."

Until 1935 the U.S. Limitation act made no special provision for death and personal-injury claims. Public indignation was aroused in 1934 when the owners of the steamship "Morro Castle," which burned off the New Jersey coast with large loss of life, petitioned to limit their liability to $20,000. The following year congress added to the Limitation act provisions, modeled on those of the British act, requiring that a special fund in the amount of $60 per ton be set up to satisfy death and personal-injury claims. The loss-of-life provisions apply only to "seagoing vessels."

The Brussels convention of 1957 on limitation of liability adopted the structure of British limitation law, setting the limitation fund at amounts of about £23 and £73, which were closer to actual ship values. In cases of loss of life or personal injury there were provisions for a "minimum tonnage" of 300 tons, where the limiting ship was in fact smaller than that tonnage. This has removed a source of great injustice. The convention figures were stated in terms of the gold content of Poincaré francs and would convert into U.S. dollars (1958) at $140 per ton for death and personal-injury claims exclusively with another $67 per ton to be shared ratably by such claims and property claims. As stated, the convention has not been adopted by the U.S.

In general, the limitation law of any country will be applied by its own courts in favour of foreign shipowners as well as of citizens. From the point of view of shipowning interests, however, a major weakness of limitation law has been the fact that decrees of limitation (unlike *in rem* decrees of admiralty courts) are not given international recognition (*The Titanic,* 233 U.S. 718 [1914]). That has meant that a shipowner whose ships move in international trade could find himself sued in several countries, as a result of one disaster, and forced to set up limitation funds in each country (although in Britain an owner who paid claims in foreign proceedings was allowed to credit those amounts against the British limitation fund). The Brussels convention of 1957 makes limitation decrees delivered by admiralty courts in ratifying countries internationally effective; that is, a shipowner could be required to set up only one limitation fund, out of which all claims would be paid, no matter in how many countries proceedings might be instituted against him. Thus the convention, which increases the liability of shipowners in most countries, does offer in return this considerable advantage to the group of shipowners whom the present rule affects adversely. Special provisions are likely to be applied by international convention to damage caused by nuclear-powered ships. Special limitation already exists with regard to cargoes of nuclear material (7 & 8 Eliz. II, c. 46).

Marine Insurance.—An appreciation of the part played by marine insurance (*q.v.*) is essential to an understanding of the shipping industry and the special law which governs it. With certain obvious exceptions, such as claims for death and personal injury and claims of seamen for wages, the great majority of claimants have insured themselves. The shipowner carries hull insurance on his own ship and protects himself against claims by third parties under a variety of arrangements. Water-borne cargo is almost universally insured against the perils of the seas. It is impossible in a brief outline such as this to go into any of the special intricacies, which are many, of marine insurance law. The point to be borne in mind is that any case of property damage, to a ship or its cargo or to ships in collision, resolves itself into a settlement between insurance carriers. Proposals for reform of the maritime law must always be evaluated against this background of universal insurance coverage. Abolition of the shipowner's privilege to limit his liability or of the peculiar maritime rules of general average or an increase in ship's liability to cargo would all mean not much more than that insurance now taken out and paid for by A would be taken out and paid for by B, who would pass on the additional cost of his insurance in the rates or prices charged to his customers. Since the same insurance carriers write both hull and cargo insurance, the end result of such reforms would be merely a redistribution of business among their several departments. Except for litigation involving death and injury claims in the U.S., there appears to have been during the 20th century a notable decrease in maritime litigation of all sorts. It is reasonable to suppose that this decrease is related to the increasing availability of all-risk insurance; insurance carriers notoriously, and commendably, prefer settlement or arbitration to litigation, even when a given carrier does not find itself in the position of having insured both parties.

Marine insurance is the oldest form of insurance that is known. Indeed, the institution of general average, under which the participants in a maritime venture contribute to losses incurred by some for the benefit of all, may itself be looked on as a primitive form of self-insurance. Marine insurance in a discernibly modern form made its appearance in the middle ages; many of the medieval sea codes contained regulatory provisions, and a special commission for trying marine insurance cases was provided for in England in 1601 (43 Eliz., c. 12). Modern hull-insurance policies still reproduce the language, which has come to seem quaint and archaic, of the so-called Tiger policy, written in London in 1613. Marine insurance seems to have grown up in the interstices, so to say, of existing maritime law and to have adapted itself to that framework. Until the 20th century it was a characteristic of marine insurance that a substantial number of risks could not be covered, and this remains to some degree true in cargo policies customarily written to exclude losses under stated percentages (the so-called F.P.A. or "free of particular average" clauses—"average" meaning a loss and a "particular average" meaning a loss not made good in a general average contribution). The theoretical basis for exclusion of certain risks is often said to be the furnishing of an inducement to the owner of property to look after it himself, as in the case of the "deductible" feature in the familiar automobile collision-insurance policy. However that may be, the pressures from shipowners for comprehensive insurance coverage have gradually led to the inclusion of almost all risks: "collision and running down" clauses, war risk riders, so-called "disbursements" policies and "P. and I." (protection and indemnity) insurance.

The British Marine Insurance act of 1906 codified British law and was of great influence in the development of U.S. marine-insurance law. The U.S. supreme court has consistently insisted on the need for international uniformity in this field, with the result that both the British codification and British cases have been recognized as authoritative. Nevertheless, certain differences have grown up between British and U.S. practice; for example, in cargo policies variant clauses are in use in the two countries with respect to the risk covered in cases of stranding or collision (the clauses are referred to as F.P.A.E.C. and F.P.A.A.C.—Free of Particular Average, English Conditions; Free of Particular Average, American Conditions). The case of *Wilburn Boat Co.* v. *Fireman's Fund Insurance Co.*, 348 U.S. 310 (1955), which held that a state statute controlled the decision whether a policy on a houseboat kept on an inland lake was void for breach of warranty, led some commentators to speculate that the supreme court had abandoned its long-held policy of uniformity in the marine-insurance field.

Nature of Maritime Law.—Maritime law is often thought of as being a species of international law rather than a branch of domestic or municipal law. It should not be denied that the international aspect of maritime law gives it a distinctive flavour; in doubtful cases courts of one country will often look to the precedents or statutes of another country for inspiration or guidance, and a relaxed attitude toward the principles of the law of conflict of laws is customary on the ground that the rules of maritime law are world-wide in scope. The supranational nature of maritime law was emphasized in an opinion written by Justice Robert H. Jackson of the U.S. supreme court in 1953: "[C]ourts of this and other commercial nations have generally deferred to a non-national or international maritime law of impressive maturity and universality. It has the force of law, not from extraterritorial reach of national laws, nor from abdication of its sovereign powers by any nation, but from acceptance by common consent of civilized communities of rules designed to foster amicable and workable commercial relations" (*Lauritzen* v. *Larsen*, 345 U.S. 571 [1953]). Traditionally, the interplay between British and U.S. courts in this field has been close and continuous.

It is, however, possible to overstate the degree to which maritime law is a branch of the law of nations. Justice Oliver Wendell Holmes pointed out long ago: "The maritime law is not a *corpus juris*—it is a very limited body of customs and ordinances of the sea" (*Southern Pacific Co.* v. *Jensen*, 244 U.S. 205 [1917]). In all countries there is a discernible tendency to codify maritime law, and the nature of national statutes in the U.S., at least, is such as to preclude reference to outside sources of law. It is undoubtedly true that maritime law in the U.S. in the mid-20th century was much more a creature of nationalism than it had been 100 years earlier.

Countervailing pressures of an internationalist kind, however, have been of considerable importance in many countries, and the tendency is growing. Since the late 19th century the Comité Maritime International has produced a series of international conventions. While many of these conventions have failed to be widely ratified, others have been highly successful, such as the convention on the Carriage of Goods by Sea of 1922 and the Safety of Life at Sea convention of 1929. There are, of course, many more maritime conventions in existence. The U.S. and Great Britain have not adopted a uniform policy with regard to them. The former, for example, did not ratify the Brussels convention of 1910, which, among other things, abolished the presumption of fault for breach of collision regulations and failure to "stand by" after collision, abrogated the rule of equal division of loss in case of collision where both colliding vessels are at fault, and introduced the two-year period of limitation of action in collision and salvage cases. Great Britain has not ratified any convention relating to salvage.

The international rules of navigation, the result of recommendations of the Safety conference held at London in 1948 and adopted by statute in many countries, including Great Britain and the United States, are in effect an international code of navigation on the high seas; these rules of the road are of the greatest importance in determining fault in ship collision. A further safety conference held in London in 1960 revised the current navigation rules. (*See* RULE OF THE ROAD AT SEA.) In other fields much has been accomplished to ensure international uniformity through private agreements voluntarily adhered to by affected interests; the York-Antwerp Rules of General Average, first promulgated in 1890 and most recently amended in 1950, are the best-known example of such agreements which, although they do not technically have the force of law, nevertheless, by incorporation in charter parties and bills of lading, determine the shape of the law as effectively as any statute.

It may also be that the widespread submission of maritime disputes to arbitration, where the informality of the procedure facilitates escape from aberrant national rules, reflects the stubbornly international bias which has characterized the shipping industry from earliest times.

See ADMIRALTY, HIGH COURT OF; AFFREIGHTMENT; MARINE INSURANCE; NAVIGATION LAWS; SALVAGE; *see* also references under "Maritime Law" in the Index.

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British Law: British Shipping Laws (a new encyclopaedic work, incorporating many standard works, in 14 vol., including a master index: vol. 1–4 and 8–11 had been published by Jan. 1964; publication of remainder planned to follow soon thereafter); Halsbury's *Encyclopaedia of the Laws of England*, 3rd ed., vol. 1, *Admiralty* (1952), vol. 22, *Insurance* (1958), vol. 35, *Shipping and Navigation* (1961), and annual cumulative supplements; Kennedy's *Civil Salvage*, 4th ed. by K. C. McGuffie (1958). (G. GI.; K. C. MCG.)

MARITIME PROVINCES, the Canadian Atlantic coast–Gulf of St. Lawrence provinces of New Brunswick, Nova Scotia and Prince Edward Island. *See* NEW BRUNSWICK; NOVA SCOTIA; PRINCE EDWARD ISLAND.

MARIUS (MARCUS AURELIUS MARIUS), rival Roman emperor A.D. 268, probably in Cologne, is said to have been a workman (*faber*) who assumed the purple on the murder of Postumus, and to have reigned two days. But his numerous coins indicate a reign of at least some months. (JN. R. M.)

MARIUS, GAIUS (157–86 B.C.), consul seven times (in 107, 104–100, 86), a great general and the first Roman to illustrate the political support that a successful general could derive from the votes of his old army veterans. Born, as was Cicero later, at Arpinum (Arpino), the son of a farmer, he was taken up by the Metelli (*see* METELLUS) and married into the family of the Julii Caesares. Tribune in 119, praetor in 115 and governor of Farther Spain in 114, he served on the staff of the consul Quintus Caecilius Metellus Numidicus against Jugurtha in 109. In returning to Rome in 108 to canvass for the consulship he defied Metellus and, to secure the support of business men (*equites*) and populace in Rome, he unscrupulously discredited Metellus' conduct of the war. He was elected consul, appointed successor to Metellus by a popular bill and, together with other reforms in military organization and equipment, revolutionized recruiting practice by enlisting volunteers from those who were too poor to be liable to conscription (*capite censi*). Lucius Cornelius Sulla, his quaestor in 107, won Marius' abiding jealousy by securing the surrender of Jugurtha in 105 at the end of the two years of Marius' own successful campaigning. Marius was transferred to the command of the war against the Cimbri and Teutones, after the heavy defeat of the Roman army at Arausio (Orange) in 105, defeated the invaders at Aquae Sextiae (Aix-en-Provence) in 102 and, with Q. Lutatius Catulus, his colleague as consul in 102, at Vercellae (Vercelli) in Cisalpine Gaul in 101. He was consul, with his friend L. Valerius Flaccus as colleague, for the sixth time in 100.

The veterans of his African army had already been settled in Africa in colonies, some of which were called after him, by a bill of L. Appuleius Saturninus (*q.v.*) as tribune in 103. In 100 Saturninus, tribune again, made proposals for the settlement in Transalpine Gaul of men who had served in the Cimbric war, and for Latin colonies in Sicily and Macedonia-Achaea in each of which Marius was to be allowed to create three Roman citizens.

(Already in the Cimbric war he had broken the law by giving Roman citizenship to two cohorts of the Italian Camertes on the battlefield, with the excuse that "in the din of battle he could not hear the law.") Marius combined with Saturninus and the praetor Gaius Servilius Glaucia in opposing the senate, but he was not statesman enough to handle the political complexity of events, first the hostility of the urban proletariat to the land bill (on the ground that its own interests were disregarded) and then the evidence that Saturninus and Glaucia were embarked on mob violence and unconstitutionalism. The clause in the land bill compelling senators to swear within five days to observe it led to the exile of Metellus, who refused to swear, Marius having equivocated by remarking that "he swore to obey the law as far as it was one." He subsequently abandoned Saturninus and Glaucia and after the passing of the last decree (*senatus consultum ultimum*) following on disorder at the consular elections (at which he or Valerius had refused to accept Glaucia's candidature) Saturninus and Glaucia, who had seized the Capitol, were forced to surrender. Marius had no responsibility for their murder.

After this he traveled in Asia. He commanded an army which defeated the Marsi in the Social War (or "war of the allies," 91–89). After the failure in 88 of P. Sulpicius Rufus' attempt to replace Sulla by Marius as commander in the war against Mithradates VI, he fled south (evading his pursuers in the marshes of Minturnae), and thence to Africa, returning the next year when Sulla had gone east, collecting an army and with L. Cornelius Cinna (*q.v.*) capturing Rome. There followed a hideous massacre of their political opponents, including Catulus, and for Marius a seventh consulship, for 86, which he survived 13 days (he died from natural causes).

His son Gaius Marius, consul in 82, committed suicide at Praeneste after Sulla's return and capture of Rome in that year. The family was then extinct and Marius' reputation was eclipsed until his nephew Julius Caesar replaced his trophies on the Capitol in 65. The lost sources from which ancient accounts of him largely derive were unfriendly: the historian Sisenna, an admirer of Sulla, and Sulla's own autobiography. Sallust's surviving *Bellum Iugurthinum,* written after Caesar's death, is a powerful, but not altogether uncritical, rehabilitation.

See also references under "Marius, Gaius" in the Index.

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(J. P. V. D. B.)

MARIVAUX, PIERRE CARLET DE CHAMBLAIN DE (1688–1763), French novelist, playwright and moralist, author of two novels among the most outstanding of the 18th century, and of plays second only to those of Molière in their popularity with French audiences, was born in Paris on Feb. 4, 1688. His father, Nicolas Carlet, took him to Riom (Auvergne), where he had been appointed comptroller of the mint, in about 1696. From 1710 to 1713 Marivaux, who had returned to Paris, studied without much enthusiasm at the École de Droit. He was already thinking of his first works. These were novels, some romantic, like *Les Effets surprenants de la sympathie* (1712–13), in imitation of Cervantes and Gautier de Costes La Calprenède; others semi-parodic and semi-romantic, like *La Voiture embourbée* and *Pharsamond* (1713, later entitled *Le Don Quichotte moderne*); and lastly, the satirical burlesque *Le Télémaque travesti* (1714, supplemented by *L'Iliade travestie,* in verse, 1714–16). These early works do not show an assured talent but they are interesting and unusual, and characteristic of a writer trying to find his way.

In 1717 Marivaux married Colombe Bollogne of Sens (d. *c.* 1723, leaving him a daughter, b. *c.* 1719, who was destined to become a nun). After his marriage Marivaux turned his attention to more serious writings: little satires on Parisians and coquettes; articles of literary criticism hostile to the *Anciens* and favourable to the *Modernes;* philosophic and moral reflections on the social classes, the condition of women, etc. These appeared as articles in *Le Mercure de France* (1717–20), then in a periodical of his own inspired by Joseph Addison and his Dutch imitators and entitled *Le Spectateur français* (1720–24). The same "philosophic" view, in the then current sense, showed itself in other journals, *L'Indigent Philosophe* (January–June 1727), *Le Cabinet du philosophe* (1733–34), and in plays, *L'Île des esclaves* (1725), *L'Île de la raison* (1727), which can be compared with *Gulliver's Travels,* and *La Nouvelle Colonie* (1729). This vein was also revealed in his discourses at the Académie Française, to which he had been elected in 1742, and in articles in *Le Mercure* (*Le Miroir,* 1755).

Marivaux's interest in the drama seems to have been inspired by meeting the Italian troupe brought to France by Luigi Riccoboni. Its most famous actors were Sylvia (Gianetta Rosa Benozzi) and Arlequin (Thomas Antoine Vicentini), for whom Marivaux wrote his best plays: *Arlequin poli par l'amour* (1720), in which the stage setting is of considerable importance, *La Surprise de l'amour* (1722), *La Double Inconstance* (1723), *Le Prince travesti, La Fausse suivante* (1724), *Le Jeu de l'amour et du hasard* (1730), *Le Triomphe de l'amour, L'École des mères* (1732), *L'Heureux stratagème* (1733), *La Mère confidente* (1735), *Les Fausses confidences* (1737), *Les Sincères* (1739) and *L'Épreuve* (1740). The plays produced at the Théâtre Français were fewer and less successful. The most notable, besides his tragedy *Annibal* (1720), are the comedies *Le Dénouement imprévu* (1725), the theme of which heralds Alfred de Musset's *La Nuit vénitienne,* the second *Surprise de l'amour* (1727), a variation on the play presented at the Théâtre Italien, *Les Serments indiscrets* (1732), his only play in five acts, *Le Legs* (1736) inspired by a comedy of Bernard de Fontenelle, *Le Testament, La Dispute* (1744) and *Le Préjugé vaincu* (1746).

All these plays—more than 30—make up a varied theatrical output, ranging from the pure comedy of intrigue (*La Fausse suivante*) to heroic comedy (*Le Prince travesti*); from the play of contemporary manners reminiscent of William Congreve (*Le Petit-maître corrigé,* 1734) to the fairylike fantasy (*Arlequin poli par l'amour*) or to the classical fantasy (*Le Triomphe de l'amour*). But in almost all are displayed his characteristic qualities: dialogue so spirited and witty that the word *marivaudage* has been coined to describe it, an acute sense of nuance and of the finer shades of feeling, a sensitivity and delicacy which never degenerate into mawkishness and do not exclude moments of downright boisterous comedy (*Le Jeu de l'amour et du hasard, Les Fausses confidences*). These explain the eminent position which Marivaux enjoys in the French theatre where, after Molière, he is the most acted playwright and one of the most living—a fact attested by the many productions of his least-known plays at, for example, the Théâtre National Populaire.

A playwright of unquestioned fame, Marivaux is also among the most gifted 18th-century French novelists. His *Vie de Marianne,* the 11 parts of which took 11 years to appear (1731–42), constitutes a considerable novelty in the history of the French novel: the celebrated "reflections" woven into the narrative gave a new dimension to the novel, exhibiting a technique which calls to mind that of Proust. *La Vie de Marianne* has been compared with Samuel Richardson's *Pamela.* In fact, the likeness is probably to be explained by a common source—*Les Illustres françaises* by Robert Challes (1713). But the comparison is interesting for the differences it reveals. Briefly it may be said that Marivaux's ethic is grounded neither in traditional morality nor in a cult of the passions but in respect for the human person as such, whether this be self-respect (as in Marianne, for example) or that respect for others demanded by Marianne and shown especially by Mme de Miran.

In contrast to *La Vie de Marianne,* which deals with aristocratic society and is dedicated to the glorification of woman's feeling and intuition, stands *Le Paysan parvenu* (1735–36), a novel dominated by Jacob, a young peasant with a peasant's failings (lack of excessive scruple, artless self-satisfaction, fickleness in love), but having a countryman's resources—good humour, crafty frankness and, in addition, sparkling eyes and a fresh complexion.

Shorter and terser than *La Vie de Marianne,* bolder too in the scenes where Jacob is *en tête à tête* with women older than he who are captivated by his person, *Le Paysan parvenu* is often regarded as Marivaux's romantic masterpiece.

Assailed by critics who, like the Abbé Desfontaines, accused him of *"néologie";* envied by Voltaire, who intrigued against him; and exercising his talents in fields which were looked upon as inferior (comedy and the novel), Marivaux did not become famous during his lifetime, as is shown by the fact that none of his correspondents preserved his letters. Pre-eminently *un bon et honnête homme,* he is the only man of letters of whom J. J. Rousseau speaks nothing but good. He had devoted friends in Houdar de la Motte, Fontenelle, Mme de Lambert, Mme de Tencin, C. A. Helvétius and Jean d'Alembert, but he survived most of them just as he survived his own reputation. Himself extremely charitable, he depended in his old age on the help of an old friend, Mlle de Saint Jean, and died in poverty in Paris on Feb. 12, 1763.

Bibliography.—The least faulty general edition of Marivaux is that of 1781 in 12 vol., which does not, however, include the satire *Le Bilboquet* (1713), never reprinted; the novel, *Le Télémaque travesti,* the greater part of which was unknown until the complete work was published in an edition by F. Deloffre in 1956; and several articles (cf. *Revue des Sciences Humaines,* 1954, pp. 5–24 and 97–115). Most modern editions reproduce a text arbitrarily adapted by the publisher of the 1825–30 edition. Only a few reproduce the original text of *La Vie de Marianne* and *Le Paysan parvenu* (Garnier, 1957); of some plays (*Théâtre choisi de Marivaux,* Sansoni, 1959, *Le Petit-maître corrigé,* 1955); and of *Le Miroir* (Libraria Scientifica Editrice, 1958). *See* also G. Larroumet, *Marivaux, sa vie et ses oeuvres* (1882), still useful in spite of errors and omissions; F. Deloffre, *Marivaux et le marivaudage* (1955); and, for its biographical importance, Mme M. J. Durry, *A Propos de Marivaux* (1960). Two discerning essays are those by G. Poulet in *Etudes sur le temps humain,* vol. ii, pp. 1–34 (1952), and that by Leo Spitzer, in reply, "A Propos de la Vie de Marianne," in *Romanic Review,* vol. xliv, no. 2 (April 1953). In English the most noteworthy studies are Ruth K. Jamieson, *Marivaux: a Study of Sensibility* (1941); K. N. McKee, *The Theater of Marivaux* (1958); and a special issue, devoted to Marivaux, of *L'Esprit Créateur* (winter, 1961). (F. P. D.)

MARJ, AL: *see* Barca.

MARJORAM, aromatic herbs or undershrubs, belonging to the genera *Origanum* and *Majorana* of the mint family (Labiatae). Wild marjoram (*O. vulgare*), a perennial native to Europe and Asia, is common in dry copses and on hedgebanks in England and is naturalized in the eastern United States. It has many stout stems, one to three feet high, bearing short-stalked somewhat ovate leaves and clusters of purple flowers. Sweet marjoram (*M. hortensis*) and pot marjoram (*M. onites*) are cultivated for their aromatic leaves, either green or dry, used in cooking; the tops are cut as the plants begin to flower and are dried slowly in the shade. *See* Food Preparation: *Herbs and Spices. See* also Flavour.

MARK, SAINT, evangelist, an apostle of first-generation Christianity and the traditional author of the second Gospel (*see* Mark, Gospel According to Saint). His symbol, therefore, has become the lion, the second animal at the throne of God (Ezek. i, 10; *see* Rev. iv, 7). In the New Testament, Mark is mentioned several times, but even an uncritical combination of this information produces only a very fragmentary picture. Furthermore, critical investigation has raised serious doubts about the historicity of most of the given data.

The only unquestionably reliable information is to be found in Philem. 24, where a certain Mark is mentioned as one of Paul's fellow workers who sends greetings from Rome to the Christians at Colossae. But there is no indication there as to the identity of this person. The information in Col. iv, 10, that the Mark of Paul's company was a cousin of Barnabas, may also be authentic, although the Pauline authorship of Colossians is not beyond doubt.

Acts xii, 12, 25 and xv, 37 speaks about "John whose other name was Mark," and xiii, 5, 13 simply says "John"; but elsewhere in the New Testament he is known by his Latin surname Mark (a name related to that of the god Mars). Acts also relates that his mother's house in Jerusalem was a centre of Christian life (xii, 12), and that Barnabas and Paul took him along to Antioch (xii, 25) whence he became their assistant on a mission journey (xiii, 5). When they arrived at Perga in Pamphylia, however, Mark left them and returned to Jerusalem (xiii, 13). According to Acts, this was the reason why Barnabas and Paul later separated, because Barnabas insisted on giving Mark another chance, while Paul declined (xv, 37–39). Subsequently, Mark sailed to Cyprus with Barnabas, never to be mentioned again in Acts.

The dependability of the Acts account is highly questionable. The writer of Acts is particularly interested in finding a reason for the breach between Paul and Barnabas, and probably introduces the rather colourless figure of John Mark for this very reason; but in so doing, he contradicts Paul's own account (Gal. ii, 11–14). What did the author of Acts actually know about Mark? Apparently he had only the information contained in the Pauline Epistles; *i.e.,* he knew about a Mark who was mentioned among Paul's company as a relative of Barnabas.

II Tim. iv, 11, which pictures a forsaken Paul requesting Timothy to bring Mark "for he is very useful in serving me," is almost certainly a pseudepigraphic synthesis of data from Acts and Colossians. Greetings from "my son Mark" are included in I Pet. v, 13, which was written from Rome ("Babylon"), and a close relationship between Mark and Peter also is suggested by Papias' presbyter tradition, which identifies Mark as the interpreter of Peter and thus the author of the Petrine Gospel. But this seems to be a wishful identification aimed at giving the Gospel greater authority. If I Peter is spurious, as many scholars are convinced, its mention of Mark is a part of the device of pseudonymity which only proves that the tradition connecting Mark with Peter and Rome goes back to the end of the 1st century A.D.

Later tradition assumes that Mark was one of the Seventy (Luke x, 1), and identifies him with the young man fleeing naked at Jesus' arrest (Mark xiv, 51 f.). The tradition first mentioned in Hippolytus (*Refutation,* vii, 30, 1) metaphorically calls Mark "shortfingered," since his Gospel is the shortest of the Gospels. Mark also was claimed by the Egyptian church as its founder, and from the 4th century A.D. the Alexandrian see has been called *cathedra Marci.* Dependent on the tradition that connected Mark with Peter and Rome, the church of the once important city of Aquileia (north Italy) traced its origin back to Mark. After the destruction of Aquileia by Attila in A.D. 452, its refugees founded Venice, of which Mark became the patron saint (a fantastic legend tells how Venetian merchants stole Mark's remains from Alexandria), and Venice's glory and predominance gave Mark's winged lion widespread fame throughout the middle ages. St. Mark's feast day is April 25.

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MARK, the name of the monetary unit of the Federal Republic of Germany and of the German Democratic Republic. In the 19th century the mark was a common small coin in the German states, but its value varied between areas. In 1873, soon after creation of the German empire, the gold mark, equal to 100 pfennigs, was adopted as the standard of value and the money of account for the empire. Its value was 6.146 grains of gold, 900 fine. After the inflation of 1923, when the mark collapsed, the *Rentenmark* was introduced and was made equal to one gold mark. In 1924, when Germany went on the gold exchange standard, the reichsmark (RM.) was issued and was made equal to the *Rentenmark.* After World War II, when the reichsmark collapsed, the currency reform of June 1948 replaced the reichsmark with the deutschemark (DM.) worth 100 pfennigs, issued by the newly established Bank Deutscher Länder in West Germany. In the same month the currency reform in the eastern zone also introduced the deutschemark. On March 5, 1961, the International Monetary Fund parity of the deutschemark of West Germany was revalued at 4.00 = 1 U.S. dollar, and its content at .222168 grams of fine gold per unit. As of March 31, 1963, the official basic rate of the ostmark of East Germany was 2.22 = 1 U.S. dollar; the valuta-mark, 4.20 = 1 U.S. dollar; and the black market rate, 15.60 = 1 U.S. dollar.

The early history of the term can be traced back at least to the 11th century when the mark was mentioned in Germany as a unit

of weight (approximately eight ounces) most commonly used for weighing gold and silver. In the 12th century it began to displace the older Roman-Frankish pound. It was widely used in Cologne during the 12th and 13th centuries, and the Kölnische mark became the standard weight throughout the Holy Roman empire. As a unit of account it was employed during the middle ages for payment of large sums; the small silver coins of different sizes and finenesses were melted and cast into lumps on which were stamped the weight and the purity of the silver. The latter were called Usualmark. (Jo. M. L.)

MARK, GOSPEL ACCORDING TO SAINT, in canonical order the second of the four Gospels of the New Testament. As the earliest of the three so-called Synoptic Gospels it was used as a source by the others, Matthew and Luke (*see* GOSPEL). Since Mark also was probably the first Gospel ever written, its outline of the life and ministry of Jesus can be considered as the first attempt to present the whole tradition of Jesus in a continuous "story."

Composition.—The core of Mark's Gospel is the Passion narrative, which Christian tradition already had formulated on the basis of the actual order of events in Jesus' trial, Passion and death. This comprises about 40% of Mark (in Luke, it is only 20%). To this core, the author of Mark added other traditional materials (mainly narratives), thereby extending the Passion narrative backward into a life of Jesus. The term Gospel, which originally meant the oral preaching about Jesus' death and resurrection, was used for the first time in Mark as the leading motif for a literary composition concerning the entire story of Jesus. Since in Mark this term occurs exclusively in editorial sentences, it was clearly the author of Mark himself who applied the word Gospel to tradition that previously had not been so designated. Therefore, the author of Mark may justly be called the creator of the early Christian literary form, Gospel.

The outline of the Gospel of Mark is certainly more primitive than that of Matthew and Luke, but it is nevertheless largely the result of the author's own editorial work and reflects his own theological understanding of Jesus. The framework of the Gospel contains very little reliable historical information. Only a few geographical references and personal names already were associated with the narratives used by Mark; *e.g.*, Capernaum (i, 21; ii, 1), the Sea of Galilee (i, 16, etc.), Dalmanutha (viii, 10), Caesarea Philippi (viii, 27), John the Baptist (i, 4–11; vi, 14–29, which also includes Herod) and Peter (viii, 27–29). Especially in the Passion narrative, persons and places are original elements of the tradition.

But beyond these few instances, the framework of Mark is an artificial device by which originally isolated stories are combined and some kind of chronological sequence is established (*see*, for example, the common phrase "from there he went to . . ."). Some scenery is always at Mark's disposal to give life to the picture, as "the sea" (ii, 13, etc.), "the other side of the sea" (v, 1, 21), a "lonely place" (i, 35; vi, 32), "hills" (iii, 13, etc.) or the "synagogue" (i, 21 ff., etc.). Seldom is a direct chronological connection made except during the Passion week narrative. The persons pictured in the Gospel are partly the author's own editorial work, partly already presented in the tradition. The "crowd" (ii, 13 ff., etc.) serves as the background for Jesus' acts and preaching, and is artificially introduced and quickly forgotten; the opponents appear abruptly whenever they are necessary for a controversy; the disciples frequently are nothing more than a foil for Jesus' miraculous power, belonging to Jesus' company as a matter of course, but scarcely anywhere acting as independent personalities.

Mark is not, however, simply a mechanical compilation by means of such technical devices, but both in its essential structure and in its details it is thoroughly governed by theological principles. These are most evident first in the arrangement of the traditional material, second in the short comprehensive summaries of Jesus' activity inserted by the author himself (i, 32–34; iii, 7–12; vi, 53–56), and finally in the introductions and conclusions he has added to many traditional stories.

Outline.—Mark's Gospel deals with the following:

i, 1–13:	"Beginning of the Gospel" (the Baptist)
i, 14–viii, 26:	the Galilean ministry
i, 14–iii, 35:	first disciples, healings and controversies
i, 14–ii, 12:	activity around Capernaum
ii, 13–iii, 12:	first conflicts
iii, 13–35:	first crisis and separation (calling of the Twelve, Beelzebul controversy, true brethren)
iv, 1–viii, 26:	around the Sea of Galilee
iv, 1–34:	mystery of the parables
iv, 35–v, 43:	the great miracles (tempest, Gadarene [Gerasenes] demoniac, Jairus' daughter)
vi, 1–56:	the great events (Nazareth, death of John the Baptist, sending of the Twelve, feeding of 5,000)
vii, 1–viii, 26:	the great controversy (clean and unclean, healings and feeding of 4,000, discourse on signs and leaven)
viii, 27–x, 52:	from Galilee toward the Passion in Jerusalem
viii, 27–30:	confession of Peter
viii, 31–ix, 29:	the right understanding of discipleship (transfiguration)
ix, 30–x, 31:	problems of discipleship (discussions about greatness, offense, marriage, the rich young man)
x, 32–52:	Christ and the disciples on their way to Jerusalem (the sons of Zebedee)
xi, 1–xv, 41:	the Jerusalem ministry and the Passion
xi, 1–xiii, 37:	the closing ministry
xi, 1–11:	first day: entry into Jerusalem
xi, 12–19:	second day: cleansing of the Temple
xi, 20–xii, 44:	third day: Jesus' authority—the wicked husbandmen; controversy with Jerusalem's leaders (tribute to Caesar, great commandment, David's son)
xiii, 1–37:	mystery of the future ("the Little Apocalypse")
xiv, 1–xv, 41:	Passion of Jesus
xiv, 1–42:	the preparation (anointing, betrayal, Last Supper, Gethsemane)
xiv, 43–xv, 20:	the trial of Jesus
xv, 21–41:	crucifixion and death
xv, 42–xvi, 8:	conclusion (burial and empty tomb)
(xvi, 9–20:	spurious ending: the appearance of the Risen Lord)

Themes.—The introduction makes it clear that the "Gospel" means not only Passion and Resurrection but the entire Jesus event. The story of Jesus' temptation (i, 12–13) shows symbolically the meaning of Jesus' activity. It is the eschatological battle between God and Satan in history.

The first main section of the Gospel depicts this struggle in a strange way. Jesus' ministry is limited to Galilee, which He leaves only occasionally (Decapolis, Tyre) and never for Jerusalem. Almost all of the Marcan miracle stories are found in these first eight chapters, and except for the parable chapter (iv) this section contains almost no sayings and few discourses. Thus the "Galilean ministry" is concerned with the revelation of Jesus' messiahship in his mighty works. But this is at conflict with another motif found in Mark's editorial comments—the "Messiah secret": (1) Jesus repeatedly forbids public announcement of his messiahship (i, 34, 44, etc.); (2) he speaks in parables in order to prevent the crowd from understanding the message (iv, 10–12, 33–34); (3) even the disciples appear to be completely blind and without understanding of Jesus' messiahship (vi, 52; viii, 14–21). Without any doubt such a description of Jesus' ministry contradicts both the historical reality and the tendency of the already messianized narrative traditions used by Mark. But in extending the primitive Gospel (that the Messiah has paradoxically overcome the Satanic powers in his suffering and death) to include Jesus' life, Mark is primarily interested in the theological comprehension of that life. Accordingly, the Marcan edition of Jesus' life emphasizes his *mysterious* struggle for power with Satan in history. For Mark, the fact that the Messiah had to suffer necessarily implies that Jesus' ministry had to be described as concealed revelation.

Peter's confession (viii, 27–30) is an exemplary description of one acknowledging Jesus as the Christ, but it is rebuked since it does not also include the recognition that the Messiah has to win his battle through suffering and death. This becomes the theme of the central part of the Gospel, where both Jesus' messiahship and the anticipation of suffering are disclosed to the

disciples. Miracle stories are incidental to this section (only ix, 14–29 and x, 46–52). Instead, Mark assembles stories and discourses that are concerned with the disciples' facing suffering. Predictions of the Passion run through these chapters like an unbroken thread (viii, 31; ix, 31; x, 32–34), not as a recollection of the actual psychological preparation of the disciples for the Passion, but as a presentation of those traditions which Mark considers to be the very centre of Jesus' message for the church. In contradistinction to the other Gospels (Matthew and Luke) Mark does not portray Jesus primarily as preaching the coming of the Kingdom, but as calling his "disciples" (*i.e.*, the church) to participate in his own eschatological struggle with Satan.

The last part of the Gospel presents Jesus' ministry in a strikingly different way. The location is restricted to Jerusalem; miracle stories are totally lacking; Jesus' action is now pictured as attack and victory much more than before (*see* especially the great discussion with Jerusalem's leaders in xii, 13–44); and the motif of concealment is missing. The entry into Jerusalem and cleansing of the Temple present Jesus in the open display of his messiahship. The so-called Synoptic Apocalypse (xiii), a purposeful arrangement and interpretation of (partly Jewish) apocalyptic traditions, stresses that the church will have to continue Jesus' fight in history until the Second Coming and the final consummation. The first fruits of the victory are Jesus' Passion and death, and the church can only follow her master with fear and trembling into the ongoing battle (x, 32; xvi, 8). Despite the fact that the disciples were aware that, paradoxically, suffering was the victory, their behaviour during Jesus' Passion was complete failure (xiv, 27–31, 32–42, 50–52, 66–72). Thus Mark depicts Jesus' Passion and death as a continuing "scandal" for those to whom the secret of the Messiah already has been disclosed in the Resurrection (ix, 9; xvi, 1–8).

Literary History.—The last verse of the authentic text of Mark is xvi, 8. The verses that follow (9–20) in many Greek manuscripts and in almost all Bible translations are missing in some of the best manuscripts and are clearly a summary compiled later. Their originality already was doubted in the ancient church (Eusebius, Jerome). A shorter alternative ending contained in certain manuscripts is likewise spurious. Scholars are divided about whether the peculiar last sentence of the authentic text ("for they were afraid") was intended to be the original ending, whether Mark was perhaps prevented from completing the Gospel, or whether he wrote another ending that is now lost.

The related question, whether Mark is preserved in its original form at all, has led to several attempts either to reconstruct a Proto-Mark (*Urmarkus*) or to discover extensive written sources that provided the pattern and most of the material for the present Mark. Although none of these attempts has found wide acceptance, the problem of the "original Mark" admits to no facile solution. The hypothesis that the present Gospel is a Greek translation of an Aramaic original is to be rejected. Certainly it contains some Semitisms, often caused by the originally Aramaic traditions used by Mark; nor is its Greek style that of a well-educated Hellene, since it contains many colloquialisms; but it cannot be doubted that its original language was Greek. It is equally sure that Matthew and Luke used a Greek text of Mark, although there is some evidence that their edition of Mark was not identical with ours. Neither Matthew nor Luke contains anything to correspond with Mark iv, 26–29; viii, 22–26; xiv, 51–52, and there are a few minor "common omissions" (*e.g.*, Mark xi, 10a). Matthew and Luke also seem to preserve a more original wording in certain common synoptic pericopes. But if such instances suggest the existence of an "original Mark," it is also clear that it was only slightly different from the present text.

The questions of authorship, date and place of the Gospel are still debated. The use of Mark by Matthew and Luke establishes a date earlier than about A.D. 80. All attempts have failed to establish a close connection between the Neronian persecution (A.D. 64) or the Jewish War (A.D. 66–70) and the writing of Mark. A time shortly before A.D. 70, but certainly after Paul, would be possible, unless Mark xiii, 2, 14 is to be taken as "prophecy arising from the event" (*i.e.*, formulated after the destruction of the Temple in Jerusalem); if this is true, the years A.D. 70–80 would fit best. The earliest information about Mark is a presbyter tradition in Papias, bishop of Hierapolis (about A.D. 140, quoted by Eusebius in his *Church History*):

> Mark, who had become the interpreter of Peter, wrote accurately the things said or done by the Lord, though not in the right order. For he had neither heard the Lord, nor had he been his follower, but later, as I said, he had followed Peter, who composed the teachings for his needs, but not as if making a composition of the sayings of the Lord. Therefore Mark committed no sin in writing certain things just as he remembered. For he had only one concern: to leave out nothing of what he had heard nor to include anything false.

Some consider this tradition to be a trustworthy indication of the Petrine basis (and perhaps also Roman origin) for the Gospel. But the picture of Peter traveling with an interpreter for his "courses of instruction" is as questionable as the suggestion that the "recollection of the Apostles" and their followers was the connecting link between Jesus and the written Gospels. Furthermore the statement about the disorder of Mark's Gospel is plainly wrong, and the role of Peter in the Gospel does not suggest the specifically Petrine origin of its material; nor does its character in general indicate that the Gospel was written by someone like Mark, who is mentioned in the New Testament as a personal companion of the Apostles (*see* MARK, SAINT). Papias' statement springs from a desire to establish the authorship of an Apostle, or at least of a direct follower, for certain writings used by the church, and is therefore not reliable. This leaves us almost completely in the dark about the author of Mark, and about the place of origin as well. That the *Shepherd* of Hermas (Rome A.D. 100–150) used Mark cannot be substantiated. It is not impossible that Justin knew it. But until Tatian, who composed a harmony of the four Gospels in Syriac (about A.D. 170), and Irenaeus, who values Mark as one of the four canonical Gospels, there is virtually no trace of Mark's being used, except in other Gospels (Matthew, Luke and the apocryphal Gospel of Peter). Later evidence comes from Rome, but this does not imply anything about the place of Mark's origin a century earlier (nor do Mark's Latinisms strengthen the argument for its Roman origin). It is just as reasonable to hold that Mark was written somewhere in the Greek-speaking church in the east (Syria or Asia Minor), where Matthew and Luke found and used it.

See also BIBLE.

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MARKET. The word "market" or some similar term derived from the Latin *mercatus* appears in most European languages and always refers to the place or method of contact between buyer and seller. The contact may be relatively simple, direct and personal, as in a market place, meat market or farmer's roadside market. It may be a highly organized institution such as those for securities, cotton or grain; or it may be concerned with factors of production rather than with products.

Early History.—Historically the word meant a place at which buyers and sellers met at set times to do business, under certain rules and regulations, in certain kinds of goods. Lack of markets is one sign of a primitive community. With a growth in specialized production and trade, it became necessary for buyers and sellers to meet together and markets thus became the nuclei around which towns developed. Markets held at long intervals, such as 3,

6, or 12 months, were called fairs. Business conducted by peddlers or in private retail stores or warehouses or by personal orders was not regarded as taking place in the market proper.

In ages when the volume of trade was small and transportation difficult it was helpful for sellers to know that if they took their wares to a certain spot on an appointed day they would find buyers gathered there. This knowledge centralized supply and demand, saved time and stimulated production for sale. Produce that became available only at certain seasons—wool, grain, cotton, furs, young livestock, etc.—could be disposed of at the end of the productive period in an annual fair. Commodities that were produced the year round—particularly perishable foodstuffs such as butter, cheese, eggs and fish—would need to be sold weekly at a market. Further, while a producer of seasonal commodities would not mind a long trip to a remote fair once a year, the seller of goods that were produced continuously needed some nearby market. He could not afford to spend more than one day a week taking his goods to market, selling them, buying what he required and then returning home.

While fairs were, therefore, located relatively far apart, markets had to be thickly sprinkled over settled areas. If, however, they became too numerous, the supply of goods or of buyers in each might be inadequate or uncertain, and the market-owner's income from tolls, stall dues and other charges would decline. During the rapid expansion of the western European economy in the 13th century the supply of markets seems to have outrun the demand to such an extent that strong efforts were made to prevent new ones from being set up wherever they might injure existing ones. Lawyers urged that markets should be at least two leagues (six miles) apart. This figure was probably quite reasonable and acceptable; it was near to the seven-mile radius which even in the early 19th century protected the markets in London from excessive competition; and it emphasized the essentially local character of the business transacted in the market.

Some markets remained general in character and were chiefly devoted to the exchange of farm produce for urban manufactures. John Ramsay M'Culloch, in his *Dictionary of Commerce and Commercial Navigation* (1835 edition), defined a market as "a public place in a city or town where provisions are sold." Producer and consumer met there face to face. Such contact was maintained not only in buildings or open spaces set aside for the purpose, but in the market squares of county towns and the so-called street markets of cities like London. If an area specialized in some staple product, however, middlemen would flock there to obtain their supplies for a wider national or foreign market. Classic illustrations of this condition were the cloth markets of Yorkshire and other textile areas. To them, small producers residing within a radius of not more than five or six miles brought their weekly output of one or two pieces of cloth and sold it to merchants, commission agents or factors. Held at first in a main street or market place for a fixed period of time on the regular market day, they were eventually transferred indoors when large "cloth halls" were built, often sponsored and financed by the merchants who bought the fabrics. Larger producers did not rely on such local outlets, but sent their wares in bulk to the central market at Blackwell hall in London.

Similar developments took place in many continental markets. In Bruges, Belg., for example, the large, open market place had by 1240 become flanked on one side by a *halle* in which cloth was sold on three days each week. By 1300 a second hall, the Waterhalle, was built astride a small river so that goods could easily be unloaded, and was open every day. A third hall, the Cruudhalle (Spice hall), appeared, to serve as market centre for Spanish wool, drugs, spices and other goods from the Mediterranean.

Legally a market was the property and source of income of the person on whose land it was held or to whom it had been granted. In feudal society subordinate landowners sought from their superiors the right to hold a fair or market; and in modern states the same rule may prevail, that the right has to be obtained from the government. The charter that granted the medieval franchise gave the owner power to collect tolls on goods sold—or even on all goods displayed—and fees for the use of stalls; it protected his clients from competition by restricting sales in stores on market day; occasionally it conferred the right to operate a mint. In return it explicitly or by implication imposed the obligation to see that the "king's peace" or the "peace of God" prevailed and to preserve law and order in market transactions. This involved the provision of a market court to deal promptly with disputes concerning sales, disorder or violations of the regulations concerning weights and measures, price or quality. A clerk of the market had to be provided to approve all weights and measures, and a steward to preside over the court. Some markets passed eventually into the hands of the towns in which they were located; but private or corporate persons continued to seek permission to establish markets well into modern times, as for example the grant of Covent Garden market to the duke of Bedford in 1671.

Modern Trends.—In the late 18th and early 19th centuries many large towns arose, factories sprang up in many areas and commerce grew in volume. Wherever goods came to be made in factories by fewer, larger units, private buying and production-to-order bypassed cloth halls and similar markets; these therefore declined and were finally closed down.

On the other hand, the vast numbers of urban consumers could no longer deal directly with the rural food producers, especially where supplies came from a wider national or international area. With fast transport, bulk handling, refrigeration and the use of warehouses, goods could readily be moved and stored; but to conduct the attendant commercial transactions meant that many more men became intermediaries, such as agents and brokers, wholesalers and retailers. The pattern of distribution became at once more advanced and more complicated. Retailing in particular was transformed, as specialized shops increased in numbers and department stores developed in the late 19th century. Consumer retail markets declined in relative importance, but at the same time wholesale markets, including markets dealing in international products, became increasingly organized. The "extent of the market" as well as the variety of markets became a criterion of economic growth.

The processes of change were world-wide, but the chronology varied from country to country. The history of most expanding European cities in the early 19th century reveals the efforts made by private or civic enterprise to extend the accommodation for both wholesale and retail purchases. The five great London chartered markets—Billingsgate, Leadenhall, Smithfield, Spitalfields and Covent Garden—outgrew their local traditions and became national centres of distribution, but the local street markets survived. There were 15 Sunday morning street markets held in the middle of the 19th century. An attempt to replace East End street markets with a large new covered market (Columbia market) in 1869 failed to win popular support. In provincial cities the pattern of marketing changed considerably. For instance Leeds, a Yorkshire cloth centre, more than trebled its population between 1801 and 1851. In 1801 it had a weekly market for grain, cattle and hogs, and a twice-weekly one for cloth and provisions. By 1851 it had added a fortnightly fair for cattle and sheep and eight periodical leather fairs each year; it had removed the markets for provisions and livestock from the narrow main street, created a large open "free market" area for use by farmers and set up a meat market with an underground slaughterhouse. Meanwhile groups of investors had erected buildings for a bazaar, a meat and fish market, a central provision market, a corn exchange, leather fairs and a stock exchange. It was only in the later 19th century that a new "shopping area" reduced the relative importance of the consumer retail markets.

On the continent also, private and municipal markets were expanded as population became more dense. The construction of central markets (*halles centrales*) in Paris during the reign of Napoleon III was one of the most ambitious market undertakings. Napoleon I had been impressed by the congestion of the ancient market district and ordered the building of spacious new markets, but the expropriation and clearing of part of the site were the only accomplishments before 1815. The Parisian municipal authorities took up the matter again in the 1840s, but it was only when Napoleon III gave the project a first priority in his building program

that real progress was made. Work started in 1851 and eventually ten pavilions were completed, each with a light ironwork structure. Together the new central markets comprised an area of 21 ac., nearly half of it covered. Two more pavilions were added in the 1930s. The 19th-century Paris market buildings were models of their kind, serving the needs of both retailers and consumers. They were only one sign, however, of the initiative of Paris during this period. The city was also the first centre of the large department store. In most other parts of Europe the market remained the dominant retail centre.

In North America the European type of market developed naturally, rather than as the result of charter grants, to meet similar requirements, and in its simplest form can still be seen in operation in the market squares or halls of some of the older towns. The expectation of getting fresher or cheaper produce from a farmer still takes customers there in spite of the lavish array of retail stores. Of larger markets to supply retailers as well as consumers, the Fulton fish market in New York city or the Faneuil hall market in Boston are examples. Rapid urbanization and the rising cost of living after 1900 stimulated interest in efficient and economical marketing and led to considerable activity in providing city markets. Private businesses, especially the railroads, began to establish terminal markets at which country produce could be unloaded and displayed for sale. But in most of the public markets the customer is rarely the consumer. The spread of suburban stores and supermarkets, the extension of chain stores, the congestion of traffic around public markets, the production of branded consumer goods and the pull of advertising have all minimized the role of the public market in the system of distribution.

Retail markets are economic institutions geared to the economic life of societies that have not reached what is regarded in the 20th century as an advanced stage of economic and social development; they predominate in societies where alternative retail institutions are not well developed and where large numbers of people have relatively low incomes and plenty of time and are willing to haggle about prices. The best contemporary examples of traditional consumer markets are found in the middle east.

International commodity markets with wholesalers and brokers at the centre grew in importance in the 17th and 18th centuries, and during the 19th century became highly organized. Amsterdam was the first great modern international market centre, but during the 18th and 19th centuries London became the undisputed capital of international transactions both in money and in goods. For some commodities, notably cotton and wheat, a "futures" market was organized. The Liverpool Cotton exchange was the scene of regular and intricate dealings of this kind. In the case of many other commodities, such as wool, tobacco and tea, accurate grading is difficult at a distance and sales in those markets took place by auction on the basis of samples, or by private treaty. The organized produce markets themselves faced difficulties during the 20th century. Dislocation of international trade, caused by war or by economic depression, led to the development of bulk purchase and controlled trade and the emergence of separate economic blocs which sometimes bypassed the international markets altogether. Policies of international commodity control were advocated and in some instances pursued. The supremacy of London, particularly in the money and capital markets, was challenged, in some cases successfully. Nonetheless many of the markets survived and some of them took on a new lease of life after the middle of the 20th century.

Conceptions of "freedom" and "control" have influenced the history of markets during the 19th and 20th centuries. Free-trade arguments that were first applied to the market for commodities, particularly corn, were later extended to the land and labour markets, which some people argued should be as free as the rest. During the 20th century the "laws of the market," particularly of the "labour market," were deliberately set aside. In most instances this was part of national policy. Control, if not of the market, at least of particular markets or of particular aspects of the market, came to be regarded as a necessary, if still controversial, activity of government. *See* also EXHIBITIONS AND FAIRS.

(H. HEA.; A. BRI.)

ECONOMIC THEORY

In economics, the phrase "a market" refers to a set of interrelated buying and selling activities. The terms "buying" and "selling" are taken in their broadest senses. They include hiring, lending and forward trading (the present purchase and sale of a commodity to be delivered in the future). Economists speak of the labour market, the money market and the market for secondhand cars, as well as of markets for newly produced consumer goods. The existence of a market does not require the existence of a market place. The buyers and sellers of a commodity may never meet, and some of them never even see the commodity in which they deal, but they will still be described as trading in a market.

Market forms are distinguished according to the number of buyers and sellers, the degree of relevant knowledge they have, how easily additional traders can enter the market and how far the commodity dealt in is homogeneous. At one extreme is the perfectly competitive market in which there are so many buyers and sellers that none can singly influence the price of the commodity. Each of them takes price as given and determines what quantity he will buy or sell. It is assumed that all buyers and sellers are aware of any price quoted on the market and the costs of production of the commodity, that there are no hindrances to movement in or out of the market by buyers or sellers and that the commodity is homogeneous (all sellers offer identically the same product).

Examples of approximately perfectly competitive markets are the international markets in primary products such as wheat, wool, copper and tin, and those trading in a particular security on the stock market. The conditions for perfect competition are met reasonably well on a day-to-day basis: the commodities are homogeneous; as a rule no individual buyer or seller can exert a significant influence on price; and all buyers and sellers are in a position to know the prices at which trade takes place. Should one seller or group of sellers offer the commodity at a price below that being offered by sellers in a different part of the market, arbitragers will purchase from the former to sell to the customers of the latter; this arbitrage brings the prices quoted in the two sections of the market into line.

Opposed to perfect competition is the market form of monopoly, where there is only one seller and no others can enter the market. The pure monopolist assumes that the quantity of his commodity that he can sell depends on the price he charges; the lower the price the more he can sell, and he selects the price at which his profits are greatest. No actual monopoly is ever quite pure, although the granting of patents and other state-conferred rights may temporarily produce a market form which closely resembles pure monopoly.

What often develops in practice is the mixed case of monopolistic or imperfect competition. In this, each firm's product is recognizable as its own; *i.e.*, there is differentiation of product; the firm may be said to have a monopoly in it. But there are many firms producing very similar products, so that together they form a market which is competitive. In such markets firms do not compete solely by price variation. Advertising, brand names, changes in quality and the provision of ancillary services are all recognized and used as means of increasing sales and profits. But the threat of potential competitors ensures that the rate of profits does not rise to an abnormally high level: if it does, new firms will be attracted into the market, bidding away customers and thus making existing firms less profitable. A great many markets are of this last type, particularly in retailing and in the making of consumer goods, where firms possess the consumer's "good will"; they may thus raise prices without losing all their customers.

A valuable distinction is made between those markets in which firms do not take account of other firms' behaviour and those in which they do. The latter are called oligopolistic. Each firm in an oligopoly must consider whether raising the price of its goods will cause another firm to follow suit. There is interdependence between firms; none can determine the outcome of its own actions without taking account of possible reactions by other firms.

Price competition in oligopoly often leads to unstable situations in which prices fluctuate considerably. But generally the market

tends to settle down, and competition occurs mostly through those nonprice variables that mark monopolistic competition.

Instead of firms fixing their own price, they may all follow the price quoted by a leading firm—perhaps the largest one in the industry, which thus exercises price leadership. Collusive or restrictive behaviour occurs where oligopolistic firms disliking the results of competition agree formally or informally to outlaw certain practices. They may come to some arrangement every year as to the prices to be quoted, the discount to be given for exceptionally large purchases and even how the market is to be split up among themselves. To maintain such practices, especially those connected with market shares, it is necessary to exclude potential competitors. This may happen naturally because of the great costs of entering the market on the supply side; otherwise the existing firms may devise schemes specifically preventing new competition. Thus, the oligopolists try to transform the market into a monopolistic one.

Interdependence makes most actual markets oligopolistic. Typical examples are the steel, chemical and motor industries, in which the number of firms is small. All these market forms depend on the various conditions of supply and entry, but not on possible differences on the demand side. But corresponding to monopoly and oligopoly, there are also markets with a single buyer (monopsony) and few buyers, each reacting to the others (oligopsony). These may be combined with their supply counterparts to produce such market forms as bilateral monopoly, one buyer facing one seller, and bilateral oligopoly, few buyers and few sellers. They are of special interest because within them occurs an important type of behaviour, namely bargaining, with its related phenomena —threats, reserve strength, arbitration and the maintenance of secrecy. The chief example is the labour market in which wage rates and conditions of work are determined collectively by trade unions and associations of employers. Prices, quantities and quality are not fixed solely by the forces of demand and supply: equally important are negotiating ability and the ability to withstand a failure to agree.

So far no account has been taken of dynamic aspects. Since decisions take time to work themselves out, a situation may in the short run be best described in terms of one market form, whereas in the long run it may correspond to an entirely different one. For example, if there is free entry, but it takes a long time for new competitors to appear, from the short run point of view this may be an oligopolistic market, but given time for adjustments to take place, a monopolistic competitive one.

See also references under "Market" in the Index. (M. H. P.)

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MARKET GARDENING: *see* HORTICULTURE.

MARKET HARBOROUGH, a manufacturing and market town and urban district of Leicestershire, Eng., on the Welland river, 15 mi. S.E. of Leicester by road. Pop. (1961) 11,535. The church of St. Dionysius (*c.* 1250) has a very fine broach spire. The Robert Smyth's grammar school, founded in 1614, occupies modern buildings, but the original half-timbered building, raised upon pillars of wood, remains. Industries include rubber, textile goods, corsets, light engineering, patent foods, accumulators (storage batteries) and shoe heels. As the market town for a large agricultural area, the cattle and general markets have been held on Tuesdays since about 1200. Market Harborough is a famous fox-hunting centre. Dingley hall (2½ mi. E.) is Elizabethan and later and has a fine gatehouse.

MARKET INDEX, a term used in marketing and economics with two different meanings. In one sense, it refers to a statistical indicator of business activity in one or more industries. The Dow-Jones daily average of the prices of 30 selected industrial stocks and Standard & Poor's 500-stock composite index are the leading examples of indexes of stock-market activity. Similarly, the Federal Reserve index of industrial production can be interpreted as a market index of activity in U.S. mines and factories. Electric power output, regional income estimates, expenditures on new construction and life insurance sales are further examples of market indexes in this sense.

In its second and more restricted sense, a market index measures the actual or potential capacity of the population, or a segment thereof, to buy an article or service offered for sale. Some market indexes limit the scope of the term in this sense to the allocation of sales among territories, in which case the market index becomes a series of percentages, each estimating the proportion of total sales that should be made in a particular region. Others, however, extend the term to cover forecasting of total sales, thereby using it more or less synonymously with "sales forecast" and "sales potential."

In some cases, a single indicator, such as retail sales, or a general index, such as the *Sales Management* estimates of effective buying income, is considered sufficiently representative of product sales to be used as the "specific" market index for the product. More often than not, however, the specific market index is derived as a composite of the main factors believed to affect sales of the product. These may include variables measuring national business conditions, as well as those of industry, and even company, factors.

There are at least two main methods of determining the index in such a case. One method involves modifying actual sales figures on the basis of a rule-of-thumb judgment (sometimes supplemented by field surveys) as to the effect and relative importance of other factors (population, prices, sales of competing products, etc.) and deriving forecasts by extrapolation. The other method seeks to derive an equation reflecting the numerical effect of each of the main relevant variables on product sales. Thus, the sales of Company Y's gas refrigerators in a given year may be found to depend on national income in that year, availability of natural gas, number of families, number of salesmen representing the company and the company's advertising expenditure. With the aid of statistical (correlation) analysis, an equation can be set up reflecting the extent to which these variables affect sales. Sales estimates or regional sales allocations for a future period are then obtained by making assumptions as to the probable values of these variables in that period and substituting these values in the equation. The application of this method has been facilitated considerably by the advent of electronic computers.

Whatever the method used, the result provides an index of the possible (or potential) market for the product and thereby aids the firm in evaluating past operations and in planning future operations. It enables sales quotas to be set by territories and predictions to be made of the effect on sales of such changes as a 10% increase in advertising expenditure or a given percentage rise in population.

A market index is usually reliable only as a measure of past performance, and often possesses major limitations even in this sense. Experience shows that market indexes are more accurate in estimating territorial distribution of sales than in forecasting their total amount. Their use as a forecasting tool is invariably predicated on the implicit extrapolation of past relationships into the future. Faulty judgment regarding the future course of the variables incorporated in the market index is another serious source of error in forecasting. Over-all market forecasts tend to be most accurate when product sales continue in the same direction as in the recent past, but are likely to err considerably when business activity changes direction. *See* also ECONOMIC FORECAST.

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MARKETING. The meaning of the term "marketing" has broadened considerably in the 20th century. It is now generally understood to comprise all the activities involved in the movement of goods from producers to final consumers. It often includes some initial processing, but not treatments which change radically the nature of the product. For some products there may be several phases of marketing, as, for example, when metal is first offered for sale as such and later again comes on the market as machinery, or when cotton is first offered raw in bales, then as spun yarn, later as cloth and finally as a shirt.

There are narrower senses of the term "marketing." To housewives in the United States it may mean only shopping for food, whereas some businessmen use it to mean the specific technique of selling their products. Such usages reflect aspects of marketing with which particular groups are especially concerned.

Historical Development.—In subsistence societies each individual or family unit collects, harvests or hunts what it needs for a livelihood and there is little exchange. Markets appeared first as meetings for bartering such products as skins, fruit and metals which were available in one locality for others, such as salt and textiles, which could only be obtained elsewhere; then at places where sales were made regularly for cash. Under the Roman civilization the *mercatus*—a public place where sellers and buyers met—was a common institution. (*See* MARKET.) With the growth of specialized artisans and of industrialization, and thus of the proportion of the population not producing its own food, professional intermediaries became necessary to bridge the gap between the food producers and nonagricultural consumers. By the second century A.D. firms specializing in the overseas purchase, shipment and wholesale distribution of grain, oil and fish had been established in Ostia, one of the ports of Rome, and large commercial warehouses had been built. With the decline of Rome and the deterioration in conditions of transport, long-range marketing operations contracted. Characteristic of the middle ages was the city supplied from the surrounding countryside; long-distance marketing was confined largely to valuable textiles and artisan ware which changed hands at centres such as Samarkand on the silk road from China to the middle east. The discovery of the sea route to the East Indies stimulated the development of extended marketing channels for sugar and other tropical products. With the Industrial Revolution came large-scale marketing of basic foodstuffs and of raw materials like cotton. In the marketing of food the 20th-century trend is toward leaving almost all of its preparation to specialized agencies which undertake it in bulk. An increasingly large proportion of the food that consumers buy is ready to eat or has only to be warmed.

Importance of Marketing.—In advanced economies where most of the population is engaged in specialized production of goods of which they themselves can use only a small part, marketing is a key activity. The modern farmer as well as the manufacturer could not manage without it. The marketing system makes possible sales for cash. The farmer can then buy improved seed, fertilizers, pesticides and machinery, and so obtain higher yields per man and per acre. The manufacturer can purchase materials from a wide range of sources. Both farmer and manufacturer can pay their workers in cash instead of in kind.

Consumers concentrated in urban centres, where they produce no food themselves, depend on marketing for survival; food must be brought to them. If the marketing channels were interrupted—as seemed likely for some cities during World War II—then many millions of people would be without food. Thus specialization, industrialization and urban concentration are associated with organized marketing, and rapid economic development is conditional upon a comparable growth of marketing functions and services.

Nature of Marketing.—The tasks involved in effective marketing are determined by the character of the product, the requirements of processor-buyers and consumers, and local conditions.

Assembly.—The assembly of produce of differing type and quality from a number of sources is usually the first step in marketing. Concentration at convenient points attracts buyers who could not spare the time to visit scattered producers; it permits transport, storage, grading, packing and processing on a larger scale and with more specialized techniques.

Most products undergo substantial changes before they are ready for the final purchaser. For example, grain is ground into flour and baked into bread; animals are slaughtered and divided into convenient meat cuts and by-products; milk is converted into butter and cheese. Some initial processing is undertaken, not because consumers seek it directly, but because it is necessary for the conservation of quality. For instance, perishable fruit and vegetables surplus to immediate demand, or intended for consumption outside the normal harvesting seasons, must be canned, dried or frozen. Savings in cost and advantages in merchandizing accruing from large-scale operation have favoured the development of very large assembling-processing-wholesaling enterprises dealing with food. A few such firms based in the United States and western Europe handle a very large proportion of the trade in vegetable oils, meat, milk, canned and frozen fruit and vegetables, prepared soup and baked goods.

Distribution.—Distribution systems develop to match available supplies to consumer demand. Supplies flowing into assembly points and warehouses fluctuate in type, quantity and quality. Consumer demand may also vary according to season, climate, religious teaching, local customs and many other factors. Distributors adapt the flow of supplies to such variations in demand by using their experience and market intercommunication. The wholesalers' work may terminate with the provision of supplies in appropriate quality and quantity for use in mills and manufacturing plants, or it may proceed to the splitting up of loads into retail quantities suitable for sale to individual consumers at local shops.

In North America and western Europe increasing concentration of management has long been a feature of retail distribution of food, clothing, pharmaceutical products and low-priced variety goods. Three food chains in the United States operated about 9,000 retail outlets in the early 1960s with total sales of about $10,000,000,000 annually. Five companies sold two-fifths of the food retailed in Canada. In most western European countries there were two or three retailing enterprises with at least one outlet in every large town. The retail co-operatives which accounted for more than one-fifth of the food trade in Britain obtained most of their supplies through a single co-operative wholesale society. To compete with the large chains and co-operatives in obtaining quantity discounts from manufacturers and other wholesale suppliers, many independent retailers had joined voluntary buying groups. One such group had about 225 wholesale and 30,000 retail members in Britain, the Netherlands and other western European countries.

Transportation.—Movement of products between places is an essential part of marketing. Transport to railheads, ports or processing plants may be provided by either the original producer or the first buyer. Longer-distance movement by road, rail or sea is often furnished by specialized transport firms. Delivery to the retail outlet may be part of the wholesale service. The last transport phase between the retail shop and the consumer's home may be arranged by the retailer, but more generally is left to the consumer.

Many products require transportation of an extremely specialized kind. The movement of fruit, vegetables and milk calls for prompt and careful handling and, perhaps, for refrigeration en route. Many of the disadvantages and much of the strength of different marketing systems have their origin in transport methods. If deliveries are slow, and equipment is inadequate, products deteriorate before reaching their market, and contracts cannot be met. Careless handling and delays can result in serious damage and loss, and impose heavy costs on that part of the load which does reach the market in sound condition.

Storage.—Storage facilities are needed at various stages of the marketing sequence. Most traders who take possession of produce also control storage facilities in order to have freedom of choice as to the time of resale. Processing plants hold reserve stocks of their raw materials in store so that their machinery and

staff are not held up by delays in the arrival of new supplies. At ports and other transshipment centres, and near important commodity markets, storage is provided by specialized enterprises and made available for a fee. Wholesalers and retailers also maintain storage to hold stocks from which they can satisfy clients' requests promptly.

Grading.—Grading products according to recognized uniform standards enables buyers to purchase more precisely what they want and are willing to pay for; to this extent it increases their satisfaction and makes the marketing system more efficient. Where buyer and seller are separated by long distances, as in much export marketing, personal inspection of individual lots is impracticable. The risks, delays and disputes involved in trading without it have led to the drawing up of standard quality specifications and contracts. Often this was undertaken first by associations of interested private traders such as the London Grain Trade association. Later, governments established detailed specifications. For shell eggs in the United States there are separate official quality, grade and weight specifications for government procurement, wholesale and retail transactions respectively.

Packaging.—Most food and manufactured products must be enclosed in some kind of container if they are to be marketed widely and efficiently. These containers afford a convenient way of handling, help to prevent physical deterioration, make theft, adulteration or substitution more difficult, ensure cleanliness, and facilitate measurement, labeling and the attachment of sales instructions and descriptions. They may also promote sales because of their attractive appearance. Specialized equipment and enterprises have been developed to pack goods in wood, metal, paperboard or plastic containers adapted to a wide range of requirements.

Exchange.—An essential part of marketing is the bringing together of buyer and seller and the facilitation of exchange. Two phases are involved: the contacting of possible buyers and sellers of particular products at a given time, and the negotiation of the terms of exchange. In many countries the town market square is the scene of a steady flow of direct transactions between producers and consumers. There each producer accepts full responsibility for advertising his produce, finding customers and obtaining information to guide him in bargaining over the price.

In larger markets, and where producers and consumers are separated by distance, time and processing requirements, the negotiation of sales may be undertaken in return for a fee by specialized commission agents, brokers and auctioneers who, perhaps, neither take possession of nor handle the goods sold. Accurate information on the character and quality of a product, its suitability for various purposes and its price in alternative markets is important for persons engaged in buying and selling. Advertising and market news reporting by specialized circulars, press and radio provide this. Special reporting services designed to supplement such information and help consumers buy to the best advantage had acquired great influence in the United States and Britain by the 1960s.

Finance and Risk.—All marketing requires finance. The owner of goods at any stage must either sacrifice the opportunity to use his own capital elsewhere or borrow the necessary capital from some other source. Farmers, wholesalers, manufacturers and retailers need capital or credit for the time during which they are in possession of products and are awaiting sale and payment. Wholesalers, for example, must finance their packing, processing and storage plants, transport equipment and display premises. Retailers must also finance their sales premises, that part of their stock which wholesalers do not carry and, in trades like that for consumer durables, a large proportion of their customers' purchases.

Risk bearing is also involved in marketing and must be covered by an equivalent expectation of profit. One of the major risks is that of a fall in price. Price variations are greater for agricultural products, which are subject to the impact of drought, rain and frost, than for many other traded commodities. The risks of such changes for individual traders are often minimized by resort to organized commodity exchanges, where "futures" may be bought and sold as a hedge against cash transactions. Risks of quality deterioration are very important in the case of perishable products such as milk and some fruits and vegetables.

Service.—Generally, the services offered by the marketing system tend to rise with the ability and willingness of the consumer to pay for them. With the relative increase in labour costs at retail establishments, however, there has been a marked trend toward the adoption of self-service sales methods for food retailing. In the early 1960s most groceries in the United States, and between one-third and one-half in northwestern Europe, were sold by self-service. Discount stores, which offer a minimum of sales and after-sales services, were becoming a potent influence in the retailing of consumer durables.

Marketing Margins.—The marketing "margin" is the difference between the price paid to the first seller and that paid by the final buyer. It is usually a composite of the margins obtained by the wholesalers and retailers involved, together with specific charges for such services as transport, storage and finding a buyer. The former are determined by competition in buying and selling; transport charges are usually at a flat rate according to the quantity handled, whereas sales commissions are an agreed percentage of the price obtained. The size of the marketing margin varies with the commodity and the conditions of marketing. Influential factors include the length and complication of the marketing channel, the wastage and risk involved, and the presentation and other services provided. The average margin between the farm value and the cost to the consumer of major foods (expressed as a rough percentage of the retail price) in the United States in the early 1960s was: for eggs and poultry 40%; meat 50%; dairy products 55%; fruits and vegetables 70%. Of an average 70 cents charged by New York retailers for one dozen large eggs it was estimated that 15 cents went to the retailer, 9 cents represented wholesaler's costs and margins, and 7 cents covered such costs as packing and transport between farmer and wholesaler. It was generally true that marketing margins tended to rise as consumers bought more elaborately packed and finished products. However, the cost to the consumer of the so-called "convenience foods"—canned, frozen or ready-mixed—marketed in the United States averaged less than that of the comparable fresh products. Moreover, while marketing margins tend to widen in the economically most-developed countries, returns to the grower also rise because he becomes more specialized.

Improvements in Marketing.—In many countries the main improvements in marketing spring from the enterprise of private traders and corporate firms seeking business profit. Competition induces them to devise cheaper and more effective handling methods and to build more economical plants, and, where it is strong, ensures that producers and consumers benefit through the competitive cutting of margins.

Marketing improvements also stem from the joint action of individuals or firms concerned in the marketing of a particular product or combination of products. This type of group action may be voluntary, as where a number of farmers or consumers join together in a co-operative to provide marketing facilities more economically or to increase their bargaining power. On the other hand, it may involve some compulsion when the effectiveness of a scheme is dependent upon participation by all concerned; levies and restraints are then imposed on individuals who might be tempted to sell independently of the scheme. This has led to the development of marketing boards and orders, whereby a government delegates authority to a specified board or commission to require producers and handlers of a commodity to observe certain rules and procedures; in some countries such a board assumes full responsibility for marketing certain products, buying and selling with its own staff or through private firms and co-operatives acting as its agents. (*See* MARKETING BOARDS AND ORDERS.)

In most countries the need for governments to help in the improvement of marketing is now recognized. Three major types of improvement measures can be distinguished:

1. Regulatory; *e.g.*, the standardization of weights, measures and containers; the establishment of minimum health standards; quality inspection and certification programs to permit sale by description; and the regulation of transport, storage and public market facilities to ensure fair practices.

2. Facilitating; *e.g.*, the provision of market information; the setting up of training and extension services; and the financing of research to raise the efficiency and reduce the cost of marketing. After the passing of the Agricultural Marketing act of 1946 the U.S. government made available about $10,000,000 annually for research on the improvement of agricultural marketing.

3. Direct intervention; *i.e.*, government entry into the purchase, sale, storage and movement of commodities in order to influence their pricing, supplement existing market channels and increase competition, or to protect producers and consumers against emergency pressures or chronic weaknesses in the working of a marketing system.

In western European countries and in the United States, concern to maintain domestic output of essential commodities such as wheat and basic metals, and the pressure of political influences have led governments to assume continuing price-fixing, stockpiling and subsidization responsibilities.

Sharp fluctuations in prices of commodities traded extensively between countries and the consequent adverse effect upon producers and consumers have inspired a number of attempts to stabilize prices on an international level. For some commodities, exporting countries with a major share of the world market have tried to control marketed supplies unilaterally, as Brazil has done for coffee. For others like wheat, sugar and tin the major export producers have joined forces to set limits to the range of prices at which sales would be made, assign export quotas or set up a buffer-stock authority to stabilize prices by market operations. (*See* STABILIZATION AGREEMENTS, INTERNATIONAL.)

See also RETAILING and references under "Marketing" in the Index.

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MARKETING BOARDS AND ORDERS. Marketing boards were set up originally in Great Britain and other commonwealth countries, including Australia and Canada, to help solve specific problems growing out of the depression of the 1930s. A comparable development in the United States was the marketing order, employed notably in California for certain fruit and vegetable crops and throughout the country for milk. The powers given under marketing board legislation and marketing orders range from authority to make a levy for the support of advisory and promotional services to full control over output and sales of specified products. Once established, statutory marketing boards usually operate independently of the government, which, however, generally retains some control over their decisions. The California marketing orders are operated by the state director of agriculture with the assistance of a board appointed under the order.

The simplest type of board is one established to carry out market research, promote sales and furnish information. It may undertake pilot programs to develop new uses and outlets; it may advise on varieties, packing and grade standards; and it may conduct quality analyses and arbitrate disputes. To finance its operation a small fee is levied on all sales of the products concerned. Sales promotion is a main activity under the California marketing orders; for example, $1,700,000 was spent on wine promotion alone in 1960–61.

Other examples are the Australian federal marketing boards, the National Coffee Board of Ethiopia, the Ceylon Tea Propaganda board and the Rhodesian Tobacco Export Promotion council.

A marketing board may be empowered to regulate terms and conditions of sale. Usually it establishes obligatory quality and packing standards for sale to certain markets, sets up laboratories for quality analyses and perhaps some processing installations, and engages an inspectorate. Such a board is frequently set up to maintain the reputation of a particular country in foreign markets; the high reputation of eggs exported from the Netherlands is due in part to that country's inspection system.

The prime motive in the establishment of some marketing boards is to stabilize producer prices. Such a board often negotiates prices with large processors, wholesale buyers and distributors on behalf of producers and/or consumers, as in Canada for various fruits and vegetables and in Britain for hops. The board may also control the area of production or the supplies put on specific markets in specified forms at specified dates, or assure certain guaranteed prices for a given volume of output, leaving additional output to find its own market. This may involve individual registration of producers and handlers and reporting of sales, especially if prices for specific quantities are supplemented.

This type of marketing board or order is often used for products whose perishability requires that sure outlets be established in advance. In the case of milk the board undertakes to assure consumers a regular supply of the fluid product, and to pool returns to farmers from sales both in this market and at lower prices to manufacturers. The fluid consumption and manufacturing markets must be kept separate by means of a control system or else fluid milk consumers will buy the milk offered for manufacture. A marketing board can maintain such a system by refusing supplies to any distributor who sells milk for domestic consumption at less than an agreed price. Milk not sold at this price is sold to manufacturers for whatever it will bring. Total receipts from both markets are then divided by the quantity sold to give an average price per unit sold and are distributed to individual suppliers accordingly. In the mid-1960s there were more than 80 federal milk marketing orders for specific U.S. city or regional market areas. There was one milk marketing board for England and Wales.

Another way in which this type of group marketing control can stabilize and raise average prices is through the manipulation of market flows. The objective of flow control programs is to adjust deliveries between different seasons or outlets in such a way as to maintain reasonably high levels of demand in all the markets at all times. Generally, an average price target is set for each outlet on the basis of experience in the preceding season. Sales are then expanded or contracted in order to avoid flooding the market at any one time or place and thus reducing the price below the target. These adjustments can be arranged through a marketing board with power to allocate markets to particular producers and limit the quantities delivered. This approach is characteristic of the marketing programs for fruits, vegetables and nuts in California. Such group control over sales in order to improve returns for agricultural production is comparable to the policies employed by large industrial manufacturers.

Where group determination of the sales made by individual producers and handlers is administratively difficult other approaches to stabilization have been tried. In the middle east and Latin America, marketing boards and branches of public banks or development institutes were set up and furnished with capital to purchase basic grains, maintain buffer stocks and sell on open domestic markets alongside other traders. The objective was to increase incentives to producers by buying to maintain a minimum price, and to protect lower-income consumers by selling from stocks when rising prices were likely to cause hardship. Such a board, using a buffer stock to stabilize supplies and prices within and between seasons, must have its own storage and marketing equipment and must also be able to control imports and exports of the commodities concerned. Usually publication of the price at which it will buy is enough to induce other market channels to offer comparable terms; consequently the board does not have to take up a large part of the total crop marketed. The buying points must, however, be sufficiently widely distributed to be within reach of most farmers.

Where a product is designed primarily for export markets, domestic producers can be protected from the effects of the more violent fluctuations in world prices by means of stabilization funds. This approach was employed by the marketing boards set up after World War II in the Gold Coast (now Ghana), the Federation of Nigeria and Sierra Leone to stabilize prices paid for cocoa, peanut and palm-oil exports. A reserve fund is accumulated when export prices are high and is drawn upon to maintain prices to farmers when they are low. To carry out such a program, marketing boards in these countries were granted a monopoly of all export sales. Domestic purchases are made through licensed agents and the board's own buying stations. Export sales are made directly by the board or through brokers on major international markets. In many of the French-speaking African countries the goal of price stabilization was approached by means of a reserve fund to which private exporters contribute when export prices are high and upon which they draw when export prices are low. A major problem with these schemes is to maintain an adequate reserve fund under pressure from producer and other interests to disburse it.

Sometimes boards are also granted a marketing monopoly for certain produce in specified areas or market channels in return for providing agreed marketing and processing facilities. Usually this is done when the investment required is considerable and the volume of produce to be handled is only enough to support one such enterprise on an economical scale. The Kenya Meat commission and the Cold Storage commission in Southern Rhodesia occupy such positions. *See* also STABILIZATION AGREEMENTS, INTERNATIONAL.

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(J. C. AB.; S. F. BE.)

MARKHAM, SIR CLEMENTS ROBERT (1830–1916), English geographer and historian whose travels, writings and patronage stimulated geographical exploration and education, was born on July 20, 1830, at Stillingfleet near York. Educated at Westminster school, he joined the Royal Navy in 1844 and accompanied the Franklin search expedition to the arctic in 1850–51. On leaving the navy in 1852 he traveled in Peru and the eastern Andes. The following year he entered the civil service, joining the board of the East India company in 1854. In 1860 he revisited South America to arrange the introduction of the cinchona plant, the source of quinine, into India and later visited the cinchona plantations of both India and Ceylon. From 1867 to 1877 he was geographical adviser to the India office in London and as such a strong supporter of the surveys being carried out in India; he was also geographical adviser on the Abyssinian campaign of 1867–68. In 1875 he went to the arctic under Sir George Nares.

Markham was elected a fellow of the Royal society in 1873; he was secretary of the Hakluyt society 1858–87, and its president 1889–1909; secretary of the Royal Geographical society 1863–88 and its president 1893–1905; president of the International Geographical congress, held in London in 1895; and it was through his personal efforts that funds were raised for Captain R. F. Scott's National Antarctic expedition in 1901. From 1872–78 he edited the *Geographical Magazine* (later the *Proceedings of the Royal Geographical Society*, and now the *Geographical Journal*) and wrote extensively in these periodicals as well as works for the Hakluyt society, many of which were translations with learned commentaries. He also wrote *Life of Robert Fairfax* (1885), *A Life of John Davis, the Navigator* (1889), *Life of Christopher Columbus* (1889) and *Major James Rennell and the Rise of Modern English Geography* (1895). He died in London on Jan. 30, 1916.

(K. M.)

MARKHAM, EDWIN (originally CHARLES EDWARD ANSON MARKHAM) (1852–1940), U.S. poet, author of "The Man With the Hoe," was born in Oregon City, Ore., on April 23, 1852, the youngest son of pioneer parents. He grew to manhood on an isolated valley ranch in the Suisun hills in central California, attended the California State Normal school at San Jose and later graduated from the Christian college at Santa Rosa. He subsequently became a high-school principal and superintendent at various places, and finally headmaster at the Tompkins Observation school, Oakland, connected with the University of California. Markham abandoned school administration in 1899, after his poetry had won favour, and devoted himself to writing and lecturing. In that year he gained national fame with the publication in the *San Francisco Examiner* of "The Man With the Hoe," his most widely known poem. Inspired by Millet's painting, Markham made the French peasant the symbol of the exploited classes throughout the world. The poem so well expressed the economic and social mood of the time that it was reprinted in nearly every newspaper of the country and was the subject of wide editorial comment. His first book of verse, *The Man With the Hoe and Other Poems* (1899), was followed in 1901 by *Lincoln and Other Poems*, the dignified title piece of which found almost as much favour as "The Man With the Hoe." His succeeding volumes—*Shoes of Happiness* (1915), *Gates of Paradise* (1920), *New Poems: Eighty Songs at Eighty* (1932) and *The Star of Araby* (1937)—have the commanding rhetoric but lack the passion of the early works. On March 7, 1940, Markham died at Staten Island, N.Y., where he had made his home since 1901.

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MARKHAM, GERVASE (JERVIS) (1568?–1637), English poet and author of a number of popular treatises on country and sporting pursuits, was born *c.* 1568, the third son of Robert Markham of Cotham, Nottinghamshire. Nothing certain is known of his early life, but he may have been brought up in the earl of Rutland's household and probably went to Cambridge university. He wrote of himself, "a piece of my life was Schollar, a piece Soldiour, and all Horseman." His brilliant reputation as a rider and his expert knowledge of the care and training of horses are reflected in his first surviving printed work, *A Discourse of Horsemanshippe* (1593), and in *Markham's Masterpeece* (1610), a popular manual on diseases of the horse and their treatment. As a soldier he traveled widely, serving in the Low Countries and in the Irish campaign of 1599, when he was probably attached to the earl of Southampton's company, and his military experience enabled him to write on the composition and training of the army.

He was a member of the earl of Essex' circle, to other members of which some of his poems, including *The Most Honorable Tragedie of Sir Richard Grinvile, Knight* (1595), *The Poem of Poems* (1596) and *Devoreux* (1597), were dedicated. His religious poems *The Teares of the Beloved* (1600) and *Marie Magdalens Lamentations* (1601) are thought to contain disguised references to the betrayal and fall of the earl of Essex. Essex is also commemorated in Markham's *Honour in His Perfection* (1624), the lives of the earls of Oxford, Southampton, Essex and Lindsay. Markham also wrote two plays, *The Dumb Knight* (1608) and *The True Tragedy of Herod and Antipater* (1622), which before performance were revised by collaborators, and *The English Arcadia* (part I, 1607; part II, 1613), a novel in the convention of Sir Philip Sidney's *Arcadia*. He was a minor poet with a few fine passages, but his association with the Essex group has led Robert Gittings to suggest in *Shakespeare's Rival* (1960) that he might be the rival poet referred to in Shakespeare's sonnets. With the decline of his fortunes, Markham was forced to take up farming, which provided material for more treatises. He married *c.* 1595, is known to have had many children and probably spent his last years in poverty in London. His name occurs in the burial register of St. Giles, Cripplegate, London, on Feb. 3, 1637.

MARKHOR ("snake-eater"), a large Himalayan wild goat (*Capra falconeri*) characterized by its spirally twisted horns and long shaggy, grayish winter coat. From the mountains of Kashmir the region of the markhor extends westward into Afghanistan. Markhors generally live beneath the timber line. The twist of the horns varies locally. The largest form may stand more than 40

in. high at the shoulders and weigh more than 200 lb.

MARKO KRALJEVIC (*c.* 1335–1395), Serbian king and national hero, was the son of King Vukasin. He became a Turkish vassal after his father's death in the battle with the Turks on the Maritsa river in 1371. He completed the church that his father had begun at Susica near Skopje; it is known as "Marko's monastery." His silver coins had the inscription: "In Christ God the pious king Marko." There is a well-preserved portrait of him in the church of the Holy Archangel at Prilep.

Marko was killed in the battle at Rovine, on May 17, 1395, in the Turkish expedition against the Walachian prince Mircea the Old.

Tradition and folk songs furnish many more details about Marko, who is always called Kraljevic (the king's son). He became the greatest Serbian hero, sometimes gay, but always just. Many of the stories connected with him are fabulous and some have been transplanted from older literatures. He is praised also in Bulgarian, Rumanian and Albanian folk songs. The oldest poem about him dates from the middle of the 16th century.

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MARKOV, ANDREI ANDREEVICH (1856–1922), Russian mathematician, was the first to give a complete and strict proof of the so-called central limit theorem. Markov passed through the academic grades at the University of St. Petersburg; he was appointed ordinary professor in 1886 and ordinary member of the Academy of Sciences in 1896. The earlier part of his work was devoted to number theory and analysis, notably to continued fractions, the limits of integrals, the approximation theory and the convergence of series. From about 1900, he was mainly occupied with probability theory. Under fairly general assumptions, he proved the central limit theorem, which states the asymptotically normal (Gaussian) distribution of the sum of a large number of independent random variables. Markov then turned to study mutually dependent variables, introducing the important notion of chained events (Markov chains). A sequence $x_1, x_2, \ldots$, of mutually dependent random variables constitutes a Markov chain if, roughly speaking, any prediction about $x_{n+1}, \ldots$, knowing $x_1, \ldots, x_n$, may without loss be based on x_n alone. He extended several classical results concerning independent events to certain types of chains. Markov's work is one of the starting points of the modern theory of stochastic processes. A selection of Markov's works in number theory and probability theory, including a biography and a bibliography, was published in Moscow in 1951.

See E. B. Dynkin, *Theory of Markov Processes* (1961). (G. EG.)

MARKOVA, ALICIA (DAME ALICIA MARKS) (1910–), an English ballerina noted for the ethereal lightness and poetic delicacy of her interpretations of *Giselle, Les Sylphides, Swan Lake* and other ballets. Born in London, Dec. 1, 1910, she studied with Seraphima Astafieva and Enrico Cecchetti. Phenomenally gifted, she made her debut with the Diaghilev Ballet at 14, and was soon dancing leading roles. Alicia Markova has appeared as ballerina of Ballet Rambert, Sadler's Wells Ballet, Ballet Russe de Monte Carlo, Ballet Theatre, and as guest artist with the Metropolitan Opera. With Anton Dolin, she headed the Markova-Dolin Ballet (1935–38) and Festival Ballet (1949–52). She was created dame of the British empire in 1963. (LN. ME.)

MARKOVIĆ, SVETOZAR (1846–1875), Serbian political writer whom the Yugoslav Communists claim as their precursor, was born on Sept. 21 (new style; 9, old style), 1846. He studied in Belgrade, in St. Petersburg, where he fell under N. G. Chernyshevski's influence, and in Zürich, where he fell under the influence of Karl Marx. A member of the Socialist International, he began his political career by editing the first Serbian Socialist newspaper, *Radnik* ("The Worker"; 1871), which was more concerned with economics than with politics. Persecuted by the Serbian government, Marković fled to Hungary (1872), but soon returned to edit at Kragujevac the newspaper *Vavnost* ("Public Opinion"; 1873), which set aside economics to deal more with politics, and then *Glas Vavnosti* ("The Voice of Public Opinion"; 1874). He denounced bureaucracy, professional judges and written laws and advocated the sovereignty of parliament and western institutions. His writings earned him nine months' imprisonment (1874). From his cell he contributed to the periodical *Rad* ("Work"). On his release he edited the newspaper *Oslobodjenye* ("Liberation") till poor health forced him to give it up. He died in Trieste on March 10 (N.S.; Feb. 26, O.S.), 1875.

A Marxist at first, Marković gradually became a left-wing democrat. He wanted the masses to be concerned with politics; he awakened an interest in the study of economics; he influenced the realistic trend in Serbian literature; and he had a strong ascendancy over a number of educated young people who first learned from him the elements of socialism. His ideas, neither particularly original nor exact, were often contradictory. There was no capitalism in Serbia during his lifetime, and scarcely any working class. He therefore attacked civil servants, though they were not capitalists, and favoured small holders, though they were not proletarians. A courageous fighter, a skilled popularizer and a great controversialist, he left a number of devoted admirers. The Serbian Radical party owed many of its ideas to Marković's radical socialism. His collected works (eight volumes) appeared in 1891–1912.

See S. Jovanović, *Svetozar Marković* (1903); J. Skerlić, *Svetozar Marković*, 2nd ed. (1922). (K. ST. P.)

MARL, an earthy mixture of fine-grained minerals. The term is applied to a great variety of sediments and rocks with a considerable range of composition. Calcareous marls grade into clays by diminution in the amount of lime, and into clayey limestones. Greensand marls contain the mineral glauconite, which is a complex silicate of alumina, iron and potassium. The greensand marls are widely distributed along the Atlantic coast in the United States and in Europe. Similar deposits occur in New Zealand. Because of their base-exchange properties the glauconitic marls are used in water-softening units. (*See* also GREENSAND; GLAUCONITE.)

Both marine and fresh-water marls are most commonly earthy and of a white, gray or brownish colour. However, red and black marls are found. In calcareous marine marls some lime is present in the form of shells (as in the Coralline crag of East Anglia, the Oligocene marls of the Isle of Wight, etc.); in others it is a fine impalpable powder mixed with clay and siliceous silt. Fresh-water marl may be similar in composition to marine marl. Much of the calcium carbonate in lake deposits is precipitated by bacteria and by algae such as the stoneworts. However, some lake marls contain numerous fragments of the shells of fresh-water snails and bivalves. Large deposits of fresh-water marl which contain from 80% to 90% of calcium carbonate and less than 3% of magnesium carbonate have been used as the calcareous material required in the manufacture of insulating material and portland cement. Marl also is used as a liming material and in making bricks. (G. A. T.)

MARLBOROUGH, EARLS AND DUKES OF. The earldom of Marlborough was held by the family of Ley from 1626 to 1679. JAMES LEY (*c.* 1552–1629), 1st earl, was lord chief justice of the King's Bench in Ireland (1604–08) and then in England (1621–24); he was also a member of parliament, first for Westbury and later for Bath, and was lord high treasurer from 1624 to 1628. He was created Baron Ley of Ley in 1624 and earl of Marlborough in 1626. JAMES (1618–1665), 3rd earl, was a sailor who was killed at the battle of Solebay on June 2, 1665, while fighting the Dutch. On the death of WILLIAM (1612–79), 4th earl and uncle of the 3rd earl, the title lapsed.

The title was revived in 1689 for JOHN CHURCHILL (1650–1722; *see* MARLBOROUGH, JOHN CHURCHILL, 1st Duke of), who, with his wife, Sarah (*see* MARLBOROUGH, SARAH JENNINGS, Duchess of), played an important part in politics under William III and Anne. For his successful military campaigns in Europe, Marlborough was raised to a dukedom in Dec. 1702. HENRIETTA (1681–1733), the 1st duke's eldest surviving daughter, who had married Francis, 2nd earl of Godolphin, inherited the title in her own right by an act of parliament passed in 1706. On her death in 1733 the title passed to her nephew CHARLES SPENSER (1706–58), 4th earl Sunderland, who became the 3rd duke; his mother was Anne, the youngest sur-

viving daughter of the 1st duke, who had married Charles Spencer, 3rd earl Sunderland. He fought at Dettingen and in the Seven Years' War and was lord privy seal in 1755. GEORGE (1739–1817), 4th duke, was lord privy seal (1763–65) and a Grenville Whig. He supported Charles James Fox over the India bill, but later followed William Pitt the younger. GEORGE (1766–1840), 5th duke, took the additional surname of Churchill in 1807. JOHN (1822–83), 7th duke, was lord president of the council (1867–68) and lord lieutenant of Ireland during 1876–80. His third son was the Conservative politician Lord Randolph Churchill, whose own son was Sir Winston Churchill, the prime minister.

CHARLES (1871–1934), 9th duke, was paymaster general from 1899 to 1902 and undersecretary for the colonies from 1903 to 1905. He married in 1895 Consuelo Vanderbilt, the American heiress, who obtained a divorce from him in 1921. JOHN (1897–), 10th duke, succeeded to the title in 1934.

MARLBOROUGH, JOHN CHURCHILL, 1ST DUKE OF (1650–1722), English soldier who won great victories against the French in the War of the Spanish Succession, was born on May 26, 1650, at Ashe, in the parish of Musbury, Devon, the son of an impoverished royalist squire. He attended St. Paul's school from 1664 to 1665; and from his early circumstances he learned the virtues of frugality and the opportunities for affluence through court service. His sister Arabella became maid of honour to the duchess of York *c.* 1665, and later mistress to the duke, while John became the duke's page: henceforward the family affairs prospered. John became the lover of Charles II's mistress, Lady Castlemaine (later duchess of Cleveland), and prudently purchased an annuity with a gift of £5,000 from her. He received a commission in the foot guards in 1667 and served at Tangier from *c.* 1668 to 1670.

In the third Dutch War (1672–74), Churchill served with the allied fleet that was defeated at Solebay on May 28, 1672, and was promoted captain. He went with the English troops sent in Dec. 1672 to assist Louis XIV against the Dutch, and distinguished himself at Maastricht with the duke of Monmouth. He was appointed colonel of the English regiment by Louis XIV in 1674 and served with distinction at Enzheim. He then served at court and on minor diplomatic missions and refused further military service under Louis XIV in order to press his suit with Sarah Jennings, an attendant upon the princess (afterward Queen) Anne. With the assistance of the duchess of York they were married secretly in the winter of 1677–78. John rose rapidly; he was created Baron Churchill in the Scottish peerage in 1682 and became colonel of the 1st Royal Dragoons in 1683. Meanwhile Sarah established her ascendancy over Anne and became a lady of the bedchamber.

On the accession of James II in 1685 Churchill was dispatched to ask Louis XIV for greater subsidies for the English crown, and after James's coronation was created lord of the bedchamber and Baron Churchill in the English peerage. He was made second-in-command of the force sent to put down Monmouth's rebellion, was promoted major general and helped to wrest victory from the night engagement at Sedgemoor (July 5, 1685). James II then proceeded more openly with his Catholicizing policy, against which Churchill was predisposed by principle, by prudence and by his connection with the stanchly Protestant Princess Anne. By Aug. 1688 Churchill had put himself into the hands of the prince of Orange (subsequently William III). After William's landing in England, Churchill was made lieutenant general of James's army. He undertook to defend the king's person but deserted his cause to join William at Axminster.

For these services Churchill was sworn a privy councilor and created earl of Marlborough in 1689, and served effectively under the prince of Waldeck with an English brigade in the Netherlands. Marlborough served upon the committee of nine who managed the government during William's absence in Ireland in June 1690. In the autumn Marlborough made an effective attack upon Cork and Kinsale. Relations between William and Marlborough were nevertheless cooling. The Churchills warmly espoused Anne's campaign in 1689 for a parliamentary settlement of £50,000 per annum and incurred the displeasure of Queen Mary. Marlborough was in touch with James at St. Germain, and threatened immediate danger by organizing opposition around the reversionary interest of the princess Anne. The queen brought about a permanent breach with Anne in attempting to compel her to dismiss Sarah in 1692; Marlborough was deprived of all his offices and was excluded from the court and was even temporarily imprisoned in the Tower of London in May 1692 upon forged accusations of treason. The later charge that Marlborough betrayed the attack upon Brest in May 1694 rested upon Jacobite evidence too dubious for credit. After the death of Mary in 1694, Marlborough promoted a reconciliation between Anne and William, and when he was implicated in Sir John Fenwick's confession to an assassination plot in 1696, the king ignored the charges.

Marlborough returned to favour in 1698 as governor to Anne's son, the duke of Gloucester, and annually till 1700 was appointed one of the lords justices. His eldest daughter, Henrietta, married the son of his old ally, Lord Godolphin, in 1698 (*see* GODOLPHIN, SIDNEY GODOLPHIN, Earl of) and in 1700 his daughter Anne married Charles, the only son of Lord Sunderland. Princess Anne granted each a dowry, and during her reign these marriages had important political consequences. Marlborough still conceived himself as serving Anne rather than William; nevertheless as the Spanish Succession crisis approached, William III appointed Marlborough commander in chief and plenipotentiary in Holland.

Upon Anne's accession in 1702, Marlborough was made a knight of the Garter, captain general of the forces and master general of the ordnance; his wife received numerous household offices and Godolphin became lord treasurer. Marlborough's campaigns were, however, hampered by the opposition of allies both at home and abroad. The Dutch preferred the protection and extension of their own territory to Marlborough's bold schemes of attacking France, while the emperor Leopold I coveted the Spanish throne for his son. However, Marlborough captured Kaiserswerth in 1702 and cleared the territory between the Rhine and Meuse rivers. For these services he was created duke of Marlborough in Dec. 1702 and was awarded £5,000 per annum for the duration of the queen's life. Marlborough had been forced to let slip valuable opportunities of destroying the French army under Louis, duc de Boufflers, in 1702 and in 1703 was again constricted by the allies' lack of enterprise. Bonn, Huy and Limburg were captured but Marlborough's plans for an attack on Antwerp were rejected.

Meanwhile Bavaria had entered the war and joined the French in the attack on the heart of the Holy Roman empire while the Austrian armies were engaged on the Rhine and in Italy. Without assistance to Austria the war would be lost, but Marlborough knew that the Dutch would oppose a distant campaign; therefore he attacked upon the Moselle river to deceive both friend and foe and deceived them again by a feint against Alsace. Though his march into central Europe caused general surprise, it was an obvious move and Marlborough's genius was revealed in the organization rather than the conception of the campaign. After a fierce struggle he took the Schellenberg fortress and opened the crossing of the Danube river at Donauwörth. On Aug. 13, 1704, he engaged the main enemy force at Blenheim (*q.v.*); a quarter (about 12,000) of his own troops were killed or wounded, but the enemy casualties exceeded three times that number. On his return to the Netherlands, Marlborough took Trier and Trarbach. These victories altered the whole balance of power in Europe and put France firmly on the defensive. Marlborough received the principality of Mindelheim from the emperor and, despite Tory animosity, was granted the royal manor of Woodstock by act of parliament. The queen accompanied the grant with an order for the construction of the palace, on which public money was spent vastly in excess of the £100,000 intended.

In 1705 Marlborough was confident that the French could be beaten in any but the strongest of positions, and wished to attack upon the Moselle. The Dutch and Austrians, however, were less keen to co-operate after a year's success; Prince Eugene was sent to Italy, and no armies were forthcoming from the German princes on the Rhine. The Moselle campaign was therefore abandoned. Marlborough broke through the Lines of Brabant at Elixem in July, taking 3,000 prisoners, but again lack of Dutch support prevented him from exploiting the victory. The French were allowed to rally at Louvain, but they abandoned the Lines of Brabant. The Grand

Alliance, which had made small progress toward its aim of the conquest of the Netherlands and Italy, by 1706 needed a victory to keep it going; the prospects of a decisive engagement were enhanced by an increased deference toward Marlborough on the part of the Dutch government and a certain contempt of him among the French leaders. Moreover, Louis XIV concluded that he must have peace and could only get satisfactory terms by an assault on all fronts. Consequently, when Marlborough threatened to move between Namur and the French army under the duc de Villeroi at Louvain and Brussels, Villeroi offered battle near Ramillies, drawing up his lines in a concave arc (May 23, 1706). Feinting an attack upon the right, Marlborough concentrated his main attack upon the left, to the south of the village of Ramillies. There the Dutch bore the sharpest fighting and Marlborough himself narrowly escaped with his life. The result was a crushing victory in which the French losses, in killed, wounded and deserters, may have been five or six times those of the allies. Most of Belgium was overrun and between June and October four successful sieges were undertaken at Ostend, Dendermonde, Menin and Ath.

During the advance, Marlborough was engaged in active diplomacy to keep the allies together, for peace with France seemed imminent. He showed no disposition for peace, and the Dutch supported him in the hope of pushing their Barrier fortress claims. The government of the Netherlands caused immediate discord among the allies. The Austrians wanted full sovereignty; the Dutch wanted to govern for the time being and to continue to occupy the Barrier fortresses of which the emperor offered Marlborough the governorship. Dutch opposition compelled Marlborough to decline reluctantly, but he hoped for appointment later and confidence among the three parties never fully recovered. With the triumph of Prince Eugene in Italy, the allies' immediate objectives were achieved and Marlborough's desire for war inevitably inclined him toward the Whigs as the war party in England. On Dec. 3, 1706, his son-in-law Sunderland became secretary of state.

With these dissensions among the allies, France and Spain possessed substantial powers of resistance. Marlborough accomplished nothing in the Netherlands in 1707, the duc de Villars made a raid into Germany and there were allied failures at Almanza and before Toulon. The allies urgently needed victory in 1708, while France was again hoping for success as a prelude to peace. The French took Ghent and Bruges. Marlborough, however, caught the French army at Oudenarde on July 8, 1708, and in a disorderly encounter beat the French back from a strong position and had almost enveloped them when darkness fell. After this victory Marlborough favoured an attack upon Paris, but he was overruled by Eugene.

Instead, the allies laid siege to Lille. In some ways it was a more dangerous enterprise, but in December both the town and citadel of Lille surrendered. Marlborough went on to capture Ghent and Bruges. By then Marlborough was secretly negotiating peace through his nephew, the duke of Berwick, marshal of France, hoping to secure a substantial French bribe for his services. Early in 1709 the marquis de Torcy was sent to The Hague to negotiate, and he promised everything he was able to concede. Negotiations, however, failed on Louis' refusal to undertake to deliver up Spain to Charles III (afterward the emperor Charles VI) within two months, a condition which the allies failed to realize he could not possibly fulfill. The result was that the French made a last desperate effort and that the morale of their troops rose tremendously. The economic crisis in France even facilitated the recruiting of an army of 80,000 men, which faced Marlborough in the Netherlands in 1709. Finding Villars' position too strong to attack, Marlborough attacked Tournai which, after a two-month siege of peculiar horror, was taken. Marlborough joined battle with Villars, who had fortified a strong position in the woods near Malplaquet on Sept. 11, 1709. The French fought better than at any time since Blenheim, and although they were defeated they withdrew in good order, leaving few prisoners. Marlborough's army was in no condition for the pursuit, but on Oct. 20 Mons was taken.

The small return for the hard fight at Malplaquet helped to weaken Marlborough's position at home. The Whigs were more firmly established in office than ever, but the Tory campaign for peace was strengthened by the belief that war could accomplish nothing further and was only being prolonged by the party and personal interest of the duke. This suspicion Marlborough aggravated by demanding to be appointed captain general for life. The duchess helped to destroy her credit with the queen by her support of the Whigs, and in 1710 the queen began her counterattack. Marlborough could only postpone a regiment being given to Col. John Hill, the brother of his wife's rival, Mrs. (afterward Lady) Abigail Masham. Sidney, earl of Godolphin, was dismissed; the Tories, bent on peace, returned to office, and won a sweeping victory at the elections.

Marlborough planned further progress toward the French frontier in 1710 and took Douai, but his authority was slowly ebbing. While negotiations for peace were in progress between the English and French ministers in 1711, Marlborough began his last campaign. Henry St. John (afterward Lord Bolingbroke) took five British battalions away; Eugene was withdrawn to defend the Rhine. Villars was entrenched behind the *ne plus ultra* lines, but Marlborough evaded him by skilful marching, crossed the lines and took Bouchain from the rear. He hoped to reduce Le Quesnoy, the last fortress on the road to Paris, but the Dutch and the English governments, deep in peace negotiations, refused support. Marlborough was dismissed from all his offices on Dec. 31, 1711, and, attacked in parliament and the press, accused of swindling in the building of Blenheim, he went abroad. While abroad he corresponded with the Jacobites, and made firm contact with the court of Hanover. After the accession of George I in 1714 he resumed his old military offices, but in 1716 was broken in health by two paralytic strokes. He continued to perform his public functions, though clearly declining, and died at Cranbourne Lodge, Windsor, on June 16, 1722, after a third stroke.

For all his duplicity and self-seeking, Marlborough had rendered inestimable services to the Protestant succession in England, and as a general he was generous to his allies and took infinite care of the welfare of his men.

See also references under "Marlborough, John Churchill, 1st duke of" in the Index.

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MARLBOROUGH, SARAH JENNINGS, DUCHESS OF (1660–1744), wife of John Churchill, 1st duke of Marlborough (*q.v.*), and confidante of Queen Anne, was the daughter of Richard Jennings and was born at Sandridge, near St. Albans, on May 29, 1660. As a child she formed a friendship with the princess Anne and entered the household of the duke of York in 1673. Beautiful and vivacious, self-possessed and self-reliant, she had a venomous temper when roused. Her romance with John Churchill, who was also at court, began late in 1675; his notorious amours ceased abruptly and he put his courtship of her even before military preferment. Sarah's attachment was equally deep and passionate and contrasted impressively with the rancorous hatreds which filled much of her life. Churchill's parents opposed an unremunerative match, but with the assistance of the duchess of York the couple were married secretly during the winter of 1677–78. Sarah was devoted to the princess Anne, who came to depend upon her; they addressed each other as Mrs. Morley and Mrs. Freeman and upon Anne's marriage in 1683, Sarah became one of the ladies of the bedchamber. Sarah escorted Anne to meet the prince of Orange in 1688 and persuaded her to accept the statutory settlement of the succession. Deeply involved in Anne's struggle for a civil list annuity in 1689, Sarah was later granted an annual pension of £1,000. Upon Marlborough's disgrace in 1692, Queen Mary compelled Anne to dismiss Sarah from her offices and excluded her from court; but after Mary's death in 1694, Anne and William III were reconciled and the Marlboroughs returned to favour. When Sarah's daughters were married Anne gave each a dowry of £5,000.

After Anne's accession, the Marlboroughs enjoyed great favour; Sarah and her married daughters obtained household offices, though she exercised little political influence. But Sarah's favour was in

the balance: for the queen had High Church sympathies, while Sarah was a strong Whig. This difference came to a head after 1705; the high Tories had fallen from office, but the queen, supported by Robert Harley (later earl of Oxford), stoutly resisted taking in the Whigs. Sarah persistently urged her to bring the earl of Sunderland into office in 1706, and mutual irritation showed that the friendship of Anne and Sarah was cooling. Harley was clearly using Mrs. (later Lady) Abigail Masham to supplant Sarah in Anne's affections by 1707. When Anne's husband, the prince of Denmark, died in 1708, relations between Anne and Sarah temporarily improved, but Mrs. Masham's power steadily advanced. The Whig junto secured office, but Sarah quarreled with them because they disliked her husband's old friend, Sidney, earl of Godolphin.

The Whigs, Godolphin and Sarah lost influence in 1710. Jonathan Swift accused her in the *Examiner* of misappropriating £22,000 a year from the privy purse; Sarah described the sum as arrears of pension money. Anne dismissed her and they never met again. The Marlboroughs settled at Frankfurt am Main in 1713. After the Hanoverian accession they returned to Blenheim, and after the duke's death in 1722, Sarah completed the building of the palace, quarreling violently with its architect, Sir John Vanbrugh, with her daughters and with her son-in-law, the earl of Sunderland, and rebuffed all suitors. Sarah published an account of her conduct in 1742. She died at Marlborough house in London on Oct. 18, 1744.

See Winston Churchill, *Marlborough, His Life and Times,* 4 vol. (1933–38). (W. R. Wo.)

MARLBOROUGH, a municipal borough and market town of Wiltshire, Eng., lies in an upland valley of the Marlborough downs, watered by the river Kennet, 28 mi. N. of Salisbury and 18 mi. W. of Newbury on the London to Bath road. Pop. (1961) 4,843. The broad High street is flanked with houses dating from the 16th century onward. At its west end is St. Mary the Virgin's, originally a Norman church, and at the east end, behind the town hall (1903), is St. Peter and St. Paul's, dating from the 15th century. Behind St. Mary's is Marlborough college, a well-known public school for boys. It was founded in 1843 mainly for the sons of clergy, and four foundation scholarships and certain other privileges are still reserved for clergymen's families. Within the grounds of the college is the Castle mound (a legendary birthplace of Merlin), where traces of Neolithic and Roman occupation have been found. From the 11th century a royal castle stood there which from the time of William I, who established a mint, until the Wars of the Roses, when it fell into disrepair, was visited by many kings and queens. Savernake forest, about 1 mi. S.E., was then a crown forest and royal hunting ground. In 1189 King John was married to Isabella (Avice) of Gloucester in the castle chapel, and in 1204 John granted the town its first charter (the present charter dates from 1575). Henry III held his last parliament in the castle (1267) when the Statute of Marlborough, curtailing royal prerogative, was passed. In 1316 the priory of White Friars was founded; the site is now occupied by a boarding house of Marlborough college. The borough held a common seal in 1353 and its ancient arms were confirmed in 1565. During the reign of Edward VI, who in 1550 founded the grammar school (since 1947 a coeducational school), the castle site, together with Savernake forest, passed to the Seymours. This family supported the king in the Civil War, while the town supported parliament and was besieged and captured in 1642. In 1653 a great fire destroyed much of Marlborough, and in 1679 and 1690 other fires occurred. After the last fire an act of parliament was passed forbidding the use of thatch in Marlborough. The castle, rebuilt in the 17th century and again in the 18th, is now part of Marlborough college. From 1295 until 1867 the borough returned two members to parliament and until 1885 one member, after which it was merged in the East Wiltshire division; it is now in that of Devizes.

In Preshute by the Kennet stands the Norman church of St. George, largely restored in 1854; it contains a black basalt font which is said to have come from the castle chapel. Seven miles west of Marlborough is the prehistoric monument of Avebury (*q.v.*), with Silbury hill, a huge artificial mound, to the south.

The trade of the town is largely agricultural, with some light industries. A sheep fair is held on the common in August, and two other fairs, the "little mop" and the "big mop," are held in October.

MARLBOROUGH, a provincial district at the northeastern end of the South Island of New Zealand, embraces the parallel Wairau, Awatere and Clarence valleys, the lofty ranges between them, and the narrow strip between the Seaward Kaikoura range and the sea. Area 4,220 sq.mi.; pop. (1961) 27,748. Blenheim (pop. [1961] 11,956) and Picton (2,315), its port, are the only boroughs in this thinly populated district. In the Wairau valley, cradle of the South Island's wool industry, Merino sheep are reared on indigenous tussock grassland. Besides livestock, the lowlands support crops such as barley, peas and lucerne. At Lake Grassmere salt is produced by the solar evaporation of sea water, and Te Awaiti, Tory channel, has New Zealand's only remaining whaling station. (K. B. C.)

MARLIN, common name for several large sea fishes of the billfish family (Istiophoridae), which includes also sailfishes. They are among the most prized of big game fishes. The upper jaw is prolonged into a rounded spear; ventral fins are present and the dorsal fin, unlike that of the sailfishes, is not prominently enlarged to form a sail-like superstructure. They occur in the warm parts of all oceans and seasonally visit temperate regions in the northern hemisphere as far north as Nova Scotia and in the southern hemisphere as far south as Chile and the Cape of Good Hope. They are generally found traveling alone, in pairs or in small groups. The white marlin sometimes schools. Marlins feed on all kinds of smaller fishes that swim near the surface, such as mackerel, mullet and sardines, and on larger invertebrates, such as squids.

Because ichthyologists have had difficulty in obtaining enough specimens for comparative studies, there is considerable uncertainty regarding the number of species. Among those best known is the striped marlin (*Makaira audax*), ranging from southern California to northern Chile and westward into the Indian ocean and attaining 700 lb.; the blue marlin (*M. ampla*), widely distributed in the warm parts of the Atlantic and Pacific oceans and attaining over 1,600 lb.; and the white marlin (*M. albida*), ranging in the Atlantic from Brazil to Nova Scotia, in the Mediterranean and off the coast of Portugal and attaining hardly more than 160 lb.

The black marlin (*Istiompax indicus* or *marlina,* also called *Makaira indica*) is the largest species, growing to over 15 ft. and near to 2,000 lb. It ranges over tropical and temperate waters of the Pacific and Indian oceans. A related genus of billfishes, *Tetrapturus,* the spearfishes, is distinguished from *Makaira* in having pectoral fins that are not much if at all longer than the lower jaw and a spear that is hardly longer than the deepest depth of the body. *Tetrapturus* species range in the warm parts of the Atlantic and Indian oceans and in the Pacific as far east as Hawaii. *See* also FISH. (L. A. Wd.)

MARLOW, an urban district of Buckinghamshire, Eng., lies on the banks of the Thames 33 mi. W. of London by road. Pop. (1961) 8,704. An iron suspension bridge, built in 1831, connects the counties of Buckinghamshire and Berkshire. The parish church of All Saints, by the bridge, was built in 1835, on the site of a previous church which dated from the 12th century, and the spire, 170 ft. high, was added at the beginning of the 20th century. The Roman Catholic church of St. Peter was opened in 1846. The Old Parsonage (14th century) has two fine Decorated windows. Opposite is Marlow place, built in 1720 for George II when prince of Wales. The house called Remnantz contained the Royal Military college from 1802 to 1812 when it moved to Sandhurst. Percy Bysshe Shelley lived at Shelley house from 1817 to 1818 and was visited there by Lord Byron. Sir William Borlase school for boys was founded in 1624. The town is mainly residential but in summer its boating facilities, especially the one-day regatta in June, attract many visitors.

Bisham abbey, now a national recreation centre, about 1 mi. N. of Marlow, dates back to the Domesday Book. Many famous men were buried within its precincts and Queen Elizabeth I lived there

for three years before coming to the throne.

Medmenham abbey, about 4 mi. S.W. of Marlow, is on the site of a monastery founded about A.D. 1200 by Cistercian monks. It became famous in the 18th century as the headquarters of "The Hell Fire Club," founded by Sir Francis Dashwood and notorious for the revels of its members, whose motto was *Fay ce que voundras* ("Do as you like"). (C. W. Re.)

MARLOWE, CHRISTOPHER (1564–1593), a major English poet and Shakespeare's most important predecessor in English drama. The son of a Canterbury shoemaker, he was baptized on Feb. 26, 1564. In 1579 he entered the King's school, Canterbury, and in 1581 proceeded to Corpus Christi college, Cambridge, where he obtained his B.A. in 1584, but thereafter frequent absences from the university are recorded; in 1587 he was allowed to proceed to the M.A. only after a letter from the privy council to the university had made it clear that his service to the government had been useful, and that his government employment, doubtless in Elizabeth I's secret service, had on occasion taken him abroad. After this he is found in London, writing for the theatres, from time to time in trouble with authority (in 1589 he was concerned in an affray in which one William Bradley was killed, and this led to a brief time in Newgate; and in May 1592 two constables of Shoreditch asked that he be bound over to keep the peace), and probably also engaging himself from time to time in government service. Edward Phillips in *Theatrum Poetarum* (1675) asserted that Marlowe was an actor before being a playwright, but this statement may depend on nothing more than the notion that his career might well have taken the same course as Shakespeare's. He won a dangerous reputation for "atheism," but this could in Elizabeth I's time indicate merely unorthodox religious opinions: in Robert Greene's deathbed tract, *Greenes Groatsworth of Wit . . .*, he is addressed as a "famous gracer of Tragedians" and reproved for having said, like Greene himself, "There is no god," and for having studied "pestilent Machiuilian pollicie." When Henry Chettle, the publisher of this tract, apologized after Greene's death for its attack on Shakespeare, he made it clear that he was indifferent to any resentment felt by Marlowe. There is much further evidence of his unorthodoxy, notably in the denunciation of him written by the spy Richard Baines and in the letter of Thomas Kyd to the lord keeper, Sir John Puckering, in 1593 after Marlowe's death, alleging that certain papers found in his room belonged to Marlowe, who had shared the room two years before. Both Baines and Kyd suggest atheism in the stricter sense and a persistent delight in blasphemy. On not very strong evidence it appears, too, that Marlowe may have been associated in some measure with Sir Walter Raleigh, who at this time was certainly adventurous in his religious ideas. On May 18, 1593, the privy council issued an order for Marlowe's arrest; two days later the poet was ordered to give daily attendance on their lordships. On May 30, however, Marlowe was killed by Ingram Friser, in the company of Nicholas Skeres and Robert Poley, at a house in Deptford, where they had spent most of the day and where, it was alleged, they quarreled concerning the reckoning: Skeres and Poley, at least, had been engaged in government service. Marlowe was buried at Deptford on June 1 and Friser pardoned on June 28.

Plays.—*"Tamburlaine."*—Probably the earliest of Marlowe's plays was the two-part *Tamburlaine the Great* (*c.* 1587; publ. 1590), where his characteristic "mighty line" (as Ben Jonson was to call it in his verses prefixed to the Shakespeare Folio of 1623) established blank verse as the staple medium for later Elizabethan and Jacobean dramatic writing. It appears that originally Marlowe intended to write only the first part, concluding with Tamburlaine's marriage to Zenocrate and his making "truce with all the world." But, according to the prologue to part II, the popularity of the first part encouraged Marlowe to continue the story to Tamburlaine's death. This gave him some difficulty, as he had almost exhausted his historical sources in part I; consequently the sequel has, at first glance, an appearance of "padding." Yet the effort necessarily demanded in the writing of a continuation made the young playwright look more coldly and searchingly at the hero he had chosen: the resultant impression that part II gives is more complex and more judicial than anything that clearly emerges from part I. Or, perhaps to put it more exactly, part II makes explicit certain notions that were below the surface, insufficiently recognized even by the dramatist, in part I. Tamburlaine is a man avid for power and luxury and the possession of beauty: at the beginning of part I an obscure Scythian shepherd, he wins the crown of Persia by eloquence and bravery and a readiness to discard loyalty; he conquers Bajazeth, emperor of Turkey; he puts the town of Damascus to the sword; he conquers the soldan (sultan) of Egypt but, at the instance of the soldan's daughter Zenocrate, the captive whom he loves, he spares him and makes truce. In part II his conquests are further extended; whenever he fights a battle he must win, even when his last illness is upon him; but Zenocrate dies and their three sons provide a manifestly imperfect means for ensuring the preservation of his wide dominions; he kills Calyphas, one of these sons, when he refuses to follow his father into battle. Always, too, there are more battles to fight: when for a moment he has no immediate opponent on earth, he dreams of leading his army against the powers of heaven, though at other times he glories in seeing himself as "the scourge of God"; he burns the Koran, for he will have no intermediary between God and himself, and there is a hint of doubt whether even God is to be granted recognition. Certainly Marlowe feels sympathy with his hero, giving him magnificent verses to speak, delighting in his dreams of power and of the possession of beauty. Thus Tamburlaine in these lines makes us at least partially respond to his notion of human glory:

> Nature, that fram'd us of four elements
> Warring within our breasts for regiment,
> Doth teach us all to have aspiring minds:
> Our souls, whose faculties can comprehend
> The wondrous architecture of the world,
> And measure every wandering planet's course,
> Still climbing after knowledge infinite,
> And always moving as the restless spheres,
> Wills us to wear ourselves and never rest,
> Until we reach the ripest fruit of all,
> That perfect bliss and sole felicity,
> The sweet fruition of an earthly crown.

But, especially in part II, there are other strains: the hero can be absurd in his continual striving after yet further demonstrations of his power; his cruelty, which is extreme, becomes sickening; his human weakness is increasingly underlined, most notably in the onset of his fatal illness immediately after his arrogant burning of the Koran. In this early play Marlowe shows already a power to view a tragic hero from more than one angle, achieving a simultaneous vision of grandeur and impotence.

"Dr. Faustus."—Marlowe's most famous play is *The Tragicall History of Dr. Faustus*, but it has survived only in a corrupt form and its date of composition has been much disputed. It was first published in 1604, and another version appeared in 1616. It has been argued by Sir Walter Greg (see *Bibliography*) that the 1604 text is a corrupt version of the play as Marlowe ultimately revised it, and that the 1616 text depends partly on the author's unrevised manuscript and partly on the 1604 text. The source of the play seems without question to be the English translation of the German *Faustbuch* (1587), but no edition of the English translation is known to exist before 1592 and Greg has argued on bibliographical grounds that the extant edition is the earliest. This would put Marlowe's *Faustus* in 1592–93, but a difficulty arises in the apparent echoing of Faustus' final speech of remorse in both Greene's *Frier Bacon and Frier Bongay* (generally dated *c.* 1589; publ. 1594) and Greene's and Thomas Lodge's *A Looking Glasse for London and England* (*c.* 1590; publ. 1594). Certainly there are lines in *Faustus* which seem more mature in poetic craftsmanship than anything to be found elsewhere in Marlowe's work, but, since Greg's analysis of the two texts suggests revision, it remains a possibility that these lines were not in an original version that dated from soon after *Tamburlaine*. This, admittedly, does not meet Greg's bibliographical arguments, but it is a question whether they are conclusive.

Faustus takes over the dramatic framework of the morality dramas, presenting a story of temptation, fall and damnation, with a free use of morality figures such as the Good Angel and the Bad Angel, the Seven Deadly Sins, along with Lucifer and Mephisto-

philis. P. H. Kocher has argued in *Christopher Marlowe: a Study of His Thought, Learning, and Character* (1946) that Marlowe was attracted to the subject because it gave him an opportunity of voicing atheistical or blasphemous opinions through the mouth of his chief character, while safeguarding himself by the use of the traditional morality framework. Yet, as Kocher admits, the play gives eloquent expression to the idea of damnation, in the moving lament of Mephistophilis for a lost heaven, and to the idea of a possible redemption (though ultimately impossible for Faustus) through Christ's blood:

> The stars move still, time runs, the clock will strike,
> The devil will come, and Faustus must be damn'd.
> O, I'll leap up to my God!—Who pulls me down?—
> See, see, where Christ's blood streams in the firmament!
> One drop would save my soul, half a drop: ah, my Christ!—
> Ah, rend not my heart for naming of my Christ!
> Yet will I call on him: O, spare me, Lucifer!—
> Where is it now? 'tis gone: and see, where God
> Stretcheth out his arm, and bends his ireful brows!
> Mountains and hills, come, come, and fall on me,
> And hide me from the heavy wrath of God!

Just as in *Tamburlaine* Marlowe had seen the cruelty and absurdity of his hero as well as his magnificence, so here he can enter into Faustus' ambition while seeing him too as absurd and wanton. Yet in the course of the play there is suggested a carefully subdued resentment against a cosmic system that includes the initial possibility and the ultimate certainty of Faustus' damnation. Certainly Marlowe shows here an enormous interest in theological detail (which has been brought out particularly by Kocher and in Greg's article, "The Damnation of Faustus," *Modern Language Review*, vol. xli, no. 2, pp. 97–107, April 1946), an interest of a kind and degree that suggest detached scrutiny. The economy of the play leaves much to be criticized: it has frequently been assumed that the comic and farcical scenes were written by one or more collaborators, but there is no firm evidence for this. Although their workmanship is crude, in idea they contribute to the play's total statement, bringing out the essential absurdity of Faustus' dream. (*See* also FAUST; MEPHISTOPHELES.)

Other Plays.—In *The Famous Tragedy of the Rich Jew of Malta* (*c.* 1589) there is another power-hungry figure in the Jew Barabbas, who in the villainous society of Christian Malta shows no scruple in self-advancement. But this figure is more closely incorporated within his society than either Tamburlaine, the supreme conqueror, or Faustus, the lonely adventurer against God. In the end Barabbas is overcome, not by a divine stroke but by the concerted action of his human enemies. There is a difficulty in deciding how fully the extant text of *The Jew of Malta* represents Marlowe's original play, for it was not published till 1633, after a successful revival at Charles I's court under the sponsorship of Thomas Heywood. But *The Jew* is to be closely associated with *The Massacre at Paris* (1593), a dramatic presentation of incidents from contemporary French history, including the massacre of St. Bartholomew, and with *The Troublesome Raigne and Lamentable Death of Edward the Second* (*c.* 1592; publ. 1594), Marlowe's great contribution to the Elizabethan plays on historical themes. *The Massacre* introduces in the duke of Guise a figure unscrupulously avid for power, and the same play's brief representation of the philosopher Ramus, a victim of the massacre, gives another, though more favourably drawn, example of the man ready to run counter to received opinion and to dare greatly. So in the younger Mortimer of *Edward the Second* Marlowe shows a man developing an appetite for power and increasingly corrupted as power comes to him. In each instance the dramatist shares in the excitement of the pursuit of glory, but the three plays are at one in presenting such figures within a social framework: the notion of social responsibility, the notion of corruption through power, the notion of the suffering that the exercise of power entails, are all prominently within the dramatist's concern. Apart from *Tamburlaine* and the minor work *The Tragedie of Dido Queene of Carthage* (of uncertain date, published 1594 and written in collaboration with Thomas Nashe), *Edward the Second* is the only one of Marlowe's plays the extant text of which is to be relied on as adequately representing the author's manuscript. And certainly *Edward the Second* is a major work, not merely one of the first Elizabethan plays on an English historical theme. The relationships linking the king, his neglected queen, his favourite Gaveston, the ambitious Mortimer, are studied with detached sympathy and remarkable understanding: no character here is lightly disposed of, and the abdication and the brutal murder of Edward show the same dark imagination as appeared in the presenting of Faustus' last hour. Though this play, along with *The Jew* and *The Massacre*, shows Marlowe's fascinated response to the distorted Elizabethan idea of Machiavelli (for there is no certain evidence that he knew Machiavelli's writings), it shows a simultaneous awareness of the nature of disaster, the power of society, and the dark extent of an individual's suffering. T. S. Eliot in his essay on Marlowe (in *Selected Essays*, 1932; rev. ed. 1951) has suggested that in *The Jew of Malta* the playwright was working toward a form of grotesque comedy akin to Ben Jonson's: this brings out an aspect of the complexity of Marlowe's dramatic world, but may disregard the range of his sensitivity.

"Hero and Leander."—In addition to translations (Ovid's *Amores* and the first book of Lucan's *Pharsalia*), Marlowe's nondramatic work includes the poem *Hero and Leander*, freely derived from Musaeus. This was incomplete at his death, the first two "sestiads" of his composition being followed by four "sestiads" by George Chapman: the joint work of the two poets was published in 1598. Marlowe's writing here shows an astonishing skill in the management of the narrative decasyllable couplet, and his sensual descriptions of the lovers and their meetings are to be linked with the superb erotic poetry of Faustus' address to the appearance of Helen near the end of his tragedy. No agreement has been reached on the composition date of Marlowe's share in the poem, but it must rank with *Tamburlaine*, *Faustus* and *Edward the Second* as a major work.

Apocrypha.—A play called *Lust's Dominion* was published as Marlowe's in 1657, and the lost *The Maiden's Holiday* was entered in the Stationers' Register in 1654 as the work of Marlowe and John Day. It is no longer customary to see Marlowe's hand in the *Henry VI* plays published in the Shakespeare First Folio. The attempt of Calvin Hoffman (*The Man Who Was Shakespeare* [U.S. title, *Murder of the Man Who Was Shakespeare*], 1955) to present him as the author of Shakespeare's work as a whole has won no scholarly support.

Dramatic Power.—Criticism of Marlowe has tended to exalt his lyric and rhetorical gifts above his skill as a dramatist. This is understandable in view of the quality of his utterance, and in view too of the defective state of the text of *Faustus*, *The Jew of Malta* and *The Massacre at Paris*. But on further examination he reveals a greater power of dramatic craftsmanship than is often recognized: part I of *Tamburlaine* is indeed almost laboriously patterned; part II depends on its discursiveness for its capacity to include a wide range of shrewd implication; *Faustus* shows at least a firm sense of what is required at a play's key moments; *Edward the Second* is expertly controlled throughout. And Marlowe has the conscious complexity of view that makes him both the forerunner and the peer of the Jacobeans.

BIBLIOGRAPHY.—*Editions.*—The standard edition of Marlowe's work is that published in 6 vol. under the general editorship of R. H. Case (1930–33): this includes a biography by C. F. Tucker Brooke (1930), along with an edition of *Dido* in the same volume, and editions of *Tamburlaine* (ed. by U. M. Ellis-Fermor, 1930; rev. ed. 1951), *The Jew of Malta* and *The Massacre at Paris* (ed. by H. S. Bennett, 1931), *Poems* (ed. by L. C. Martin, 1931), *Faustus* (ed. by F. S. Boas, 1932; rev. ed. 1949) and *Edward II* (ed. by H. B. Charlton and R. D. Waller, 1933; rev. ed. by F. N. Lees, 1955). C. F. Tucker Brooke's ed. of the *Works* (1910) is the standard 1-vol. text. Sir Walter Greg's companion volumes, *Marlowe's Doctor Faustus 1604–1616: Parallel Texts* and *Doctor Faustus: a Conjectural Reconstruction* (both 1950) are of the first importance for the textual history of the play. Publication of separate editions of all the plays, in the Revels Series, began with *Faustus*, ed. by J. D. Jump (1962).

Criticism and Biography.—Critical and biographical writing on Marlowe is considerable in extent and uneven in quality. Kocher's book, and articles by Greg and Eliot have been mentioned above. Books of importance, either for information or for critical comment, include J. L. Hotson, *The Death of Christopher Marlowe* (1925); U. M. Ellis-Fermor, *Christopher Marlowe* (1927); F. S. Boas, *Marlowe: a Biographical and Critical Study* (1940); R. W. Battenhouse, *Marlowe's Tamburlaine* (1941); John Bakeless, *The Tragicall History of Christo-*

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MARLOWE, JULIA (Sarah Frances Frost) (1866–1950), U.S. actress, was born near Keswick, Eng., on Aug. 17, 1866, and at an early age went with her family to the United States. Her first formal appearance on the stage was in New York in 1887, although she had before that traveled with a juvenile opera company. Her first great success was as Parthenia in *Ingomar,* and her subsequent presentations of Rosalind, Viola and Julia in *The Hunchback* confirmed her position as a "star." In 1894 she married Robert Taber, an actor, with whom she appeared until their divorce in 1900. Subsequently, she had great success as Barbara Frietchie in Clyde Fitch's play of that name, and in other dramas. Beginning in 1904, she acted with E. H. Sothern (*q.v.*) —to whom she was married, Aug. 17, 1911—in a notable series of Shakespearean plays, as well as in modern drama.

She retired in 1924 and died in New York city on Nov. 12, 1950.

MARMARA, SEA OF (Turkish Marmara Denizi, *i.e.,* "sea of marble"; ancient Propontis), the small inland sea which (in part) separates Turkey in Europe from Turkey in Asia, and is connected through the Bosporus with the Black sea and through the Dardanelles with the Aegean. It is 175 mi. long (east to west) and nearly 50 mi. in extreme width. Despite its small area (4,429 sq.mi.) its average depth is about 270 fathoms reaching a maximum of 670 fathoms in the centre, the deepest parts (exceeding 500 fathoms) occurring in three depressions in the northern portion—one close to the European shore south of Tekirdag (Rodosto), another near the centre of the sea and a third at the mouth of the Gulf of Izmit (Izmit Korfezi).

There are two distinct island groups. The first comprises the Princes' Islands (*q.v.*) in the northeast; the second consists of the Marmara Islands proper in the southwest, off the Kapidag peninsula (Kapidagi Yarimadasi). Largest of the Marmara Islands are Marmara Adasi (ancient Proconesus), Avsar Adasi and Pasalimani Adasi. They are composed mainly of granite, slate and marble which have been quarried since ancient times (hence the derivation of Marmara, *i.e., mermer* meaning "marble"). The Sea of Marmara was formed as a result of crustal movements which occurred at the end of the Tertiary and in the first half of the Pleistocene epoch. It is an area of frequent earthquakes. The salinity averages 22‰; this increases, however, from the northeast toward the Dardanelles. Surface waters generally drift to the southwest, but no strong current occurs. The Marmara Islands have important fishing and canning industries and many localities are also rapidly developing as tourist resorts. (N. Tu.; S. Er.; E. Tu.)

MARMION, COLUMBA (1858–1923), Irish Benedictine monk, abbot of Maredsous, and noted theologian of Christian asceticism, was born in Dublin on April 1, 1858. He was christened Joseph but from the beginning of his monastic novitiate was known by his name in religion, Columba. Educated in Ireland, he completed his theological studies in Rome, where he was ordained priest in 1881. After a year of parochial work, he was appointed to teach philosophy at his own college, Holy Cross in Clonliffe, but a desire for the monastic life had steadily been growing within him and in 1886 he entered the novitiate of the Benedictine monastery of Maredsous (Namur, Belg.). In 1899 he was sent to the newly founded monastery of Mont-César at Louvain, where he functioned as prior and professor of theology until 1909, when he was elected abbot of Maredsous. He ruled that monastery until his death on Jan. 30, 1923.

Always a zealous and eager *conférencier,* Abbot Marmion himself had no interest in publishing, but in the last years of his life three volumes, compiled from notes taken down by his auditors and submitted to the correction of the abbot himself, did finally appear: *Le Christ, vie de l'âme* (1918), *Le Christ dans ses mystères* (1919) and *Le Christ, idéal du moine* (1922). These works had an astonishing circulation, which testifies to his extraordinary gifts as a spiritual writer: each was translated into nine languages. To them were added a number of posthumous publications.

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MARMONT, AUGUSTE FRÉDÉRIC LOUIS VIESSE DE, Duc de Raguse (1774–1852), French marshal whose long devotion to Napoleon came to a disappointing end in 1814, was born at Châtillon-sur-Seine in Burgundy on July 20, 1774. Having entered the artillery in 1792, he attached himself to Napoleon Bonaparte from 1793 and as his aide-de-camp in 1796 was so prominent in the Italian campaign that he could be made a colonel at the age of 22. Bonaparte made him a general on the voyage to Egypt in 1798, but kept him on artillery work until 1804, when he gave him command of a corps in Holland. Marmont brought this corps to Italy in 1805 without fighting; then, on July 7, 1806, he was appointed governor of Dalmatia. Though there was a Russian fleet in the Adriatic, he forced the Russians to abandon the siege of Ragusa (Dubrovnik) in September and secured control of the coast southward to Cattaro (Kotor). Furthermore he built roads and introduced a modern administration. He was made duc de Raguse in 1808, but lamented the "cruel obscurity" of a command so far away from the emperor. The war of 1809 brought him, with arduous fighting for his 10,000 men, from Zara (Zadar) to the Danube; and after the battle of Wagram he was made a marshal in July. After the peace of Vienna, however, he was sent back to be governor-general of Illyria.

A visit to Paris for the birth of Napoleon's son ended in Marmont's being sent to supersede André Masséna in command of the French army of Portugal in May 1811 (*see* Peninsular War). He formed the army into divisions under energetic officers and marched at once to help Soult at Badajoz. His operations turned on the key points of Ciudad Rodrigo and Badajoz. Within a year the French had lost both fortresses and Marmont was back on the upper Douro (Duero), having on four occasions avoided battle with the British. In July 1812 he pushed the British back across Castile and then, in the unexpected battle of Salamanca (July 22), was overwhelmed by a counterattack and severely wounded.

Marmont was given a corps in Germany in 1813. His conduct in the battles of Bautzen and Leipzig made him Napoleon's chief lieutenant for 1814. He commanded in the final battle at Paris (March 30, 1814), but four days later deserted Napoleon and passed to the allies. At the restoration of Louis XVIII he was made a peer of France, but French opinion never forgave him. During the revolution of July 1830, when his troops failed to hold Paris for Charles X, the dauphin (Louis, duc d'Angoulême) said that he had betrayed the king as he had betrayed "the other." In exile for the rest of his life, Marmont died in Venice on March 2, 1852. His *Mémoires* were published in eight volumes in 1856. (I. D. E.)

MARMONTEL, JEAN FRANÇOIS (1723–1799), French poet, dramatist, novelist and critic, chiefly remembered for his *Mémoires d'un père,* was born at Bort, Cantal, on July 11, 1723. In 1745, encouraged by Voltaire, he settled in Paris where good management made his career more brilliant than his second-rate talent warranted. He was a mediocre dramatist, composing short-lived tragedies in the Voltairian manner and, for Niccolo Piccini, the libretti of *Didon* (1783) and *Pénélope* (1785). More original were his *Contes moraux* (1761), first published separately in the *Mercure de France* which Marmontel edited between 1758 and 1760. Sentimental and edifying, insipidly elegant in content and style, these tales were widely appreciated and imitated. Marmontel's reputation was considerably enhanced by the publication of two philosophical romances, *Bélisaire* (1767) and *Les Incas* (1777). The first was condemned by the Sorbonne because of its plea for religious toleration; the second denounced the evils of fanaticism.

Marmontel derived from Voltaire the liberal classicism he expounded in his articles for the *Encyclopédie* and in his *Éléments de littérature* (1787). Elected to the Académie Française in 1763, he became its permanent secretary in 1783. He was appointed

royal historiographer in 1771. During the Revolution he displayed his usual prudence, in 1792 retiring to the country near Gaillon, Normandy, where he wrote his most interesting work, the autobiographical *Mémoires d'un père* (1804), and where he died on Dec. 31, 1799.

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MARMOSET in the widest sense refers to any small South American monkey of the family Callithricidae, but strictly denotes the genus *Callithrix*. All members of the family agree in their small size, squirrellike form and habits and in having all the digits except the big toe terminating in clawlike structures that are an aid in scampering along tree branches. Differing from other American primates in having one pair less molar teeth in both jaws, marmosets are remarkable for their high-pitched voices and their preference for a diet of insects, spiders and fruit.

The most familiar species is the common marmoset (*Callithrix jacchus*), notable for its large white ear plumes and ringed tail. The group includes many species with remarkable coloration and bizarre adornments. The female gives birth to twins after a gestation period of about 145 days. *See* also PRIMATES.

(W. C. O. H.)

MARMOT, any of the large, thickly built, burrowing rodents of the genus *Marmota*, of which there are numerous species ranging from the Alps through Asia north of the Himalayas, and in North America. They are members of the squirrel family (Sciuridae). Some North American species are commonly called woodchucks (*q.v.*), especially *M. monax*. In addition to their stout build, brownish to black pelage and thickly haired tails, marmots are characterized by the absence of cheek pouches. Europe possesses two species, the Alpine or true marmot (*M. marmota*), and the more eastern bobac (*M. bobac*). There are numerous kinds in central Asia, one of which, the red marmot (*M. caudata*), is a larger animal, with a longer tail. Marmots inhabit open country, either among mountains or in the plains; they associate in large colonies, forming burrows, each tenanted by a single family. During the daytime the hillock at the entrance to the burrow is frequently guarded by one or more members of the family. In the winter when the ground is deep in snow, marmots retire to the depths of their burrows to hibernate. They mate in early spring; one litter of two to nine young is produced each year. Their food consists of green plants.

W. SUSCHITZKY

ALPINE MARMOTS (MARMOTA MARMOTA)

The yellow-bellied marmot (*M. flaviventris*) ranges from New Mexico and southern California to British Columbia, while the hoary marmot or whistler (*M. caligata*) is found from Alaska to the high mountains of Idaho.

See also RODENT.

MARNE, a *département* of northeastern France, formed in 1790 from parts of ancient Champagne (*q.v.*) and bounded north by the *départements* of Aisne and Ardennes, east by Meuse, southeast by Haute-Marne, south by Aube and west by Seine-et-Marne. Area 3,168 sq.mi. (8,205 sq.km.). Pop. (1962) 442,195.

Although the Marne river, crossing the *département* from southeast to northwest, drains most of its area, the north is drained by the upper Aisne in the forested highland of the Argonne and farther west by its tributaries the Suippe and Vesle; in the extreme southwest the *département* extends into the basin of the Aube, as that river approaches its confluence with the Seine near Romilly.

Most of the *département* lies within the belt of permeable chalk country, about 40 mi. wide, that girdles the Île-de-France, but in the west it extends on to the platform of Tertiary limestone itself. This dominates the chalk in an imposing, ragged escarpment, the Falaise de l'Île-de-France, which reaches an altitude of almost 1,000 ft. overlooking Reims. There are rich grain lands on the limestone where it is enriched by a covering of *limon;* and on the lower slopes of the escarpment, both north and south of the Marne, the favourable sunny exposures and quick-warming, open-textured soils make possible the rich vineyards that supply the famous champagne wine industry of Reims, Épernay and nearby villages.

To the east, the slightly undulating chalk surface is extremely dry and has only a scant cover of poor soil, so that it merits the name *Champagne pouilleuse*. The great maneuvering grounds of the French army near Châlons-sur-Marne and Mailly-Champagne show the chalk country at its poorest. For long its chief use was as pasture for sheep, reared for their wool, but after the mid-19th century there were notable improvements. Extensive afforestation has been carried out, and pine plantations now relieve the bare, shaven landscape. They also provide valuable shelter belts for farms, and some sites of the earlier plantations now provide agriculture with soil that has been enriched with humus. Use of artificial manures has also enhanced the agricultural resources, but the chalk country is still sparsely peopled except in the widely spaced, trenchlike valleys, notably that of the Marne, favoured alike by shelter and water supply.

To the east, beyond the edge of the chalk outcrop, the Lower Cretaceous rocks, in contrast, are impermeable, and surface water is abundant or even excessive. The valleys of the Marne and its tributaries the Ornain and Blaise, converging upon Vitry-le-François, have fertile alluvial soils, but they cross a tract of varied, hilly and wooded country whose poor clay soils have resisted much agricultural development. Farther north the rugged Argonne massif interposes a historic barrier between Champagne and Lorraine.

By virtue of its situation as well as its physical character, Champagne has long been a passageway. Reims developed as a great trade centre in the middle ages, with famous fairs and an early important cloth industry. This has survived in the changed circumstances of modern industry by specializing upon materials of high quality. Reims and Châlons also have considerable engineering industries. Important roads and railways cross the *département* and canals connect the great navigable tributaries of the Seine with each other (Aisne-Marne canal) and with Lorraine (Marne-Rhine canal).

Although Reims is much the largest town and is the major ecclesiastical centre, with an archbishop, Châlons-sur-Marne, which is more centrally situated in the *département*, is the *préfecture*, and its see, under the archiepiscopal control of Reims, covers most of the *département*. For the administration of education, Châlons is the centre of an *académie*, but for justice the *département* comes under the court of appeal at Paris. The *département* is divided into five *arrondissements*, centred upon Châlons-sur-Marne, Reims, Épernay, Ste. Menehould and Vitry-le-François. The last is a regular, planned town, founded in 1545 to replace the nearby market town of Vitry-en-Perthois, which had been destroyed in warfare. With other towns of the *département* it in turn suffered heavy damage in the wars of the 20th century, but the great cathedral at Reims, in which the kings of France were consecrated, survives as one of the chief glories of Gothic architecture. (AR. E. S.)

MARNE, BATTLES OF THE (1914 and 1918), two battles fought by the Allied armies against the Germans in World War I.

The First Battle of the Marne.—By the first week in Sept. 1914 the northern flank of the Allied (Anglo-French) armies on the western front had been driven back to within 25 mi. of Paris. The formation of a new French army (the 6th, under Gen. Michael Joseph Maunoury), which threatened the right flank of Gen. Alexander von Kluck's 1st German army, and the resultant gap which occurred between the 1st and 2nd German armies, provided a favourable opportunity for the Allies to take the offensive.

On Sept. 7 the British expeditionary force under Field Marshal Sir John French advanced into the gap and crossed the Grand Morin river. By the morning of Sept. 9 they had begun an assault

crossing of the Marne river between La Ferté-sous-Jouarre and Château-Thierry. The two German armies were in full retreat and the pursuit northward continued until the Aisne river was reached on the night of Sept. 11—by which time French troops on the flanks had come up into line with the British. This ended the first battle of the Marne, a strategic rather than a tactical victory. (*See* WORLD WAR I: *The Crisis of the Marne.*)

The Second Battle of the Marne.—In July 1918 the Germans made their last major attack of the war. The front selected ran 30 mi. to the east and 30 mi. to the west of Reims. Grouped along this front were 67 Allied divisions (56 French, 7 U.S., 2 British and 2 Italian), 24 of which comprised the 6th and 10th French armies assembled for an offensive west of Reims. Against these the Germans had concentrated 52 divisions.

The German attack began early on July 15. East of Reims, where the resolute French officer Gen. Henri Joseph Gouraud was in command, the attack failed and was not renewed. West of the town the Germans overran the two Italian divisions, but were halted by troops of the British XXII corps. Farther west, the attackers crossed the Marne and established a substantial bridgehead. Little progress was made on July 16 and 17, and at midnight on July 17–18 orders were issued to stop the offensive.

On July 18 the Allies counterattacked with French, British and U.S. divisions in the area west of Reims; and initial gains of several miles were made. By July 20 the Germans had withdrawn from the Marne bridgehead. They continued to conduct a fighting withdrawal until Aug. 2, when the counterattack came to an end. Allied casualties were about 112,000. The Germans lost about 168,000 men and 793 guns. (C. N. B.)

MARNE RIVER, in northern France is 326 mi. long and rises on the limestone plateau of Langres. It flows in a wide valley across the successive belts of Jurassic, Cretaceous and Tertiary rocks of the Paris basin toward Paris and joins the Seine at Charenton-le-Pont, just above Paris.

Leaving Langres on the left, the upper Marne flows north past Chaumont to St. Dizier, where it turns west. It enters the chalk platform of Champagne at Vitry-le-François, crosses the permeable chalk country in a wide trench, past Châlons-sur-Marne to Épernay in the famous wine-producing district, and then traverses the Tertiary limestone platform of the Île-de-France. Its valley there is flanked by the rich grain lands of Brie and Valois, and the river is joined by the Petit-Morin, Ourcq and Grand-Morin tributaries. The Marne is canalized upstream as far as Dizy, beyond which it is doubled by a lateral canal that connects with the Saône. Other canals connect the Marne with the Rhine at Vitry-le-François and with the Aisne at Condé-en-Brie. (AR. E. S.)

MARNIX VAN SINT ALDEGONDE, PHILIPS VAN (1540–1598), Flemish nobleman, statesman and author, one of the earliest Calvinist writers in the Netherlands. Born in Brussels in 1540, he studied at Louvain, Paris and Dôle. He intended to take orders but while staying in Italy became a Calvinist and studied at Geneva, 1560–61. Returning to the Netherlands, he took an active part in the Reformation, but fled to Germany, where he wrote his famous and influential satire, *Biencorf der H. Roomsche Kercke* (1569; German trans. by J. Fischart, 1580), apparently defending the Church of Rome but in reality ridiculing it. In 1571 he entered the service of William of Orange. He went on a mission to England, 1581–82; took part in the settlement of the Pacification of Ghent (1576); requested help for the Netherlands at the diet of Worms (1578); and in 1583 was made burgomaster extraordinary of Antwerp, which he had to surrender in 1585 to the duke of Parma. Disheartened, he retired to his castle, West-Souburg, in Walcheren, where he revised his fine translation of the Psalms from the Hebrew (1st ed. 1580; 1591). In 1594 he was entrusted with the translation of the Bible, but only completed Genesis and the Psalms. He also adapted his *Biencorf* as a *Tableau des Différends de la Religion* and wrote essays on politics and religious polemics. The words of the *Wilhelmus,* the Dutch national anthem, are attributed to him, but his authorship has not been proved. He died in Leiden on Dec. 15, 1598.

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MARONI (Dutch: MAROWIJNE), a river forming the boundary between Dutch and French Guiana, South America, rises in the Tumuc-Humac mountains and flows 450 mi. mostly through tropical forest to reach the Atlantic about 18 mi. below Albina and Saint-Laurent. Its upper course is called the Itani in French and Litani in Dutch and its middle course the Aoua or Lawa. Moderate-sized vessels can reach Saint-Laurent. Gold placer mining is conducted on a small scale along the Lawa but the basin is otherwise undeveloped. The river's chief tributary is the Tapanahoni from the southwest. (G. LN.)

MARONITES (AL-MAWARINAH), Roman Catholics following the Syro-Antiochene rite, form the most numerous religious community of the republic of Lebanon (*q.v.*). Their immediate spiritual head under the pope is the Maronite patriarch, residing in Bkirki near Beirut, the capital of the republic; his title is "patriarch of Antioch and all the east." The name of the group derives from two historical figures, the first an influential Syrian solitary of the late 4th and early 5th centuries, called St. Maron (d. *c.* 423). At his tomb a monastery was built near Apamea on the Orontes. Because of persecution from the Jacobites, the monks transferred the monastery to more remote Lebanon, where it became the dynamic religious centre of the region. According to Maronite legend, a later monk of this community, St. John Maron, became patriarch of Antioch in 685–707 and the father of the Maronite nation. The tradition is uncritical, though St. John Maron may well have been an energetic patriotic bishop of Lebanon. The Maronites, hardy, martial mountaineers, have always valiantly preserved their liberty and folkways. The Muslim empire could not absorb them, and two Omayyad caliphs paid them tribute. Under John Maron they became a fully independent people after routing the invading Byzantines of Justinian II in 694.

According to Maronite tradition, the Maronites were always orthodox Christians in union with the Roman see, but the best evidence indicates that for centuries they were Monothelites (*q.v.*), following the heretical doctrine of Sergius, patriarch of Constantinople, who affirmed that there was a divine but no human will in Christ. According to the medieval bishop William of Tyre, the Maronite patriarch sought union with the Latin patriarch of Antioch in 1182. At this time the Maronites were certainly close friends and allies of the French crusaders, and an unstable union with Rome at this early date is most probable. At all events, a definitive consolidation of the union came in the 16th century, thanks in great part to the work of the Jesuit John Eliano. In 1584 Pope Gregory XIII founded the Maronite college in Rome, which still flourishes under Jesuit administration. In this centre great scholars and leaders were trained, of whom the most distinguished were the four Assemani (al-Sam'ani), two brothers and their two nephews, who worked in the 18th century.

During the days of the Ottoman empire the Maronites, largely unhampered because of their isolation, maintained their religion and customs under the protection of France. In the 19th century the Turkish government incited the neighbouring Druze (*q.v.*) to harass the Maronites. This policy culminated in the great Maronite massacre of 1860, and as a result of this tragedy the Maronites achieved formal autonomy within the Turkish empire under a non-native Christian ruler. After the downfall of the Ottoman empire, the Maronites of Lebanon along with Syria became self ruling in 1920 under French protection. In 1944 the fully independent republic of Lebanon was established. Other religions in addition to that of the Maronites exist in the republic, but the president is always a Maronite.

The language of the Maronites is Arabic but their liturgical tongue is West Syriac. The Maronite cultural centre is the University of St. Joseph, conducted by French Jesuits at Beirut. There are nearly 400,000 Maronites in Lebanon and Syria, and 15,000 live in Egypt, Israel and Jordan.

Under the pressure of the persecutions of the 19th century, the

Maronites began to emigrate from the near east in great numbers, and as many as 475,000 can be found in the lands of southern Europe and in North and South America. The *émigrés* keep their own liturgy and have their own clergy (some of whom are married), but are subject to the local Latin-rite bishops who work in collaboration with the Maronite patriarch, who remains the true head of the dispersed congregations.

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MAROT, CLÉMENT (1496–1544), one of the greatest poets of the French Renaissance, was born at Cahors in the province of Quercy, probably in 1496. His father, Jean Marot, was a poet of the *grands rhétoriqueurs* school of poetry (*see* French Literature: *Poetry in the 15th Century*) and left Cahors with his son to take up a post at the court of Anne of Brittany. Later he became *valet de la garderobe* to Francis I.

Little is known of Clément Marot's youth except for some references found in his poetry. It appears that his education was not very good. In 1514 he became page to Nicolas de Neufville, seigneur de Villeroi, secretary to the king, and at the same time seems to have worked as a clerk in the department of justice, the normal way for boys of bourgeois families to prepare for a career in the civil service. About 1515 he appears to have begun to write poetry. Soon he wished to follow in his father's footsteps by obtaining a place as court poet. In 1519 he entered the service of Margaret of Angoulême (*q.v.*), duchess of Alençon and later queen of Navarre, sister of Francis I and one of the most remarkable women of the Renaissance, herself a poet and novelist of stature who, during the whole of her life, protected fellow-poets, philosophers and religious reformers. He remained in her service until 1527 when, on the death of his father, he obtained the post of *valet de chambre* to Francis I, which, apart from the interruption of the years of his first exile (1534–36), he was to retain until his second exile in 1542.

In 1526 Marot, because of eating meat in Lent, which at that time was an indication of Lutheranism or at least of strong objection to the Roman Catholic Church, was arrested on a charge of Lutheranism and imprisoned in the Châtelet. He was not tried, however, but released in somewhat obscure circumstances after a few weeks. This episode inspired some of the poet's best-known works, especially "L'Enfer," an allegorical account of his imprisonment containing a violent satire on justice, as well as the famous "Épitre à son amy Lyon" (1526). In 1527 he was again put into prison, this time for having freed an unknown prisoner by attacking his guards. He appealed to the king in another famous epistle "Marot, Prisonnier, escript au Roy pour sa déliverance" (1527) and was released by his orders. Early in 1531 the *parlement* of Paris ordered his arrest for again eating meat in Lent, no doubt a trumped-up charge. He was, however, saved from prison through the intervention of Margaret of Angoulême and of her husband, Henry II, king of Navarre.

About this time his fame was firmly established and his many poems seemed to have enjoyed a wide circulation. In Aug. 1532 he published a collection under the title *L'Adolescence Clementine.* Toward the end of 1533, probably, he published a second collection, *La Suite de l'adolescence Clementine.*

In Oct. 1534, on the morning after the *Affaire des Placards* (*see* France: *History: Francis I;* Reformation), when posters violently attacking the Catholic Church were fixed on the walls of the principal towns of France and on the very door of the king's bedchamber, Marot fled and made for the kingdom of Navarre where Margaret was then in residence. On the way he was recognized in Bordeaux and arrested, but managed to escape. He found refuge with Margaret during the winter but in the spring she felt powerless before the intensification of the persecution of the Protestants ordered by the king, and advised Marot to leave. He fled to Ferrara where he was received by the duchess, Renée of France, sister-in-law of Francis I, and obtained a post as her secretary. Renée, a woman of great culture and an ardent Protestant, protected a number of French Lutheran refugees and Marot seems to have felt happy at her court. Some of his finest poems date from his stay at Ferrara. However, early in 1536, Renée's husband, Ercole II d'Este, rigidly orthodox and wishing to free himself from his alliance with France, ordered the expulsion of practically all Renée's French entourage, and the Inquisition of Ferrara took up proceedings against Marot and other Lutherans. Once again the poet fled, this time to Venice, where he spent the summer and autumn of 1536.

During his stay in Venice he attempted, successfully, to obtain permission to return to France, where Francis I, in two edicts, had put a stop to the persecution of Protestants. In Dec. 1536 Marot crossed the Alps, arriving at Lyons shortly before Christmas. There he was forced to abjure his errors publicly. He then went to Paris and in March 1537 rejoined the court. Apart from official poems which his duties compelled him to write, most of his time from then on seems to have been taken up with a translation of the Psalms, of which a first edition was published in 1539.

In the autumn of 1542 renewed severity toward Protestants was decided upon and it was, no doubt, to escape from fresh persecutions that the poet again fled. This time he went to Geneva, where John Calvin received him warmly, hoping that he would complete his translation of the Psalms. The *Conseil de la Ville,* however, refused to grant the poet a pension and after staying for about a year, Marot left Geneva and went to Savoy where he stayed with a number of the local gentry. In 1544, the presence of a French army in Piedmont under the young duke of Enghien probably gave Marot the hope of returning to France under Enghien's protection. In the summer he went to Turin but died there in Sept. 1544.

His translation of the Psalms was condemned by the Sorbonne, and his whole work was placed on the first Index Librorum Prohibitorum (*q.v.*) published by Pope Paul IV in 1557.

Reputation and Poetic Status.—Although Marot's poetry never lost favour and was constantly admired for its ease, elegance and wit, Marot's real importance has never been quite recognized, mainly because the Pléiade (*q.v.*), coming on the scene within a few years of his death, claimed and obtained the credit for most of the innovations introduced by him. Yet it is Marot who has influenced the whole course of French poetry by judicious imitation of the *genres* and themes of antiquity. Though his first compositions were entirely in the style of the *rhétoriqueurs,* he soon gave up not only the set genres of the school, but also its mannerisms, its abuse of allegory and its complicated versification. He introduced the elegy, the eclogue, the epigram and the epithalamium. Moreover, from his youth onward, he attempted to create a new lyrical genre, composing a number of *chansons* and later several *cantiques.* These attempts led to his translations of the Psalms in which he created the lyrical metres which Ronsard was to use in his Pindaric odes. He imitated Catullus, Virgil and Ovid and was the first French poet to use extensively the imagery of Latin poetry.

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MAROT, DANIEL (1661–1752), architect, engraver and decorative designer, was trained under his father, Jean Marot (*q.v.*), in his native Paris. He was a Protestant and retired to Holland in 1684, thereby anticipating the revocation of the Edict of Nantes. He entered the service of the stadholder, the prince of Orange, for whom he designed the audience chamber at The Hague (1686), as well as apartments and gardens at the new palace of Het Loo (*c.* 1692); he also worked for private Dutch clients. In 1694

he followed his master, now William III, to England and henceforward often introduced the royal arms and cipher into his engraved designs. In the frontispiece to his collected works he is styled *Architecte de Guillaume III*, but if he received any official appointment it was as intendant of the royal gardens only. He certainly provided several designs for the east parterre at Hampton court, and was probably consulted about the interior decoration and furniture also, though his pay seems to have been borne on Dutch, not English, funds. A group of delftware tulip vases, milk pans and tiles bearing the royal insignia, some of which survive, appear to have been made for Hampton court after his designs, and a state coach for William III was constructed at The Hague to Marot's design. He returned to Holland about 1698 and until his death (at The Hague, June 4, 1752) continued to work for the stadholder's family, notably at Slot Oranienstein, in Friesland, and in the Huis ten Bosch. His later work for private patrons at The Hague included the houses of the Fagel, Van Schuylenburch and Van Wassenaar families, the present royal library and the Portuguese synagogue.

His numerous engraved designs for furniture, silver, textiles, interior decoration, etc., in an opulent and often fantastically elaborate style, exercised a widespread influence. As a record of contemporary fashions, particularly of the beginnings of the European taste for oriental motifs, they are invaluable. Although Marot's style derives in some degree from Jean Lepautre and J. Bérain (*q.v.*) it contributed nothing to the formation of the Louis XIV style in France itself, but is rather a Dutch variant of that style.

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MAROT, JEAN (*c.* 1619–1679), French architect and engraver, was one of a large family of Parisian craftsmen and artists. He was architect of various private houses, including the Hôtels de Pussort, de Mortemart and de Monceau, but he is chiefly renowned for his two great series of architectural engravings known as "Le Petit Marot" and "Le Grand Marot," essential for the study of French 17th-century architecture. In addition he engraved a large number of ornamental designs for chimneys, ceilings, etc., a practice in which he was followed by his son Daniel Marot (*q.v.*). He died in Paris, Dec. 15, 1679. (F. J. B. W.)

MARPECK (Marbeck), **PILGRAM** (*c.* 1490–1556), the outstanding 16th-century South German Anabaptist leader and writer (*see* Anabaptists), was born at Rattenberg in the Inn valley of Tirol. By profession an engineer, he served first as a mining judge at his home town, whence he was expelled in 1528 as an Anabaptist, then as an engineer of water works for the cities of Strasbourg (1528–31, until his expulsion) and Augsburg (1544–56), where he died.

In Strasbourg he emerged as a vigorous Anabaptist leader, at first in close touch with the reformers Martin Bucer, Wolfgang Capito and Zell, with whom he had numerous theological discussions. Marpeck's three major theological works and two small pamphlets, with a total of over 2,000 pages, place him in the ranks of the top Anabaptist writers with the Dutch Menno Simons (*q.v.*) and Dirk Philips and the Hutterite Peter Riedemann. Two of these books, the *Vermahnung* (printed in 1542) and the *Verantwortung* (written in 1544–50 but never printed), both written in collaboration with Leupold Scharnschlager, arose out of his controversy with the spiritualist Kaspar Schwenckfeld. The Anabaptist group led by Marpeck, sometimes called Pilgramites, was never large and was absorbed into the Swiss Brethren about the middle of the 16th century. *See* also Mennonites.

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MARPRELATE CONTROVERSY, the most famous Elizabethan pamphlet war. From the autumn of 1588 to the summer of 1589 there were secretly printed (by Robert Waldegrave) at least seven tracts, the author being described as "Martin Marprelate gentleman" (or, on one occasion, as his younger brother, "Martin junior"). The tracts appeared at the point when John Whitgift (*q.v.*; archbishop of Canterbury since 1583) was effectively silencing Puritanism by his rigorous use of the court of high commission and control of printing. They were Puritan attacks on episcopacy in general and on certain bishops in particular: "profane, proud, paltry, popish, pestilent, pernicious, presumptious prelates." They do not seem, however, to have been in touch with the main trend of Puritanism, for they failed to win the support of the movement's leaders. The English invective was exceptionally vigorous and racy, improving on such earlier masters of rude rhetoric as the Reformers John Bale, Hugh Latimer and Thomas Becon, and the Separatist Robert Browne.

The seven surviving tracts are: *Epistle and Epitome*, being the two parts of *Oh read over D. John Bridges* (Bridges was dean of Salisbury and author of *A Defence of the Government established in the Church of Englande*, 1587); *Certaine minerall and metaphisicall school-points, to be defended by the reverende byshopps; Hay any worke for Cooper* (Thomas Cooper was bishop of Winchester); *Theses Martinianae, that is, certaine demonstrative conclusions*, by Martin junior; *The just censure and reproofe of Martin junior, by Martin senior;* and *The Protestatyon of Martin Marprelat*. The secret presses moved from Molesey (near Kingston-upon-Thames) to Fawsley house (near Daventry, Northamptonshire), to Worcestershire, Coventry and Manchester. When the press was discovered by government agents, the tracts ceased (1589).

The authorship was, and remains, a mystery; probably more than one writer was involved, under the sponsorship of some Puritan peer. Claims were made at the time and later for John Udall, John Field, Henry Barrow and a certain Sir Roger Williams (Fluellen in Shakespeare's *Henry V*); and, more convincingly, for Job Throckmorton and John Penry (*q.v.*). Whitgift thought Penry was the author. C. S. Lewis has written that Martin "displayed a new manner in controversy, and probably his successors learned from him. It can hardly be claimed that in this new kind he attained excellence. He seems at times a little tired of it himself. He is not best when he is rowdiest. I believe a quieter and more ironic prose, a prose closer to Swift's, would have been more congenial to him" (*English Literature in the Sixteenth Century;* Oxford University Press, 1954). Martin's successors among anti-episcopal pamphleteers included John Milton.

The Marprelate tracts occasioned replies. Of those printed (anonymously) in 1589, some are sometimes attributed to Thomas Nashe (including *An almond for a parrat, or Cuthbert Curry-knaves almes*, and *Mar-Martine*). Some have been attributed to John Lyly, including *Pappe with an hatchet* and *A Whip for an ape, or Martin displaied*. Again, the attribution is not proved. The tracts were attacked in Feb. 1589 at Paul's Cross, London, by Richard Bancroft (*q.v.*) in a sermon usually considered as the first statement of the "divine right" of episcopacy in Anglican apologetic.

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MARPURG, FRIEDRICH WILHELM (1718–1795), German composer and writer on music, was born on Nov. 21, 1718, at Marpurgsdorf, near Seehausen, Brandenburg. Nothing is known of his musical training but in 1746 he is heard of as secretary to a Prussian general in Paris, where he met Voltaire, J. d'Alembert and J. P. Rameau. Later he lived in Berlin and Hamburg, and from 1763 to 1795 he was director of the Prussian state lottery. Although he composed various pieces for the harpsichord, it is as a theoretical and critical writer on music that he is best remembered. Such works as the *Historisch-kritische Beyträge* (Berlin, 1754–78) and his various introductions (*Anleitungen*) to different branches of the art, of which perhaps his *Abhandlung von*

der Fuge (Berlin, 1753–54) is the most important, are still of great interest to students of 18th-century music theory and practice and contain much valuable historical information. Marpurg's published compositions include *6 Sonaten für das Cembalo* (1756) and *Fughe e caprice* (1777). He died in Berlin on May 22, 1795. (Cs. Ch.)

MARQUAND, JOHN PHILLIPS (1893–1960), U.S. novelist noted for his satirical yet sympathetic portrayals of a crumbling New England gentility, was born in Wilmington, Del., Nov. 10, 1893, and graduated from Harvard university in 1915. After about 15 years devoted to writing popular fiction, including the widely read adventures of the Japanese detective Mr. Moto, Marquand turned to his New England studies, his first novel in this vein being *The Late George Apley* (1937), which won a Pulitzer prize. *H. M. Pulham, Esquire* (1941) developed a similar theme, with the conforming Bostonian renouncing romantic love for duty. Other titles deserving specific mention are *Point of No Return* (1949), *Melville Goodwin, U.S.A.* (1951) and *Sincerely, Willis Wayde* (1955).

Somewhat an anomaly among modern American writers, Marquand achieved a mass audience as well as respectful critical attention. During 40 years as a professional writer, he published 25 novels and historical studies, collaborated on adaptations of two of his novels for the theatre and wrote dozens of short pieces. In his major work he was a superb reporter of the shifting social patterns in American life and a chronicler of social status seeking among the lower upper class. Marquand died at his home in Newburyport, Mass., July 16, 1960. (J. J. Gr.)

MARQUESAS ISLANDS: *see* French Polynesia.

MARQUESS or Marquis, a title and rank of nobility. Etymologically the word has the same meaning as margrave (*q.v.*), denoting a count or earl holding a march or mark, that is, a frontier district; but this original significance has long been lost.

In England the Late Latin term *marchiones* (plural) was early applied to the lords of the Welsh marches (*see* March, Earls of); but it was there used in a sense descriptive only of their lordships' location near the frontier without implying that they were superior to other earls. On Dec. 1, 1385, however, Robert de Vere, 9th earl of Oxford, was created marquess of Dublin with precedence between dukes and earls; the other earls resented this creation, and the patent of the marquessate was revoked on Oct. 13, 1386, after its holder had been created duke of Ireland. John Beaufort, earl of Somerset, was created marquess of Dorset and marquess of Somerset on Sept. 29, 1397, but he was degraded to his former earldom on Nov. 3, 1399. When the commons petitioned for his restoration as marquess of Dorset in 1402, he objected because of the strangeness of the term in England. On June 24, 1443, however, his son Edmund Beaufort was raised to be marquess of Dorset, after which the title retained its place in the peerage. As earlier creations became extinct or were raised to dukedoms, the premier marquessate of England in the 20th century was that of Winchester, created on Oct. 11, 1551.

A marquess has precedence next after a duke, is "most honourable" and is styled "my lord marquess"; his mantle of parliament is scarlet, with three and a half double linings of ermine; his coronet is worn at coronations. The wife or widow of a marquess, or a lady holding in her own right the position equal to that of a marquess, is a marchioness.

In western Europe the Carolingian *marchiones* or margraves had been royal officials whose duty of defending a frontier might justify an exception's being made to the normal rule that no count should hold more than one countship or county. Their authority was thus not much less than that of a duke (*q.v.*); indeed the term *Markherzog* is occasionally found instead of *Markgraf*. But as conditions on the frontiers or the frontiers themselves were changed, the special importance of the old marches diminished.

In France, as the great feudatories' power grew at the expense of the king's, the old *marquisats* were practically lost in the great duchies or countships. Then, with the multiplication of little fiefs, minor counts holding several such lordships took to assuming the style of marquis to distinguish themselves. The kings indeed were very chary of erecting *marquisats;* that of Trans in Provence, raised from *baronnie* in 1505 for Louis de Villeneuve, is reckoned as the *premier marquisat de France*. Moreover the rank of marquis, always inferior to that of a duke, was in a controversial relation to that of a count. Sometimes a count's nobility was better established and his fief greater than that of any marquis; sometimes a marquis with a royal patent should obviously have precedence. These ambiguities served to bring the title into disrepute in the 17th and 18th centuries, as being too often self-made or pretentious; and after the Revolution had abolished it Napoleon did not see fit to revive it. Louis XVIII, reviving it after the Restoration, gave its holders definitive precedence between dukes and counts.

In Italy the mark (*marca*, plural *marche*) long survived as a major territorial unit, though the original Carolingian demarcations were considerably altered. By the 14th century, however, barons and *signori* had begun to erect their fiefs into *marchesati*, after which the title grew to have much the same fate as the French *marquisat*.

In Spain the remnant of the original Marca Hispanica was merged in the countship of Barcelona. The first Castilian *marquesado* was that of Villena (on the Valencian frontier), created for Don Alonso of Aragon in 1376; the Pacheco family, who acquired it from the crown in 1445, subsequently became dukes of Escalona. The next senior *marquesado* was that of Santillana (1445).

MARQUETRY, a form of decorative woodwork in which pieces of thin wood or other materials (including ivory, bone, brass and other metals, tortoise shell and mother-of-pearl), combined to form a design, are veneered to a surface. Marquetry differs from true inlay in that the entire surface is covered, whereas with inlay, pieces are set in the surface. For a full discussion of the techniques of marquetry and its history *see* Woodwork, Decorative.

MARQUETTE, JACQUES (Père Marquette) (1637–1675), French explorer and Jesuit missionary priest who with Louis Jolliet traveled down the Mississippi river in 1673 and reported the first accurate data on its course. He was born in Laon, France, on June 1, 1637, and entered the Society of Jesus at Nancy at the age of 17. He was ordained to the priesthood at Toul on March 7, 1666, and arrived at Quebec on Sept. 20 of that year. He founded two missions which have given their names to towns in Michigan: Sault Ste. Marie (1668) and St. Ignace (1671). While at Holy Spirit mission (Ashland, Wis.), 1669–71, Indians from Illinois invited him to come to their territory. Hence, when Governor Frontenac commissioned Jolliet's Mississippi expedition in the autumn of 1672 Jolliet asked Marquette to go along. Leading a party of five Frenchmen, Marquette and Jolliet left St. Ignace in canoes in the spring of 1673. They coasted westward into Green bay and ascended the Fox river to a portage (Portage, Wis.) that crossed to the Wisconsin river. On June 17 they entered the Mississippi river (about three miles south of Prairie du Chien, Wis.). On July 17, near the confluence of the Arkansas river, apprehending Spanish hindrance, they turned homeward. They visited the Illinois Indians along the Illinois river and, thence, by the Chicago portage reached Lake Michigan.

A year later, in failing health, Marquette returned to the Illinois Indians to found his third mission, Immaculate Conception (Utica, Ill.). Caught by winter, he and two French companions built a cabin on the site of Chicago, thus becoming the first white men to live there (Dec. 4, 1674–March 30, 1675). Sickness forced him to abandon the mission in April 1675. He and his companions directed their course toward St. Ignace, following the east shore of Lake Michigan. At a river that now bears his name he died (Ludington, Mich.) on May 18, 1675. Two years later his bones were transferred to St. Ignace.

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MARQUETTE, a city and port of the upper peninsula of Michigan, U.S., and seat of Marquette county, surrounded by rugged hills, is located on Lake Superior in a summer and winter resort area, about 400 mi. N. of Chicago.

Established in 1849 as Worcester, it was the first shipping point on the lake for the iron ore, pig iron and lumber of the region. It was renamed in 1850 for Father Jacques Marquette, the Jesuit missionary-explorer, incorporated as a village in 1859, was largely destroyed by fire in 1868 but rapidly rebuilt, and chartered as a city in 1871.

A city commission form of government was established in 1914 and a city-manager form was adopted in 1946.

Marquette is still an important ore shipping centre with railroad shops and impressive docks. Other industries include chemicals, foundry products, mining machinery, wood products and foods. It is the home of Northern Michigan college (1899, state supported) and Michigan State Branch prison (1885), and is a Roman Catholic diocesan centre (St. Peter's cathedral). Presque Isle, within the city, is a 328-ac. natural park deeded to Marquette by the U.S. government in 1886. Sugar Loaf mountain, K. I. Sawyer air force base and Cherry Creek fish hatchery are nearby. For comparative population figures *see* table in MICHIGAN: *Population.* (K. B.)

MARQUINA, EDUARDO (1879–1946), Spanish poet and dramatist, was born in Barcelona, Jan. 21, 1879, and died in New York, Nov. 21, 1946. Curiously disengaged from the vicissitudes of contemporary thought and expression, he devoted his considerable gifts as narrative and dramatic poet to celebrating the traditional glories and virtues of Spain (altar, throne, valour, chivalry) in the days of its greatness and empire, in resonant uncomplicated verse (*Tierras de España*, 1914; *Vendimión*, 1908). Among his many plays some of the best are *Las hijas del Cid* (1908), *En Flandes se ha puesto el sol* (1910), *Teresa de Jesus* (1932) and *La Santa Hermandad* (1937).

See his *Obras completas*, ed. by S. Aguilar, 7 vol. (1944). (R. F. B.)

MARQUIS, DON (DONALD ROBERT PERRY MARQUIS) (1878–1937), U.S. poet and playwright, creator of Archy and Mehitabel, was born in Walnut, Ill., July 29, 1878, and educated at Knox college, Galesburg, Ill.

Marquis worked as a reporter on several newspapers and assisted Joel Chandler Harris in editing the *Uncle Remus* magazine. From 1912 to 1922 he conducted a column, "The Sun Dial," in the *New York Sun*, and in it first appeared that extraordinary pair of creatures, Archy the cockroach and Mehitabel the cat. Archy's poetic reflections on the world as seen "from the under side" and Mehitabel's racy misadventures were combined in a unique record, part whimsical, part bitter, wholly philosophical. Among Marquis' published collections of humorous poetry, satirical prose and plays are *Danny's Own Story* (1912), *Dreams and Dust* (1915), *Hermione* (1916), *The Old Soak* (1921), *Sonnets to a Red Haired Lady* (1922), *The Dark Hours* (1924), *Out of the Sea* (1927) and *Archy and Mehitabel* (1927). Marquis died at Forest Hills, N.Y., on Dec. 29, 1937, after a long illness.

MARR, NIKOLAI JAKOVLEVICH (1865–1934), Soviet linguist, archaeologist and philologist whose area of specialty was the Caucasus, was born on Jan. 6, 1865, at Kutais. In 1930, he was elected vice-president of the Academy of Sciences of the U.S.S.R. Marr's substantial achievements in Caucasian archaeology and philology have been obscured by his notorious linguistic theories. He postulated a stage development (corresponding to Marxist economic stages) of all the world's languages from an original word stock of four elements: *sal, ber, yon* and *rosh*. He died on Dec. 20, 1934, at Leningrad.

See L. L. Thomas, *The Linguistic Theories of N. Ja. Marr*, University of California Publications in Linguistics, vol. 14 (1957). (L. L. T.)

MARRAKESH (MARRAKECH), the chief city of southern Morocco and the second in the kingdom, capital of Marrakesh province. In the centre of the Haouz plain, the city lies just south of the Tensift wadi and about 25 mi. N. of the snowcapped High Atlas mountains. By road it is 150 mi. S. of Casablanca. Pop. (1960) 243,134.

Marrakesh has a mild dry climate from November to April but becomes extremely hot in summer. The city is divided into two parts: the medina, or ancient Moorish town; and the modern French-built quarter west of it. The medina, surrounded by a palm grove yielding coarse dates, is enclosed by ramparts about 8 mi. long and 16 ft. high made of reddish clay, of which most of the houses are also built. The heart of it is the Place Djemaa Al Fna, a vast square with market stalls and booths, and enlivened by acrobats, storytellers, snake charmers and dancers. North of the Place is the crowded sook, or market quarter, and just west of it the 12th-century Koutoubia mosque, whose 220-ft. minaret decorated with turquoise-blue mosaics dominates the town. Other notable buildings include the late-19th-century Bahia ("the brilliant") palace; the Dar Si Said, a palace converted into a museum of Moroccan art; the Université Ben Youssef (traditional Islamic studies); and the necropolis of domed mausoleums built in the late 16th century to enshrine the tombs of the Sa'adi rulers. South of the medina the Aguedal gardens, surrounded by high walls, cover about 1,000 ac. and are planted with olive and fruit trees. The French-built part of the city dates from 1913. It is known as the Gueliz after the Jabal Gueliz (1,728 ft.) rising north of it; and is laid out in wide streets most of which are lined with trees.

Apart from local crafts Marrakesh is little industrialized and is, like Fès, a regional centre which did not share the development of the coastal Moroccan towns in the first half of the 20th century. It is, however, a popular centre for tourism and for winter sports in the High Atlas. The city is the terminus of the railway from Casablanca and is linked by scheduled air services with Casablanca, Fès and Agadir. Regular automobile services connect with Essaouira (formerly Mogador, 109 mi. W.) and other centres; there are local bus services.

History.—Marrakesh, misnamed Morocco by Europeans, gave its name to the kingdom of which it was for long the capital. It was founded in 1062 by Yusuf ibn Tashfin of the dynasty of the Almoravids (*q.v.*), and served as the Almoravid capital until it fell to the Almohads (*q.v.*) in 1147. In 1269 it passed to the control of the Marinids, whose preferred capital was Fès. Although Marrakesh was embellished by the Sa'adians in the 16th century, the succeeding Alawid rulers (*see* FILALI) resided more often at Fès or Meknès. In 1912 Marrakesh was captured by the Saharan insurgent al-Hiba, who was defeated and driven out by French forces commanded by Col. (later Gen.) C. M. E. Mangin (1866–1925). Under the French protectorate (1912–56) Marrakesh was for many years administered by the Glaoua family, the last of whom, Haj Thami al-Mezuari al-Glaoui, celebrated for his pomp, was the chief instigator of the deposition of sultan Mohammed ben Yusuf (Mohammed V) in 1953.

MARRAKESH PROVINCE had a population of 1,990,808 in 1960. It extends from the High Atlas northward to the Chaouia region of Casablanca province, and from Essaouira in the west to the Beni Mellal province in the east. The economy is chiefly agricultural. It is divided administratively into the *cercles* of Abda, Ahmar, Aït-Ourir, Amizmiz, Essaouira, Imi-N-Tanoute, Marrakesh Banlieue, Rehamna and Srarhna-Zemrane. (A. AM.)

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MARRAM GRASS, a common name for important sand-binding plants of the genus *Ammophila*, called also beach grass and sea marram, native to sandy seacoasts of Europe, Britain and North America from North Carolina northward and to the Great Lakes. They are erect somewhat coarse perennials, with hard, tough, scaly, creeping rootstocks; long leaf blades; and pale dense spikelike flower heads. The American species is *A. breviligulata;* in Britain and western Europe *A. arenaria* and *A. baltica* are found. Marram is employed in Europe to hold in place the barrier dunes along coasts, as in the Netherlands; also with like success on Cape Cod, Mass., at San Francisco, Calif., and in northern Indiana.

MARRANO, a derisive name meaning "swine," applied to crypto-Jews in Spain and Portugal who accepted baptism to escape massacre or expulsion but practised Judaism secretly.

In the late 14th century Spanish Jewry was threatened with extinction at the hands of mobs. Thousands of Jews accepted death,

but tens of thousands found safety at the baptismal font. The number of "saved" converts is moderately estimated as over 100,000. By the mid-15th century the persons who had been baptized but continued to practise Judaism in secret—marranos—formed a compact society. The marranos began to grow rich and to rise to high positions in the state, the royal court and the church hierarchy. They intermarried with the noblest families of the land. The hatred directed against them by the old Christians, ostensibly because they were suspected of being untrue to their converted faith, was in fact directed indiscriminately against all *conversos*, even those who became denunciators of Judaism and persecutors of Jews and marranos.

In March 1473 riots broke out in Córdoba, with pillage and carnage lasting for three days. The massacres spread from city to city, instigated by fanatical priests. The one institution that seemed adequate to deal with the marranos was the Inquisition, but so strong was the opposition to it that it was not until 1480, under the strong rule of Ferdinand and Isabella, that the Inquisition was finally introduced. In its first year, over 300 marranos were burned, their estates reverting to the crown. The number of victims grew into tens of thousands.

To the Jews, the marranos were pitiful martyrs. They were not renegades but *anusim*, "forced converts," Jews at heart, who could be trusted to escape from intolerable religious duplicity at the first opportunity. At grave danger to themselves, the Jews maintained religious bonds with the marranos and kept strong their faith in the God of Israel. By giving religious comfort to the *conversos*, however, the Jews also came under the surveillance of the Inquisition, which was finally convinced that only the total expulsion of the Jews could end the alliance. Purity of faith became the national policy of the Catholic sovereigns, and thus came about the final tragedy, the edict of expulsion of all the Jews from Spain on March 31, 1492. Portugal promulgated an edict of expulsion in 1497 and Navarre in 1498.

A considerable minority of Jews saved themselves from expulsion by baptism, thus adding strength and numbers to the marranos, but the mass of Spanish Jews went into exile. The physical separation of the marranos from their spiritual sympathizers, however, did not make them more amenable to inquisitorial discipline. The Jewish religion remained deeply rooted in their hearts and they continued to transmit their beliefs to the succeeding generations.

In Portugal, where the Inquisition was established in 1497, the same process was repeated. The Inquisition also followed the marranos to the Spanish and Portuguese dependencies in Latin America. It is difficult to estimate accurately the number of marranos who settled in Latin America in the centuries following the expulsion of the Jews from Spain and Portugal. A fair estimate of those who died at the stake in the Americas would be approximately 2,000; in addition, a far larger number was sentenced to whipping, incarceration or the galleys. It may be assumed that there was considerable assimilation of Jews in the general population; intermarriage with Indians was particularly noticeable in Mexico.

The more fortunate marranos emigrated to safer countries in North Africa and, on the European continent, to Holland and to Italy as temporary stations on the way to the Ottoman Empire. In Amsterdam the marranos openly avowed Judaism and established there a notable cultural centre. Other smaller marrano centres were established in Bordeaux, Hamburg and London. The first Jewish group that settled in North America (New Amsterdam, 1654) were religious refugees from the Portuguese colony of Brazil.

The decreasing number of marrano trials at the tribunals of the Spanish Inquisition during the 17th and 18th centuries indicates that marranism died out gradually and virtually disappeared a century before the Inquisition tribunals were abolished early in the 19th century. This was not the case in the Balearic Islands, where marrano descendants known as Chuetas ("swine") still persist as an isolated stigmatized community.

Marrano communities continue to linger in Portugal. Having been isolated from the Jews and the stream of living Judaism for centuries, they developed strange customs and religious beliefs, many of them alien to the faith of their fathers. Many Portuguese marranos still adhere to their rites and customs and resist the efforts of Jewish communities to educate them in the traditional tenets of Judaism. *See* also INQUISITION.

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MARRIAGE, as used in this article, is a legally and socially sanctioned union between one or more husbands and one or more wives that accords status to their offspring and is regulated by laws, rules, customs, beliefs and attitudes that prescribe the rights and duties of the partners. The universality of marriage within different societies and cultures is attributed to the many basic social and personal functions it performs, such as procreation and provision for sexual gratification and regulation, care of children and their education and socialization, regulation of lines of descent, division of labour between the sexes, economic production and consumption and provision for satisfaction of personal needs for affection, status and companionship.

The kinds of institutions and customs that a society develops to fulfill these functions depend on a number of characteristics, as size and complexity of the society, level of economic development, form of kinship system and the nature of economic, political and religious institutions. For example, the status of women affects the power that husbands have over wives; religious beliefs are related to attitudes about divorce and remarriage; the age of marriage and the economic role of wives is partly determined by the economic system; and social class boundaries define limits of eligibility for mate selection. For discussion of variations in marriage in different types of societies, *see* KINSHIP; MARRIAGE, PRIMITIVE; MARRIAGE, LAW OF. *See* also CONCUBINAGE; ENDOGAMY; EXOGAMY; EXCHANGE MARRIAGE; GROUP MARRIAGE; LEVIRATE; POLYANDRY; POLYGYNY; articles on various cultures as ESKIMO; NAYAR; and SOCIAL ANTHROPOLOGY.

HISTORY

The institution of marriage as it appears in modern western civilization is the product of a long development in which Greek, Roman, Hebrew and Christian traditions were the main elements. At the time immediately preceding the rise of Christian notions of marriage, the Jews as well as the Germanic peoples had a type of marriage that at an earlier period appears also to have been that of the Greeks and Romans and that, indeed, was the type natural for a society based upon dominance of kinship groups headed by patriarchal chiefs. In an extreme way this type of social structure existed in the social system of early Rome and to some extent it can still be found among nomadic Bedouins of Iraq or Arabia. Every person, male or female, belonged of necessity to a clan (*q.v.*) dominated by a patriarch-chief. By marrying, a woman left the clan into which she was born and entered that to which her husband belonged, either as the chief or as a son, grandson or adopted son of the chief. Apart from the case of wife stealing, no female member could be parted from her clan without the co-operation of her chief, and no male member could take a wife without the co-operation of his chief. Marriage thus was a transaction not between the two partners immediately concerned but between their respective chiefs. Furthermore, under this system, the idea that a marriage, by definition, was indissoluble was unknown: since the chief also had absolute power to expel any member of the clan, he could expel his own wife as well as the wife of a son or of any other member. The exercise of this power was restricted by the possible disapproval of an "improper" expulsion, by his own clan or by the clan to which the woman had belonged before her marriage. Thus the termination of a marriage, like its initiation, would frequently appear as a bargain between the chiefs of the two clans concerned. (Because expulsion could be expected if a woman had been discovered in unfaithfulness or simply if she was barren or had failed to bear a male heir, there has been a tendency, applying modern social concepts, to speak of adultery or barrenness as grounds for divorce: what they actually consti-

tuted in the different context of patriarchy were grounds to ensure social approval for a chief or, later, a husband, to exercise his power of expulsion.) Among the Jews of postexilic times, clans no longer regulated marriage, but the idea that a wife could be expelled at any time was not only kept alive but had become part of the divine law, and thus unalterable. Talmudic jurists, as those of modern Islamic countries, thus faced the tasks of subjecting the exercise of the power of repudiation to rabbinical control as well as of finding ways to compel a husband to exercise that power when necessary to free a wife from an unbearable marriage. As far as the "law" stood at the time of Jesus, a marriage could at any time be terminated arbitrarily by the husband, while no corresponding power whatever existed for the wife.

Among the Greeks and particularly the Romans, however, radical changes had occurred. In early Rome a marriage could be concluded by the parties going through the ceremony of either *confarreatio* or *coemptio*. Whether even in ancient days such a ceremony was absolutely necessary is not clear. From later republican times on it was unquestionably possible to initiate a marriage without any ceremony or at least without a ceremony prescribed or defined by law. It is probable that an event of such great significance as marriage was marked by some celebration of a religious kind and by a family feast. However, the relation of *matrimonium iustum* was initiated simply by the parties beginning to live together with the intention of being husband and wife (*affectione maritali*). This free union moreover could be terminated by either party as freely as it could be entered.

Among the Greeks and hellenized orientals, who constituted the bulk of the population in the eastern parts of the Roman empire, the situation was more or less the same as among the Romans and the Germanic and other romanized peoples of the western parts. Marriage could be freely initiated and could be terminated without formality by either party and at any time.

Christian Church.—The situation generally prevailing in the ancient world was profoundly changed by Christianity. In the Christian tradition as it evolved, the sex relationship, in order to constitute marriage, must be monogamous, must be combined with a full community of life and must be characterized by the duty of faithfulness. At one time the union also had to be indissoluble and the doctrine of the indissolubility of marriage was given special dignity by its being combined with the dogma of the sacramental nature of marriage, which came to full elaboration in the 4th century through St. Augustine.

Through the doctrine of the sacramental nature of marriage, it was elevated to the level of being a vehicle of divine grace. (*See* SACRAMENT.) Marriage was thus endowed with the highest possible responsibility of the spouses to each other, to their offspring, and to the Lord. It was a sublime idea, but one that has been difficult for men to live up to. We do not know enough to say to what extent the realities of life have ever corresponded to the dogma. In evaluating its effectiveness one has to consider that it has long been accompanied by indulgence toward marital unfaithfulness of the male, and by toleration of prostitution and of the mistress system. In more recent times the duty of faithfulness in the sense of absolute disapproval of sexual intercourse with any person other than the marriage partner, long limited to the female party alone, has come to be applied to the male partner, too (*see* SEXUAL BEHAVIOUR).

The doctrine of indissolubility gained strength as the medieval church, slowly enough, succeeded in establishing its claim that only the ecclesiastical court was competent to decide a question pertaining to a sacrament, including the sacrament of marriage. Thus, whenever in a secular court it was necessary to determine whether or not a marriage existed, for instance, as a preliminary to the adjudication of claims to an estate, the secular court had to stay its proceedings and wait for the decision of the ecclesiastical court. Even so, the indissolubility of marriage was not firmly established as a dogma of the church, even in France, until about A.D. 900, and it would be interesting to know to what extent that dogma was offset by the enormous scope given toward the end of the middle ages to the impediments to marriage of consanguinity (blood relationship) and affinity (the spiritual relationship created by marriage), the convenient discovery of which would allow the annulment of many an unhappy marriage. If Henry VIII had not sought and obtained papal dispensation for his marriage to Catherine of Aragon, he would have had little difficulty in having it annulled because of Catherine's prior marriage to his brother Arthur.

Formality of Marriage.—All during the middle ages the regulation of marriage was regarded as a task not of secular but of ecclesiastical authority. However, just as absence of any legal requirements of formality for the conclusion of a marriage was characteristic not only of Roman law but also of the laws of those Germanic peoples by whom the Roman empire was overrun, for many centuries the canon law did not require any marriage formalities either. The church, of course, desired, and later demanded, that an act of such deep religious significance as marriage should not be performed without the blessing of the church. It thus became customary that parties planning to be married, before entering upon their life in common, would meet at the door of the church, but outside of it (*in facie ecclesiae*), with the parish priest, who would then and there bestow upon them his blessing. The conclusion of marriage remained, however, the private transaction of the parties, consisting in the informal exchange of the expressions of their intentions from there on to be husband and wife (*sponsalia per verba de praesenti*). When followed by carnal consummation, this exchange of expressions of *consensus maritalis* would mature into the sacrament, and the marriage would thus become indissoluble. Such is still the law of the Roman Catholic Church under the Code of Canon Law of 1917.

The custom just mentioned of the marriage being blessed by the priest at the church door came to be established as a religious duty. A solemn pronouncement in that sense was particularly issued by the fourth Lateran council of 1215. However, violation of this command did not bring with it the invalidity of the marriage, but only ecclesiastical censure and punishment of the violator. A marriage ought not to be entered into informally, but if it was entered into in such way, it was a valid marriage nevertheless.

This state of affairs was not altered until the Council of Trent, which, in 1563, took the final step of requiring the celebration of marriage before the parish priest or the local ordinary (or a priest nominated by one of these) and in the presence of at least two witnesses as an essential requirement of validity. Informal as well as clandestine marriages have thus become impossible within the area of application of this *Decretum Tametsi*. However, this new pronouncement of canon law could apply only in those parts of the world which had remained faithful to the Church of Rome. Even in Catholic countries exceptions had to be made for overseas regions with difficult communications and of general wilderness character, regions, that is, in which it would not be easy to find a priest and a church. In certain parts of Latin America the *Decretum Tametsi* was thus not promulgated until centuries later. It had no effect whatever in countries that had split away from Rome, such as England.

The *Tametsi* decree was superseded by the decree *Ne Temere*, which came into force in 1908 and was later, with minor modifications, incorporated in canon 1094–1103 of the Code of Canon Law.

In England the pre-Tridentine canon law remained in effect, administered by the ecclesiastical courts of the Church of England. Informal or, as it came to be called, "common law" marriage, thus remained possible in England and Wales until it was outlawed in 1753 by Lord Hardwicke's reform of the marriage laws, under which it became necessary, for the conclusion of a valid marriage, to go through a ceremony in accordance with the rites of the Church of England after publication of the banns (*see* BANNS OF MARRIAGE). Since, with the exception of Quakers and Jews, the statute also applied to members of religious communities other than the Church of England, that is, to Protestant dissenters and to Roman Catholics, much hardship and resentment were created, until in 1836 marriage was rendered possible before ministers of religious communities other than the Church of England and before secular "registrars." However, the essential fact is that through Lord Hardwicke's reform the conclusion of informal marriages became impossible in England.

The reform did not apply to Scotland, and there informal mar-

riages remained possible until 1939. Lord Hardwicke's reform did not apply either to the English colonies beyond the seas. In the American colonies in particular, common-law marriages thus remained possible and for each colony or, later, for each state of the United States, that situation continued until by express statutory enactment a public ceremony would be established as an essential requirement for the validity of the marriage. Such statutes have now been enacted in most but by no means all of the U.S. states. At the beginning of the second half of the 20th century common-law marriage was still possible in Alabama, Alaska, Colorado, Connecticut, District of Columbia, Florida, Georgia, Idaho, Iowa, Kansas, Montana, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota and Texas.

What is meant here is common-law marriage in the strict sense of a marriage of equal legal validity as a marriage formally celebrated and terminable in no way other than by death or divorce. This meaning must be distinguished from that in which the term common-law marriage appears in popular U.S. usage and in which it means a union between a man and a woman that is made outwardly to appear like a marriage, but in which the parties do not have the intention "really" to be married to each other, so that the term is used as a more polite word for concubinage.

Civil and Religious Ceremonies.—Marriage now being almost universally a formalized transaction requiring a public act or ceremony, there remains the question of what kind of act or ceremony shall be required, or, more specifically, whether the ceremony is to be a secular or a religious one. This problem of the *marriage civil* has engendered much heat and passion. In European and Latin-American countries it has constituted and still constitutes a topic of contention between church and state.

Before the 18th century marriage was clearly a religious affair in all countries of Europe. Only in New England in North America had it become possible to conclude marriages before secular officers, especially justices of the peace. In Europe civil marriage was conspicuously established by the French Revolution, which made it even compulsory in the sense that it would not be possible to conclude a valid marriage in any way other than by a ceremony before a secular officer, regularly the mayor of the city or village. From France the requirement of compulsory civil marriage spread to Belgium, Luxembourg, Switzerland and other countries. In Germany compulsory civil marriage was established in the course of Otto von Bismarck's struggle against the Roman Catholic Church, the so-called Kulturkampf. Needless to say that compulsory civil marriage is the rule in the Soviet Union and the several peoples' republics, although there the ceremony has been simplified into an act of registration by the officer of civil status.

The opposite position, under which a valid marriage cannot be concluded in any way other than by a religious ceremony, has almost disappeared. The rule was characteristic, before the modern revolutions, of the countries of the Orthodox Eastern Church, especially tsarist Russia, as well as in certain oriental countries. At present a compulsory religious ceremony seems to exist in Greece; in Israel, at least for Jews; in the Vatican City; and, curiously enough, in the U.S. state of Maryland. In that latter state the requirement is innocuous, however, because parties desiring a secular ceremony can easily have it performed in any neighbouring state.

Those countries that require a civil ceremony have, of course, not prohibited the performance of religious ceremonies. However, the religious ceremony is of no effect as far as the secular law is concerned and, in order to ensure the effectiveness of the state's command of a civil ceremony, it is regularly provided that the religious ceremony may not be performed until after the civil one. The minister who would perform a religious ceremony before the performance of the secular is liable to punishment.

In contrast to France on the one side and tsarist Russia on the other, the Anglo-American and Scandinavian countries have not seen any reason why parties to a marriage should be subjected to the compulsion of going through a ceremony that might be contrary to their convictions and desires. In all these countries parties may choose freely between a secular and a religious ceremony. (M. Rn.)

MARRIAGE AND FAMILY ORGANIZATION

In the industrialized, urbanized culture of the contemporary western world, the type of organization most commonly established by marriage is the small, nuclear family, consisting of a married couple and their children (*see* Family: *Classification of Forms of Family Organization*). In many other countries, especially in the east, marriage is most commonly a part of the large, extended family system, in which the family may include parents, aunts, uncles, cousins, grandparents and possibly other relatives all living in the same household or at least having close and interdependent economic and social ties. This system, during the second half of the 20th century, has been in a state of revolutionary change.

There are a number of basic differences between the large, or extended, family system and the small, nuclear family system. In the extended family system marriages are arranged by the family, the assumption being that love comes after marriage, and thought is given to the socioeconomic advantages for the larger family; more value is placed upon having many children, especially boys; the man is recognized as head of the home and prestige and power often rest in the hands of the aged; many relatives are intimately acquainted since they may live and work together; and old or dependent members are cared for by the family. In contrast, in the nuclear family system children usually choose their own mates, it is assumed that love precedes marriage and less thought normally is given to socioeconomic aspects of a marriage contract; less value generally is placed upon numbers of children; there tends to be more equality in the home and age of relatives does not necessarily command prestige and power; the nuclear family may be isolated from other branches of the family; and old or dependent members may live alone or be cared for by the state.

In western countries emphasis has been placed upon romance and love as an essential prelude to marriage. The origin of the idea of love before marriage is obscure; it is not held in eastern countries and is, in fact, viewed with skepticism by many.

Arranged Marriages.—The majority of marriages throughout the world are arranged and partners do not do the choosing. In Africa, much of Europe and especially southeastern Europe, the near east and the orient, arranged marriages predominate.

In countries with arranged marriages the almost universal custom is that someone acts as an intermediary or go-between. The chief responsibility of the go-between (or matchmaker or marriage broker) is to arrange a marriage that will be satisfactory to the two families represented. Young people in these countries accept the view that their families should make the marriage choice for them.

The go-between is usually an older and respected person. He may or may not be related to the families involved and he may or may not be paid for his services. In some countries the older women in the family—aunts or grandmothers—act as go-betweens. After preliminary investigations have been made, the men of the two families may take over and conclude the financial and other arrangements for the marriage. From the first inquiries of the go-between to the final arrangements economic considerations are in the forefront. Some form of the dowry or dower (*qq.v.*) system or both are almost universal in countries having arranged marriages. The economic arrangements are such that both families are protected in case of a lasting marriage and in cases of divorce.

In Afghanistan the arrangements include a specific agreement on the financial settlement that would have to be made by the groom if the marriage should later fail. In Pakistan parents usually give their daughter a dowry but in turn the bridegroom often makes a settlement, called a dower, which is to be used by the wife in case the marriage is ended in divorce.

Communism theoretically eliminates the economic basis of marriage and of matchmaking; although local or national traditions and customs may persist to varying degrees, countries that have adopted communism have wiped out the foundation of arranged marriages and have substituted the free choice of individual marriage partners (*see* Marriage, Law of).

The arranged marriage system functions best in stable, nonmobile societies where families know one another. Even in such societies, however, there have always been young people who, for varying reasons, have had difficulty in finding someone to act as go-betweens for them. The number of young people with this problem has been increasing because of the breakdown of the large family system. Young people move to the cities for work and are cut off from their families. Or they live in a small family in countries where most people still live in large family units. Under such conditions the matchmaker who operates for a fee becomes necessary for some. In cities of the east the Sunday editions of newspapers often contain advertisements for people interested in marriage. The matchmaker uses this method to find mates since he can no longer know all the families in the large city. In Japan young people who do not have anyone to sponsor them in marriage may register with their neighbourhood public official whose duty it is to help them arrange a marriage.

In almost all countries in which the pattern of arranged marriages predominates, some young people question the system. More and more young people think they should know their betrothed before marriage although few have come to the place where they would choose a mate without consulting their parents. In some countries a stage between individual selection of mates and parental selection has developed. In these countries the young people themselves first find someone whom they think they would like to marry and then consult their parents. If the parents approve, the young people are encouraged to go ahead and become acquainted, or the parents may help them to arrange the marriage. The greatest shift from arranged marriages to some other type came about after World War II in Japan, where previously all marriages had been arranged. A postwar study of university and high-school students there found that two-thirds of those responding thought marriage partners should be chosen by the parents and children working together. One-fourth of the students thought the young person should make his own choice of a mate. Only a small percentage thought the parents alone should choose mates for the children.

Dating and Courtship System.—The dating and courtship approach to marriage as it has grown up in western countries and especially as it has developed in the United States during the 20th century is an outgrowth of the way in which people in these countries view marriage. A successful marriage is viewed as one that brings personal satisfaction and happiness to the two people who marry. It is believed that happiness in a marriage is based upon many things such as mutual respect, sharing similar goals in life, companionship, similar moral and spiritual values, mutuality in sexual satisfaction and the meeting of psychological needs.

By the time young people in the United States have graduated from high school (at 16–18 years of age) three-fourths of the girls and more than half of the boys have had considerable experience in dating. Dating does not start at such an early age in other countries. In western Europe young people of high-school age in general do not date except possibly in a group. The pattern of pairing off does not usually take place until the young people are older and ready to consider marriage.

If dating served all of the functions it should serve, it might be considered an ideal system of mate selection in a society that places happiness of the individual couple as a paramount value. In actual practice the method leaves much to be desired. The high divorce rate in the western countries has caused some authorities to conclude that the dating-courtship system results in more unhappy marriages than result from marriages arranged by families. This may be a doubtful conclusion. The standards for successful marriage under the two systems are different. A successful arranged marriage is one that brings economic advantage and prestige to the family and produces children. Less value is placed on the quality of the husband-wife relationship.

The dating system may prove disastrous when copied by young people in cultures that have traditionally had arranged marriages. Increasingly, college students in countries around the world are breaking away from the custom of arranged marriages. In throwing overboard family traditions and in adopting a new system of mate selection, however, they may not make as good marriages as their parents would have arranged for them. They are rebelling against arranged marriages but may not be prepared for individual selection of mates.

It must be noted that young people of eastern countries also often face great difficulty in the traditional arranged marriage. Many of the young men go to western nations for their college and professional training. They return to their countries and in many cases marry the girl chosen for them by their families. The wife so chosen may have a limited education. She may not feel at ease in mixed social functions since her social life would have been with women alone or with male members of her family only. Further, she would naturally play the rather well-defined role of the wife prescribed by her culture. The husband may have come to like the man-woman relationship he has observed in the west, the companionate relationship in marriage, the recognized equality of the sexes and the democratic type of family life. If he likes the western way as he has perceived it, he may be unhappy in the arranged marriage in his own country.

MARRIAGE EDUCATION AND COUNSELING

Widespread concern over high divorce rates in the western countries with, for example, reported increases in the 20th century of more than three times in England and Wales, France, Sweden and Switzerland, helped focus attention on marriage problems and stimulated efforts to strengthen marriage and family life. The International Union of Family Organizations, established in Paris in 1948, has been sponsoring a world family conference biennially and in alternate years it has sponsored smaller international seminars for intensive study of problems of the modern family. The approach differs between those countries in which the emphasis is upon strengthening the marriage relationship of the couple and those that focus upon the larger family. In the United States and to a certain extent in England the emphasis is upon programs to strengthen marriage through better understanding of the interpersonal relationships between husband and wife. Generally the approach in other countries is through social and economic benefits to strengthen the larger family units.

Marriage Education.—One approach to strengthening marriage in the United States has been through marriage education in the public schools. No other country has developed such a program, although other countries are becoming interested in such. Courses in preparation for courtship and marriage, many instituted at the request of students, were first given at the college and university level. After World War II there was a rapid expansion of university courses in marriage, the family, child development and marriage counseling. The increase in courses was in part due to the alarm over the increase in divorce among North Americans after World War II. In a few colleges a course in preparation for marriage was made a requirement for graduation. One study found that out of 768 colleges and universities responding in a survey, 630 or 82% had courses in marriage and the family. The 630 institutions offered more than 1,000 courses in marriage and the family during the school year surveyed and at least 100,000 students were enrolled in the courses.

With the rather sharp decline in the average age at marriage since World War II there has been increasing belief that marriage education should be given at a younger age for the many who will never go to the university. Courses in preparation for marriage at the high-school level have been generally accepted. A survey in one state found that three-fourths of the schools responding to a questionnaire reported giving some time to marriage education in high school. The period of study might be from one week to a full semester course. Units of study have also been organized on interpersonal relationships within the family and are given by many schools at the junior-high and elementary levels. These courses do not focus upon preparation for marriage as at the college and high-school level, but they focus upon relationships so that the child will have some understanding of family life. Many churches have also organized short courses in preparation for marriage for their young people.

In 1938 the National Council on Family Relations was organ-

ized. This was the first attempt to bring together in one organization professional people interested in strengthening the family. Since 1938 the council's journal has published research findings on all aspects of marriage and the family. The members of the council are in the main from the fields of medicine, law, counseling, social work, religion, public-school teaching and college and university teaching and research.

Marriage Counseling.—In 1930 Paul Popenoe founded the American Institute of Family Relations in Los Angeles and in 1932 Emily Mudd established the Marriage Council of Philadelphia. These, and others established since, engage in premarital and marital counseling. Premarital counseling may be largely marriage education or it may deal with the special problems of the premarital period. Often couples who come for premarital counseling have doubts about whether they should marry and they come seeking guidance. Marriage counseling focuses upon the relationships between husbands and wives, in contrast to relationships between parents and children or relationships with the larger family. In addition to well-organized and well-staffed marriage counseling services, many individuals do marriage counseling. Some set themselves up as full-time counselors and charge a regular fee; others, such as ministers, are called upon to do counseling as a part of their over-all jobs. In 1942 the American Association of Marriage Counselors, Inc., was organized with the purpose of setting standards in the growing profession. Through setting minimal standards they hoped to give the general public some protection from unqualified counselors. The association has also worked with universities in helping them develop a training curriculum for people wishing to become counselors. The program of marriage education and counseling has been called a "folk" movement by some. People were interested in improving marriage and the family but they were not necessarily professionals. They came from many different walks of life and their ideas about improving family life ranged from pure superstition to the scientific. For this reason professional leaders place more and more emphasis upon the need for basic research into all aspects of family living. For years the area of marriage and the family has been the second largest field of research by sociologists in U.S. colleges and universities, and foundations have increasingly given support for family research.

Great Britain.—Outside the United States marriage counseling has developed in Great Britain more than in any other country. The pattern of development has been different in that marriage counseling has developed on a private fee basis in the United States whereas it has developed as a volunteer service in Great Britain. The first British Marriage Guidance centre was opened in 1943 in London. By 1947 there were almost 100 centres and in that year they united to form the National Marriage Guidance council. Since there were few trained counselors the plan was followed of selecting laymen who were qualified in terms of personality and marital experience, and then giving a preliminary course in counseling followed by in-service training and supervision. More than 1,000 counselors have been so trained and each year handle more than 10,000 clients who seek help with marital and premarital problems. The great majority of the counselors are in the age group from 35 to 50 and almost all have had the experience of successful marriage and parenthood. All counselors give their services without charge and they volunteer their services for from one to five counseling sessions per week. The cost of the marriage guidance centres is borne by contributions from clients, interested individuals and organizations and by grants from the government.

The British system of counseling has advantages in that those needing counseling have but one source to turn to when in trouble and this source is carefully regulated and supervised by qualified people. Couples having marital problems in the United States have almost no way of distinguishing between those who are qualified and those who are not. Further, the cost of marriage counseling is prohibitive for low-income families. Countries now starting marriage counseling services are more likely to copy the British system because it is inexpensive to operate and has the advantage of supplying a large staff of counselors in a short time. Further, the laymen given training and supervision seem to do as well in counseling as do those who have had long years of professional training.

Europe.—On the continent of Europe marriage education in the schools and marriage counseling in the community have not developed as they have in the United States, although in Germany and in Italy marriage counseling is offered in many communities. Some research on the family has developed in universities, especially in the Scandinavian and in certain German universities. The principal approach to improving marriage and family life on the continent has been through the work of family organizations. In France family organizations are strong and have been instrumental in getting the government to establish family allowances, paid family vacations, improved facilities where families can spend their vacations, loans to build family apartment houses, loans for families who wish to buy apartments or homes, lower rail fares for families with children, special privileges for pregnant women and medical care for families. In several continental countries there is interest in the study of interpersonal relationships in the family.

Eastern Countries.—Marriage counseling as it is understood in the west has not developed in the east but a type of counseling has existed there for many years. Among some groups the matchmaker or go-between who arranges a marriage also becomes a permanent sponsor of the marriage. If the marriage does not go well the couple may turn to the go-between with their problems. Since the go-between is often older, mature and respected he is also trusted with helping the married couple with their problems. In a way it is a reflection upon his ability as a go-between if a marriage fails. If the go-between cannot save the marriage through counseling then he may work with the couple in arranging the terms for divorce. In China the family organization called the Kiafong associations settled matters of family disputes. In Hong Kong the associations still handle marriage problems, as they do other problems in the community. The British government in Hong Kong has set up courts where people can take their family and marriage problems, but in most cases these courts do not act as counselors or as arbitrators in disputes. Rather the courts refer the marital problem back to the Kiafong associations, which attempt to arbitrate the matter.

In Japan the government has established courts of conciliation to deal with many of the family problems growing out of the changing family pattern. The courts are not marriage counseling centres as they function in the western nations. Rather they are courts where people go with their problems and get a hearing before a board of three people. Two of the three people are called family court counselors and they are chosen from leading citizens who volunteer to give their services. The chairman of the group, the family court probation officer, is a permanent part of the court and usually has had special training in sociology or psychology and has attended the training and research institute for probation officers. The function of the court is not in most cases to help two people work through the problems in their relationship, but rather to arrange a settlement for family problems or affairs.

Many countries of the east are faced with a rapidly growing population and a scarcity of food supply. In India, for example, concern with marriage and the family centres almost entirely around encouraging married couples to limit their family to no more than four children. Some 2,500 family-planning clinics have been opened by the government and married couples are approached through discussion groups, the daily papers, the radio and posters, with the point of view that they should limit their families (*see* also BIRTH CONTROL).

See also DIVORCE; MARRIAGE RATE; and references under "Marriage" in the Index. (J. T. L.)

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MARRIAGE, LAW OF. Marriage as understood in the Christian world means the lifelong union of one man and one woman to the exclusion of all others, such unions being preceded by some form of ceremonial recognized by the law of the particular country in which it takes place.

Lord Stowell, one of the most eminent of the ecclesiastical judges in England, stated in the case of *Lindo* v. *Belisario* (1795) 1 Hag. Con. 216, 230:

> It is held by some persons that marriage is a contract merely civil, by others that it is a sacred, religious and spiritual contract, and only so to be considered. . . . I conceive that neither of these opinions is perfectly accurate. According to juster notions of the nature of the marriage contract, it is not merely either a civil or religious contract. It is a contract according to the law of nature, antecedent to civil institutions, which may take place to all intents and purposes wherever two persons of different sexes engage, by mutual contracts, to live together. Our first parents lived together not in political society, but as individuals, without the regulation of any institutions of that kind. . . . A mere casual commerce, without the intention of cohabitation, and bringing up of children, would not constitute marriage under any supposition. But when two persons agree to have that commerce for the procreation and bringing up of children, and for such lasting cohabitation, that in a state of nature would be a marriage . . . in the sight of God. In most countries it is also clothed with religious rites, even in rude societies, as well as in those which are more distinguished for their religious and civil institutions.

Lord Stowell proceeded to quote from Henry Swinburne, 1560–1623, on *Espousals*, when he wrote: "It is a present and perfect consent which alone maketh matrimony, without either public solemnization or carnal copulation, for neither is the one, nor the other, the essence of matrimony, but consent only." This last enunciation was in effect endorsed in the 20th century by the house of lords in *Baxter* v. *Baxter* (1948) A.C. 274, where it was laid down that the procreation of children is not an essential requirement for a valid marriage.

When this was accepted as expressing the true law of marriage, complete divorce, save by the rare method of legislative act, did not exist (*see* DIVORCE). Although divorce has become common throughout the western world, it does not touch the previous validity of the marriages dissolved, this being dependent, with few exceptions, on mutual consent and the law of marriage formalities.

Roman Law.—The three primitive modes of marriage were *confarreatio, coemptio in manum* and *usus*, all of which had the effect of placing the woman in the "power" (*manus*) of her husband and on the same footing as the children. The first was a religious ceremony before 10 witnesses, in which an ox was sacrificed and a wheaten cake broken and divided between the spouses by the priest. *Coemptio* was a conveyance of the woman by *mancipatio* (handing over), and might be described as a fictitious sale. *Usus* was the acquisition of the wife by prescription, through her cohabiting with the husband for one year, without having been absent from his house three continuous nights. But a true marriage might be concluded without adopting any of these modes, which all fell into desuetude and with them the subjection of the wife to the *manus*. Marriage without *manus* was contracted by consent, without writing or formality of any kind. The consent of the *paterfamilias* to the marriage of the children under his power was essential.

In Roman law no slave could contract marriage whether with another slave or a free person. The union of male and female slaves (*contubernium*) was recognized for various purposes; a free woman entering into a union with a slave incurred under the *S.C. Claudianum* the forfeiture of her own liberty; but the bondwoman might be the concubine of a freeman. (In the United States, where slavery was said to be regulated by the principle of the civil law, the marriage of slaves was so far recognized that on emancipation complete matrimony took effect and the children became legitimate without any new ceremony.)

In Roman law no legal marriage could be contracted unless there was *connubium* between the parties. Originally there was no *connubium* between plebs and patricians, and in later times between the *Latini* and *peregrini*, unless it had been expressly conferred. The *Lex Julia* and the *Lex Papia Poppaea* introduced restrictions depending on the condition of the parties which later legislation extended and perpetuated. Senators under that law were forbidden to marry freedwomen or women of inferior rank, and the husband of a freedwoman on becoming a senator was set free from his marriage. (*See* also ROMAN LAW.)

Canon Law.—The canon law of the Roman Catholic Church was the only law governing matrimonial relations in western Europe until the Reformation and has still exclusive authority in some Roman Catholic countries.

The church adheres to the principle of the indissolubility of marriage except by the death of one of the spouses, and there is no divorce *a vinculo* (from the bonds of marriage) as is administered in Anglo-American law. The principle of indissolubility purports to have been proclaimed by Christ without qualification according to Mark x, 11, 12 and with the qualifying clause "saving for the cause of fornication" according to Matt. v, 32. Scholars still question whether the word "porneia," translated as "fornication," really meant adultery or premarital conduct, but it is now the majority opinion that it meant unchastity by the wife generally, with special reference to postmarital unfaithfulness persisted in to a point where it became a virtual renunciation of the marriage. This exalted view of marriage envisaged that man and wife were made "one flesh" by the act of God; "What therefore God hath joined together, let not man put asunder" (Mark x, 9). It is to St. Paul that the idea of marriage as a sacrament is to be traced, in the mystic comparison of the relations of husband and wife to those of Christ and his church (Eph. v, 23–32). Marriage, from being no more than a terminable civil contract, became a sacrament, a mystic union of souls and bodies never to be divided; valid, indeed, but not spiritually complete, without the public blessing of the church (Tertullian, *Ad uxorem*, bk. ii, ch. 9).

In canon law mutual consent of the parties was regarded as essential to marriage: *matrimonium non facit coitus sed voluntas*. In A.D. 866 Pope Nicholas I proclaimed: "If the consent be lacking in a marriage, all other celebrations, even should the union be consummated, are rendered void." The practice of marriage between a man and a woman, without witness or ceremony (*per verba de presenti*), led to so many evils of clandestinity that the Council of Trent's decree *Tametsi* in 1563 enacted that marriages should be celebrated in the presence of a priest and not less than two witnesses.

In the absence of any impediment a marriage is, according to canon law, completed between baptized persons by the facts of consent and consummation; the principle is still maintained that the parties to the marriage, not the priest, are the "ministers of the sacrament." From early days the church, while recognizing the validity of private contracts, enjoined the addition of a public religious ceremony (1 Tim. iv, 5). Tertullian (*De pudicitia*, ch. iv) says that clandestine marriages, not professed in the church, were reckoned among Christians as all but fornication. Charlemagne, in a capitulary of A.D. 802, forbade the celebration of a marriage until "the bishops, priests and elders of the people" had made diligent inquiry into the question of the consanguinity of the parties. This was the origin of the publication of banns which, long customary in France, was made obligatory on the whole church by Pope Innocent III. Canon law held a marriage to be null and void for a variety of reasons; *e.g.*, if the parties were within certain prohibited degrees of consanguinity of affinity. The grounds of nullity under the *Corpus Juris Canonici* published in the 16th century numbered 18, some of which are obsolete. Those still administered by the Roman Catholic Church include consanguinity and affinity, very much reduced from their former wide scope, disparity of religion, and mental reservations contrary to the real purposes of marriage, but exclude willful refusal to consummate a marriage.

For concubinage, which restrictions on marriage tend to develop, *see* CONCUBINAGE. The left-handed or "morganatic" mar-

riages of the German royal family are the nearest approach ever made by concubinage to true marriage, the children being legitimate, but neither they nor the wife acquiring any right or rank or fortune of the husband (*see* MORGANATIC MARRIAGE).

Canon law also restricts marriage in other directions: the order of clergy were forbidden to marry. Disparity of faith was recognized by the early church as a bar to matrimony; *e.g.*, between Christians and pagans and between orthodox and heretics. In modern times when Roman Catholics marry non-Catholics, canon law requires that the non-Catholic spouse agree that any children they may have will be baptized and brought up as Catholics. (W. LA.)

Orthodox Church.—The canon law of the Orthodox Church is made up on one hand by the rules of the councils and early fathers found in the official collections of canon law and on the other by the religious legislation of the Byzantine emperors. The decrees of the standing synods (*endêmousai*) of the Byzantine epoch have also to be taken into consideration. Since that time the legitimacy of jurisprudence and local legislation has been judged by its conformity with the norms fixed in the earlier period.

Christian marriage is a sacrament and the blessing of a priest is considered one of the necessary conditions of validity (novel 89 of the emperor Leo VI). The betrothal is invariable and is accompanied by a religious ceremony which creates the same obligations in canon law as the marriage itself. The prohibition against consanguinity and affinity extends in principle to the seventh degree; and a dispensation cannot be given beyond the limit fixed by canon 54 of the Council of Trullo (fifth degree). Affinity is also created between godparents and godchildren (canon 53 of Trullo). The Orthodox church is tolerant of three successive marriages (canon 50 of St. Basil) but under no circumstances will permit a fourth. Parish priests are permitted wives but bishops are never married (council of Trullo, canon 12). In Greece there is no civil marriage for persons of the Orthodox faith.

(P. L'H.)

BRITAIN AND THE COMMONWEALTH

Requisites for a Valid Marriage in England and Wales.—By English law the requisites for a valid marriage are that: (1) each party shall have attained the age of 16 years (Age of Marriage act, 1929); (2) each party shall be mentally capable; (3) the parties shall be outside the prohibited degrees of affinity and consanguinity; (4) each shall be free to marry; *i.e.*, not bound by a subsisting marriage; (5) each shall give his free and mutual consent to marry, with a proper understanding of the contract; (6) each shall be sexually competent, except where consent is given notwithstanding impotence, known to both parties; (7) the marriage ceremony conforms with the statutory formalities. Monogamy is the invariable rule.

Age of Marriage.—Before the Age of Marriage act, 1929 (which covers Scotland), the common-law rule in general was that the ages for a valid marriage were 14 for a male and 12 for a female. This rule was not abrogated in the Republic of Ireland. In former days marriages were celebrated between children over seven years of age, especially in royal families, but any such marriage was voidable on the male reaching the age of 14 and the female of 12 years. Henry VIII, when under 14, was married to Catherine of Aragon, widow of his deceased brother Arthur. On reaching the age of 15 he avoided, or repudiated, the marriage, but in 1509 he married her again. How the marriage was annulled years later is a well-known matter of history. In England the age of 16 is binding; there can be no departure from the 1929 act (now merged in the Marriage act, 1949) with regard to anyone under that age, although the courts will recognize marriages of young persons under that age in countries where they are legally valid, if such persons are domiciled in those countries. A marriage between a man domiciled in England at the time of the ceremony with a foreign girl under 16 years of age was held to be invalid, though by the law of her country such a marriage was permissible (*Pugh* v. *Pugh* [1951] P. 482).

Mental Capacity.—Mental capacity to marry has been judicially interpreted as possessing an understanding of the elementary duties and obligations of marriage. If the man or the woman is merely a dullard, that fact alone is not a bar to marriage, even if either enters into the bond ignorant of what, in regard to sex, is commonly termed "the facts of life." If a person has been temporarily treated as a mental patient he may marry during a lucid period.

If a person is proved to have been of unsound mind at the time of the marriage the other spouse may obtain an annulment. In a nullity suit in England Lord Merrivale, president of the divorce division, said (*Forster* v. *Forster* [1923]): "The question is whether the respondent was mentally incapable of understanding the nature of the marriage contract, and the duties and responsibilities which it creates. The mind of one of the parties may be capable of understanding the language used, but yet may be affected by such delusions, or other symptoms of insanity, as may satisfy the tribunal that there was not a real appreciation of the engagements entered into." In this statement of principle the judge was repeating a dictum of a former eminent president, Sir J. Hannen (*Durham* v. *Durham* [1885] 10 P.D. 20).

Under the Matrimonial Causes act, 1950, a marriage may be annulled on the ground that a party to the marriage was at the time of the ceremony of unsound mind or a mental defective or subject to recurrent fits of insanity or epilepsy. Medical opinion is divided on the last-named malady, but in rare cases decrees have been pronounced on that ground. A petition on these grounds must be presented within a year, and must be subject to the condition that the petitioner was ignorant at the time of the ceremony of the respondent's malady and that there has been no marital intercourse after its discovery. (*See* also ANNULMENT.)

Prohibited Degrees of Marriage.—These were at first those set out in the *Book of Common Prayer,* but by a series of acts beginning with the Deceased Wife's Sister Marriage act, 1907, and ending with the Marriage (Enabling) act, 1960, the rules of affinity on barring marriage have been modified, so that people may, in specified degrees, marry relatives not of the same blood. The exceptions are set out below:

A man may marry his
- deceased wife's sister;
- deceased brother's widow;
- deceased wife's brother's or sister's daughter (*i.e.*, niece by marriage);
- father's or mother's deceased brother's widow;
- deceased wife's father's or mother's sister;
- brother's or sister's deceased son's widow.

A woman may marry her
- deceased husband's brother;
- deceased sister's widower;
- deceased husband's brother's or sister's son;
- father's or mother's deceased sister's widower;
- deceased husband's father's or mother's brother;
- brother's or sister's deceased daughter's widower.

In a case in the English divorce court, *Cheni* v. *Cheni* (1962), a marriage between a Sephardic Jew and his blood niece in Egypt, where such marriages are valid according to Jewish ecclesiastical law, was recognized as valid.

The Marriage (Enabling) act, 1960, removed the former bar against a man's marrying the sister of his divorced wife during the latter's lifetime, or of a woman's marrying the brother of her divorced husband, as well as the bar from the more remote relationships which had been excepted by statute. (*See* also CONSANGUINITY.)

Although marriages within the prohibited degrees have been described as incestuous in civil law, incest is only a criminal offense in England if there is sexual intercourse between a man and his mother, daughter, sister or granddaughter.

Bigamy.—There can be no valid marriage between two persons one of whom has a living wife or husband. Polygamous marriages are not recognized by the English courts unless the parties are domiciled at the time of the ceremony in countries where polygamy is authorized by law, as for example in the case of Muslims, according to the Islamic law. Even so it has been held in judicial decisions that a man who has lawfully contracted a polygamous marriage abroad cannot lawfully marry another woman according to English law wherever it prevails. Notwithstanding, polygamous marriages, valid according to the law of the domicile, have fre-

quently been recognized as binding with regard to questions of property, succession and legitimacy. (*See* BIGAMY.)

Mutual Consent.—On the subject of mutual consent there must be no duress or threats leading up to the ceremony; and if one of the parties is incapable through drink or drugs or mental incapacity, or if there was a misunderstanding as to the nature of the ceremony, *e.g.*, supposing it to be a mere betrothal, it may be pronounced invalid by the court.

Impotence.—Impotence by one or other of the spouses has always been regarded as invalidating a marriage if the aggrieved party chooses to petition for nullity, and a spouse may also petition for nullity on the ground of his own impotence. But where it is proved that the petitioning party consented to marry though aware of the other's impotence, his or her remedy may be barred.

Formalities.—In England formalities of marriage are set out in the consolidating Marriage act, 1949. Marriage in the Church of England may be solemnized after the previous publication of banns on three successive Sundays following seven days' notice to the clergyman; or by the issue of (1) a special licence by the competent ecclesiastical authority permitting the ceremony to take place in any church or chapel or other convenient place at any time; or (2) a common licence from the ecclesiastical authority for a marriage in a church or chapel in the residential district or the usual place of worship of one of the spouses; or (3) a superintendent-registrar's certificate, which necessitates certain declarations by the parties.

Before a licence can be granted an oath must be taken as to the fact of residence and, when either party is under 21, that the necessary consent has been obtained from the father or lawful guardian. The absence of such consent does not, however, render a marriage void once solemnized. But if persons wilfully intermarry (unless by special licence) in a place other than a church or public chapel, or without due publication of banns or proper licences, or before a person not in holy orders, the marriage is null and void for all purposes. Marriage must be celebrated within three months after banns or licence, and between the hours of 8 A.M. and 6 P.M. In the Church of England the clergyman officiates, there must be two witnesses and the spouses must sign the register. The moment of marriage in church is when the hands of the spouses are joined together and the clergyman pronounces them to be man and wife. The production of a wedding ring is not obligatory.

The Anglican canon prohibiting the marriage in church of a person whose previous marriage has been judicially dissolved has no statutory authority, but by the Marriage act, 1949, if in those circumstances a clergyman declines to officiate he must permit any other clergyman within the diocese to perform the ceremony if the latter is willing. A discretion is left to the bishop to override the prohibition, but it is seldom exercised.

According to the earliest Roman customs a woman took her husband's name on marriage. The Roman Catholic Church continued this practice. Subsequently it was judicially laid down that a woman after divorce or nullity may reassume her maiden name, and nowadays any person, married or otherwise, may assume another name by deed poll.

Civil Marriage.—Civil ceremonies at the office of registrar of marriages, first sanctioned by the Marriage act, 1836, may be authorized by the issue of a superintendent-registrar's licence or certificate, after due notice and statement of specific particulars, and in the presence of the registrar. In the case of marriages according to Roman Catholic, Jewish or Quaker rites the presence of a registrar is required, subject to certain statutory exceptions. The Marriage act, 1949, was amended in 1954 with respect to the residential requirements and in 1958 regarding the registration of buildings and persons before whom marriage might be celebrated. The Royal Commission on Divorce reported in 1912: "Many witnesses . . . point to the power to contract marriage at an age too early; to the need for further and more stringent provisions as to obtaining the consent of parents or guardians to the marriage of minors [later the Guardianship of Infants act, 1925, in some measure dealt with this problem]; to the need for more adequate public notice of intended marriages, and more publicity and formality in marriages before registrars; to the want of any provisions for insuring the fitness of persons, mentally and physically, to marry, and that they have adequate means of livelihood and to other matters which render a marriage unsuitable." The minority report contained the following passage: "(In church) the promise publicly made by each of the spouses to the other is: 'I take thee to be my wedded wife, to have and to hold from this day forward, for better for worse, for richer for poorer, in sickness and in health, to love and to cherish, till death us do part.'. . . In a marriage at a register office, the corresponding undertaking is put more briefly, thus: 'I do take thee to be my wife.' It may, we think, be safely assumed that the latter form is not intended to denote any less far-reaching acknowledgement of reciprocal obligation than the former expressive terms."

Irregularities.—Irregularities in prescribed formalities which do or do not invalidate ceremonies of marriage may be summarized as follows:

A marriage is valid despite irregularities when: (1) the licence was granted the day after ceremony; (2) the licence was obtained under assumed names or by fraud of one spouse unknown to another spouse; (3) there was fraud in the inducement of marriage; (4) certain false or mistaken particulars were given for publication of banns or for a register office marriage; (5) the marriage in church was before only one witness. A marriage is invalid when: (1) in a building not authorized for marriage; (2) the banns were published unduly with the knowledge and consent of both partners.

Royal Marriages.—The sovereign king or queen is debarred from marrying a Roman Catholic under the Bill of Rights, 1688, and the Act of Settlement, 1700, but otherwise may in law marry whom he or she likes. The case of King Edward VIII (duke of Windsor), who abdicated his throne in 1936, pointed to the strong influence of ministerial and ecclesiastical opinion hostile to his choice. The Royal Marriages act, 1772, laid down that no descendant of George II who is under 25 shall be able to marry without the consent of the sovereign, under the Great Seal. If such a descendant is over 25, and his intended marriage is disapproved of by the sovereign, then he should give 12 months' notice in writing of it and after that time, unless both houses of parliament disapprove, the marriage can be validly solemnized.

Foreign Marriages.—The form and ceremonies of entering into a contract of marriage are regulated by the place where the marriage was celebrated, but the capacity for marriage depends on the law of the country in which the parties are domiciled at the time of the marriage. Under the Foreign Marriage act, 1892, all marriages between parties of whom at least one is a British subject in a foreign country before a competent marriage officer are valid in English law, though such marriages are not solemnized according to the *lex loci celebrationis* (according to local usage). The same applies to any part of the British forces stationed abroad or occupying foreign territory, as in the case of the army of occupation in Germany after World War II. At such a marriage any chaplain or authorized marriage officer may conduct the ceremony.

Common-Law Marriages.—What are termed common-law marriages are allowed in rare circumstances, as for instance a marriage in emergency aboard a British merchant ship, whether a clergyman or ship's officer officiates. The intention of the parties to marry must be clearly expressed wherever such a marriage of necessity is contemplated. A ceremony between British subjects in China before a minister not authorized by the Foreign Marriage act to officiate was pronounced a valid common-law marriage (*Wolfenden* v. *Wolfenden* [1946] P. 61). When a Polish officer in the army of occupation in Italy was married according to Roman Catholic rites in that country, both Italian and Polish laws then requiring civil marriages, the court of appeal held that it was a valid common-law marriage (*Taczanoswska* v. *Taczanoswska* [1957] P. 301).

Presumption of Marriage.—The doctrine of marriage by habit and repute applies where a man and a woman are proved to have lived together as man and wife for years; the law presumes that there has been a valid marriage in the absence of clear proof to the contrary. The question only arises after the death of one

of the parties, and it may relate either to succession or the legitimacy of a child.

Jurisdiction in Nullity.—If, when the nullity suit is commenced, the petitioner or both parties are domiciled in England, or both parties are resident in England, or the wife is enabled to sue on the ground of three years' ordinary residence in England under the Matrimonial Causes act, 1950, s. 18, then the court can entertain the suit on any of the established grounds. Until 1962 jurisdiction also arose from the fact of the marriage having been celebrated in England, but in the house of lords case of *Ross-Smith* v. *Ross-Smith* (1962) 2 W.L.R. 388, it was held that jurisdiction on that basis was permissible only if it was a case of a marriage void *ab initio* (from the beginning) as distinguished from voidable.

Marriages void *ab initio* are those in which one or both parties are barred by (1) nonage; (2) bigamy; (3) affinity or consanguinity; (4) informality in ceremony; (5) insanity at the time of marriage. It is frequently necessary to obtain a decree or declaration of the court to put on record the fact that such a marriage was a nullity. In the category of voidable marriages at the wish of one of the parties are also (1) impotence; and the following grounds of nullity first introduced in the Matrimonial Causes act, 1937, and now contained in the Matrimonial Causes act, 1950, viz., (2) wilful refusal to consummate the marriage; (3) the degree of unsoundness of mind mentioned previously in this article; (4) venereal disease in a communicable form at the time of marriage; and (5) pregnancy of the wife at the time of the marriage by another than the husband. As regards the last four grounds there are time limitations and other conditions attached.

Legal Effects of Marriage.—Until the Law Reform (Married Women and Tortfeasors) act, 1935, a husband could in certain circumstances be held liable in tort for his wife's wrongful acts, but since that act a woman is in the position of a single woman unless it can be shown that she was in fact an employee or agent. Similar considerations apply to the law of contract.

A husband is not liable for obligations contracted by his wife unless it can be shown that she acted as an agent of necessity. At common law a man is bound to support his wife, and under a section of the Matrimonial Causes act, 1950, she may, without embarking on a suit for divorce or any other matrimonial cause, claim maintenance in the high court if he has wilfully refused to provide her with reasonable maintenance. Moreover by an act which came into operation on Aug. 1, 1962, both parties to a marriage have the same right of action in tort as strangers, though the court has a discretion to order a stay of proceedings if no substantial benefit would be gained or if the claim could more conveniently be brought under s. 17 of the Married Woman's Property act, 1882.

The English law, whereby the father was normally entitled to dictate the faith of his children, has been modified in cases of dispute between the parents on this point by judicial practice, so that each case is dealt with on its merits. The practice on this point varied in Europe—the question being ignored in French law, Germany following in some respects the same rule as England, in others giving effect to antenuptial stipulations. In Ireland mixed marriages (*i.e.*, between Roman Catholic and Protestant) were by 19 Geo. II, c. 13, null and void if celebrated by a Roman Catholic priest. This act was repealed by 33 and 34 Vic., c. 110, which permitted mixed marriages to be validly celebrated by an Episcopalian or Roman Catholic clergyman, subject to conditions set forth in s. 38.

On marriage any will made by either of the parties lapses, unless it is specifically made in contemplation of the marriage, although of course after marriage a fresh will may be made. (*See* HUSBAND AND WIFE, LAWS CONCERNING. For Scotland *see* SCOTS LAW.)

British Commonwealth.—In Canada, Australia and New Zealand the English law of marriage prevails, subject to minor variations in formalities, as also the law of nullity. The same applies to Northern Ireland, as part of the United Kingdom, and no change has been made in Eire since it became the independent republic of Ireland outside the commonwealth, most of the marriages there being celebrated according to Roman Catholic rites. The British Colonial Marriages act, 1865, provided that all laws made by legislatures in British possessions abroad for the proof of valid marriages should have the same form throughout, subject to legal competence of the parties to marry. The Indian Christian Marriage act, 1872, laid down the formalities. Within the remaining British crown colonies racial and religious customs with regard to non-Christian marriages have always been taken into account.

UNITED STATES

Marriage law in the United States is subject to the exclusive province of each state. The legal conception of marriage is the same as that described under English law. The fundamental principle is simply that a man and a woman, each possessed of the requisite capacity, may become married by mutual consent. Although marriage has been defined variously in different states as a contract, a status, or an institution, the well-known jurist J. P. Bishop, in his *New Commentaries on Marriage, Divorce and Separation* (1891), emphasized that marriage had scarcely any of the ordinary elements of civil contract but pertained to status. He defined marriage as the civil status of one man and one woman legally united for life, with the rights and duties which, for the establishment of families and the multiplication and education of the species, were assigned by the law to matrimony. Nevertheless about a third of the states have passed statutes defining marriage as a civil contract, including Nevada, which is conspicuous for both its marriage and divorce laws.

Requisites for a Valid Marriage.—In general the legal capacity of a person to marry is the same all over the Christian world and subject to impediments such as consanguinity and affinity. The parties must have attained a certain age to be married. At common law, marriages below the age of 12 for girls and 14 for boys were void. As J. P. Bishop points out (vol. I, p. 244) these ages, based on puberty, were set up in the common law and, having originated in the warm climate of Italy, were not entirely suited to northern latitudes. These ages have been raised in almost every state. Typically a state forbids the marriage of girls below 15 or 16 and of boys below 18. Whether the marriage of a person below the statutory age is absolutely of no effect (void) or is effective unless nullified (voidable) depends upon the special facts of each case and upon the particular law of each state. In Alabama (1886) the minimum ages were fixed at 17 for a male and 14 for a female; in North Carolina 16 years for each. Usually, males under 21 and females under 18 must obtain the consent of their parents before a licence can be issued.

Impediments to Marriage.—Persons may not intermarry if a close relationship by blood (consanguinity) or by marriage (affinity) exists between them. Prohibited degrees are fixed by statutes in the various states and in general are the same as in England in respect to blood relationship, but about half the states have forbidden marriages on the ground of affinity. In general, a marriage is incestuous if one attempts to marry an ancestor, a descendant, an aunt (uncle), a sister (brother) of the whole or the half blood or any of their respective spouses. In the 1960s, over 30 states had prohibited marriages between first cousins, while several forbade marriage to a grandniece (grandnephew) and to a first cousin once removed. In Texas a man may not marry his son's divorced wife but may marry his son's widow. In Iowa it was held that a man could marry the daughter by a former marriage of his divorced wife. In none of the states is marriage forbidden between a man and his deceased or divorced wife's sister or a woman with her deceased or divorced husband's brother.

Miscegenation statutes prohibiting and declaring invalid marriages between persons of different colour are on the statute books of about 30 states, but their compatibility with the 14th amendment to the U.S. constitution is doubtful. In California, the state statute was declared invalid in 1948 under both the federal and the state constitutions. In a case in which a negro living in Virginia proceeded from there with a white woman to the District of Columbia and went through a ceremony of marriage there, afterward returning to Virginia, the marriage was held to be void. But

on the other hand when there was a marriage in Rhode Island between a negro and a white person domiciled in Massachusetts, which state prohibited such a marriage, the marriage was held to be valid because Rhode Island allowed such marriages.

Provisions forbidding the marriage of persons afflicted with certain diseases such as imbecility, epilepsy and even tuberculosis exist in almost all states, but without the process of medical inspection and certificates they are of little use. By 1959, 44 states had forbidden the marriage of a person suffering from communicable venereal disease, but once such a marriage has been celebrated despite the existence of such diseases, it is valid.

Marriage Formalities.—For the initiation of a marriage a ceremony of some kind is generally required, so that, in order to be married, the couples have to present themselves to a magistrate or some other secular officer or to the minister or priest of a religious community. None of these, however, may perform a marriage ceremony unless the parties have a licence issued by a secular officer, usually the county clerk, who is supposed to withhold the licence if the intended marriage would be illicit. More than half the states require a notice by the parties of short periods varying from one to five days. In order to secure proper records the minister or justice before whom the ceremony is performed has to notify the recording officer of the state, usually the director of the state department of public health. Nevertheless the ease and comparative cheapness of the marriage solemnization may be illustrated by the extreme case of Las Vegas (Nevada), with a population of about 65,000, where in 1961, for example, no less than 30,000 marriages took place, mostly between migratory persons.

Common-Law Marriages.—Informal, or "common law" marriages as they came to be termed, by which a couple could marry by mutual consent without any ceremony or even witnesses, were prohibited to England in 1753 by Lord Hardwicke's act, a religious ceremonial being substituted. This act did not apply to Scotland or the English colonies beyond the seas. In the American colonies in particular, common-law marriage thus remained possible, and that situation continued until most states, by express statutory enactment, required a public ceremony as an essential requirement for the validity of the marriage. In the 1960s common-law marriage was still possible in about one-third of the states.

Validity of Marriage.—A "common law" marriage is valid "notwithstanding the existence of any statute on the subject, unless the statute contains express words of nullity." Thus if a statute forbids solemnization without a licence, in the absence of a clause of nullity the marriage will be good. "In any view," said Chief Justice Marshall in *Stevenson* v. *Gray*, 17 B. Mon. 193, "these directory provisions, though prohibitory and even penal with respect to the officers (*i.e.*, justice or ministers), have not been regarded as affecting the validity of a marriage otherwise legal." These words were uttered in the 19th century, and since that time marriage without the usual formalities has become a rarity and has earned judicial disfavour. Nevertheless it had been held in Pennsylvania where a statute required 12 witnesses to a marriage that marriages not so celebrated were valid; in Massachusetts, though officiating persons were forbidden under a heavy penalty to perform marriage ceremonies in the case of minors, except with the consent of their parents, the absence of such consent did not void a marriage once it was celebrated.

In general the principle is maintained in the United States that the validity of a marriage is governed by the law of the place in which it is solemnized. If the formalities of a foreign marriage differ from those required by the law of the domicile but are duly observed, the marriage is valid everywhere, subject of course to the competence of the parties to enter into marriage.

Marriage by proxy, although a comparatively rare procedure, is not forbidden in any state except Louisiana, and there only in respect of such marriages contracted within that state; and it is expressly allowed in Kansas by statute. Such marriages were not uncommon during World War II between couples of which the man had gone abroad on war service. There were cases of valid proxy marriages through the medium of telegram and radio. Though rarely exercised now, owing to the facilities for rapid transport, it was a common practice in medieval days among royal or princely families. A marriage by proxy in the law of the District of Columbia was held to be good in New York (*Fernandes* v. *Fernandes*, 274 App. Div. 777 [1949]). Among the recorded cases of proxy marriage by telegram during World War II was one when a girl in Washington, D.C., married a soldier in Australia. It took 17 days to complete. The man telegraphed to the girl: "Will you marry me by cable? Today I (full name followed) take you (her full name followed) to be my lawfully wedded wife." She telegraphed back in similar terms. A minister deposed to the wife's acceptance.

North American Indians.—As regards Indians who continue to live in tribal conditions in the United States, the tribal custom of marriage is generally recognized, and the courts have even held to be valid polygamous marriages performed in Indian reservations. An Indian marriage was held valid in Nebraska, though both parties had been married before and divorced according to tribal law, and the ordinary law against bigamy was not allowed to invalidate some polygamous Indian marriages in Oklahoma. Before the abolition of slavery in the United States the degree of recognition of unions between slaves as lawful marriages varied from state to state. Formerly there was no such recognition in Alabama, but after the emancipation such marriages were held valid if cohabitation between the parties continued, and it was the same in Louisiana and Oklahoma.

Disposition of Property.—In the United States the old English common-law principle that a man must maintain his wife has always prevailed, coupled with the equitable principle which in the course of over a century has given the wife more or less equal rights to property. Estates by the entirety, generally arising when real property was conveyed to husband and wife jointly and upon the death of one the property accrued to the other, have been limited in most states by legislation or case law. In about half the states, no such right attaches to the marriage status, though it is still applicable in the District of Columbia. In New York and New Jersey "estate by entireties" partakes more of the character of a tenancy in common. Community of property (*see* COMMUNITY PROPERTY), a system borrowed from Latin Europe, prevails in 8 states, whereby husband and wife are each entitled to half the property.

In most states the common law as to the effect of marriage is applied by statute, *i.e.*, wills made before the marriage lapse, but in some statutes the will revives if the wife survives her husband. In some states, where wives were held incapable of making a will, they might by republishing antenuptial wills revive them. In several states an antenuptial will made in contemplation of the marriage, as in English law, does not lapse.

Actions for Enticement.—Apart from proceedings for divorce and separation (*see* DIVORCE), there still exists in a number of states the right of action by a married person for alienation of affections. This arises from the traditional action in England, abolished in 1857, for criminal conversation, and is equivalent to the very rare English action of enticement. If a husband in these states is deprived of the consortium of his wife by the active and deliberate conduct of a third person he may sue for damages. Wives have the same right of action as their husbands in those states where this action is possible.

Annulment of Marriage.—In the United States the law relating to validity of marriage, derived from canon law, is much the same as in England, except that statutes in certain states allow some grounds of nullity not exercised in England. The minimum age required for marriage differs in various states, as does the requirement of parental consent to the marriage of minors. Marriages under the prescribed ages may be ratified by subsequent cohabitation, and if ratified no action for annulment may lie on the ground of nonage. The purpose of most of the statutes requiring consent of parents is not to void such marriages but to impose penalties on ministers and magistrates who negligently officiate at such ceremonies. In about half the states a marriage may be annulled for nonage only on the application of the parties or their parents, and there is judicial power to recognize certain marriages which would otherwise be voidable for infancy. A marriage

may be annulled if the parties are within the forbidden degrees of affinity and consanguinity. Although at common law the children of a void marriage are illegitimate, in over 30 states such issue is legitimate by statute.

Regarding jurisdiction in annulment, there are no such nice distinctions in the United States as there are in England. The juridical considerations are the same as in divorce except that the place of the marriage would confer the power of annulment in that state, whatever the ground. Yet in some states the grounds for annulment are wider than in English law; *e.g.*, concealment of conviction for a serious crime, or of affliction with tuberculosis, or gross fraud and misrepresentation as to a man's property or character.

(W. La.)

EUROPE

Italy, Spain and Portugal.—In Italy, Spain and Portugal the Roman Catholic Church preserves its ancient powers and has exclusive jurisdiction over matrimonial affairs.

Greece.—For Greek marriage law see *Canon Law: Orthodox Church*, above.

France.—In France articles 144–226 of the civil code, as amended by several acts, prescribe the qualifications and conditions of marriage. The man must be 18 and the woman 15 years of age. A son or daughter under 21 cannot marry without consent of the father and mother, or of one of them (act of July 17, 1927) if they disagree or have been divorced, or of the survivor if one is dead. If both parents are dead, the grandfather and grandmother, or one of them, take their place. If the grandparents are also dead, the consent of the family council, deciding by a majority, must be given. Between the ages of 21 and 30 the parties do not have to obtain the consent of their parents but must make a "respectful and formal act" before a notary when consent is failing (act of Feb. 2, 1933). Adoptive children under 21 cannot marry without consent of their adoptive parents (act of July 29, 1939). (*See* also French Law: *The Civil Code* [*1804*].)

Marriage is prohibited between all ascendants and descendants in the direct line, and between persons related by marriage in the same line, between brother and sister, between uncle and niece, aunt and nephew, between adopter's and adoptive children and between adoptive children. In the collateral line, the act of July 1, 1914, suppressed the prohibition between brother-in-law and sister-in-law unless the marriage producing the affinity has been annulled by divorce.

Before the solemnization of marriage, a publication notice must appear on the door of the town hall for a period of ten days. The notice contains the names, Christian names, occupations, domiciles or residences of the parties and the place where marriage is to be celebrated. Since the act of Aug. 9, 1919, the notice has contained nothing about the parents. According to an act of Nov. 2, 1945, the parties must give a medical certificate to the civil officer. If the marriage cannot be celebrated during the year, a fresh notice must be put up. The marriage is celebrated in the parish to which one of the parties belongs by the civil officer or registrar. He reads to the parties the various necessary documents, with the chapter of the code relating to husband and wife, receiving from each a declaration that they take each other for husband and wife and drawing up the act of marriage. All this must be done in the presence of two witnesses. In the case of Roman Catholics a religious ceremony will take place after the civil ceremony. Marriages contracted abroad between French subjects or between French subjects and foreigners are valid in France if celebrated according to the forms of French law, before French competent consuls, or according to the forms of the foreign law, provided the French conditions as to consent of parents have been observed.

(J. M.-M. L.; X.)

Germany.—The law of marriage and divorce in 1946 adopted the marriage law of 1938, with the exception of typical National Socialist provisions. The law recognizes only marriage concluded before the registrar; *i.e.*, civil marriage. Church marriage may only take place afterward. Since 1947 foreigners may be married in Germany before diplomatic or consular representatives according to their own laws.

A man may not contract a marriage before he has completed his 21st year; a woman before she has completed her 16th. With special permission, both may marry earlier, but the man only if he has completed his 18th year and is no longer subject to parental authority or under the care of a guardian.

After public notice is given, the marriage is concluded when the contracting parties declare in the presence of each other before the registrar that they wish to marry each other. Two witnesses should be present and the registrar should enter the marriage in the register.

Marriages are forbidden and, when celebrated, are void, between ascendants or descendants or full or half brothers and sisters. Also forbidden and void (unless special permission is given before or after the marriage) are marriages between relations by marriage in a direct line; and between a person divorced for adultery and the person with whom the adultery was committed, subject to exemptions where appropriate. Marriages should not be contracted (although such marriages are not therefore void) by persons between whom there is an adoption relationship; by a woman whose former marriage has ended less than ten months previously, subject to exemption; and by foreigners without a certificate from their own country stating that there is no impediment to the marriage.

Marriages are also void where, at the time of the marriage, one of the parties was legally incapable, or where the essential form of the ceremony was infringed. In these cases marriages are, however, valid if the parties have lived together for a certain time. After 1945 formerly invalid "free" marriages between persons persecuted on racial or political grounds, displaced persons and refugees were under certain conditions recognized by law. A marriage is void if contracted solely or primarily for the purpose of enabling the wife to bear the name of the husband without the establishment of conjugal relations, but the marriage will be validated if the couple have lived together after the ceremony for five years, and in certain circumstances for at least three years.

Void marriages count as being so from the beginning; but this effect only comes into operation once a court decision has been given. Children of such marriages are legitimate if they would have been so had the marriage been valid. The disposition of the property of the partners is regulated according to the divorce rules if at least one partner is ignorant of the nullity.

A marriage can only be declared null by the court for grounds existing at the time when the marriage took place: lack of consent by legal representative; an error over the marriage ceremony, the person or the person's essential characteristics; wilful deceit; and threats. The marriage becomes invalid only at the time when the court annuls it, though before 1938 it was void from the beginning. (*See* German Law: *Civil Law.*) (G. K.; W. La.)

U.S.S.R.—Soviet law recognizes only civil marriage. Unregistered marriages were acknowledged in several republics of the Union until July 8, 1944, when a decree of the presidium of the supreme soviet enacted that only a registered marriage could confer marital status and rights. Complete equality of spouses in every respect is guaranteed by the constitution (sec. 122). Monogamy is strictly enforced, bigamy being a criminal offense.

Marriage in the Soviet Union must be completely voluntary and both parties must be over 18 years of age. Local councils may permit marriage where one of the parties is a year or at most two years younger, but such permission is granted only in exceptional circumstances. In certain of the Asian republics women may marry at the age of 16. By a decree of Feb. 15, 1947, marriage between Soviet citizens and foreigners is forbidden (*see* Soviet Law). (I. Gy.)

AFRICA, ASIA AND THE FAR EAST

Middle East and North Africa.—Islamic law applies in all matters of personal status of Muslims, and in some Arab countries such as Saudi Arabia and Yemen, Muslim law applies to all other matters as well.

Marriage (*nikāḥ*) in Islam is a contract for the "legalization of intercourse and the procreation of children" and may be constituted without any ceremonial. It is purely a civil contract,

the terms of which depend on the will of the consenting parties, and is accompanied by payment of dower which may be regarded as the price paid to the wife for the "connubial rights" of the husband.

The essential requirements of marriage are offer (*ijāb*) and acceptance (*qubūl*), expressed at one meeting. The declaration and acceptance may be made by the parties, or by their agents, if both are competent. In case of legal incompetency, the guardians may enter into a contract of marriage on behalf of their wards.

In Islamic law, a Muslim man who has attained majority (at 15) may marry any number of wives not exceeding four, but a Muslim woman can marry only one husband. A Muslim woman can only marry a Muslim, but a Muslim man may marry a Muslim woman or a Kitabiya, one who believes in a religion revealed to its followers in a book. There are seven limitations on the unfettered capacity of a Muslim man to marry: number of wives, religion, relationship (consanguinity or affinity), fosterage, unlawful conjunction, *iddat* (a period of continence imposed on a woman on the termination of a marriage in the interests of certainty of paternity), or miscellaneous prohibitions. (*See* also ISLAM: *Muslim Society.*) (J. NR.)

Israel.—No marriage age is laid down in the Mosaic law, but 18 years is said by the rabbis to be the right age. An Israel statute has made it an offense to marry a girl under 17. Consent of parents of minors is not essential. Originally polygamy was common, but by decree of a famous rabbi of the 11th century it was prohibited to western Jews (Ashkenazim), and now in Israel to all. The Mosaic law prohibited marriage of many near relations, but allowed it between uncle and niece and with a deceased wife's sister. Marriage with cousins is more frequent among Jews than in the general community. The Levirate institution obliged a man to marry the childless widow of his deceased brother, but in modern times that is avoided by a ceremony of repudiation.

Marriage is a religious ceremony (*kiddushin,* meaning sanctification), with a civil contract (*ketuba*) attached. The ceremony consists of recitation of blessings, the drinking of wine, and the bridegroom's placing a ring on the forefinger of the bride's right hand. The ceremony takes place under a canopy (*huppa*), and there must be two Jewish witnesses, but the celebrant need not be a rabbi. After the blessing the bridegroom breaks with his foot a glass, symbolizing the destruction of the Jerusalem Temple. The civil part is the signing by the husband of an undertaking to provide a sum for the wife's maintenance. The marriage must be between Jew and Jewess, but either party may have been received into the Jewish community. (No. B.)

Asia and Africa.—Polygamous marriages are still permitted under customary laws in the republics of Africa and under tribal laws in the North East Frontier agency of India, while Islamic law sanctions limited polygamy. Monogamous marriages, however, are the only ones recognized in Japan and Ceylon, and in India for those citizens not governed by Islamic law. In Pakistan the Muslim Family Laws ordinance, 1961, tried to restrict polygamous marriages and required a man to get permission before marrying a second wife and that all marriages be registered. In Africa there was a growing tendency for the younger generation to marry monogamously.

In Asian countries like Ceylon, India, Pakistan, and in the republics of Africa the major difference from western marriage law is that, with the exception of Japan, there is no uniform marriage law. Family relations are governed by the personal law of the citizens—a law based either on religion (as among Muslims or Hindus, irrespective of the country they belong to) or the customary law of the territory. This leads to a diversity of laws within one territorial unit and often gives rise to complex problems when, after marriage, one of the parties is converted to another religion.

In Africa and Asia, marriage commonly seals the coming together of two families. The marriage is arranged by the families and the girl is usually given away. This is symbolized in the *kanyadan* ceremony among the Hindus (giving of the daughter to the groom by her guardian) or the *tiri-aseda* under Ghanian Akan law, which is the thank offering by the groom to the person giving the bride in marriage.

The Indian Child Marriage Restraint act of 1929 (repeated in the Hindu Marriage act, 1955) tried to raise the age of marriage and prescribed penalties for its violation; but, because there are still so many child marriages, they have not been declared *ipso facto* void. In Nigeria marriage to a minor is likewise penalized. Under Islamic law in both Africa and Asia marriage is a contract, and therefore the consent of the parties is required; but, to give this consent, it is not necessary for the parties to have reached the age of majority but only the age of puberty, 15 years being the accepted age for both.

The payment of bride wealth (*q.v.*) to the bride's guardian as an essential of marriage is prevalent in many African marriages. In most places marriage cannot be consummated till the entire stipulated amount is paid; in Pondo and Zulu law, however, there is the modification that marriage payment can be demanded after consummation. In Natal, though not a requirement of the marriage, a payment is usual because the guardian's consent is required, and he withholds it till agreement has been reached.

A dower, *mahr* in Islamic law, is paid to the bride as a token of respect, and both under that law and under African customary law it is an insurance against the husband's bad behaviour or divorce without cause. In India and Ceylon, the payment of a dowry—not for the bride but with her—became a social evil, and in an effort to stamp it out the India government passed the Dowry Restraint act, 1961, making the giving and receiving of dowries an offense. (*See* INDIAN LAW: *Hindu Law.*) (LA. S.)

French-Speaking Central Africa.—The gathering together of various African societies under French authority has not really given them a legal unity, although a new code was expected in the early 1960s to achieve a relative unity. The decrees of June 15, 1939, and Sept. 14, 1951, established certain general characteristics: a minimum age for marriage, the nullity of marriages contracted by girls before puberty, the requirement of the consent of both parties, limitations on dowries and the remarriage of widows, etc. These rules have, however, done little to modify customary law; *e.g.,* requirement of delay before a widow remarries, prevention of a child marrying its wetnurse, or children of the same nurse marrying, and limitations because of paternity.

The dowry has a wide usage and common characteristics: as a seal on marriage, authenticating the union and demonstrating that the woman is no concubine; and as a provision (paid in kind by the bridegroom) permitting the husband alone to exercise rights of paternity over children of the union. In principle the customary marriage is a union between two families in which the bride has no voice, though African women are now acquiring rights in this sphere. Marriage with a dowry is much more extensive than other forms (such as an exchange of gifts). Marriage "by abduction" is a ritual of formal significance only. Polygamy was formerly almost universal, all wives being equal. Generally customary unions do not involve the fusion of the inheritances of the two spouses. (J. L. P.)

China.—Under a civil code which came into operation in 1931 monogamy was ordained and bigamy forbidden, and if a bigamous marriage was contracted any interested party might apply to the court for annulment. This law still prevails in Formosa, although in practice the custom of concubinage continues and more than one wife is recognized. Formality in the marriage celebration was dispensed with, and all that was necessary was that the couple should declare themselves husband and wife before witnesses. Some of these signed their names on a large sheet of red paper, though this did not become a legal document. In the Chinese People's Republic a code was promulgated in 1950 ordering monogamy and that civil marriages be duly registered. Customary laws of marriage were abolished.

Japan.—Family relations were regulated by the law of Horei, 1896, which was reformed after the constitution of 1947, in the new civil code. Polygamous marriage was prohibited and an age of 18 years for the man and 16 years for the woman was laid down by law, though a minor marrying was decreed to have obtained his majority. Consanguinity was a prohibition to the third degree, and all marriages had to be registered in accordance with the Family Registration law.

See also MARRIAGE: *History;* MARRIAGE, PRIMITIVE; also references under "Marriage, Law of" in the Index. (X.)

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MARRIAGE, PRIMITIVE. Human beings as higher animals multiply by the union of the sexes. But neither conjugation nor even the production of offspring is sufficient as a rule for the maintenance of the species. Advanced animals in the order of evolution tend to show extended immaturity and helplessness of the young and a need for prolonged care and training. It is thus the combination of mating with parenthood that constitutes marriage in such animals as man. Even in its biological aspect, "marriage is rooted in the family rather than the family in marriage" (E. A. Westermarck).

In human societies, however, other elements often are added to the sexual and parental sides of marriage: marriage is given the hallmark of social approval; it becomes a legal contract; it defines status and the relations among parents and children; it imposes duties of economic co-operation; it may have to be concluded in a public and solemn manner, receiving as a sacrament the blessings of religion and as a rite the good auspices of magic.

Human marriage also appears in a variety of forms: monogamy, polygyny and polyandry; matriarchal and patriarchal unions; households with patrilocal and matrilocal residence. Other forms, such as group marriage, promiscuity, anomalous or gerontocratic marriages, have been assumed by some writers as an inference from certain symptoms and survivals. In the 1960s these forms were not all to be found, while their hypothetical existence in prehistoric times is doubtful; it is important in such speculations never to confuse theory with fact.

Mid-20th-century field research revealed such forms as the Nuer (*q.v.*) marriage of a woman to a woman, inconsistent with the 6th edition of *Notes and Queries in Anthropology* (1951) that defined marriage as ". . . a union between a man and a woman such that children born to the woman are the recognized legitimate offspring of both partners."

E. R. Leach (1955) argued that the Nayar (*q.v.*) of the Malabar coast traditionally had no marriage in the strict sense of the term, since the notion of fatherhood was lacking; he proposed that marriage be defined in terms of some ten classes of rights establishing legal parenthood, control over sexuality, labour service, property and so on. If Leach's interpretation of the Nayar case is accepted none of these rights is established invariably by marriage. However, E. Kathleen Gough, on whose analysis Leach relied, reexamined the Nayar situation and concluded (1959) that ". . . the notion of fatherhood is not lacking and that marriage does serve to establish the legitimacy of children." But her data forced her to classify Nayar unions as a form of group marriage in which individual Nayar women were associated with a series of men of appropriate caste. As a result of this and such practices as those among the Nuer she proposed a modified definition of marriage as ". . . a relationship established between a woman and one or more persons which provides that a child born to the woman . . . is accorded full birth-status rights common to normal members of his society or social stratum."

Marriage in human culture is never a matter of entirely free choice. People related by descent or members of certain classes are often either barred from marrying each other or are expected to marry. The rules of incest, of exogamy, of hypergamy and of preferential mating form the sociological conditions of marriage. To these are added certain societies with such preparatory arrangements and conditions as initiation, special training for marriage and moral and economic tests that have to be satisfied before marriage is allowed.

Love and marriage are closely associated in daydreams and in fiction, in folklore and poetry, in manners, morals and human institutions—but marriage is more than the happy ending of a successful courtship. As an ideal it is the end of a romance; it is also the beginning of a sterner task, and this fact finds an emphatic expression in the laws and regulations of marriage throughout humanity.

Love tends to sexual intimacy and this to procreation. Marriage on the whole is rather a contract for the production and maintenance of children than an authorization of sexual intercourse. The main reason marriage has not been regarded uniformly as establishing an exclusive sexual relationship lies in the fact that in many human societies sexual relations are allowed under certain conditions before marriage, while marriage does not necessarily exclude the continuance of similar relations.

Marriage, however, remains the most important form of lawful intercourse, and it dominates and determines extra-connubial liberties. In their relation to marriage the forms of licence include prenuptial intercourse, relaxations of the marriage bond, ceremonial acts of sex, prostitution and concubinage.

Prenuptial Intercourse.—In the majority of aboriginal tribes unmarried young people have been free to mate in temporary unions, subject to the barriers of incest and exogamy and of such social regulations as prevail. But there are other tribes where chastity of the unmarried is regarded as a virtue, especially in girls, and any lapse severely censured or punished. Many technologically primitive peoples such as the Vedda, Fuegians, Senoi and neighbouring Malayan Negritos reportedly did not tolerate sexual intercourse before marriage. Among the Bushmen and the Andamanese instances of prenuptial unchastity do occur, but they are not condoned, still less provided for by custom and moral approval. Aboriginal Australians, however, allow prenuptial freedom, except perhaps a few of the southeastern tribes.

Among less primitive aboriginals considerable variety is found in this respect. All over the world, in Oceania, in Asia, in Africa and in the Americas, examples are found of peoples who demand continence more or less stringently, yet have neighbours who allow full freedom. In only a few cases has the demand for chastity been found expressed in very definite usages that physically prevent copulation, such as infibulation practised among northeast African, Hamitic and Semitic peoples and reported also from Thailand, Burma and Java. The testing of the bride by a publicly exhibited token of defloration that forms part of certain marriage ceremonies and expresses the value of virginity lends itself to deception and circumvention. It has been found sporadically throughout the world, in the noble families of Oceania (Tonga, Samoa, Fiji), in Asia (Yakut, Koryak, Chuvash, Brahui of Baluchistan, southern Celebes), in North America (Chichimec of Mexico), in Africa (Mandingo, Ruanda, Yoruba, Swahili, Morocco, Algeria and Egypt) and likewise among many Semitic and Hamitic peoples. In other parts of the world it is merely reported that chastity is praised and prenuptial intercourse censured (Bantu, Kavirondo, Galla, Karanga and Bechuana of Africa; Dobu and Solomon Islanders of Melanesia; Omaha, Mandan, Nez Percé, Apache and Takelma of North America; Canelo of South America; Bodo Dhimal of Assam; hill Dayak of Borneo).

Freedom to mate at will has been fully allowed and even en-

joined and provided for by such institutions as mixed houses for bachelors and girls (Trobriand Islanders, Nandi, Masai and Bontok). In some communities prenuptial intercourse is not meant to lead to marriage, and there even have been cases (as among the Masai, Kunbi of India, Guaycuru and Guana of Brazil), where prenuptial lovers were not supposed to marry. Elsewhere prenuptial mating is a method of courtship by trial and error leading gradually into stable unions, and is finally transformed into marriage. Thus among the Trobriand Islanders considerable sexual freedom has been observed. It begins very early, children taking a great deal of interest in certain pursuits and amusements that come as near sexuality as their unripe age allows. This is by no means regarded as improper or immoral, is known and tolerated by the elders and is abetted by games and customary arrangements. Later on, after boys and girls have reached sexual maturity, their freedom continues with the result that there is a great deal of indiscriminate mating. In fact, at this age both sexes show a great deal of experimental interest, a tendency to vary and to try, and here again a number of arrangements and customs play into the hands of these juvenile lovers. As time goes on, however, and the boys and girls grow older, their intrigues naturally and without any outer pressure extend in length and depth, and the ties between lovers become stronger and more permanent. One decided preference as a rule develops and stands out against the lesser love affairs. It is important to note that such preferences are clearly based on genuine emotional attachment. The protracted intrigue becomes a matter of public notice as well as a test of mutual compatibility; the girl's family signify their consent and marriage is finally concluded between the two lovers. Similar forms of prenuptial selection have been found in other tribes (Igorot of Luzon, Kamba of Kenya and Tiv of Nigeria).

However, prenuptial liberty is not regarded by these groups as a negation of or substitute for marriage. In fact in such communities it is in the nature of a preliminary or preparation to marriage; it allows the young people to sow their wild oats, eliminates cruder forms of sex impulse from matrimonial selection and often leads to a mature choice that considers attractions beyond sexual appeal.

The Principle of Legitimacy.—Perhaps most important in the consideration of prenuptial liberty is the rule that freedom of sexual intercourse does not generally extend to freedom of procreation. One of the symptoms of this is that in communities where chastity is demanded and enforced, deviation entails more censure on girls than on boys, while prenuptial pregnancy is penalized much more severely than mere wantonness. But even where prenuptial intercourse is enjoined by tribal law pregnancy is often regarded as a disgrace.

Among such aristocratic fraternities of Polynesia as the Areoi of Tahiti licence between men and women was universal, but children of such unions were killed unless adopted by a married couple. Among the Melanesian communities of New Guinea and the adjacent archipelago that allow full sex liberty before marriage, the occurrence of pregnancy under such circumstances is a grave disgrace to the mother and entails disadvantages for the child. The Masai punish a girl for prenuptial pregnancy, although free unions of unmarried boys and girls have been traditional with them. A similar combination of prenuptial full licence with severe punishment of illegitimate childbirth is recorded from several African tribes (Nkole, Basoga, Kikuyu, Nandi, Beni Amer), from the Americas (Indians of British Guiana, Guaycuru, Guana, Creek and Cherokee), from Asia (Lisu of Burma, Nias Islanders of Indonesia and Siberian Aleut), from Melanesia (Solomon Islanders). In such cases pregnancy probably is prevented by contraceptive practices for which few reliable reports are available from primitive tribes; or by abortion, which is far more frequent; or is expiated by punishment of the mother and sometimes also of the father.

The main sociological dictum embodied in these rules and arrangements is that children are not to be produced outside a socially approved contract of marriage. In several tribes the remedy for the disgrace of a prenuptial child has consisted therefore in an obligation of the presumptive father to marry the girl (Bantu, Madi, and Kagoro of Africa; Tepehuane and Hupa of North America; Kachari of Assam; Kayan and Punan of Borneo). In some cases a child of a free union is a condition to marriage which is concluded upon its birth (Sea Dayak, hill Dayak, Moi and Bontok of Malaysia; natives of the Bismarck archipelago; Lengua, Guarayo and Pueblo Indians of the Americas; Wolof and Bambata of Africa). Such cases, although they contrast with those in which a prenuptial child is a disgrace, involve the same principle: the elimination of illegitimate offspring. As a matter of fact, where prenuptial pregnancy is welcomed, children are regarded as an advantage. The father consequently need not be forced to marry the mother; he does so of his own accord, usually because fruitful marriage is desirable. Thus a socially recognized father commonly is regarded as indispensable for each child, *i.e.*, a husband for each mother. An illegitimate child typically is an anomaly, whether it be an outcast or an unclaimed asset. A group consisting only of a woman and her children is a legally incomplete unit.

Relaxations of the Marriage Bond.—Among tribes where prenuptial chastity is demanded marital fidelity is also usually enjoined. As a rule adultery is regarded as a grave offense and more severely penalized than prenuptial intercourse, though exceptions to this rule do exist. In many communities where freedom was granted before marriage, as soon as the matrimonial knot was tied both partners, or the wife at least, were bound to remain faithful, under more or less serious penalties (Trobrianders, Nukuhiva and Maori of Oceania; Land and Sea Dayak, Kuki and Ceramese of Indonesia; Botocudo and Guarayo of South America; Illinois, Comanche, Iroquois, Pawnee and Californian Indians of North America; Temne, Ashanti, Konde, Zulu, Kaffir and Thonga of Africa). The penalty inflicted upon an adulterous wife tends to be much graver than upon an unfaithful husband, and considerable differences prevail according to the circumstances of the offense, the status of the third party, the husband's anger and his attachment to his wife.

There are, however, a number of communities that permit promiscuity with the consent of the marital partners and with the sanction of tribal law, custom and morality. In some societies the only occasion on which the wife is allowed connection with other men, indeed must submit to their embraces, is at the very beginning of marriage. This custom has apparently been known in medieval Europe under the name *jus primae noctis* (*droit du seigneur*). It has been reported in many aboriginal cultures (Brazilian Indians, Arawak, Carib, Nicaraguan and Tarahumara of South and Central America; Ballante and Berber of Africa; Banaro of Melanesia; Arunta, Dieri and other Australian tribes). Such customs are to be regarded not so much as the abrogation of matrimonial exclusiveness, but rather as expressing the superstitious awe with which sexual intercourse, and above all defloration, is regarded by some primitive peoples. As such these customs should be considered side by side with the numerous instances in which girls are artificially deprived of their virginity, without the intercourse of any man; with prenuptial defloration by strangers; with temporary prostitution of a religious character; and with sexual intercourse as a puberty rite.

A greater encroachment upon sexual exclusiveness in marriage is found in the custom of wife lending as a form of hospitality; this has been very widely distributed. It must be realized that this practice is not an infringement of the husband's rights, but rather his assertion of authority in disposing of his wife's person. Very often indeed a man will offer his sister, daughter, slave or servant instead, a fact indicating that this custom is not so much the right of another man to infringe upon the matrimonial bond as it is the right of the head of the household to dispose of its female inmates.

Very often sexual hospitality has been exercised in anticipation of future reciprocal benefits, and must be considered along with the custom of wife exchange (Gilyak, Tungus and Aleut of Asia; Bangala, Herero, Kamba and Yao of Africa; various Himalayan and Indian tribes; in the Marquesas Islands, Hawaii and among the Maori of Polynesia; and various Australian tribes). At times there has been an exchange of wives at feasts, when general orgiastic licence prevails (Araucano, Bororo, Keres, Arapaho, Gros Ventres and Lower Mississippi tribes of the Americas; Dayak and

Jakun of Indonesia; Hos and Kota of India; Ashanti, Ekoi and various Bantu tribes of Africa; Kiwai Papuans). On such festive and extraordinary occasions not only are sexual restrictions removed, and the sexual appetite stimulated, but ordinary discipline is relaxed, normal occupations abandoned and social barriers overridden, while at the same time people indulge in gluttony, in amusement and social intercourse. Sexual licence, as well as the other relaxations, liberties and ebullitions at such feasts, fulfills the important function of providing a safety vent that relieves normal repressions, furnishes people with a different set of experiences, and thus tends to safeguard ordinary institutions.

These cases where wives are exchanged only for sexual intercourse must be distinguished from the less frequent instances of more or less legalized prolonged exchange with common habitation., W. H. Gilder reported that among the Eskimos of Repulse bay, "If a man who is going on a journey has a wife encumbered with a child that would make travelling unpleasant, he exchanges wives with some friend who remains in camp and has no such inconvenience. Sometimes a man will want a younger wife to travel with, and in that case effects an exchange, and sometimes such exchanges are made for no special reason, and among friends it is a usual thing to exchange wives for a week or two about every two months." Analogous forms of prolonged exchange have been found among certain tribes of southern India, while among the Siberian Chukchi it has been recorded that a man will often enter into a bond of brotherhood with those relatives who dwell in other villages, and when he visits he will be given access to his relative's wife, presently receiving a return visit in order to make the obligation mutual; sometimes cousins exchange wives for a prolonged period.

Again, among the Dieri and cognate tribes of central Australia, a married woman may be placed in the so-called *pirrauru* relationship to a man other than her husband. Such a man may, with the husband's permission, have access to her on rare occasions. Or if the husband is absent and gives his consent the woman may join her paramour for some time at his camp, but this is apparently rare. In order to lend his wife in this way a man must wait until she is allotted by the tribal elders as the *pirrauru* to another man. Then he may consent to waive his marital rights for a short time, though he is under no constraint to do so. Circumstances, jealousy, even the disinclination of the woman are obstacles that must make *pirrauru* extremely rare. This custom has been adduced as an occurrence of group marriage, but some authorities disagree, since it is always a temporary and partial surrender of marital rights with only rare episodes of extramarital liaison.

It is important to remember that marriage has come to be regarded as defined primarily by parenthood. Social parenthood in primitive ideas, behaviour, custom and law is not affected by the various forms of relaxation just described. The children are reckoned as belonging to the legal husband, and in this as in many other ways, *i.e.*, economic, legal and religious, these temporary relaxations do not seriously disturb the primitive marriage relationship. It must be realized with regard to fatherhood that even where the main principles of physiological procreation are known, many primitive peoples do not attribute undue importance to actual physiological paternity (*see* KINSHIP). It is almost always the husband of the woman who is considered the legal father of her children, whether he is their biological father or not.

Concubinage.—This can be defined as a legalized form of cohabitation that differs from marriage in that it implies a considerably lower status of the female partner and her offspring than that enjoyed by the legal wife. It is a terminological confusion to speak of concubinage when there is temporary access to a woman or exclusively sexual rights to her. On primitive levels of culture real concubinage has not been observed. Some similarity to it can be found in the institution of subsidiary wives. In certain polygynous communities there is one principal wife and the subsidiary ones have a much lower status, as has been the case among the Guarani, Eskimos, Araucanians, Apache and Chippewa (the Americas); Chukchi, Koryak and Yakut (Asia); Marquesas Islanders, Tongans, Tahitians, Maori and Marshall Islanders (Polynesia); Bemba, Wafipa, southeastern Bantu, Herero, Nandi and Yoruba (Africa); Osset (Asia); Bagobo and Kulaman (Philippines).

The institutions of temporary and limited partnership described above, such as the *pirrauru* of Australia or the protracted exchange of partners among the Eskimos, should not be regarded as concubinage.

Prostitution.—The institution of commercial eroticism or prostitution has a very limited range among primitive peoples. It has been reported from Oceania (Santa Cruz Islands, Rossel Island, Line Islands, Caroline Islands, Easter Island and Hawaii), Greenland, North America (Omaha), South America (Witoto and Boro) and Africa (Nyoro). In its relation to marriage it begins to play a very important part only in more advanced cultures (*see* PROSTITUTION). On the one hand it provides an easy satisfaction for the sexual appetite to unmarried men or to those who for some reason cannot cohabit with their wives. It thus constitutes an institution complementary to marriage. On the other hand, in certain communities, of which ancient Greece was a notable example, prostitution in a higher and more refined form (hetaerism) allowed some women to devote themselves to cultural pursuits and to associate with men more freely than was possible to those legally married.

In general prostitution is rather a subsidiary institution than either a relaxation or a form of sexual preparation. Unlike other forms of sexual licence, prostitution is neither directly correlated with marriage nor does it affect its integrity so seriously as does relaxation of marital bonds that involve both partners.

The Economics of the Household and Family.—Empirically, it appears that the institution of marriage is primarily determined by the needs of the offspring, by the dependence of children upon their parents. Since she is handicapped at pregnancy and for some time after birth the mother needs the assistance of a partner. The role of associate and helpmate is almost universally played by the husband exclusively; exceptions include some extremely matrilineal societies where the wife's brother shares with the husband in some of the responsibilities and burdens of the household. The economic as well as the biological norm of a family is thus mother, child and husband—or exceptionally both the husband and the wife's brother. (*See* FAMILY.)

In the vast majority of human societies the individual family, based on monogamous marriage and consisting of mother, father and children, forms a self-contained group. Within the household there is a typical scheme of division in functions; by virtue of natural endowment the wife not only has to give birth to and nourish the children, but also is destined to give them most of the early tender cares: to keep them warm and clean, to lull them to sleep and soothe their infantile troubles. Even in this the husband often helps to a considerable degree, prompted by natural inclination as well as by custom. The latter often imposes upon him duties and ritual manifestations such as tabus during pregnancy and at childbirth, and performances at the time of confinement, of which the couvade (*q.v.*) is a striking example. All such obligations emphasize the father's responsibility and his devotion to the child. Later on in the education of offspring both parents commonly have to take part, performing respective duties that vary with the society and the sex of the children.

Apart from the special task of producing and rearing children, the wife in primitive marriage normally looks after food preparation; she almost invariably provides fuel and water, is the actual attendant at the hearth or fireplace, manufactures, tends and owns the cooking vessels, and she is typically the main carrier of burdens. In the very simplest cultures the woman also erects the hut or shelter and looks after camp arrangements (Australian aborigines, Bushmen and Andaman Islanders). The husband generally is the protector and defender of the family, and he also performs work that requires greater strength, courage and decision, such as hunting game, fishing, heavy building of houses and craft, and clearing timber.

The division of labour between husband and wife outside the household differs with the community, but on the whole makes fighting, hunting, sailing and metalworking male occupations; collecting, agriculture, pottery and weaving predominantly female oc-

cupations; while fishing, cattle tending, making of clothing and utensils are done by one sex or the other according to culture. The Tchambuli of New Guinea, as an exception, have tended to reverse the typical male and female roles.

The division of labour outside the household means also as a rule that each parent has to collaborate with other community members of the same sex in some wider collective enterprise, from which the family benefits only partially and indirectly. In spite of repeated theoretical assertions as to the existence of the closed household economy or even of individual search for food among primitive peoples, every community, however simple, displays a wider economic collaboration embracing all members and welding the various families into larger co-operative units.

The fuller the knowledge of relevant facts, the better is seen on the one hand the dependence of the family upon the rest of the community, and on the other hand the duty of each individual to contribute not only to his own household but to those of others as well. Thus in primitive Australia a great part of a man's yield in hunting has to be divided according to fixed rules among his immediate and classificatory relatives. Throughout Oceania a network of obligations unites the members of the community and overrules the economic autonomy of the household. In the Trobriand Islands a man traditionally has been required to offer about half of his garden produce to his sister and another part to various relatives, only the remainder being kept for his own household, which in turn is supported substantially by the wife's brother and other relatives. Economic obligations of such nature cutting across the closed unity of the household are uniformly encountered.

The most important examples however come from communities organized on extreme mother right, where husband and wife are in most matters members of different households, and their mutual economic contributions are in the nature of gifts rather than of mutual maintenance.

The Split Household Under Matrilocal Mother Right.—Most of this discussion so far has dealt with marriage based on a united household and associated as a rule both under father right and mother right with patrilocal residence. This means that the bride moves to the husband's community when she either joins his family house or camp or else inhabits a house built for the new couple and owned in the husband's name. Patrilocal marriages are by far the most prevalent.

Matrilocal marriage consists in the husband's joining the wife's community, taking up residence in her parents' house and often having to do some services for them. Matrilocal residence may be permanent; or it may be temporary, the husband having to remain for a year or two with his parents-in-law, and having also possibly to work for them (Eskimos, Kwakiutl, Guaycuru and Fuegians of the Americas; Bushmen, Hottentots, Bapedi, and Nuer of Africa; Negritos of the Philippines; Ainu of Japan).

In a few cases that might be regarded as the extreme development of mother right combined with matrilocal conditions the wife remains at her mother's residence and the husband does not even take up a permanent abode there, but simply joins her as a frequent and regular but still temporary visitor (Menangkabau of Sumatra, Nayar of Malabar). Such extreme cases of mother right are an exception. They are the product of special conditions found as a rule at a high level of culture and should not be taken as the prototype of primitive marriage.

A most important fact is that even in such extreme matriarchal conditions the principle of social legitimacy holds; though the father is domestically and economically almost superfluous, he is legally indispensable and the main bond of union between such matrilineal and matrilocal consorts is parenthood. It is also seen that the economic side can have a symbolic, ritual significance—the gift exchange functions as token of affection—thus marking a sociological interdependence, while it has hardly any utilitarian importance.

Marriage as an Economic Contract.—While marriage embraces a certain amount of economic co-operation as well as sexual connubium, it is not primarily an economic partnership any more than a merely sexual appropriation. It is as necessary to guard against an exclusively economic definition of marriage as against the overemphasis on sex. Marriage is not entered upon for economic considerations, exclusively or even mainly; nor is the primary bond typically established by mutual economic benefits. This is shown by the importance of matrimonial bonds even where there is no community of goods nor co-operation nor even full domesticity. Economics are a means to an end: the rearing, education and parental influence over the offspring. Economic co-operation is one of the obligations of marriage and like sexual cohabitation as well as mutual assistance in legal and moral matters, it is prescribed to the married by law and enjoined by religion in most cultures. But it certainly is neither the principal end nor the unique cause of marriage.

Marriage by Purchase.—As unwarranted as the overemphasis on economics and its hypostasis as the essence of marriage is also the tearing out of some one economic trait and giving it a special name and thus an artificial entity. This has been done notably with regard to the initial gifts at marriage, especially when given by the husband. More or less considerable gifts from the husband to his wife's family at marriage occur very widely. The term "marriage by purchase" applied to such gifts usually serves to isolate them from their legal and economic context, to introduce the concept of a commercial transaction that is not found in primitive culture as a part of marriage and to serve as one more starting point for unverified speculations about the origin of marriage.

The presents given at marriage should be considered as a link—sometimes very important, sometimes insignificant—in the series of services and gifts that invariably run throughout marriage. The exchange of obligations embraces not only the marital partners, but also the children, who under mother right are counted as one with the mother while under father right they take over the father's obligations. The family and clan of the wife, and more rarely of the husband, also become part of the scheme of reciprocities. The presents offered at marriage by the husband are often made up of contributions given him toward this end by his relatives and clansmen (Thonga, Zulu, Xhosa, Tswana and Madi of Africa; Toradja of Indonesia; Trobrianders of Melanesia), and are not all retained by the girl's parents but shared among her relatives and even clansmen (Achomawi, Delaware, Osage and Araucanians of the Americas; southeast Bantu, Swahili, Pokomo, Turkana, Bavili, Baganda, Masai and Lotuko of Africa; Osset, Samoyed, Aleut, Yakut and Yukaghir of Siberia). The giving of presents is thus a transaction binding two groups rather than two individuals, a fact reflected in such institutions as the inheritance of wives, sororate, levirate and so on. An understanding of the initial marriage gift should be obtained against the background of the wider economic mutuality of husband and wife, parents and children and maternal and paternal families and clans.

Another type of marriage gift is found among the patrilineal and patrilocal communities of the southeast Bantu, who live by combined agriculture and cattle raising. The wife and children are here regarded as definite economic and social assets. The wife is the main agricultural and domestic worker, while the children are valuable because the boys continue the line and the girls bring in wealth at marriage. Marriage is concluded by the payment of cattle, the amount varying greatly according to tribe, rank and other considerations from a few head to a few score. These cattle are known as lobola, or bridewealth (*q.v.*). The lobola in fact is not the motive for the transaction, nor is there any bidding on any market, nor can the cattle be disposed of at will by the receiver, *i.e.*, the girl's father. Some of them have to be distributed by him according to fixed tribal custom among particular relatives of the girl; the rest he has to use for the provision of a wife for his son, *i.e.*, the girl's brother, or else, if he has no male heir, he contracts another wife for himself in order to obtain the desired male descendants. In case of divorce the marriage gift has to be returned as the identical cattle given and not merely in an equivalent form. The lobola is thus rather a symbolic equivalent representing the wife's economic efficiency, and it has to be treated as a deposit to be spent on another marriage.

In Melanesia the husband's initial gift at marriage is a ritual act required to be reciprocated by the wife's family. This has been the case also among certain American tribes (Tsimshian, Coast

Salish, Bella Coola, Delaware, Ojibwa, Navaho and Miwok); in Siberia (Mordvin, Ainu, Buryat, Samoyed and Koryak), and in Polynesia (Samoa). This return gift may take the form of a dowry given to the bride by her father or parents or other relatives but also directly or indirectly benefiting her husband (Greenlanders; Brazilian aborigines and Yahgan of South America; Ibo, Ovambo, southeast Bantu, Banyoro and Masai of Africa; Buryat, Yukaghir and Samoyed of Siberia; Toda of India; Banks Islanders and Maori of Oceania). In some communities the balance of gifts is so much in favour of the husband that instead of wife purchase one could speak of buying a husband for the girl (coast tribes of British Columbia; Tehuelche of Patagonia; Yakut).

Property and Inheritance Within Marriage.—As a rule the marital partners have not only their own sphere of activity but their own possessions. The wife usually claims the title and right of disposing of her articles of apparel, of the domestic utensils and often of the special implements and fruits of her pursuit. The importance of woman's work in agriculture, her social influence due to this and her specific claims to the agricultural produce—not the ownership of the land, which generally is vested in men—have given rise to the economic theory of mother right.

Very often the possessions of the husband and wife are inherited by their respective kindred, and not by the surviving partner. The inheritance of the wife by the husband's brother (the custom of levirate; *q.v.*) that is known from the Old Testament but has a fairly wide range of distribution should not be regarded as an economic transaction. Like the suttee once common in India, the inheritance of a widow under mother right and like the custom of killing the widows, it is the expression of the matrimonial bonds outlasting death, and defining the widow's behaviour afterward.

Marriage as a Legal Contract.—Marriage is no mere cohabitation, and in no society are people expected to share life in common and produce children without having the approval of the community. This is commonly obtained by going through legal and ritual formalities that constitute the act of marriage, by accepting in this the obligations entailed in marriage and the privileges it gives, and by having later on to submit to the consequences of the union as regards children.

The legal side of marriage is therefore not made up of such special activities as constitute its sexual, economic, domestic or parental aspects. It is rather a special way of treating these aspects that makes them defined by tradition, formally entered upon and made binding by special sanctions.

First of all, the whole system of obligations and rights that constitute marriage is in each primitive society laid down by tradition. The way in which people have to cohabit and work together is stipulated by tribal law; whether the man joins his wife or vice versa; whether and how they live together, completely or partially; whether the sexual appropriation is complete, making adultery in either partner an offense, or whether, subject to certain restrictions, there may be waiving of the sexual rights; whether there is economic co-operation and what its limits are. The details and the typical rules and variations have already been discussed, as well as the ways in which the rules are enforced. But it must be added that knowledge is quite limited concerning why rules are kept, how they are enforced and how they are evaded or partially broken.

Only on one or two points do ethnographic observers habitually report: what penalties attach to a breach of law and custom and what premiums are set on their careful and generous observance. Thus, information often is given on how adultery is dealt with, though accounts of the severity of the law on this point are usually exaggerated. Again, to anticipate, incest and exogamy are usually surrounded with definite sanctions, some social and some supernatural. The manners and morals of daily contact within the household are usually laid down and enforced by that complicated and imponderable set of forces that governs human behaviour in its everyday aspects and makes people distinguish between proper and improper form in every human society. The validity of the economic duties of husband and wife is as a rule based on the fact that the services of the one are conditional on the services of the other, and that a very lazy or unscrupulous partner tends eventually to be divorced by the other.

Divorce.—Marriage is as a rule concluded for life—at times beyond death as mentioned above. It is questionable whether the short-period marriages reported from isolated districts (Eskimos of the Ungava district in Canada, some tribes of the Indian archipelago, Arabia, Iran and Tibet) deserve the name of marriage, *i.e.*, whether they should not be put into a different sociological category; but accounts of them are too slight to allow of deciding this question. In some tribes it is reported that marriage is indissoluble (Vedda, Andamanese, certain tribes of the Indian archipelago and Malay peninsula). The general rule, however, is that divorce among primitive peoples is possible but not easy and entails damages and disabilities to both partners. Even where divorce is said to be easy for either partner it is found on further enquiry that a considerable price has to be paid for the liberty to divorce, that it is easy only to exceptionally powerful or successful men and women, and that it involves in most cases loss of prestige and a moral stigma. Also, divorce tends to be easy only before children have been born, and it becomes difficult and undesirable after their arrival. In fact the major basis for primitive divorce, besides adultery, economic insufficiency or bad temper, is sterility in the wife or impotence in the husband. This emphasizes the aspect of marriage as an institution for the preservation of children.

The threat of divorce and of the disabilities it entails act to keep husband and wife to their prescribed conduct. At times the husband is kept in check by the marriage payment which he can reclaim only when the union is dissolved through no fault of his. At times the considerable economic value of the wife is an important motive for good and dutiful conduct.

The Status of Husband and Wife.—The duties of the wife toward the husband are in some primitive communities apparently enforced to a considerable extent by his personal strength and brutality, and by the authority given him by custom. In others, however, husband and wife have almost equal status. Unfortunately, ethnographic accounts too often contain such generalities and stock phrases as "the wife is regarded as the personal property of the husband," "his slave or chattel," or "the status of the wife is high." An adequate definition of status requires a full enumeration of mutual duties, of the limits to personal liberty established by marriage and of the safeguards against the husband's brutality or neglect, or against the wife's shrewishness and lack of sense of duty. It is often held that mother right and the economic importance of woman's work, especially in agricultural communities, go with a high social status of the wife, while in collecting, nomadic and pastoral tribes her status is on the whole lower.

Marriage not only defines the relations of the consorts to each other, but also their status in society. In most tribes, marriage and the establishment of an independent household are a condition for the attainment of the legal status of full tribesman in the male and of the rank and title of matron in the woman. Under the system of age sets (*q.v.*) the passage through certain initiation rites is a condition of marriage. In all tribes, however, all normal and healthy tribesmen and women are under constraint to be married, and even widows and widowers remarry if they are not too old, under the penalty of losing some of their influence. The attainment of a full tribal status is always a powerful motive for marriage.

The Laws of Legitimate Descent.—Marriage affects not only the status of the consorts and their relations, but imposes also a series of duties on the parents with regard to children, and defines the status of children by reference to the parents.

In virtue of the universal principle of legitimacy, the full tribal or civil status of a child is obtained only through a legal marriage. Legitimacy is at times sanctioned by penalties that devolve on the parents, at times by the disabilities under which illegitimate children suffer, at times by inducements for the adoption of children or for their legitimization by the presumptive father or some other man.

In this connection it should be realized that children are expected to return in later life some of the benefits received earlier. The aged parents tend to be dependent on their children, usually

on the married boys. Girls at marriage often bring some sort of emolument to their parents and then continue to help and look after them. The duties of legal solidarity also devolve on the children, uniting them to father or to mother according to whether the primitive society is patrilineal or matrilineal.

One of the most important legal implications of marriage is that it defines the relation of the children to certain wider groups: the local community, the clan, the exogamous division and the tribe. The children as a rule follow one of the parents, though more complex systems also exist and the unilateral principle of descent is never absolute (*see* KINSHIP).

Modes of Concluding Marriage.—In studying the legal aspect of marriage, it should be realized that the matrimonial contract never derives its binding force from one single act or from one sanction. Different modes of concluding marriage often have been given special genetic importance or legal value in discussing the origin of the institution. Marriage has in turn been speculatively derived entirely from mere subjugation by brutal force (the old patriarchal theory); from appropriation by capture in foreign tribes (J. F. McLennan's hypothesis); from feminine revolt against hetaerism (J. J. Bachofen); from economic appropriation or purchase (the materialist interpretation of early marriages); from pithecanthropic patriarchy (J. J. Atkinson, S. Freud); and from the power of mothers (R. S. Briffault). All these views overstate the importance of one aspect of marriage or even of one element in the modes of its conclusion; some even invent an imaginary state or condition.

Empirically, marriage is a most important legal contract in human society, one that refers to the continuity of the race; it implies a most delicate and difficult adjustment of a passionate and emotional relationship with domestic and economic co-operation; it involves the cohabitation of male and female, perennially attracted and yet in many ways incompatible; it focuses in a difficult personal relationship the interest of wider groups: of progeny, parents, kindred and in fact of the whole community.

The validity of the marriage bond derives its sanctions from all these sources. The complexity of motives for which it is entered, the utility of the partners to each other, their common interest in the children's welfare and the interest kindred and community have in the proper upbringing of offspring—these emerge as foundations of marriage and its legally binding character.

All this finds an expression in the modes of contracting marriage. These always contain the element of public approval; the collaboration of the families and the kindred of each partner; some material pledges and securities; some ritual and religious sanctions; and the consent of the parties concerned.

In the old manuals and statements concerning marriage an important place usually is taken by a classical list of the various modes of conclusion: marriage by capture, by purchase and by service, by infant betrothal, elopement, exchange, mutual consent and so on.

This classification as a rule exaggerates one aspect out of all proportion, and attributes to this one aspect an overwhelming influence on the whole institution. Marriage by purchase already has been dismissed as a crude misnomer, while service is but a detail in the economics of certain marriages. Marriage by capture, which has played such a prominent part in speculation and controversy from McLennan onward, never could have been a real institution. Though a man may occasionally wed a woman captured by force, such an occurrence is an exception; there is no evidence that it ever was a rule, still less a stage in human evolution. Tribal endogamy (*see* below) is essentially universal. Ceremonial fights and ritual capture occur at wedding ceremonies over a wide area but they can be interpreted in terms of immediate psychology and of existing social conditions (Westermarck, Briffault, Havelock Ellis). To regard them as survivals of marriage by capture is without basis and on this point there was in the 1960s almost universal agreement. Capture and violence, as well as purchase from other tribes or on the slave market, lead to concubinage and at times provide prostitutes, but only very rarely do they supply legal wives.

Like the contract itself, modes of concluding marriage involve a great variety of binding and determining factors. But a real distinction still can be made among those marriages contracted primarily by rules of tradition; those arranged by the families or kindred of the consorts; and those that arise by choice of the mates. In no type of marriage is any of these three elements—tradition, arrangement by families or their consent and mutual choice—completely absent. But one or another may predominate conspicuously.

The most usual type of traditionally prescribed union is cross-cousin marriage (*see* COUSIN MARRIAGE), with a wide distribution and reported practised very extensively all over Oceania, Australia and southern India, and sporadically in Africa, North America and Asia. The marriage of parallel cousins is less frequent, and has been found notably among Semitic peoples. Even less common are marriages prescribed between other classes of relatives, *e.g.*, between a man and his brother's daughter (northern Australia, some parts of Melanesia), or his sister's daughter (southern India), or his father's sister (certain parts of Melanesia and the Athapaskan Tinneh of North America). Another type of prescribed marriage is by inheritance, of which the levirate and sororate (*qq.v.*) are the most notable.

Besides such traditionally defined unions, there are also marriages recognized as convenient and desirable by the respective families and arranged by them. Infant betrothal (prevalent in Australia and Melanesia) in which a definite claim is established, or infant marriage (reported especially from India) where the bond is effectively concluded, are two of the most usual forms. The main motive for infant unions is the determination of families to secure a convenient union. In aboriginal Australia, where an infant is often allotted to a mature male, the power of old men and their keenness to secure young wives are at the root of this institution. Whether such marital gerontocracy still survives or even ever existed in Africa is problematical.

In many communities, including some advanced nations of Europe, marriage has been mainly determined by social or financial considerations, and in this the parents of the bride and bridegroom have as much to say as the two people directly concerned. In some primitive tribes two brothers exchange sisters (Australia), or a man's matrilineal uncle or patrilineal aunt has some say (Melanesia). Where the initial payments are very heavy and where they are used to secure a wife for the bride's brother marriage is usually also a matter for an arrangement rather than personal choice.

Nevertheless, mutual choice remains the most important element. Very often an infant betrothal or some other form of arranged union is broken by one of the people directly affected, and marriage by elopement with the subsequent consent of family and kindred overrules other considerations. Invariably in primitive communities the majority of unions come from the initiative of the partners. Marriage by mutual choice is the norm and the choice is determined largely by personal attraction; this does not mean only sexual or erotic attraction. In general the physical appeal combines with psychological compatibility and such social considerations as suitability of rank, occupation and economic benefits. Here again the nature of marriage entails a complexity of motives and its stability is secured by a suitable compromise between conflicting interests.

Religious and Ceremonial Aspects of Marriage.—The sanctity of the marriage bond is not found merely in the Christian religion nor is it a prerogative of the more technologically advanced cultures. The supernatural sanction, derived from a solemn public ceremony, adds to the binding forces of mere law. Marriage is valid as a legal contract insofar as its breach incurs worldly retributions and its generous fulfillment carries worldly benefits. As a sacrament, marriage in primitive and advanced societies alike is believed to be protected by spiritual powers that reward those who observe matrimonial duties meticulously and piously, and punish those who neglect them.

The religious side of marriage is therefore closely akin to the legal in that it adds to the validity and sanctity of other functions. It finds expression in acts of establishment and those of dissolution: religious rites are found at betrothal and wedding, while

divorce is often religiously defined and qualified, and at death the breach of the bond finds its spiritual expression in the duties, observances and ceremonies incumbent on the surviving partner. Besides ceremonial manifestations in which the bonds of marriage are religiously tied or dissolved, religious ethics establish rules of matrimonial conduct that are believed to be sanctioned supernaturally or are felt binding through their appeal to moral sense rather than to self-interest.

Ceremonies of Betrothal and Wedding.—Betrothal can be defined as an act preliminary to marriage, establishing mutually presumptive claims. The period between betrothal and marriage varies, and where it is short it is often difficult or even impossible to decide whether it is an act of betrothal or an inaugural wedding rite. It is also unprofitable to draw a very sharp line of distinction between infant betrothal and infant marriage. Where betrothal imposes real obligations and a valid tie, the rites then observed usually fulfill the same function as those of marriage. Therefore the binding rites of marriage and betrothal will be discussed together.

These rites and ceremonies cover a very wide range: from the simplest act such as a meal openly taken in common to complex and elaborate tribal festivities extended over a considerable period of time. But in every human society marriage is usually concluded by a ritual enactment. It might be disputed whether such rites in their simplest form present a genuine religious character; but most sociologists would agree that they always have some religious elements in that they are solemn and public; in their more elaborate form they tend to become definitely religious.

"The most general social object" of a wedding rite is "to give publicity to the union" (Westermarck). By this the legal as well as religious sanction of the union is established. The contract is made binding in that members of the community bear witness to it; it is hallowed in that the mates solemnly and openly declare before man and deity or other spiritual powers that they belong to each other. A marriage rite as a rule is also a ritual act with symbolic significance, and as such is often conceived to have magical efficacy, to contain a moral precept or to express a legal principle.

Biological Symbolism.—Thus the fundamental purpose of marriage, the continuity of the race, is indicated in wedding ceremonies by ritual intended to make the union fruitful, to obviate the dangers associated with sexual intercourse, especially with defloration, and to facilitate the various stages of the process of generation from the first act to delivery. Among the fertility rites a prominent place is taken by fruit or grain sprinkled over the newly wedded couple or on or round the nuptial bed, handed to them or brought into contact with them in some other way. Such rites as the accompaniment of the bride by a little child, the use of various symbols of generation and the direct offering of prayers and sacrifices are intended to make the union fruitful. The breaking of some object at the wedding is held to avert the dangers of defloration and to facilitate the consummation of the union. The untying of knots and laces found in many wedding rites is believed to make for easy delivery at childbirth. These acts express the biological nature of marriage.

Marriage as a Crisis.—As an official and public recognition of a biological fact, as perhaps the most important contract ever entered by the marital partners and as an act that creates a new family, marriage is a crisis. A crisis in human life is surrounded by powerful emotions: forebodings and hopes, fears and joyful anticipations. Innumerable rites exist that are obviously intended to remove the dangers associated with the crisis of marriage.

Dangers apprehended in subjective forebodings are usually conceived in the form of evil agencies: demons or ghosts or malevolent spirits, forces of black magic, mysterious concatenations of ill luck. These have given rise to many rites intended to avert ill fortune and bring happiness and good fortune to the new household. Among these are the avoidance of certain days and places as unlucky, or the selection of certain days as being of good omen; the shutting out of evil influences from the place where the wedding is being celebrated; the making of noises, the firing or brandishing of some weapon; the bathing or washing of bride and bridegroom or sprinkling them with water; the lighting of fires and waving of torches; the circumambulation of the bridegroom's tent or of the church; the beating of the bridegroom's tent, and the observance by the bride and bridegroom of various kinds of abstinences with regard to action and eating. Other rites believed to avert bad luck include disguising the participants who may dress in the clothes of the opposite sex, cover themselves, or paint their faces; substituting for them with effigies; marriage by proxy; and the contracting of mock marriages with trees or animals or inanimate objects. Finally an important antidote against supernatural dangers is thought to be the state of spiritual invulnerability achieved by moral purity and the observance of those mixed ethical and ritual rules that in primitive culture often surround important acts of human life. An important tabu (*q.v.*) of this kind in connection with marriage is that of sex continence. The principle that the couple have to abstain sexually for some time after the wedding is known from primitive savagery to the most refined ethics of the Christian church, while on the wedding night there are occasionally other minor abstinences.

It is characteristic that while the marital pair are often considered vulnerable to dangers they are at the same time esteemed as a source of blessing and beneficent influences. Thus certain rites are supposed to influence favourably the welfare of other persons even independently of their relations to the principals; joining in at a wedding is sometimes believed to produce benefit; a wedding is looked upon as a potential cause of other weddings; while good luck is often expected from contact with the bride or bridegroom or something worn or carried by them.

Marriage as a Sociological Change.—Marriage is a crisis not merely in the spiritual sense. It is also a sociological transition, one or both partners often forsaking old families to form or join a new one. The rupture with the parental family, clan, local community or tribe is expressed in a number of interesting wedding rites: sham fighting between the bridegroom or his party and the bride's family, or some other kind of resistance made by the latter; the barring of the wedding procession; weeping and other ritual expressions of grief and unwillingness on the part of the bride and her relatives; and the enactment of capture or abduction of the bride. These serve as dramatic expression when the bride has to be torn from her old home, and symbolize a violent, critical and final act.

Marriage as a New Bond.—A most important type of wedding rite is one that reflects marriage as a sacramental bond. Here again the symbolism is wide and varied, from the most direct expression of union by the joining of hands or fingers, the tying of garments, the exchange of rings and chains, to complicated dramatic enactments of the separation and union. A symbol of the new ties to be established is the performance of some act that will constitute one of the future duties or privileges of married life. Such acts in a way define the nature and exclusiveness of marriage by anticipation in ritual. Among them are included ceremonial performance of the sexual act and ceremonial participation in a common meal. In certain rites the symbolism lays down the relative domains of marital influence. Thus in some cases the assertion of the husband's power is prominent: he is presented with a whip, or he boxes the bride's ears, or pretends to beat her, and so on. In others the wife may by similar acts mark her independence and power over her husband. The economic aspect of marriage is often also expressed in some magical act intended to ensure prosperity to the future household, *e.g.*, the smearing of butter and honey by the bride over the pole of the tent to ensure abundance of food. The division of economic functions is expressed in rites during which the wife tends fire, prepares and cooks food for her husband, and so on.

The General Function of Wedding Symbolism.—Clearly, wedding symbolism is extremely rich and varied, and embraces almost all aspects of marriage. There are rites that bear directly on sex and gestation; there are rites with clear domestic and economic significance; there are rites referring to emotional attitudes at marriage and to moral notions of its purposes. In technique these rituals are legalistic, magical or religious. In short, the ceremonial of marriage covers and expresses relevant sides of the in-

stitution of marriage, and as such it has been a most fruitful subject of anthropological study. It also has been a major source of errors in interpretation by anthropologists.

In order to avoid such errors it is important to realize that ritual symbolism tends to be vague. Speaking of the marriage ceremonies, Westermarck observed that "Anthropologists are often apt to look for too much reasoning at the bottom of primitive customs. Many of them are based on vague feelings rather than on definite ideas." The ritual symbolism at marriage also commonly expresses mixed and compound meanings. Thus the spilling of corn over the couple may mean fecundity, prosperity, good husbandry as well as union, and probably it vaguely expresses all these elements. Sham fights and captures, marriages to trees or marriages by proxy can have a plurality of meanings.

Nor is the function of symbolism exhausted by its direct and literal meaning. A ritual act also can function to impress through pomp and circumstance its social importance and binding moral significance. The ethical rules and tabus that usually go hand-in-hand with ritual add to this spiritualizing function of wedding ceremonies. The public and official nature of the marriage act, often marked by the presence of an officiating priest, ruler or magician; heralded by banns and public announcements; sealed by witnesses and documents; enhanced by the sacredness of place and time, constitutes the widest and most general function of the rite: to make marriage public, binding, sacred and morally impressive.

The Dissolution of Marriage in Ritual.—The binding nature of the marriage contract, and its ritual and moral character, are expressed as clearly at its dissolution by divorce or death as at its inception. Unfortunately anthropological data in the 1960s were so defective on this point that only a brief survey can be given.

Divorce in technically advanced cultures is often a religious matter, to be carried out under the supervision of theological authorities and with the observance of formalities designed to express and safeguard the sanctity of the sacrament. Primitive cultures have yielded only a few examples of divorce rites, where such symbolic acts as the breaking of a rod, the tearing of a leaf or the casting away of some object are publicly performed (Kachari and Khasi of India; Bagobo of Mindanao; Tumbuka of Nyasaland; certain Canadian Indians; Maori of New Zealand).

Far more available material refers to the persistence of matrimonial bonds at death. They are not known to be dissolved automatically by the decease of either partner among primitive peoples and their tenacity tends to be greater for the widow than for the widower. But in either case the death of one imposes a number of ritual and moral observances on the other, the fulfillment of which is an essential part of the marriage contract.

The widow or widower usually plays the most prominent part among all mourners. Among certain peoples the widow has to perform duties extending over a more or less considerable period at the grave of her husband. She has to sleep beside or over it, supply it with provisions and keep a continuous fire burning there (Carrier, Kutchin, Mosquito and Pima Indians of North America; Mina, Nzakara and Baganda of Africa; Pentecost Islanders and certain Papuans of Oceania; Kuki of India). Even more telling are the long series of tabus and duties to be observed by the widow in some cultures before she is allowed to remarry: she must remain chaste, refrain from bathing or renewing her garments, avoid certain foods and so on (Omaha, Creek, Chickasaw, Algonkin, Iroquois, Dakota and Eskimos of North America; Angoni, Baya, Baganda, Kamba, Herero, Thonga and Zulu of Africa; Bontok of the Philippines; Maori of New Zealand; Amur river tribes, Kuki, Ainu, Yakut and Kamchadal of Asia).

Similar regulations prevent the widower from entering into a new alliance immediately after his wife's death. Thus among many peoples (Greenlanders; Eskimos, Aleut, Dakota, Omaha and Shawnee of North America; Herero, Bushmen, Thonga and Zulu of Africa; certain Papuan tribes; the Bontok and the Ainu) the surviving husband has been reported to live single for a time during which he is subjected to such restrictions and observances as refraining from sexual intercourse.

A most definite affirmation of the persistence of marital bonds is found among those people who have been reported to forbid widows to remarry (Tikopians, Rotumans, Marquesans and Line Islanders in Polynesia; Chinese; Ainu of Japan; Formosans; Brahmans of India) or widowers to remarry (Ainu and Formosans).

Even this is overshadowed by the institution of suttee, the sentence of death passed by religious tradition on the widow at her husband's death so that her spirit might follow his into the next world. This institution was found not only in India, from where it takes its name, but also among the Comanche, Cree and certain Californian tribes of North America; in Dahomey and among the Bafiote of Africa; in the New Hebrides, Fiji, Solomon Islands, Pentecost Island and New Zealand of Oceania.

The Social Conditions of Marriage.—*Endogamy.*—Marriage is never free in the sense that any man is at liberty to marry any woman. It is clear that in order to marry, people must come into contact; under primitive conditions this is feasible when they belong to the same tribe, or to tribes that meet in peaceful commerce or in warfare. Tribal or natural endogamy (*q.v.*), is thus a first condition of marriage, but it is of secondary interest to the sociologist, and must be distinguished from strict endogamy.

Endogamy proper is the practice that allows marriage only between members of the same section of a tribe and forbids unions between members of different sections. Strict endogamy is rare. It has occurred mainly in India where members of only the same caste are allowed to marry. Also encountered in India is a system called hypergamy in which a man is allowed to marry a woman of a lower section in his caste. He may also marry a woman of the same section if other conditions allow. But a woman may not marry a man of a lower section on penalty of loss of status of her whole family. In some communities there is competition to secure husbands of high sections. (*See* CASTE [INDIAN].)

In primitive communities endogamy is not widespread. It has been reported in tribes where there is a degraded class of artisans or else stratification by rank (Polynesia; Korea; Japan; Trobriand Islands of Melanesia; Algonkin and Salish of North America; Masai, Nkole, Karanga and other tribes of Africa). In such cases endogamy often has been found in what might be called an approximate form. Indeed such approximate endogamy as a tendency to marry within the profession, class or rank is well-nigh universal.

Another widespread type of endogamy is associated with religion. In few religions is marriage outside the group of the faithful encouraged. Islam, Judaism, Christianity and Hinduism are cases in point. Primitive religions are less involved in endogamy when tribal barriers and lack of communication act with sufficient stringency.

The Prohibition of Incest.—The most widely spread and most rigidly enforced qualification to marriage is embodied in a set of rules prohibiting unions between the members of the same family. Known as the rules of incest (*q.v.*), they play a great part in the constitution of the family and in the regulation of primitive kinship. Incest also assumed great importance in psychology through the influence of psychoanalytic theory.

Although incestuous unions are abhorred and prohibited, rules differ greatly from one society to another as regards their stringency and character. Marriages between mother and son and between father and daughter are commonly prohibited by law, custom and moral sentiment. However, more or less irregular unions between parents and children apparently occur. Marriages between mother and son have been reported from the Carib, Eskimos, Pioge and Tinneh of the Americas; Minahassa of Celebes and Kalang of Java; and New Caledonians. Unions between father and daughter have been said to occur among the Minahassa of Celebes, Karen of Burma and in the Solomon, Marshall and Palau Islands of Oceania. Even better attested to are marriages between brother and sister (Marshall Islands and Hawaii; ancient Irish, Egyptian and Incan royal families).

Beyond the family group the prohibitions of marriage between uncles and nieces, aunts and nephews, first and second cousins, and so on, vary greatly. In some communities certain of these unions are explicitly encouraged and regarded as desirable; in others they

are forbidden. Extensive prohibitions of marriage between distant kindred exist among a number of tribes and cultures (Salish, Eskimos, Aztec, Araucanian, Abipon, Ona and Yahgan of the Americas; Koryak, Yukaghir and Kalmyk of Asia; Torres Straits Islanders of Oceania; southeast Bantu of Africa).

Exogamy.—This is the system under which far larger groups of people are regarded as related to each other and their members forbidden to intermarry. It is found mainly in association with the classificatory nomenclature of kinship terms and clan organization (*see* EXOGAMY; KINSHIP TERMINOLOGY). Whether exogamy is an extension of the tabu on intercourse and marriage within the family, or an independent institution, was a debated question in the 1960s.

Exogamy based on the dual organization debars from intercourse or marriage one half of the tribesmen and tribeswomen (*see* DUAL ORGANIZATION). Normally exogamy is an attribute of clan, *i.e.*, of a group of people who trace their descent to a common ancestor, usually have the same totem, and fulfill a number of functions together (*see* CLAN; TOTEMISM). A clan sometimes is a subdivision of a tribe, based numerically on the dual principle, as where there are two, four or eight clans. At times there is an odd and more or less considerable number of clans, and exogamy is enforced only within each of these divisions. The prohibitions as a rule have applied unilaterally (Iroquois, Huron, Mohegan, Miami, Shawnee, Creek, Sauk, Fox, Kickapoo, Blackfoot, Dakota, Seminole, Arawak and Goajiro of the Americas; Tungus, Yakut, Samoyed, Ostyak and Tatars of Asia; various aboriginal peoples of India; Torres Straits Islanders, Papuans and other Melanesians, Polynesians and Micronesians of Oceania; Hottentot, southeast Bantu, Anyanja, Wayao, Awemba, Makololo, Masai, Kamba, Baganda, Ashanti and other African tribes). Only in a few cases has exogamy been observed with regard to the clans of both parents (Omaha and Osage of North America; certain Naga tribes of Assam; Herero and Lango of Africa).

A specially complex set of conditions has prevailed in the tribes of central Australia with a twofold division into (1) totemic clans that are not strictly exogamous; and (2) matrimonial classes that regulate marriage to the extent that a member of one of them has to marry into a specified one of the remaining classes.

The Forms of Marriage.—The term "form of marriage" has been applied to what might be called the numeric variation in marriage, *i.e.*, the variation according to the number of consorts united to each other. The major forms of marriage usually listed are monogamy, polygyny and polyandry.

Polyandry.—This is the name given to a union in which several men are legally bound in marriage to one woman. Polyandry is among the rarest of the varieties of marriage, and the one on which, in spite of its great theoretical importance, there is unfortunately very meagre and inadequate information. Polyandry has rarely been found among any of the most primitive peoples, and its distribution is almost completely confined to the highlands of southern India and central Asia, with such isolated exceptions as one African people (Hima), some Eskimos, among whom it occurs infrequently, and sporadically among the Great Basin Shoshone.

In Tibet and adjacent areas there exists polyandry of the fraternal type, *i.e.*, several brothers share a wife in common. All the husbands live together with their common wife as members of the same household, and cohabit successively with her. Children born of these marriages are sometimes regarded as the legal descendants of the eldest brother-husband only; in other cases it appears that when a child is born it is attributed to the brother who the mother asserts is the biological father.

Among the Nayar of India there is a form that has played an important part in theories of marriage. A girl goes through a ritual marriage with a man, but then consorts with a number of men who need not be related to one another. She lives apart from her partners, who cohabit with her successively by agreement among themselves. Owing to the matrilineal institutions of this people, the children of such marriages inherit from their mother's brother, but the social importance of fatherhood is seen in the fact that the woman always nominates one or other of the men as the father of each child, and he is obliged to provide for and educate it. As noted earlier, Nayar marriage in the 1960s was interpreted by some anthropologists as a form of group marriage.

The Toda (*q.v.*) can be taken as representative of a simpler type of polyandry (*q.v.*) in India. Among the Toda a number of men, usually two or three brothers, share a wife, but it is the rule that they cohabit with her in succession. The children are not owned in common by the husbands, but each child is allotted to one, not with reference to physical paternity, but in virtue of a ritual act performed by the man over the child to establish social paternity and confer legitimate descent.

Polyandry is thus a compound marriage, in which cohabitation is usually successive, and not joint, while children and property are not shared by the husbands.

Polygyny.—This is a form of marriage in which several wives are united to one man, each wife having the status of legal consort, while her offspring are regarded as the legal descendants of the husband. As an institution polygyny (*q.v.*) has existed in all parts of the world. Few primitive tribes are known in which a man has not been allowed to enter into more than one union. Many peoples have been said to be monogamous, but it is difficult to infer from the available data whether monogamy is the prevalent practice, the moral ideal, or an institution safeguarded by sanctions. It must be remembered that polygyny is not practised throughout the community; it is difficult to maintain a community in which every man has several wives, since this would entail an enormous surplus of females. Also, in reality polygyny is not so much a form of marriage fundamentally distinct from monogamy as rather a multiple monogamy. It is the repetition of a marriage contract, entered individually with each wife and establishing an individual relationship between the man and each of his consorts. As a rule each relationship is little affected legally or economically by the others.

Where each wife has her separate household polygynous marriage resembles very closely a temporarily interrupted monogamy. In such cases there is a series of individual marriages in which domestic arrangements, economics, parenthood and legal and religious elements do not as a rule seriously encroach upon each other. Polygyny with separate households is more commonly reported. Among most Bantu and Hamitic peoples of Africa, where the number of wives, especially in the case of chiefs, often has been considerable, each wife commonly occupies a separate hut with her children, and manages an independent household with well-defined legal and economic rights. Where, as among many North American tribes, two or more wives have shared the same household, polygyny affects matrimonial life much more deeply.

In most cases the motive for polygyny is economic and political. Thus in the Trobriand Islands (Melanesia) the chief's income is due to his wives' annual endowment. In many African communities the chief derives his wealth from the plurality of his wives, who by means of the produce of their agricultural labour enable him to exercise the lavish hospitality upon which so much of his power rests. A multitude of wives, however, may increase not only a man's wealth but also his social importance, reputation and authority, apart from the influence of the number of his children. Hence it has been found in many Bantu communities of Africa that the desire to have many wives is a leading motive in the life of almost every man; while the fact that in many Melanesian and Polynesian communities polygyny is a prerogative of the chief testifies to its social prestige.

Monogamy.—Monogamy is not only the most common form of marriage, it is also the pattern and prototype of marriage. Both polyandry and polygyny are compound marriages, consisting of several unions combined into a larger system, but each of them constituted upon the pattern of a monogamous marriage. As a rule polygamous cohabitation is a successive monogamy and not joint domesticity; children and property are divided, and in every other respect the contracts are entered individually between two partners at a time.

Monogamy as the unique and exclusive form of marriage, in the sense that bigamy is regarded as a grave criminal offense and a sin as well as a sacrilege, is very rare indeed among primitive

groups. Such an exclusive ideal and rigid legal view of marriage is perhaps not to be found outside the modern, relatively recent development of western culture. Some argue that it is not even implied in Christian doctrine. Apart from such isolated phenomena as the Church of Jesus Christ of Latter-Day Saints (Mormons) and the heretical sect of Anabaptists (16th century), polygyny was legally practised in Europe and accepted by the Christian church in the middle ages, and it occurred sporadically as a legal institution accepted by church and state as recently as the middle of the 17th century.

Monogamy as the pattern and prototype of human marriage, on the other hand, is universal. The whole institution, in its sexual, parental, economic, legal and religious aspects, is founded on the fact that the functions of marriage—sexual union, production and care of children, and the co-operation it implies—require essentially two people.

B. K. Malinowski asserted (1929) that conjugation necessarily takes place only between two organisms; children are produced by two parents only, and always socially regarded as the offspring of one couple; the economics of the household are never conducted group-wise; the legal contract is never entered upon jointly; the religious sanction is given only to the union of two. A form of marriage based on communism in sex, joint parenthood, domesticity, group-contract and a promiscuous sacrament had never, he said, been described. He claimed monogamy is, has been and will remain the only true type of marriage. To place polygyny and polyandry as forms of marriage co-ordinate with monogamy was held erroneous. In his thinking, to speak about group marriage as another variety shows a complete lack of understanding as to the nature of marriage.

Theories of Marriage.—Theories of marriage have been concerned largely with its origins and history, and attempts have been made to range the various forms of marriage into an evolutionary series. However, if it is understood that varieties of marriage are determined by the type of community, its economic and political organization, and the character of its material culture, the problem becomes one of observation and analysis, and ceases to move on the slippery plane of hypothesis.

The view that marriage originated in promiscuity, hetaerism or matrimonial communism and that monogamy is a product of gradual development through a number of stages was advanced by Bachofen, McLennan and L. H. Morgan; it found support in the work of such eminent writers as Lord Avebury, A. W. Howitt, B. Spencer and F. J. Gillen, J. G. Frazer, A. O. Kovalevski, W. H. R. Rivers, Briffault and others; and was criticized and opposed by Darwin, Westermarck, Malinowski, A. E. Crawley, C. G. Lang and others. This theoretical schism was continuing in the 1960s.

Despite theoretical arguments, disputes over marriage as a sacrament as compared with a civil contract and other speculative disagreements, primitive marriage as an area of anthropological interest increasingly has become a subject of empirical research. As communication among peoples has been facilitated, many of the primitive marriage practices discussed here appear to have disappeared or to be in the process of extinction and change; where they persist in many cases it seems to be largely as a function of cultural isolation.

See also references under "Marriage, Primitive" in the Index.

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(B. MA.; F. R. E.)

MARRIAGE RATE. Basic data for the study of marriage include the marriage rate, which, in its most usual form, is expressed as the number of marriages occurring in a community during a calendar year per 1,000 of total population. For example, it was estimated that there were 1,523,000 marriages in the United States during 1960. Since the total population for that year was 179,323,175, the number of marriages per 1,000 population was 8.5. By expressing annual marriages of communities in terms of a common unit, *i.e.*, per 1,000 of population, it is possible to make comparisons between communities of different size, or in the same community over different periods of years. However, the marriage rate computed in this way is not entirely satisfactory, particularly in comparing rates of marriage in different populations or for different years. In the first place, the proportions of persons who are legally free to marry may differ from one population to another or one year to another. Among those free to marry, the ratios of men to women may vary, affecting the opportunities to marry. The proportions of legally free-to-marry persons in the most marriageable ages may also differ from one population to another or from one year to another. Variation in the proportions of these persons who are single, who are divorced, and who are widowed may also alter frequencies of marriage. Finally, but far from least in importance, a number of social and cultural factors may influence frequencies of marriage. For example, the migration to cities from rural areas of larger numbers of young women than men results in a surplus of marriageable women in many large urban areas and of marriageable men in many rural areas.

Marriage rates more specific than the rate per 1,000 population can be computed for those persons in a population who are free to marry or for any subgroups of these persons such as women aged 15–19 years, and so on. In order to compute any specific rate, the investigator must have enough information to be able to estimate the number of marriages that happened in some period of time to persons in the group in which he is interested, and the total number of persons in the group who might have married during that same period of time. The ratio of the former to the latter multiplied by 1,000 yields the marriage rate per 1,000. For example, the number of women aged 20–24 who married in England and Wales in the year 1951 to the total number of not-married women of the same ages in these countries in that year, multiplied by 1,000, yielded a marriage rate specific for women aged 20–24 of 220.0, indicating that, in this population, more than one in five marriageable women aged 20–24 in 1951 married during the year.

An important use of specific rates in computing adjusted marriage rates may be illustrated briefly. An investigator might note that the marriage rate per 1,000 total population is higher in the United States than in England and Wales, and he might wish to know the extent to which this results from differences in the proportions of women at various age levels in the two areas. From age specific rates for women for both areas he could compute age adjusted rates which would show what the marriage rate in each nation would be if the proportions at various ages were equal. Unfortunately, specific rates and adjusted rates are not in common use, and it therefore becomes necessary to make some allowance for the differences in age and other characteristics of different populations when comparing unadjusted rates.

Allowance should also be made for the limitations of the statistics. Some nations keep more accurate and complete records of marriages than others, and there are differences in the definition of a legal marriage. For instance, some communities recognize common-law marriages as legal, while others do not. The low marriage rates of certain Latin-American countries, among others,

are to be explained in part by the large Indian population whose marriages, if not performed according to the civil or religious requirements of the state, are not recorded as legal marriages.

(Hu. C.; C. E. O.; X.)

MARRUCINI, an ancient tribe which occupied a small area around Teate (modern Chieti) on the east coast of Italy. Though kinsmen of the Samnites, the Marrucini were probably not members of the Samnite league; yet they came into conflict with the Romans during the Second Samnite War, at the end of which they entered the Roman alliance (304 B.C.). Loyal to Rome during the Second Punic War, they revolted in 91 B.C.; thereafter they were enrolled in the Roman tribe Arnensis. Their language is known from an inscription, the "Bronze of Rapino" (*c.* 250 B.C.). It is written in the Latin alphabet, but in a dialect of the northern Oscan group (*see* ITALIC DIALECTS; PAELIGNI). The earliest Latin inscriptions belong to the Ciceronian period.

For the "Bronze of Rapino" *see* R. S. Conway, *The Italic Dialects,* pp. 253 ff. (1897).

MARRYAT, FREDERICK (1792–1848), English naval officer and novelist, the author of *Mr. Midshipman Easy* and other tales of adventure at sea, and of *The Children of the New Forest,* a story of the English Civil War which has stirred the imagination of generations of children, was born in London, July 10, 1792. His father owned land in the West Indies and was for some time chairman of Lloyd's. Marryat entered the Navy at the age of 14 and served with distinction in many parts of the world. He rose to captain's rank and was made a companion of the Bath for his conduct in the first Burmese War (1824–26). He also devised a code of flag signals (1817) which was long in use and for which he was made a member of the French Légion d'Honneur. He retired in 1830.

Captain Marryat was the first novelist of importance since Tobias Smollett to make full and amusing use of his varied experience at sea. He had an admirable gift of lucid, direct narrative, and an unfailing fund of incident, and of humour, sometimes bordering on farce. His first book, *The Naval Officer: or Scenes and Adventures in the Life of Frank Mildmay* (1829), was succeeded by a series of which the most popular were *The King's Own* (1830), *Peter Simple* (1834), *Jacob Faithful* (1834), *Japhet in Search of a Father* (1836), *Mr. Midshipman Easy* (1836; written in three weeks), and *Poor Jack* (1840). From 1832 to 1835 he edited the *Metropolitan Magazine,* in which many of his stories first appeared. In 1837 he went to Canada and the United States, publishing his critical impressions on his return in 1839. His first story written specifically for children was *Masterman Ready* (1841–42); this was followed by *The Settlers in Canada* (1844), *The Children of the New Forest* (1847), and the posthumous *The Little Savage* (1848–49), completed by his son Frank. In his later years he lived and farmed at Langham, Norfolk, where he died on Aug. 9, 1848.

BIBLIOGRAPHY.—*The Life and Letters of Captain Marryat* were published by his daughter Florence in 1872. *See* also Christopher Lloyd, *Captain Marryat and the Old Navy* (1939); Oliver Warner, *Captain Marryat: a Rediscovery* (1953). (O. M. W. W.)

MARS (MAVORS, MAMAR, MARSPITER or MASPITER), after Jupiter the most important deity of the Roman state. He was commonly identified with the Greek Ares (*q.v.*), but was never so much affected by foreign influences as to lose his essentially Roman and Italian character. The importance of this deity throughout central Italy from the earliest times is reflected in the fact that Alba Longa, Falerii, the Hernici, Aricia, Tusculum, Lavinium, the Aequi, the Peligni, and the Sabines all had months named for him. At Rome, Martius (March) was the first month of the old calendar.

In spite of his importance, little is known of the original character of the Italian deity, and what is known (chiefly from the cult at Rome) is variously interpreted. It is clear that by historical times he has developed into a god of war (hence his connection with Ares), and in Roman literature he is protector of Rome, a nation proud in war, which traced its founding back to a son of Mars, Romulus. There are at least three tenable views, however, of his ultimate origin: (1) that he was originally a war god whose functions were extended to the physical and hence the spiritual protection of the fields and crops; (2) that he was originally a deity connected with the fertility of the soil, of chthonian nature and thus a god of death and war; and (3) that he was originally a high god of the Italian peoples who were both warlike and agrarian and thus he reflects their interests.

The problem probably cannot be solved, for evidences of all three possibilities are found in his cult.

Mars's festivals at Rome occurred in the spring and the fall, embracing both the agricultural and the military seasons. The month of March was, as might be expected, especially filled with festivals wholly or partially in his honour. The Feriae Marti, March 1, was New Year's Day in the old Roman calendar; the second Equirria, "horse races," occurred on March 14 (the first Equirria, Feb. 27); the Quinquatrus on March 19 was originally a festival of Mars which eventually was extended over a five-day period and became a festival of Minerva (*q.v.*); and the Tubilustrium, a purification of the war trumpets, occurred on March 23. All these have a connection with the initiation of the war season. Significant also is the role played through this period up to March 23 by the ancient priesthood of the Salii (*q.v.*), particularly associated with Jupiter, Mars and Quirinus, who came out several times during the month to dance their ceremonial war dance in old-fashioned armour and chant a hymn to the gods. Again at the end of the season, October was an important month for Mars. The festival of the October horse on Oct. 15 was marked by a two-horse chariot race in the Campus Martius, one of the winning pair being sacrificed to Mars. On Oct. 19 the Armilustrium marked the purification of the arms of war and their storage for the winter.

Certain features in the Mars cult, however, make it probable that the god was connected in early times at least with agriculture, and some of the features of the festivals already enumerated can be explained equally well as of agricultural origin. Thus Mars was invoked in the ancient hymn of the Arval brothers (*q.v.*), whose religious duties had as their object to keep off enemies of all kinds from crops and herds, and in this his association with the Lares (*q.v.*) would suggest that he is not regarded as a war god who could avert the raid of an enemy. Likewise in Cato's description of the annual lustration of his land by the Roman farmer (*de Agricultura,* 141), where pure Italian cult might be expected to be reflected, Mars (with the cult title Silvanus) is invoked to ward off disease, calamity, dearth and infertility with no mention of his war function. Cato describes the ritual in detail; the procession around the field, the recitation of the prayer to Mars after libations to Janus and Jupiter, and the sacrifice of the pig, sheep, and ox (*suovetaurilia*), representing the farmer's most valuable stock. This description has been taken to be a miniature of the state rite in the lustration of the *Ager Romanus* which, if true, would make Mars the chief deity worshiped at the Ambarvalia (*q.v.*).

The festival of the October horse, mentioned above, an undoubtedly primitive rite, has definite associations as a harvest fertility ceremony. Although the animal sacrificed was a war horse, the head was cut off and decked with cakes as an object having the power to procure fertility. Thus the festival may equally mark the end of the harvest as well as the end of the war season. Even Quirinus (*q.v.*), who is associated with Mars as a war deity, is not without agricultural connections, for it was his *flamen* who sacrificed the victims at the Robigalia on April 25, when the spirit of the mildew (Robigus) was invoked to spare the grain.

Until the time of Augustus, Mars had but two temples at Rome. One of these, originally only an altar, was in the Campus Martius, the exercising ground of the army. The other was outside the Porta Capena and there each year the Equites met in order to start in procession through the city. Each of these sites was outside the *pomerium,* and this has been explained to mean that the war god "must be kept at a distance" (J. B. Carter, *Religion of Numa,* p. 19). But in the heart of the city there was a *sacrarium* of Mars in the *regia,* originally the king's house, in which the sacred spears of Mars were kept, or rather, Mars in spear form (Mars Hasta); for on the outbreak of war the consul had to shake these spears, saying, "*Mars vigila*" ("Mars, wake up!"). If the spears moved of themselves the omen was bad and called for expiation.

Under Augustus the worship of Mars at Rome gained a new impetus; not only was he traditional guardian of the war affairs of the Roman state but as Mars Ultor he became the personal guardian of the emperor in his role as avenger of Caesar. The temple of Mars Ultor vowed at Philippi was not dedicated until 2 B.C., but then it dominated the magnificent Forum of Augustus, occasionally referred to as the Forum of Mars. His worship at times rivaled that of Capitoline Jupiter and about A.D. 250, Mars became the most prominent of the *di militares* worshiped by the Roman legions.

In literature and art he is hardly distinguished from the Greek Ares.

BIBLIOGRAPHY.—W. H. Roscher, *Lexikon der griech. u. röm. Mythologie* (1884–1933); W. W. Fowler, *Roman Festivals* (1908) and *Religious Experience of the Roman People* (1911); G. Wissowa, *Religion und Kultus der Römer*, 2nd ed., pp. 141–53 (1912); S. B. Platner and T. Ashby, *Topographical Dictionary of Ancient Rome* (1929).

(R. B. LD.)

MARS is the fourth planet in order of distance from the sun and the next beyond earth. When within 100,000,000 mi. of earth it is too bright to be easily mistaken for a star. When more distant, however, it might be confused with a bright red star such as Antares or Aldebaran. At an exceptionally close opposition (*i.e.*, when on the opposite side of earth from the sun), Mars outshines Jupiter for a few weeks, and becomes the fourth brightest object in the heavens, being exceeded only by the sun, moon, and Venus. When one gazes at the planet glowing in the sky like a red danger signal, it is easy to understand why the ancient people identified this object with the god of war—the Romans with Mars, the Greeks with Ares.

Owing to the photographs taken by the U.S. spacecraft Mariner 4 in July 1965, more is known about the surface of Mars than of any other body in the solar system except the moon and earth. Mariner 4 was launched from Cape Kennedy, Fla., in November 1964, and traveled 326,000,000 mi. in 228 days to reach Mars.

TABLE I.—*Elements of Orbit of Mars*
(For epoch Jan. 1, 1960, at 12 hr. ephemeris time)

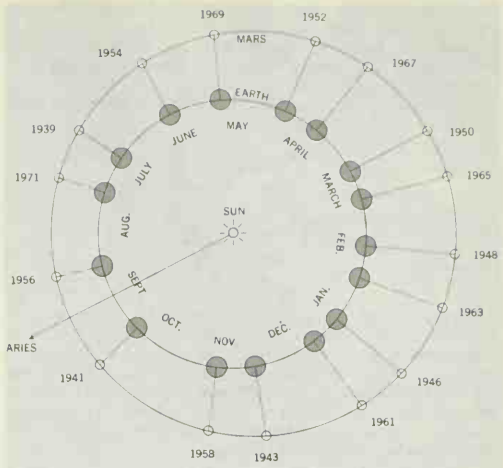
Mean distance (in astroomical units)	1.523691
Eccentricity	0.093368
Inclination	1.84991°
Mean longitude of node	49.21903°
Mean longitude of perihelion	335.32269°
Sidereal period	686.9804 days
Mean synodic period	779.94 days
Distance from sun	
Mean	141,500,000 mi. (227,700,000 km.)
Perihelion	128,300,000 mi. (206,500,000 km.)
Aphelion	154,800,000 mi. (249,100,000 km.)
Distance from earth	
Mean opposition	48,695,000 mi. (78,365,000 km.)
Minimum distance	34,670,000 mi. (55,795,000 km.)
Maximum distance	247,900,000 mi. (398,950,000 km.)
Orbital velocity	
Mean	15.0 mi./sec. (24.1 km./sec.)
Perihelion	16.4 mi./sec. (26.4 km./sec.)
Aphelion	13.6 mi. sec. (21.9 km./sec.)

Source: *Explanatory Supplement to the American Ephemeris and Nautical Almanac* (1961).

The spacecraft reached the planet within about 200 mi. of its selected position. In 22 minutes the television camera secured 19 useful photographs of the planet before crossing the evening terminator into the unilluminated hemisphere. The pictures covered a strip about 200 mi. wide and 3,000 mi. long, beginning near the Trivium Charontis and ending in Aonius Sinus. The area photographed was about 1% of the surface area of Mars. *See* also SPACE EXPLORATION.

MOTIONS OF MARS

Most of the time Mars is so far from the earth and so nearly in our line of sight with the sun that observations are unsatisfactory or useless. Usually Mars can be observed to advantage only for about two months before and after opposition. As is shown in the diagram, the orbit of earth appears as a circle centred on the sun, but the orbit of Mars is considerably off centre. The orbits are not circles, however, but are slightly elongated closed curves called ellipses, with the sun at one focus of the ellipse. The orbit of earth is so slightly eccentric (e = 0.017) that its departure from a circle cannot be detected in a diagram. The



FROM FRED L. WHIPPLE, "EARTH, MOON AND PLANETS"; REPRODUCED BY PERMISSION OF THE BLAKISTON COMPANY

OPPOSITIONS OF MARS FROM EARTH (1939–71). RELATIVE DISTANCES ARE SHOWN BY STRAIGHT LINES JOINING THE ORBITS. MARS IS NORTH OF EQUATOR FOR OPPOSITIONS FROM SEPTEMBER TO MARCH

orbit of Mars is sufficiently eccentric (e = 0.093) that its ellipticity is just appreciable to the eye.

When opposition occurs near perihelion (point of the orbit nearest the sun), Mars may come as close to the earth as 35,000,000 mi. When opposition occurs near aphelion (point of the orbit farthest from the sun), the distance may be as much as 63,000,000 mi. Mars and earth are in opposition on an average of once every 26 months. The favourable oppositions occur in July, August, and September; the unfavourable ones are in January, February, and March. The exceptionally favourable oppositions occur at intervals of either 15 or 17 years. The last close opposition was in September 1956, when Mars came within 35,200,000 mi. of earth. The next close one will be on Aug. 6, 1971, when Mars will be 35,080,000 mi. distant, and after that on Sept. 28, 1988, when the distance of the planet will be 36,300,000 mi. (These dates and distances are subject to slight change when better data become available.)

SEASONS

The equator of Mars is tilted to the plane of its orbit by nearly 25°, or 1.5° more than earth. The north pole of Mars is directed toward longitude 354°; the north pole of earth toward longitude 90°. As a consequence, the beginnings of the four seasonal positions in the orbit of Mars occur at approximately the same time as those for earth. But they are not the same seasons. If Mars were at opposition on the dates when the seasons begin on earth, the correspondence would be as shown in Table II.

TABLE II.—*The Martian Seasons*

Date	Approximate distance of Mars from earth (mi.)	Beginning of seasun in northern hemisphere of earth	Beginning of Martian season	
			Northern hemisphere	Southern hemisphere
March 21	61,000,000	Spring	Summer	Winter
June 21	41,000,000	Summer	Autumn	Spring
Sept. 23	35,000,000	Autumn	Winter	Summer
Dec. 22	51,000,000	Winter	Spring	Autumn

Since the axial tilt of Mars to its orbit is nearly the same as that of earth, the seasonal variations are roughly the same for both planets. The orbit of earth is so nearly circular that the intensity of sunlight it receives scarcely changes throughout the year, but the orbit of Mars is so eccentric that the intensity of sunlight received at perihelion is 45% greater than at aphelion.

The changes in distance are apparent in the behaviour of the polar caps. Mars is at perihelion during the southern summer and at aphelion in the northern summer. As a result, the south polar cap often disappears in summer whereas the northern cap has never been known to vanish.

Since the Martian year is nearly twice as long as that of earth, the seasons there are correspondingly longer.

TABLE III.—*Length of Seasons on Mars and Earth*

Seasonal interval	Northern hemisphere		Southern hemisphere	
	Earth	Mars	Earth	Mars
Winter to spring (days)	89	160	93	182
Spring to summer	93	199	90	146
Summer to fall	93	182	89	160
Fall to winter	90	146	93	199
Length of year	365	687	365	687

The aspect of Mars at opposition differs widely depending upon the date. At the favourable oppositions of summer the south pole is presented to earth, and hence it is on these occasions that observers on earth get the best view of the southern hemisphere of the planet. Conversely, the north pole is presented to earth at the unfavourable oppositions of winter. This is a fortunate circumstance because most of the interesting surface features are in the southern hemisphere of the planet.

TEMPERATURE

The only practical means of determining the temperature of a body (such as a planet) millions of miles from earth is indirect: by measuring the heat or radiant energy it transmits to earth. The hotter a body is, the more heat it radiates, and the amount of heat received at any point depends upon the distance from the source of radiation. The heat of a candle, for example, can be felt a few feet away. On the other hand, the sun's radiation is perceptible even at a distance of 93,000,000 mi. If one can measure the amount of heat a body radiates per unit area of surface, one can calculate the temperature of the body from the laws of radiation. The absolute temperature is proportional to the fourth root of the energy radiated. The heat radiated from a planet is exceedingly weak but can be measured by sensitive detectors placed at the focus of a large telescope.

Radiation received from a planet is of two kinds: the sunlight reflected from its surface and the true planetary radiation resulting from the temperature of the emitting surface. The two kinds of radiation are widely separated in wavelength: reflected radiation lies mostly in the visual region of the spectrum, while low-temperature planetary radiation is in the far infrared region. The two kinds of radiation can be separated by interposing a suitable filter in the beam that is being measured. The sensitive receiver upon which the radiation falls is so small that the temperature of various parts of the surface of the planet may be measured individually.

Measures of the radiation from Mars were made in 1924 and 1926 by Seth B. Nicholson and Edison Pettit at the Mount Wilson Observatory, and by W. W. Coblentz and C. O. Lampland at the Lowell Observatory. Nicholson and Pettit found that the temperature of the south polar cap of Mars was about −70° C (−94° F), that of the sunset edge about −13° C (8.6° F), and that of the point directly under the sun about 10° C (50° F). Coblentz and Lampland obtained somewhat higher values but the two sets of results were in remarkable agreement, considering the difficulties of the measurements. Since Mars never shows more phase than the moon when about three days from full, the radiation from the surface at midnight cannot be measured directly. But the minimum night temperature on Mars was estimated by Gerard P. Kuiper as −100° C (−148° F).

Radiometric temperature measurements of Mars were made with the 200-in. Hale reflector in 1954 by W. M. Sinton and J. Strong, using a Golay detector about twice as sensitive as the best thermocouple tested. The temperature of Mars at the centre of the disk was found to be 15° C (59° F). The temperature near the equator at the sunrise limb was about −60° C (−76° F) and the temperature at noon near the equator about 25° C (77° F). The temperature of a yellow cloud, which appears on photographs taken by others, was −25° C (−13° F). Dark areas were a few degrees warmer than adjacent bright areas.

The mean daytime temperatures over the entire disk of Mars for all seasons has been estimated at −33° C (−27.4° F). This agrees fairly well with the microwave brightness temperature at 3.15 cm. of −62° C (−79.6° F) (J. A. Giordmaine, L. E. Alsop, C. H. Townes, and C. H. Mayer, 1959). This temperature applies to some level beneath the surface and is an average value for the whole disk.

ATMOSPHERE

That Mars has an atmosphere of some sort is evident from casual observations made when the planet is close enough to the earth for its surface features to be easily discerned. That these features are often obscured or dimmed as if by mists or clouds was noted as early as 1784 by Sir William Herschel.

Valuable information concerning the atmosphere of Mars has been obtained from photographs of the planet made in light of different colours. Blue and violet light have slight ability to penetrate an atmosphere because they are strongly scattered by fine particles. Yellow, orange, and red light, because of their longer wavelengths, are not so easily scattered and therefore are more penetrating. The effect is conspicuous on terrestrial photographs of distant objects. On photographs taken in violet light a distant landscape appears dim and flat or is wholly invisible, but the landscape generally stands out sharply on photographs taken in red light.

Attempts were made to photograph Mars even before the beginning of the 20th century, and several observers were successful in obtaining images of good quality at the close approach of Mars in 1909. Not until the opposition of 1924, however, was photography in light of different colours applied to Mars with conspicuous success by W. H. Wright at the Lick Observatory, and by E. C. and V. M. Slipher at the Lowell Observatory. These photographs showed the same effects as those exhibited by the terrestrial landscape. Thus, photographs of Mars in visual light (yellow, orange, and red) penetrated the atmosphere and revealed the surface markings. The polar cap is an inconspicuous feature on such images. In blue light the planet usually shows only a flat, featureless disk except for the polar cap, which appears much larger than on the photographs taken in visual light.

Generally, images taken in blue light are appreciably larger than those taken in visual light, and attempts have been made to determine the thickness of the Martian atmosphere by measuring this difference in size. The visual images presumably show the solid surface of the planet, while the blue images include the outer atmospheric shell. Theoretically, the method sounds plausible, but errors introduced by contrast effects and spreading of the image seem so serious as to render the method of doubtful value. For example, on blue and violet images the polar cap appears as a bright protuberance projecting considerably beyond the rest of the disk.

Clouds.—Mars shows two principal types of clouds: those that appear as conspicuous markings on the blue and violet images; and yellowish clouds that may be detected visually and that show on photographs taken in visual light. Occasionally there is a cloud that is visible in both blue and yellow light. Such a cloud was photographed at the edge of the planet from Mount Wilson Observatory in 1954. When the clouds project beyond the line between daylight and darkness (the terminator), or when they appear as protuberances at the edge of the disk, their height can be measured, although roughly. The blue clouds seem to be at a higher level than the yellow clouds, but reliable values for their relative heights are lacking.

A remarkable cloud showed on the blue images taken in 1954 and 1958, which, when viewed with the south pole uppermost, resembled the letter W. The marking was on the equator centred at about longitude 110°. There was a distinct knob at the western end of the W, and at the three intersections of the lines forming the strokes of the letter. The diameter of the knobs was about 280 mi. and the strokes between them 1,000 mi. in length. The knobs fell near

the positions of "oases" and two of the stripes coincided roughly with the "canals" named Ulysses and Fortunae (see *Canals*, below). Photographs of the W taken by E. C. Slipher in South Africa showed that it had an intermittent existence, forming in the afternoon and disappearing at night. Similar markings had been noted over this region at previous oppositions; *e.g.*, in 1926 by Wright and F. E. Ross. They also observed a cloud that formed about Martian noon and which became more intense as it was carried by rotation toward the evening terminator. Wright suggested that the cloud was a convective phenomenon of the Martian afternoons, recurrent over several days.

Blue Mist.—As already stated, the atmosphere of Mars is transparent to yellow light but remarkably opaque to blue, violet, and ultraviolet light. This opacity may be described as a blue mist. Photographs of the spectrum of Mars show that the opacity to blue light begins at a wavelength of about λ4,400.

On rare occasions, however, the blue mist clears to such an extent that the surface markings show almost as distinctly in blue light as in yellow. Attention was first directed to the blue clearing as a distinctive Martian phenomenon by E. C. Slipher of the Lowell Observatory in 1937. Notable instances of the blue clearing occurred in 1937, 1939, and 1941; in each case within a few days of opposition. At other oppositions, however, no blue clearing was observed. In 1954 the atmosphere of Mars was unusually transparent to blue light from May until July 2 (opposition date, June 25), when the atmosphere suddenly became opaque to blue light again.

At the opposition of 1956 extensive blue clearing was recorded by Gérard de Vaucouleurs in Australia, between Aug. 28 and Sept. 3, during which period the surface markings of the Syrtis Major and Mare Cimmerium were distinctly visible at wavelengths of λ4,400 and λ4,800. The end of the period was well defined, for the markings which were clearly recorded on plates taken Sept. 3 at 14:00–14:30 UT (universal time) were almost invisible on those taken Sept. 4 at 14:20–15:00 UT. No observations were taken near opposition on Sept. 10, but the violet layer was completely opaque and nearly uniform by Sept. 15.

Scarcely a trace of the blue clearing was observed from other points on earth in 1956, possibly because of a dust storm which developed suddenly on Aug. 30 over the Mare Sirenum area, and which eventually obscured a major section of the southern hemisphere of the planet by late August and early September. By Sept. 5 the atmospheric dust had covered the entire planet except the south polar region. The blue clearing was detected from Australia because the face of the planet that was visible from there was practically free of obscuration during the critical period.

There is no generally accepted explanation for the clearing of the blue mist. The fact that it has occasionally been observed to occur near opposition is of doubtful significance. This may be purely an observational effect since the planet is under intensive scrutiny at that time.

Composition of Martian Atmosphere.—Attempts have been made to detect oxygen and water vapour in the atmosphere of Mars by spectroscopic analysis ever since the pioneer work of Pierre Jules Janssen and Sir William Huggins about 1867. The chief obstacle to detection is earth's atmosphere. The problem is how to distinguish absorption due to oxygen and water vapour in the spectrum of Mars from the very strong absorption produced by these molecules in earth's atmosphere. Two methods have been tried.

The older method consists in comparing the spectrum of Mars with the spectrum of another body, the moon, which is identical with Mars in every respect except that it has no atmosphere. Consider the history of a beam of light reaching earth from Mars. Starting from the sun, it first passes through the Martian atmosphere down to that planet's surface. From the surface it is reflected through the atmosphere again into outer space. Light reflected toward earth passes through the astronomer's telescope and onto a photographic plate or other recording device. The beam that reaches earth therefore has passed twice through the atmosphere of Mars and once through earth's atmosphere. Now consider a beam of light reflected from the surface of the moon. The moon has no atmosphere. Thus the spectrum of moonlight is nothing but reflected sunlight that has passed once through earth's atmosphere. The absorption lines of oxygen (O_2) and water vapour in the spectrum of Mars are compared with those of the moon under as nearly identical conditions as possible. If these lines are stronger in the spectrum of Mars, it must be a result of the additional absorption produced by oxygen and water vapour in that planet's atmosphere. The method is sound in principle but difficult to carry out in practice. The moon and Mars must be observed at the same altitude in the sky, and the humidity at the point of observation must be the same at the time of both measurements—conditions that are seldom realized. Moreover, it is difficult to get photographs of two different objects that match so closely that detailed comparisons of them can be made. For this reason the method of lunar comparison has fallen into disuse.

BY COURTESY OF NASA

ATLANTIS, BETWEEN MARE SIRENUM AND MARE CIMMERIUM, AS PHOTOGRAPHED BY MARINER 4, JULY 1965

About 1902 Percival Lowell devised another method which seemed more promising. As Mars and earth revolve around the sun the distance between them is continually changing. At times the two planets are nearly stationary relative to each other as when they are nearest and farthest apart. At other times their velocity directly toward or away from each other may reach 12 mi. per sec. This velocity should be sufficient to produce a Doppler effect (*see* LIGHT), which shifts a line in the spectrum of Mars slightly away from the position of the same line in the spectrum of earth's atmosphere. This method consists of comparing the relative positions of spectrum lines on the same plate, a comparison in position being much easier to make than one of the intensities of spectrum lines on different plates.

Such tests for oxygen and water vapour in the spectrum of Mars were made in 1934, 1937, and 1941 by W. S. Adams and Theodore Dunham, Jr., with the 100-in. telescope at the Mount Wilson Observatory when the planet had reached nearly its maximum velocity toward and later away from earth. Study of the contours of the oxygen lines failed to reveal any asymmetry sufficient to indicate that oxygen was present in the Martian atmosphere to the extent of 1% of the quantity in earth's atmosphere. A similar conclusion was reached regarding the presence of water vapour in the atmosphere of Mars.

The only substances that have been identified in the Martian atmosphere are carbon dioxide (CO_2) and water vapour (H_2O). Carbon dioxide was first detected by G. P. Kuiper in 1947. Results obtained from observations of Mars in 1963 indicate that

there is about 40 times the amount of carbon dioxide in a vertical column over the Martian surface than there is over the surface of earth. In 1963 spectroscopic evidence was finally obtained for water vapour after nearly a century of search. On a high-dispersion spectrogram taken with the 100-in. telescope at Mount Wilson Observatory rotational lines of H_2O near λ8,300 and CO_2 near λ8,700 were detected (L. D. Kaplan, G. Münch, and H. Spinrad). They found for H_2O $14 \pm 7\mu$ precipitable water, and 55 ± 20 m.atm. of CO_2. From the absence of oxygen in the Martian spectra, they set an upper limit of 70 cm.atm. for the O_2 content.

A. Dollfus, from infrared radiometric comparisons between the moon and Betelgeuse at an elevation of 12,000 ft. in the dry air of the Swiss Alps, found that higher readings were always obtained on the Martian water-vapour bands than upon his control objects. He estimated that if all the water in the Martian atmosphere in the form of an invisible gas were condensed into liquid water, it would produce a uniform liquid film over the surface of the planet $\frac{8}{1,000}$ in. in depth. His estimate of the abundance of water vapour in the Martian atmosphere is about 15 times that of the Mount Wilson observers.

The Mount Wilson observations give a total surface atmospheric pressure of 25 ± 15 mb., much lower than the value of 85 mb. generally accepted before. This means that the atmospheric pressure at the surface of Mars is only about 1 to 2% as much as at the surface of earth, or about the same as our atmosphere at an altitude of 80,000 ft. The composition of the Martian atmosphere is exceedingly uncertain but probably consists mostly of nitrogen, with smaller amounts of argon and carbon dioxide. Their partial pressures have been put at 19 mb. for N_2, 2 mb. for A^{40}, and 4 mb. for CO_2, with trace amounts of water vapour and oxygen. Other hypotheses give partial pressures differing considerably from these. The argon probably results from decay of the radioactive isotope of potassium (K^{40}). It is unfortunate that neither nitrogen nor argon has observable spectrum lines, so that their presence can only be inferred from analogy with the atmosphere of earth.

Mariner 4 followed an orbit that caused it to pass behind Mars, as seen from earth. As the spacecraft was passing behind the planet, there was a brief period when its tracking signal was traversing the Martian atmosphere. The signal faded out for somewhat the same reasons that the disk of the sun is dimmed at sunset. As the sun approaches the horizon the disk grows fainter mainly because of the scattering of its rays by air molecules. There is also some dimming that is due to unequal refraction (bending) of light from the disk. The effect of differential refraction is to deform the solar disk and reduce its size.

In the occultation experiment, however, differential refraction is the predominate cause of fading and weakening of the tracking signal. The changes observed in the signal showed that the Martian atmosphere is so rarefied that the surface pressure is only 1 or 2% of terrestrial atmospheric pressure at sea level.

SURFACE FEATURES

When viewed through a telescope of moderate power under favourable (good visual) conditions, Mars presents the appearance of a bright-reddish or tawny-coloured disk girdled by darker markings in the southern hemisphere which may at different times be blue-green, gray-green, or light grayish-blue. The true colour of these dark markings is difficult to determine since it is strongly influenced by contrast with the bright-reddish colour of the neighbouring regions. At one of the poles there is usually a white cap which may appear as the most conspicuous marking on the disk, depending upon the Martian season and the orientation of the planet relative to earth. During moments of exceptionally good seeing the observer also catches glimpses of detailed markings—small spots and specks and lines—which come and go so rapidly that it is impossible to set them down accurately in a sketch.

The bright-reddish areas which cover about three-quarters of the planet and which give Mars its characteristic fiery red colour are apparently uniform expanses of barren desert. The dark areas, which are situated mostly in the southern hemisphere, are called maria (seas), since they were once supposed to be actual bodies of water. The absence of bright reflected sunlight from the maria, as well as the detail occasionally visible in them, indicate that they consist of dry land similar to deserts.

An interesting observation of Mars when close was made by M. L. Humason and W. Baade with the 100-in. reflector on Mount Wilson when seeing conditions were "excellent, almost perfect." These observers, although experienced professional astronomers, were not experienced in observing planets. Their observations were made visually at the cassegrain focus of the telescope through a red filter. The outstanding feature was the sharp edge of the maria, which looked black and contrasted sharply with the bright regions. Both men tried to glimpse the canals but were unable to see them. They agreed that in the bright regions there appeared to be short "grooves," as nearly as they could describe them.

Polar Caps.—It was suggested by the British physicist George

TABLE IV.—*Physical Characteristics of Mars**

	Earth = 1	km.	mi.
Equatorial diameter	0.5353	6,828	4,243
Polar diameter	0.5296	6,756	4,198
Equatorial diameter (solid surface)	0.5292	6,749	4,194
Polar diameter (solid surface)	0.5252	6,700	4,163
Velocity of escape	—	5.05 km/sec	3.14 mi/sec
Area (solid surface)	0.278		
Volume (solid surface)	0.146		
Mass	0.108		
Density	0.737		
Surface gravity	0.38		
Atmospheric pressure at surface	0.01–0.02		
Position of north pole (1905)			
Right ascension	316.55° = 21 hr. 06.2 min.		
Declination	+ 52.85°		
(1970)			
Right ascension	316.99° = 21 hr. 08.0 min.		
Declination	+ 53.08°		
Inclination of equator to orbit	24.936°		
Polaris of Mars	Alpha Cygni (Deneb)		
Flattening	0.0105		
Visual albedo	0.159		
Visual magnitude at mean opposition	1.52		
Symbol (spear and shield)	♂		
Martian sidereal day	24 hr. 37 min. 22.6689 sec.		
Martian mean solar day	24 hr. 39 min. 35 sec.		
Magnetic moment	<0.001 of earth's		

*These data are taken mostly from *The Physical Ephemeris of Mars*, Memorandum RM-3999-NASA (Jan. 1964), and *Geometric and Photometric Parameters of the Terrestrial Planets*, Memorandum RM-4000-NASA (March 1964), by G. de Vaucouleurs.

Johnstone Stoney, in 1898, that the polar caps consist of frozen carbon dioxide gas (Dry Ice) rather than snow and frost. Radiometric measures, as noted above, indicate a temperature of −70° C (−94° F) at the polar caps, but carbon dioxide under the atmospheric pressure on Mars would not solidify unless the temperature were about −144° C (−227.2° F). Measures by Kuiper in the infrared spectrum show that the polar caps reflect light like terrestrial snow. Snow becomes almost "black" beyond wavelength 1.5μ, and almost completely black beyond 2.0μ, but Dry Ice remains "white" out to 2.5μ. From his tests Kuiper concluded that the Martian polar caps are not composed of frozen carbon dioxide but are almost certainly composed of water (H_2O) frost at a temperature much below 0° C (32° F).

The melting polar cap in spring is surrounded by a dark band that remains in contact with the shrinking cap. This band was once regarded as marshy ground formed from the water of the melting polar snows, but it is extremely doubtful that there is enough water to form such a region. When viewed under the best conditions the band is seen to be discontinuous, broken up into individual spots. It appears to be part of the general wave of darkening in the Martian spring that spreads from the polar cap, over the maria, down to and beyond the equator.

Deserts.—Kuiper compared the reflectivity of the red Martian deserts with that of red soil and red rock collected in Oklahoma, Texas, and Arizona. He found the reflectivity of these specimens to be quite different from that of the red regions of Mars. However, the reflectivity of a brownish, fine-grained felsite closely matched that of the Martian deserts. He concluded, therefore, that the deserts of Mars consist of igneous rock similar to felsitic rhyolite.

Dollfus advanced a more convincing theory, based on polarimetric and photometric studies of the red regions. He found that limonite properly pulverized reproduces the polarization and

brightness curves of the deserts surprisingly well. The evidence from the polarization measures is particularly strong, since very few substances have a polarization curve resembling that of the Martian bright areas. Dollfus' early work agreed with that by Carl Sagan (1965), who found within the range of observational uncertainty that laboratory diffuse reflection spectrophotometry support the identification of powdered ferric oxides as a principal constituent of the Martian bright areas.

Maria.—As the polar cap in the southern hemisphere shrinks during the Martian spring, the maria begin to darken and become more conspicuous, first near the pole, then gradually spreading toward the equator and even over into the opposite hemisphere. In the autumn some of the maria turn brown, brownish purple, and carmine, while others are but little affected. There can be little doubt that seasonal changes occur in the maria, but they are more complex than was generally believed. These changes suggest the growth and decay of vegetation, and the idea that water vapour, not as clouds by as an invisible gas, spreads from the pole toward the equator causing plant life to spring up in its wake.

If the maria consist of vegetation, it must be of a type entirely different from that on earth, and exceedingly hardy to withstand the freezing Martian nights. Plants of the type known on earth need oxygen for respiration, but there is no free oxygen present in the Martian atmosphere.

Evidence that the maria consist of some kind of organic substance was obtained by Sinton at the oppositions of 1956 and 1958. All organic molecules possess strong absorption bands near 3.4μ, the wavelength of the carbon-hydrogen bond resonance. Measures on the spectra of Mars in this region indicate the probable presence of these bands. This evidence, together with the seasonal changes in the maria, made it seem highly probable that vegetation of some sort exists on Mars. But D. G. Rea (1963), on the basis of laboratory investigation, considers the identification of the infrared bands in the Mars spectrum with organic molecules to be at least doubtful, as they can be attributed just as well to absorption by inorganic molecules. (See *Life on Mars?* below.)

In polarimetric and photometric studies of the maria made after 1947, Dollfus found that the maria have a powdery surface structure similar to that of the bright desert regions but more absorbent. He was able to simulate the variations in brightness of the maria in the laboratory by mixing pulverized limonite ($HFeO_2$) with a powder of very absorbing grains. Similar effects were obtained by partially covering the limonite with these grains and, vice versa, by partially covering these grains with limonite.

The polarization of light from the dark regions of Mars is not unlike that from the bright deserts, but it varies with the change of seasons. This variation suggests a seasonal change in the nature of the surface, though on a microscopic scale. Physical or chemical changes in minerals are not alone sufficient to explain such changes. Dollfus found that certain algae, small lichens, or minute mushrooms, when sprinkled on pulverized limonite, showed a polarization curve similar to that of the Martian dark spots. On earth such microscopic organisms are generally creatures with a great power of adaptation. Their absorbent character suggests a superficial coloured pigment that offers protection against cold or excessive radiation by selective absorption of light.

Crustose lichens are among the hardiest plants on earth, and exhibit the same general colours and reflection spectra as the maria; their size is consistent with the postulated size of the Martian organisms (calculated from the total amount of water on the planet). Moreover, lichens are known to tolerate extreme climatic conditions.

On the other hand, Frank B. Salisbury has presented several objections to the theory that the Martian maria are composed of lichenlike organisms. First, it is unlikely that lichens could subsist in an atmosphere of low oxygen content like that of Mars. Lichens do not change colour with the seasons as do the maria. Also, crustose lichens are extremely slow growing and are sparsely distributed. In 1954 a new dark area about the size of Texas was first observed; it had developed sometime within the two years since Mars had last been viewed. If this area was due to vegetation, it would seem that plant life on Mars is not barely surviving but actively flourishing. An inorganic explanation of the maria may be considered along with the lichen hypothesis. Kuiper made observations of Mars in 1954 and 1956 with the 82-in. reflecting telescope of the McDonald Observatory, paying special attention to the colours of the bright and dark areas. The colours, which were expected to be green in the Martian spring, were, instead, a neutral gray. The lack of vivid coloration suggested the possibility that the maria might be lava fields similar to the broad dark expanses on the moon. As a working hypothesis Kuiper suggested that the maria were lava fields partially covered by some very hardy vegetation.

In 1954 the astronomer Dean B. McLaughlin had already advanced an inorganic theory of the composition of the maria. He suggested that they are deposits of volcanic ash that had been weathered to a soil in which epidote and chlorite abounded, thereby accounting for the green colour. The seasonal darkening of the maria would result from the moistening of the surface minerals rather than from a chemical change. From observations that the maria terminate in funnel-shaped markings pointing north into the deserts, McLaughlin concluded that the tips of the funnels might be the sites of volcanoes whose ash had been carried by the winds and deposited in the patterns that form the maria. Since the winds blowing to the southern hemisphere are much stronger than those blowing to the northern hemisphere, the maria would thus be expected to form primarily south of the Martian equator. In fact, most of the maria are south of the equator.

Although the atmosphere of Mars today probably consists mostly of nitrogen, long ago a considerable quantity of oxygen may have been present. The oxide-of-nitrogen hypothesis seeks to account for practically all the surface phenomena observed on Mars by oxides of nitrogen in various states, mainly nitrogen dioxide (NO_2) and nitrogen tetroxide (N_2O_4), which may combine to form nitrogen peroxide (C. C. Kiess, S. Karrer, and H. K. Kiess, 1960, 1963). On this hypothesis life on Mars would be impossible, since nitrogen peroxide is poisonous to both plants and animals. The gas is unstable, continually undergoing a dreary process of decomposition and regeneration in which nothing is created and nothing destroyed. Several investigations of the Martian spectrum put an upper limit to the abundance of NO_2 of 1 mm.atm., which is insufficient to explain phenomena such as the polar caps, the darkening of the maria in spring, colour changes, etc. Sagan remarked that the amount of NO_2 above Los Angeles has been found to be 3 mm.atm., three times as much as the upper limit on Mars.

Most astronomers favour a vegetative hypothesis despite the difficulties it encounters. E. J. Öpik presented an effective argument for this theory: the maria must have regenerative powers, or they would have been obliterated ages ago by the dust of the deserts.

The principal topographic features revealed on Mars by Mariner 4 do not correspond to the type that would be produced by stress and deformation originating within a planet, as is the case with earth. Earth is internally dynamic, creating mountains and continents, but Mars has evidently long been inactive. Lack of internal activity is consistent with the negative result of the magnetometer experiment, which failed to detect evidence of a Martian magnetic field. The results show the magnetic moment of Mars is less than one-thousandth that of earth. The results were also negative insofar as detection of any charged particles associated with the planet were concerned.

A casual inspection of the Mariner 4 photographs is enough to show that the surface of Mars resembles the moon more than the earth. About 70 craters were counted on photographs 2 to 15, inclusive, which cover about 1% of the planet's surface. On the doubtful assumption that this 1% is representative of the surface as a whole, there would be approximately 7,000 craters on Mars. The pictures show well-defined craters ranging from 3 to 25 mi. in diameter, in addition to circular markings up to 75 mi. in diameter resembling the great walled plains on the moon. Most of the Martian craters have flat, smooth floors, although a few show central peaks like some of the lunar craters. The crater walls rise a few hundred feet above the surrounding surface and reach depths of several thousand feet below the crater rims.

Canals.—Discovery of the Martian markings designated as canals was made by G. V. Schiaparelli (*q.v.*) at the exceptionally close opposition of 1877. Schiaparelli described these markings as *canali* ("channels" or "canals"). Translated into English as canals, the word erroneously suggested that these channels were artificial waterways constructed by intelligent beings. In 1892 W. H. Pickering discovered a new feature of the canals which he called an oasis, a small round spot at the junction of several canals.

All observers agree that Mars shows a vast amount of fine detailed markings so complex as to be impossible to represent properly in a drawing. The markings come and go so rapidly with fluctuations in the seeing that even the best photographs fail to show the fine details that can be glimpsed by the eye.

Most astronomers have never been able to see canals on Mars and hence are naturally skeptical of their existence.

Judging from the maps which Schiaparelli made at the six oppositions from 1877 to 1888, the canals must have appeared to him as narrow dark lines extending across the deserts. Lowell in 1894 described them as a "network of fine straight, dark lines . . . either absolutely straight from one end to the other, or curved in an equally uniform manner."

E. M. Antoniadi stated that in good seeing, the canals appeared to him as continuous lines, but in moments of the very finest seeing they broke up into a discontinuous series of lines and dots.

R. J. Trumpler's remarks about the canals (on the basis of observations made in 1924 and 1926 with the 36-in. refractor at Lick Observatory) are of value, as representing the views of a careful and conservative observer:

> The network lines, the so-called canals, are not a well-defined class of similar objects, but vary greatly in visibility, width, and definition. Some of them, like *Nectar, Cerberus, Thoth, Nepenthes,* are temporarily so wide as to resemble the dark areas. Practically every step of transition between these broad bands and the finest most difficult canals is represented.
>
> The canals as a rule, even the fainter ones, do not appear quite sharp but rather as diffuse hazy shadings. Sometimes they change in intensity along their course, and occasionally they even break off abruptly without reaching an endpoint. . . . In the dark areas the network is also present, but here the lines mostly become broad dark bands while the spots appear as diffuse condensations of shading. There are many reasons indicating that the framework structure of the dark areas is of the same topographical character as the network (canal) system of the normal surface. . . . The network exhibits a great deal of irregularity and does not make the impression of artificiality. Although a certain tendency to straightness or directness of line in the canals cannot be denied, it seems nevertheless possible to interpret the network by natural geological features of the crust of the planet. (R. J. Trumpler, "Visual and Photographic Observations of Mars Made at the Opposition of 1926," *Publications of the Astronomical Society of the Pacific,* vol. 39, p. 103, 1927.)

In 1939 Edison Pettit of the Mount Wilson Observatory began a series of drawings of Mars using a 6-in. Clark refractor. He undertook the work as a matter of self-education, with the intention of studying the seasonal changes. He had never been able to see the canals, and had concluded that they were visible only to a special type of eye, and that his eyes were of the great majority that could not see them.

Early one morning, while sketching the planet, a canal suddenly appeared and within a few seconds another. Within two hours he was able to see two more, sometimes all four being visible at once. On succeeding nights he was able to see the four canals again and some additional ones. In the following two months he made drawings of 40 canals, each identified three times before being put on a final drawing. On the best nights there were moments of "superseeing" when the whole canal pattern would flash out for a second or two. Very rarely was this interval as long as four or five seconds. The colour of the canals was an olive green, the same tint as the maria at that time.

On June 3, 1956, when Mars was at a distance of 75,000,000 mi., R. S. Richardson observed Mars under very favourable seeing conditions with the 60-in. reflecting telescope on Mount Wilson. The canals appeared to be simply narrow extensions of the maria into the deserts, and were of the same colour as the maria. The markings did not have an artificial appearance, but gave the impression of being some natural surface feature. Richardson seems to have seen the canals in much the same way as Trumpler saw them in the description cited above.

On the other hand, Kuiper maintained, "I have never seen a long, narrow canal nor a network of 'fuzzy canals.' I am personally convinced that the objective evidence which has led to this concept has been misinterpreted and erroneously represented on drawings" (Gerard P. Kuiper, "On the Martian Surface Features," *Publications of the Astronomical Society of the Pacific,* vol. 67, no. 398, Oct. 1955). Kuiper found that there was no evidence anywhere on the planet of a distinctly geometrical pattern; nor of a systematic streakiness in relation to the planetary coordinates (though in a given mare some streakiness may be observed). To him the dimensions of the patches appeared quite random and natural—and the representation of the many oases of roughly uniform size he considered definitely wrong.

An observation of Mars made by G. E. Hale and his associates at the 60-in. telescope on Mount Wilson on Nov. 3, 1909, has been quoted so often, and has come to be of such critical importance in the history of the canals, that it deserves comment. Mars was observed that night under excellent seeing conditions with a magnification of 800. Hale in a letter says: "So far as any of us could make out, there is not a trace of geometrical structure on the planet, nor any narrow straight canals."

All experienced observers of Mars are agreed that the visibility of the canals depends upon the Martian season. They first appear clearly in the southern hemisphere about early spring corresponding to April 1 (northern style season), and by the middle of June little is left of them. Very few canals are visible in the southern hemisphere from late summer through winter. Hale's observation was made in Martian midsummer corresponding to terrestrial date July 23. It is therefore not surprising that he and his colleagues failed to see any canals that night.

There is no trace of the canals on the Mariner 4 pictures. This is not so surprising, however, when one considers the nature of the photographs themselves and the circumstances under which they were taken. Photographs 8 to 13, inclusive, are all of the Mare Sirenum where a canal would be difficult to discern against the dark background. The first seven photographs, taken over the bright areas, are crossed by several well-known canals: Erebus on no. 2, Orcus on no. 3, and Avernus on no. 5. Each photo shows an area very approximately 300 mi. on a side. As a mean between various estimates, a width of about 50 mi. for a canal can be assumed. On the scale of the photographs the canals would not appear as dark lines but rather as a short section of a broad band. Such a marking would not show on the photographs unless it stood out in strong contrast to its surroundings. But one would expect the canals to be dim because the photographs were taken when the season was midwinter in the southern hemisphere and the canals seldom appear to advantage until the southern spring.

LIFE ON MARS?

Plant Life.—Despite the daily extremes in Martian temperature, the absence of oxygen from the atmosphere, and the low humidity, observational evidence from several sources indicates the presence of life in the maria. Some interesting work on this subject was carried out by G. A. Tikhoff of the Academy of Sciences of the U.S.S.R. and his co-workers near the Arctic circle in the eastern Soviet Union, where conditions except for oxygen are scarcely less rigorous than those on Mars. The purpose of the project was to study plants growing under conditions resembling as nearly as possible those on Mars. The investigation proceeded from three basic assumptions: that the laws of life in the universe are identical in essence but differ in their manifestations; that the living organism is exceedingly adaptable to external conditions; and that plants possess optical adaptations to external conditions.

One of the objections to the presence of green plants on Mars is that the maria do not reflect light as chlorophyll does. Chlorophyll, the green colouring matter in plants, shows an absorption band at about λ6,700, and reflects light strongly in the infrared beginning at about λ7,000. But the maria reflect red and infrared equally well.

Tikhoff's group found that, as a general rule, plants growing un-

der conditions of extreme cold do not reflect as much light as those growing in milder climates. Evergreens, for example, were found to reflect about half as much of the red rays in winter as in summer. About half the radiant energy from the sun is contained in the infrared region of the spectrum. Ordinarily, green plants reflect these rays strongly. But in an extremely cold climate the plants protect themselves from the cold by absorbing as much as possible of the radiant energy from the sun. They not only absorb much of the infrared radiation of the sun but a considerable portion of the red, orange, and yellow light as well. Therefore, plants growing in excessively cold climates do not show the characteristic absorption band of chlorophyll in the red simply because the radiation throughout this whole region is absorbed. Plants growing in the Arctic usually appear darker or "bluer" than plants growing in a warmer climate because they reflect principally violet, blue, and green light; whereas plants in warmer climates reflect yellow and some orange. From their observations on the Pamir plateau in the Arctic, the climate of which is hardly less severe than that of Mars, Tikhoff and his colleagues concluded that the low Martian temperatures would not necessarily be fatal to plant life.

From considerations of the maria, Salisbury concluded that life as it is known on earth could not survive the rigours of the Martian climate. But he offered two biological possibilities: that life forms, essentially similar to those known on earth, have become adapted to the planet; or that some other form of life, a parabiology, accounts for the markings on Mars.

Animal Life.—Existence of animal life on Mars is much less likely than plant life. It is unlikely that higher forms of animal life could exist in such a cold, arid, and oxygenless world. Only the lowest types of animals, with little need of oxygen or water, would be able to survive. Information on this point has been obtained experimentally by subjecting terrestrial microorganisms to an environment closely simulating that on Mars (E. Packer, S. Scher, and C. Sagan, 1963). From their results these workers stated their conclusions as follows:

> We may have some confidence that terrestrial microorganisms will survive the inclemency of the Martian environment and that under supercooled conditions at temperatures above —20° C some bacterial growth can be anticipated. Growth will depend in part on the availability of water and organic material on and near the Martian surface. The likelihood that many terrestrial microorganisms can survive on Mars has, of course, no rigorous implications for the likelihood of indigenous life on that planet. Yet it does demonstrate that evolutionary tractable biological mechanisms exist for survival and growth under contemporary Martian conditions, and suggests that organisms slowly evolving from the more clement conditions in the ancient Martian past may have even greater capability for dealing with the apparent rigours of the Martian environment.

Mariner 4 was not designed to secure information regarding life on Mars. On the evidence of the photographs, the question is still open. But the moonlike uneroded aspect of the surface shows that the planet has never had an extensive atmosphere or enough water to form seas and oceans. High forms of animal life could not develop under such unfavourable conditions, but plant life is not ruled out. The seasonal changes in the maria are yet to be explained. The new dark area that developed in the Thoth region between 1952 and 1954 begins to loom as an observation of major importance. Thoth was not a feature barely visible like the canals but was an area about the size of Texas and was easily visible to anyone with a 6-in. telescope.

Human Habitability of Mars.—By careful preparation a man could undoubtedly survive on Mars. But he would be living in a hostile, alien environment where the slightest mishap could be disastrous. Atmospheric pressure at the surface appears to be much lower than was formerly supposed. To carry on respiration a pressure suit and oxygen equipment would be necessary. Many reactions so familiar to man on earth that they are taken as a matter of course would be impossible on Mars or would proceed very slowly. A man out on the open surface could not light his pipe or start a fire. Metal would not rust. Under the reduced pressure water would boil away so rapidly it would be useless for cooking purposes. None of the natural sources of energy, such as coal and oil, is available on Mars. Solar radiation would be weak and undependable. To establish a base on Mars, suitable nuclear reactors would first have to be developed to maintain it.

Because the Martian atmosphere is bombarded continually by the full flux of cosmic rays and full fluxes of solar flare particles, the radioactive products of the disintegrations present differ from those on earth and probably are somewhat more intense relative to the density of the atmosphere. Recent evidence indicates that ultraviolet rays penetrate the Martian atmosphere and reach the planet's surface, thus creating a radiation hazard for man.

SATELLITES

The two moons of Mars were discovered by Asaph Hall of the U.S. Naval Observatory in 1877. That year was especially favourable for such a search, as the planet was within 34,800,000 mi. of earth on Sept. 5, the closest approach in 30 years. Other observers had searched in vain for a satellite of Mars, but Hall believed the new 26-in. refractor of the Naval Observatory should be able to detect a companion of Mars, if one existed.

TABLE V.—*Satellites of Mars**

	Phobos	Deimos
Discoverer	Asaph Hall	Asaph Hall
Date of discovery	Aug. 17, 1877	Aug. 11, 1877
Distance from centre of Mars (radius of Mars = 1)	2.743	6.891
Distance from centre of Mars	5,820 mi. (9,366 km.)	14,615 mi. (23,520 km.)
Sidereal period	7 hr. 39 min. 13.85 sec.	30 hr. 17 min. 54.87 sec.
Inclination of orbit to equator of Mars	0° 57′	1° 18′
Orbital eccentricity	0.0210	0.0028
Approximate magnitude at mean opposition distance	11	12
Estimated diameter	10 mi. (16 km.)	6 mi. (10 km.)

*These data are taken mostly from the *Explanatory Supplement to the American Ephemeris and Nautical Almanac* (1961).

However, he was almost ready to give up the search as hopeless when he sighted a suspicious object near the planet on the night of Aug. 11. Clouds prevented further observations until Aug. 16, when the object was sighted again and found to be moving at the same rate as Mars, thus establishing its identify as a satellite. The following night Hall found another object closer to the planet than the first one; it moved so rapidly that he thought at first Mars must have several inner moons. By keeping watch continually throughout the nights of Aug. 20–21 he satisfied himself that there was but one inner moon. Hall named the outer satellite Deimos (Terror) and the inner one Phobos (Fear), after the horses that drew the chariot of the war god Mars. The discovery of these satellites was of great practical importance as it enabled astronomers immediately to get an accurate value for the mass of Mars.

Phobos is so near the planet that it revolves around Mars in less than one-third of the rotation period of Mars. To an inhabitant of Mars, Phobos would rise in the west and set in the east, making two apparent rotations in a day. The period of Deimos is six hours longer than a Martian rotation. Its apparent motion around the planet would be so slow that more than two days would elapse between rising and setting, and setting and rising.

Phobos and Deimos are too small to present a disk even in the largest telescopes, and so their diameters cannot be measured directly. However, if an assumption is made about their albedos (overall reflecting power of their surfaces) their diameters can be calculated from their apparent brightness. Thus, if the satellites are assumed to have the same albedo as Mercury, the diameter of Phobos is 10 mi. and that of Deimos is 6 mi. But if it is assumed that they have the same albedo as Mars, the diameter of Phobos is about 8 mi. and of Deimos, 5 mi.

In 1959 I. S. Shklovskiy suggested that Phobos is a hollow sphere, and therefore of artificial origin. This startling hypothesis was made in an attempt to explain the apparent increase in the mean motion of Phobos reported in 1954 by F. J. Kerr and F. L. Whipple. If there is an appreciable Martian atmosphere 3,700 mi. above the surface at the orbit of Phobos, it would be more effective in changing the motion of a body of negligible mean density, such as a thin shell satellite, than a solid body of the same size.

Tentative results obtained by G. F. Schilling (1963) indicate the Martian atmosphere at 3,700 mi. may be of sufficient density to produce the acceleration in the mean motion of a solid satellite.

Some authorities question the reality of this acceleration, as well as the reliability of the observations from which it was derived. Until more and better data become available on this problem, hypotheses as to the constitution of Phobos seem futile.

See also references under "Mars" in the Index.

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(W. H. WR.; R. S. RN.)

MARSCHNER, HEINRICH AUGUST (1795–1861), German composer who helped to establish the style of German romantic opera, was born at Zittau, Saxony, on Aug. 16, 1795. He studied at Leipzig and about 1815 met Beethoven in Vienna. Weber produced his *Heinrich IV und d'Aubigné* in 1820 at Dresden, where Marschner was later appointed director of the opera. In 1827 he was appointed director at Leipzig, where in 1828 he successfully produced his romantic opera *Der Vampyr* and the following year *Der Templer und die Jüdin* on a libretto based on Sir Walter Scott's *Ivanhoe.* In 1831 he became director at Hanover and on May 24, 1833, he produced his more successful opera, *Hans Heiling,* at Berlin. Between 1836 and 1863 he produced five further operas, among them *Kaiser Adolf von Nassau* (1845), conducted by Wagner. None of these, however, achieved the success of his earlier works. He died at Hanover on Dec. 14, 1861.

Marschner's operas illustrate the preoccupation of early romantic opera composers with supernatural subjects. Aspects of his style, notably his brilliant orchestration, were influenced by Weber.

See H. Gaartz, *Die Opern Heinrich Marschners* (1912).

MARSEILLAISE, LA, the French national anthem. It was composed in one night (April 24, 1792), by Claude Joseph Rouget de Lisle, a captain of engineers who was also an amateur musician. After the declaration of war with Austria on April 20, 1792, the need of a marching song for the French was expressed by P. F. Dietrich, the mayor of Strasbourg, where Rouget was quartered. The hymn, originally entitled *Chant de guerre pour l'armée du Rhin,* was Rouget's response. Sung with enthusiasm by the volunteers from Marseilles on their march to Paris and at their quarters in the Faubourg St. Antoine, it came to be called "La Marseillaise."

"La Marseillaise" was accepted as the French national anthem by the Convention in a decree passed on July 14, 1795. It was banned by Napoleon during the empire and by Louis XVIII on the second Restoration (1815) because of its revolutionary associations. After the July revolution of 1830 it was again authorized. Napoleon III banned it and it was not reinstated till 1879. In 1887 Gen. George Boulanger, then minister of war, set up a commission under Ambroise Thomas to prepare a definitive edition of the music. It is now generally agreed that Rouget de Lisle wrote both the words and the music, though many composers, including Grétry and Gossec, later made improvements in it.

See L. Fiaux, *La Marseillaise* (1918).

MARSEILLES (French MARSEILLE), a city and chief seaport of southern France, the capital of the *département* of Bouches-du-Rhône. It lies 219 mi. S. by E. of Lyons and 534 mi. S.S.E. of Paris by railway. Pop. (1962) 767,146.

History.—The colony of Massilia (Massalia) was founded by Greek mariners from Phocaea (in Asia Minor) about 600 B.C.; probably Phoenicians had settled at Marseilles before the Greek period. In 542 B.C. the fall of the Phocaean cities before the Persians probably sent new settlers to Massilia and cut it off from close connection with the mother country. Isolated amid alien populations, the Massilians maintained themselves by prudence and by vigilant administration of their oligarchical government. Their colonies spread east and west along the coast from Monaco to Cape St. Martin in Spain, carrying with them the worship of Artemis. The inland trade, in which wine was an important element, can be traced by discoveries of Massilian coins across Gaul and through the Alps as far as Tirol. In the 4th century B.C. the Massilian Pytheas visited the coasts of Gaul, Britain and Germany; and Euthymenes is said to have sailed down the west coast of Africa as far as Senegal. The great rival of Massilian trade was Carthage, and in the Punic wars the city took the side of Rome, and was rewarded by Roman assistance in the subjugation of the native tribes of Liguria. In the war between Caesar and Pompey, Massilia took Pompey's side and in 49 B.C. offered a vain resistance to Caesar's lieutenant Trebonius. In memory of its ancient services the city was left as a *civitas libera* ("free city") but its power was broken and most of its dependencies taken from it. Thereafter Massilia has little place in Roman history; it became for a time an important school of letters and medicine, but its commercial and intellectual significance declined. The town appears to have been Christianized before the end of the 3rd century.

After the ravages of successive invaders, Marseilles was repeopled in the 10th century under the protection of its viscounts. The town gradually bought up their rights, and at the beginning of the 13th century was formed into a republic, governed by a *podestat,* appointed for a term of one year, who exercised his office in conjunction with 3 notables and a municipal council composed of 80 citizens, 3 clerics and 6 principal tradesmen. The higher town was governed by the bishop, and had its harbour at the creek of La Joliette, which at that period ran inland to the north of the old town. The southern suburb was governed by the abbot of St. Victor, and owned the Port des Catalans. Situated between the two, the lower town, the republic, retained the Vieux-Port (old harbour) and was the most powerful of the three divisions. In 1245 and 1256 Charles of Anjou, count of Provence, whose predecessors had left the citizens a large measure of independence, established his authority above that of the republic. In 1423 Alfonso V of Aragon sacked the town but King René, who had made it his winter residence, caused trade, arts and manufactures to flourish again. On the incorporation of Provence in the kingdom of France in 1481, Marseilles preserved a separate administration directed by royal officials. Under Francis I, Charles, duc de Bourbon, vainly besieged the town with the imperial forces in 1524 and 1536. During the wars of religion, Marseilles took part against the Protestants, and long refused to acknowledge Henry IV. The loss of the ancient liberties of the town brought new disturbances under the Fronde, which Louis XIV came in person to suppress. He entered the town by a breach in the walls and afterward had Ft. St. Nicolas constructed. Marseilles repeatedly suffered from the plague, notably in 1720–21.

During the Revolution the people rose against the ruling aristocracy. The city gave its name to the French national anthem (*see* MARSEILLAISE, LA). In the Terror the people of Marseilles rebelled against the Convention, but were promptly subdued. The wars of the empire, by dealing a blow to their maritime commerce, excited the hatred of the inhabitants against Napoleon, and they hailed the return of the Bourbons and the defeat of Waterloo. The prosperity of the city received a considerable impulse from the conquest of Algeria and from the opening of the Suez canal. During World War I part of the harbour became a British base, and many Indian, Australian and African troops passed through, and, after the Armistice, an American embarkation camp was established. In World War II Marseilles was occupied by the Germans from Nov. 1942 until it was liberated in Aug. 1944 by the French 3rd infantry division under Gen. Goislard de Montsabert. To spare the population, he besieged the city without bombing it. When U.S. soldiers returned home, in 1946, more than 1,000,000 embarked from Marseilles.

The Town.—Marseilles is situated on the Gulf of Lions on the eastern shore of a bay protected to the south by Cape Croisette but open toward the west. The city is built on undulating ground and the southwestern and most aristocratic quarter covers the slopes of the ridge crowned by a fort and the church of Notre-Dame-de-la-Garde and projecting westward into the bay to form a protection for the harbour. The newest portion lies on the southeastern slope of the ridge, which is better protected than most of the other quarters from the mistral (a cold northerly wind), and where in summer the temperature is always a little lower than in the centre of the town. From the old harbour, which opens on

the west to the Gulf of Lions, the famous boulevard La Canebière, the artery of the city's life, leads east-northeast.

The old town of Marseilles is bounded on the west by the Joliette basin and the sea, east by the Cours Belsunce, south by the northern quay of the old port, and north by the Boulevard des Dames. It consisted of a labyrinth of steep, dark and narrow streets inhabited by a seafaring population. On Jan. 24, 1943, the Germans evacuated the entire district on the edge of the port and destroyed it with explosives. Subsequently a new residential district was built there.

The entrance to the old harbour is defended by Ft. St. Jean on the north and Ft. St. Nicolas on the south. Behind the latter is the Anse (bay) de la Réserve. Beyond this again, situated in succession along the shore, come the Château du Pharo, which was given to the town by the empress Eugénie, the Anse du Pharo and the Anse des Catalans. In the roads to the southwest of the port lie the islands of Ratonneau and Pomègues, united by a jetty formerly forming a quarantine port but today abandoned. Between them and the mainland is the islet of Château d'If, in which the scene of part of Alexandre Dumas' *Le Comte de Monte-Cristo* is laid.

Marseilles possesses few remains of either the Greek or the Roman periods of occupation and is poor in medieval buildings. In the Place de la Major, the old cathedral of La Major (Ste. Marie-Majeure), dating chiefly from the 12th century and built on the ruins of a temple of Diana, is poorly preserved; the chapel of St. Lazare in the left aisle is early Renaissance. Beside this church and alongside the Joliette basin is the church begun in 1852, which has taken the place of the old cathedral.

On the south side of the old harbour near Ft. St. Nicolas stands the church of St. Victor, built in the 13th century and once attached to an abbey founded about 413. With its lofty crenelated walls and square towers built of large blocks of uncemented stone, it resembles a fortress. St. Victor is built above crypts dating mainly from the 11th century but also embodying architecture of the Carolingian period and of the early centuries of the Christian era. The spire of the ancient church of Accoules, and its only relic, marks the centre of Old Marseilles. Notre-Dame du Mont Carmel, also in the old town, occupies the place of what was the citadel of the Massilians when they were besieged by Julius Caesar. The celebrated Notre-Dame-de-la-Garde, the steeple of which is surmounted by a gilded statue of the Virgin, 30 ft. in height, rises 150 ft. above the summit of the hill on which it stands.

Of the civil buildings of the city, the Prefecture, one of the finest in France, the Palais de Justice and the Exchange all date from the latter half of the 19th century. The Hôtel de Ville (1673) stands on the northern quay of the old harbour. The Palais Longchamp (1862–69) is a museum and art gallery. The museum of antiquities, established in the Château Borély (1766–78), includes a Phoenician collection (containing the remains that support the hypothesis of the Phoenician origin of Marseilles). The city also has a colonial museum and a laboratory of marine zoology. The triumphal arch of Aix, originally dedicated to the victors of the Trocadéro, was in 1830 appropriated to the conquests of the empire.

The *canal de Marseille,* built between 1837 and 1848, which has transformed the town and its arid surroundings by bringing to them the waters of the Durance, leaves the river opposite Pertuis. It has a length of 97 mi. (including its four main branches) of which 13 mi. are underground, and irrigates approximately 7,500 ac. After crossing the valley of the Arc, between Aix and Rognac, by the magnificent aqueduct of Roquefavour, its waters are purified in the reservoirs of Realtort. It draws about 2,200 gal. of water per second from the Durance, supplies 2,450 h.p. to works in the vicinity of Marseilles, and insures a good water supply and efficient sanitation to the city.

Marseilles is the seat of an archbishop and a prefect. It has tribunals of first instance and of commerce, a chamber of commerce and a board of trade arbitration. The educational institutions include a school of navigation and faculties of science, medicine and pharmacy; these two faculties form part of the university of Aix-Marseilles.

The Port, Trade and Industry.—The surface area of the Vieux-Port was doubled toward the north in 1846 by the creation of the new port of La Joliette; it was afterward extended farther north by eight wet docks. The port facilities, which were destroyed by the Germans in 1944, have been rebuilt and perfected. The new port is connected by the Rove tunnel to the Étang de Berre, which opens to the sea, and by the canal which is destined to go from Marseilles to the Rhône; the portion from Étang de Berre to the river was not completed by the late 1950s. There is an old canal from Port-de-Bouc at the mouth of the estuary to Arles, on the Rhône, but it is not deep enough to permit the passage of modern ships. A new port, Lavéra, has been built in the inner harbour of Port-de-Bouc which can receive nine tankers at once without the entry being blocked. Together with the refineries which line the banks of the Étang de Berre, Lavéra is a port annex of great importance to Marseilles. The airport of Marignane is on the south bank, 17½ mi. from the centre of the city.

When they left in 1944, the Germans destroyed the fleet. By the late 1950s it had been rebuilt to a capacity of 915,000 tons distributed between passenger and cargo ships. Many lines are based there which send ships to the eastern Mediterranean, the east coast of Africa, Australia, India, Indochina, Algeria, Tunisia, Malta, Morocco and the Antilles, as well as Great Britain and the ports on the west coast of France. In addition, many of the big foreign lines call at the port, which is mainly a transshipment and industrial port instead of, as formerly, an entrepôt.

Marseilles is the western emporium for trade with the Levant and it is the French gate of the far east. It suffers from competition with Genoa for trade with Switzerland and from lack of communication with the inland waterways of France. It was hoped that improved navigation on the Rhône and the construction of one new canal from Bouc to Arles, or to St. Louis, would make the city of Marseilles the national outlet from the rich basin in which it lies.

In order of importance, the imports are crude petroleum, grains, out-of-season fruits and vegetables, carbon, sugar, peanuts, chrome, phosphates, vegetable oils and greases, cotton, rubber, wine, copra, sulfur, coffee, Indian corn, skins and leathers, bananas, dates and dried fruits, manganese and nonferrous metals. Less important are meats, dried vegetables, cocoa, leaf tobacco, exotic woods, cork, paper and cardboard, wool, iron and steel.

The major export is petroleum. After that, successively, come construction materials, machines, chemical products, sugar, carbon, metalwork, farina, automobiles, lumber, fresh vegetables, cloth, beer, tobacco, wine, soap and vegetable oils.

The industry of Marseilles is closely connected with its imports, from which are taken most of the raw materials processed there. By the early 1960s the most important industry was based on the pact of San Remo (1920), which gave France one-fourth of Iraq's production of petroleum of which a large part is refined at Berre.

The oldest and best known industry, founded in the 15th century, is that of soap. It retains its importance despite a sharp decrease since 1935. The production of sugar has decreased similarly since 1920. Even though the oil refineries represent half the production of France, drastically reduced in the late 1950s, their production is 50% of what it was formerly. Marseilles is the largest producer of semolina in France; and is the fourth largest producer of *pasta,* which is made from semolina. The building materials made—quicklime, cement, plaster, bricks and tiles—are a significant part of France's total. The manufacture of glass is still a major industry. Metallurgy and smelting grew in importance after World War II and Marseilles developed a very large chemical industry (sulfuric acid, superphosphates, hydrochloric acid, refined sulfur and copper sulfate), partly owing to the needs of the vine-growing region around the city.

See also references under "Marseilles" in the Index. (J. Bd.)

MARSH, JOHN (1752–1828), English amateur musician, composer and writer on music, was born at Dorking, Surrey, and, as his father was a naval officer, he spent his youth at Greenwich and Gosport, Hants. As a musician he was largely self-taught,

except for a few lessons on the violin. In 1768 he was articled to a solicitor at Romsey, Hampshire. He took part in the local musical life there as well as at Winchester and at Salisbury, then the best musical centre in southern England. In 1783 he came into a considerable fortune, including an estate near Canterbury, where he became leader of the subscription concert orchestra. In 1787 he moved to Chichester, where he remained for the rest of his life, reorganizing and directing the subscription concerts and deputizing for the cathedral organist, and where he died in 1828.

Marsh was not only a good violinist and orchestral leader but also was a competent composer, especially of chamber and orchestral music; some of his quartets and symphonies have considerable merit. He is also of interest as a writer on music; his essay, "A Comparison of Ancient and Modern Music," which first appeared in the *Monthly Magazine* for 1796 (reprinted in *Music and Letters,* April 1955), and his *Hints to Young Composers* (Chichester, *c.* 1806) are both useful and interesting, as are his numerous prefaces to his published instrumental works. His entertaining and informative autobiography has survived in manuscript. (Cs. Ch.)

MARSH, OTHNIEL CHARLES (1831–1899), U.S. paleontologist whose discoveries and descriptions of numerous fossils won him his scientific reputation, was born in Lockport, N.Y., on Oct. 29, 1831. He graduated from Yale college in 1860, and studied geology and mineralogy in the Sheffield Scientific school there. Becoming interested in vertebrate paleontology, he studied abroad and on his return to Yale in 1866 was appointed professor of vertebrate paleontology. He was aided by a private fortune from his uncle, George Peabody, whom he induced to establish the Peabody Museum of Natural History in the college. With this backing, he sent out numerous exploring parties to Wyoming and other western states almost annually for the next three decades.

In his publications on fossil finds he utilized the studies of such scientists as Samuel Wendell Williston, Oscar Harger, Max Schlosser and George Baur; these men were not generally permitted to publish individually on vertebrate paleontology while in Marsh's employ. A host of short papers by Marsh appeared in the *American Journal of Science;* his major published works, however, were quarto volumes on toothed birds, the Dinocerata (archaic horned mammals) and North American dinosaurs. Marsh was prominent in national scientific affairs, and was president of the National Academy of Sciences for 12 years. His contemporary in the exploration of the western fossil beds was Edward Drinker Cope (*q.v.*) of Philadelphia; they were originally friends but their rivalry over collecting sites developed into a bitter feud that somewhat clouded the reputations of both. Early government geological exploration of the west had been made by several independent surveys; they were combined in 1881 to form the United States Geological survey. Marsh was put in charge of its work in vertebrate paleontology and given liberal support.

Marsh's last years were saddened by financial reverses, loss of government support and demand that fossils collected under government auspices be sent to the National museum. He died in New Haven on March 18, 1899.

See Charles Schuchert and Clara Mae Le Vene, *O. C. Marsh, Pioneer in Paleontology* (1940). An interesting account of Marsh's fieldwork and the Marsh-Cope rivalry is given in G. T. Hellman's "Onward and Upward with Science" in *The New Yorker,* vol. xxxviii, no. 37, pp. 142–176 (Nov. 3, 1962). (A. S. Rr.)

MARSH, an area of low, flat-lying, wet ground subject to daily, seasonal or perennial flooding. In popular usage the term is applied interchangeably with swamp (*q.v.*). Technically marshes have many physical features common to swamps; they differ chiefly in having vegetation composed dominantly of grasses and such grasslike plants as sedges and rushes. Characteristic marsh plants include cord and salt reed grass in salt water, saw grass and reeds in brackish to fresh water, and Indian rice and giant cane in fresh water.

Salt- and brackish-water marshes are common along low seacoasts, inside barrier bars and beaches, in estuaries and on deltas, and are often extensive in deserts. Maritime marshes often extend many miles inland and are variably subjected to tidal action. Fresh-water marshes are found frequently on mineral substrates of alluvial and lacustrine origin and are both numerous and extensive on upland areas with impeded drainage, particularly those, such as the most recently glaciated areas of North America, with underdeveloped drainage. Marshes were ubiquitous in the prairie of the midwestern United States, but their value as agricultural soils resulted in early drainage and cultivation. As wildlife refuges they provide a valuable economic and recreational resource.

Notable marshes in the United States are the Everglades of Florida, the tule marshes of the Sacramento and San Joaquin valleys of California and the Humboldt Salt marsh of Nevada. The vast Pripet marshes in the Soviet Union and the Pontine marshes near Rome are of particular historical interest. (M. E. B.)

MARSHAL, a title given in various countries to certain military and civil officers, often of high rank; it has evolved from the title of the *marescalci,* or masters of the horse, of the early Frankish kings. In this original sense the word survived down to the final days of the Holy Roman empire in the titular office of *Erzmarschalk* (arch-marshal), borne by the electors of Saxony.

Elsewhere the meaning of the office and title of marshal became modified. The importance of cavalry in medieval warfare led to the marshalship being associated with military command; this came to include the duties of keeping order at court and in camp, of deciding questions of chivalry and involved the assumption of judicial and executive functions. As a military leader the marshal was originally subordinate to the constable (*q.v.*). By the 12th century, however, although still nominally second to the constable, he was rapidly coming to prominence as commander of the royal forces and as a great officer of state.

The Great Marshals of England, Scotland and France.—In England there was probably a master marshal of the king's household under the first two Norman kings; the office was certainly well established in the 12th century when the marshal's duties and remuneration were noted in the *Constitutio domus regis,* an account of the staff of the royal household compiled early in Stephen's reign (1135–54). Until the mid-13th century the marshalship was hereditary in the family which derived its surname from the office. Its importance was enhanced by the marshalship of William Marshal (d. 1219) who had by marriage become earl of Pembroke. William's son Gilbert was described by Matthew Paris (*Chronica maiora,* ed. by H. R. Luard, 1872–83, vol. iii, p. 338) as the great marshal of England, who bore his baton before King Henry III and superintended the seating of guests at a feast. By the end of the 13th century the office of marshal, now passed to the Bigod earls of Norfolk, had become as important as that of constable; its holder was usually referred to as the earl marshal, but only because he was now also an earl. The title earl marshal (*q.v.*) was granted in 1386, when Richard II gave it to Thomas Mowbray, later duke of Norfolk.

In Scotland the office of marischal (from the French *maréchal*), probably introduced under David I (d. 1153), became in the 14th century hereditary in the house of Keith. In 1458 the Scottish marischal became an earl under the designation of earl-marischal. The dignity came to an end at the attainder in 1716 of George, 9th earl-marischal.

In France, however, care was always taken to prevent the office of marshal of France (*marescallus Franciae*) becoming hereditary. The office was instituted under Philip II (d. 1223), and the marshal became one of the great officers of the crown. From the time of Philip's grandson Louis IX (d. 1270) two marshals were usually appointed; Francis I (d. 1547) added a third and Henry II (d. 1559) a fourth. Henry IV, Louis XIII and Louis XIV were all responsible for further increases in the number of marshals; for a time, after the great promotions of 1703, there were 20 marshals. Between 1763 and 1788 the number varied from 15 to 16; after the Revolution it was reduced to 6 in 1791 and in 1793 the office was suppressed. In 1804 Napoleon created 18 marshals of the empire, among whom were Michel Ney, Nicolas Soult, Jean Bernadotte and Joachim Murat. At the Bourbon restoration (1815) when the title again became marshal of France, the number was reduced to 15; in 1839 it was decided that there should be no more than 6 marshals in time of peace, 12 in time of

war. The title fell into abeyance after 1870 and marshals are now normally created only in time of war. Among famous earlier marshals were Turenne (created 1643) and Vauban (created 1703).

Marshals of Army and Air Force.—The word marshal in the sense of commander of an army was used as early as the 13th century in England; in 1214 King John appointed William, earl of Salisbury, *marescallus* of his forces. The modern military title of field marshal, imported from Germany by King George II in 1736, is derived from the high dignity of the Frankish *marescalcus* in a roundabout way. The marshal, being responsible for order in court and camp, had to employ subordinates who soon became only nominally dependent upon him. These were the *marescalci campi* or *maréchaux de camp*. On military expeditions two or more such marshals preceded the army, to select the site of the camp and assign places in it. In peacetime they arranged the king's lodging and maintenance when he traveled. The French title *maréchal des logis*, the marshal in charge of billeting, existed from the time of Louis XIV until the Revolution, and remained in the French and Belgian armies to denote a quartermaster in cavalry regiments. A modern use of the title marshal in connection with warfare is the style air marshal, given to high-ranking officers of the British and some Commonwealth air forces. A provost marshal is an officer in charge of military police.

Marshals with Judicial Functions.—In England, from the time of Edward III (d. 1377), the marshal and the lord steward (*q.v.*) presided in the Marshalsea court, held to settle disputes to which members of the household were party. This court was abolished in 1849. There was also until 1841 a *marescallus banci regii* (marshal of the king's bench), responsible for the custody of those detained in the Marshalsea prison.

The official known as judge's marshal, usually a newly called barrister, attends each assize judge, acting as his secretary and personal assistant.

In the United States the title marshal is used to denote two types of executive legal officer. The United States marshal, appointed by the president with the consent of the senate, is the executive officer of the federal courts. One marshal is normally appointed for each district. The marshal's duties are to open and close the sessions of the district and circuit courts, serve warrants and execute the orders of the court. The temporary police sworn in to maintain order in times of disturbance, known in England as special constables, are also termed marshals in the United States. In some cities the head of the fire department is known as the fire marshal.

MARSHALL, ALFRED (1842–1924), British economist who, through the influence of his work, was one of the chief founders of the school of neoclassical economists, was born in London on July 26, 1842. Educated at Merchant Taylors' school and at St. John's college, Cambridge, in 1877 he became the first principal of University college, Bristol, but resigned in 1881 because of ill health. He was a fellow and lecturer in political economy at Balliol college, Oxford, from 1883 to 1885, when he returned to Cambridge as professor of political economy in succession to Henry Fawcett. He was a member of the royal commission on labour from 1891 to 1894 and subsequently served in several government inquiries. In 1903, after years of struggle, he succeeded in establishing an economics tripos at Cambridge, separate from the moral sciences tripos. He retired from the chair of political economy in 1908 and thenceforward devoted himself to his writings until his death at Cambridge on July 13, 1924.

Marshall's first big work, *Principles of Economics* (1890), was in many ways his most important contribution to economic literature. His next volume, *Industry and Trade*, a realistic study of industrial organization, did not appear until 1919, but in the meanwhile he had devoted much time and energy to bringing out successive editions of his *Principles*. In 1923 he published his last volume, *Money, Credit and Commerce*. Marshall may be said to have been in the lineal descent of the great English economists—Adam Smith, Ricardo and J. S. Mill. His *Principles of Economics* was distinguished by its profound and systematic methods of analysis and by the introduction of a number of new concepts, such as elasticity of demand, consumer's surplus, quasi rent, the representative firm, etc., which played a great role in the subsequent development of economics. Writing at a time when the economic world was deeply divided on the theory of value, he succeeded, largely by introducing the element of time as a factor in analysis, in reconciling the classical cost of production principle with the marginal utility principle formulated by William Jevons (*q.v.*) and the Austrian school. He did much to rescue economics from rigid dogmatism by insisting that economic reasoning and laws were not themselves a body of concrete truth but an engine for the discovery of concrete truth. (C. W. G.; X.)

MARSHALL, GEORGE CATLETT (1880–1959), U.S. army officer who directed the organization and training of U.S. land and air forces during World War II, later served as secretary of state and of defense, was author of the Marshall plan for European recovery and was winner of the Nobel peace prize (1953). He was born at Uniontown, Pa., on Dec. 31, 1880, and graduated from the Virginia Military institute, Lexington, in 1901. Commissioned as a second lieutenant in Feb. 1902, with date of rank from Feb. 1901, his first service was in the Philippines (1902–03). He was advanced through the grades to general of the army in Dec. 1944. As a five-star general he was still on active duty and the highest ranking officer of the army at the time of his death.

In World War I he served as chief of operations of the 1st army and chief of staff of the 8th army corps. He drafted plans for the St. Mihiel operation and later was assigned the problem of transferring more than 500,000 men and 2,700 guns to the Argonne front for the Meuse-Argonne battle.

After World War I, he was an aide to Gen. John J. Pershing from 1919 to 1924 and served with the 15th infantry regiment in Tientsin, China (1924–27). As assistant commandant in charge of instruction (1927–32) at the infantry school, Ft. Benning, he strongly influenced army doctrine and such later wartime leaders as Bradley, Collins, Ridgway, Stilwell, Bedell Smith, Hodges and Bolté. He was sworn in as chief of staff of the army on Sept. 1, 1939, the day World War II began with the invasion of Poland by German troops. For the next six years, Marshall directed the raising of new divisions, training of troops, development of new weapons and equipment, and selection of top commanders. He was chief of staff of the army at the time of Pearl Harbor. As an adviser to Pres. Franklin D. Roosevelt on strategy, he attended the conferences at Casablanca, Quebec, Tehran, Yalta and Potsdam.

Marshall resigned as chief of staff Nov. 21, 1945. A few days later he was appointed special representative of Pres. Harry S. Truman to China with rank of ambassador. He was unsuccessful in his efforts to mediate the Chinese civil war.

Appointed secretary of state by President Truman on Jan. 21, 1947, he headed—during the next two years—U.S. delegations to international conferences at Moscow, Rio de Janeiro, Bogotá, Paris, London and New York. On June 5, 1947, at Harvard university he proposed a European Recovery program which, known as the Marshall plan (*q.v.*), was enacted into law in April 1948. The Greek and Turkish aid programs, recognition of Israel and the initial discussions of the North Atlantic Treaty organization (NATO) agreements came during his secretaryship. He resigned on Jan. 21, 1949. In the course of the year he was named chairman of the American Battle Monuments commission and president of the American Red Cross.

Marshall was secretary of defense under Truman from Sept. 21, 1950, to Sept. 12, 1951. In this post he helped implement the NATO agreements. He pressed vigorously for increases in man power and production of matériel to strengthen U.S. forces in Korea, and urged the establishment of a universal military training program.

He represented Pres. Dwight D. Eisenhower at the coronation of Elizabeth II in 1953. Later in the same year he was awarded the Nobel peace prize in recognition of his contributions to the economic rehabilitation of Europe after World War II and his efforts to promote international peace and understanding. He died in Washington, D.C., Oct. 16, 1959, and was buried in Arlington National cemetery. (F. C. Pe.)

See F. C. Pogue, *George C. Marshall*, 3 vol. (1963–).

MARSHALL, JOHN (1755–1835), fourth chief justice of the United States whose constitutional decisions gave shape and definition to the structure of the federal government, was born on Sept. 24, 1755, near a settlement then called Germantown (now Midland), Va., the eldest of 15 children of Thomas Marshall (1730–1802) and Mary Keith Marshall. His childhood and youth were spent in the near-frontier region which in 1759 became Fauquier county, first in the forested area of southern Fauquier in which he had been born, later on in the more extensive properties his father acquired in the Blue Ridge mountain area north and west of Warrenton. His education appears to have been largely the product of his parents' efforts, supplemented only by the instruction afforded by a visiting clergyman who lived with the family for about a year, and by a few months of slightly more formal training at an academy in Westmoreland county. Thomas and Mary Marshall, however, had more learning and wider experience to transmit to their children than was common among the farmers and hunters of the back country of northern Virginia. Mary Keith Marshall was the daughter of a college-trained Scottish clergyman who had migrated to Virginia. Thomas Marshall brought to the family circle a continually broadening experience. A friend of George Washington, he had been his assistant in surveying the extensive estates of Lord Fairfax. Soon after Fauquier county was established he was elected its representative in Virginia's house of burgesses. His career of officeholding next included service as sheriff of Fauquier county, a return to the house of burgesses, appointment as clerk of Dunmore county, followed once again by service in the house of burgesses. This was the period when the differences between the upland counties and the tidewater aristocracy grew sharp and were paralleled by an increasing sentiment for colonial autonomy and finally for independence among the back-country residents whom Thomas Marshall represented.

Early Career.—When political debate with England was followed by armed clashes in 1775, John Marshall, as lieutenant, joined his father in a Virginia regiment of minutemen and participated in the first fighting in that colony. Joining the Continental army in 1776, he served under Washington for three years in New Jersey, New York and Pennsylvania, including in this service the harsh winter of 1777–78 at Valley Forge. When the term of service of his Virginia troops expired in 1779, Marshall returned to Virginia and thereafter saw little active service prior to his discharge in 1781.

Marshall's career in law dates from 1780. His only formal training was a brief course of lectures given by George Wythe which he attended at William and Mary college early in that year. Licensed to practise in Aug. 1780, he returned to Fauquier county and was elected to the Virginia house of delegates in 1782 and 1784. Attending the sessions of the legislature in the capitol at Richmond, he established there both a law practice and a home after marriage to Miss Mary Ambler in Jan. 1783.

For the next 15 years Marshall's career was marked by increasing stature at the brilliant bar of Virginia. He had not, in 1787, achieved a public position which would have sent him as a delegate to the Constitutional Convention in Philadelphia, but he was an active, if junior, proponent of the constitution in the closely contested fight for ratification. Virginia was then the largest and most populous of the states. Its ratification was not only essential to the success of the proposed constitution but was also among the most doubtful. Marshall was elected to the legislature which took the first step toward ratification by issuing a call for a convention to consider ratifying; he was also elected a delegate to the convention. On the floor of that convention the contest on behalf of the constitution was led by men senior to Marshall—James Madison, Edmund Randolph, Edmund Pendleton and Wilson Cary Nicholas; Patrick Henry and George Mason led the opposition. Marshall made one address in reply to a general attack by Henry. His principal effort on the floor was, perhaps prophetically, a defense of the judiciary article. It can only be assumed that his acknowledged popularity was employed with at least equal effectiveness off the floor to gain or hold the narrow margin by which Virginia's ratification was won.

With the new government under the constitution installed, President Washington offered Marshall appointment as United States attorney for Virginia. Marshall declined. In 1789, however, he sought and obtained a further term in Virginia's house of delegates as a supporter of the national government. As party lines emerged and became defined in the 1790s, Marshall became recognized as one of the leaders of the Federalist party (*q.v.*) in Virginia. In 1795, Washington tendered him an appointment as attorney general. This, too, was declined, but Marshall returned to the state legislature as a Federalist leader. His first federal service came when Pres. John Adams appointed him member of a commission, with Elbridge Gerry and Charles C. Pinckney, to seek improved relations with the government of the French republic. The mission was unsuccessful. But when its reports were published disclosing the approach of intermediaries, the shadowy figures of "X, Y and Z," who informed the commissioners that they would not be received by the French government unless they first paid large bribes, and the rebuff of these advances in a memorial which Marshall had prepared, Marshall became a popular figure and the conduct of his mission was applauded by one of the earliest American patriotic slogans, "Millions for defense, but not one cent for tribute" (*see* XYZ CORRESPONDENCE).

Returned from France, Marshall declined appointment to the supreme court to succeed Justice James Wilson but was persuaded by Washington to run for congress. He was elected in 1799 as a Federalist from the Richmond district, though not until he had expressed opposition to the unpopular alien and sedition laws which the Adams administration had sponsored (*see* UNITED STATES [OF AMERICA]: *History: Struggle for National Government, 1783–1865*). His service in the house was brief. His chief accomplishment there appears to have been the effective defense of the president against a Republican attack for having honoured a British request under the extradition treaty for the surrender of a seaman charged with murder on a British warship on the high seas. In May 1800, President Adams requested the resignation of his secretary of war and offered the post to Marshall. Marshall declined. The president next dismissed his secretary of state and tendered the vacant place in his cabinet to Marshall. In an administration harassed by dissension and with uncertain prospects in the forthcoming election, the appeal of the invitation must have been addressed principally to Marshall's loyalty. After some hesitation he accepted and almost immediately became the effective head of government when the president retired to his home in Massachusetts for a stay of a few months. In the autumn of 1800, Chief Justice Oliver Ellsworth resigned owing to ill health. Adams, defeated in the election of November, tendered reappointment to John Jay, the first chief justice. Jay declined. The president then turned to his secretary of state and in Jan. 1801, sent to the senate the nomination of John Marshall to be chief justice of the United States. The last Federalist senate confirmed the nomination on Jan. 27, 1801. On Feb. 4, Marshall accepted the appointment but, at the president's request, continued to act as secretary of state for the last month of the Adams administration.

Chief Justice of the United States.—It fell to Marshall, and to the supreme court under and beginning with Marshall, to set forth the main structural lines of the government. Whether the constitution had created a federation or a nation was not a matter on which agreement could have been won at the beginning of the 19th century. Though judicial decisions could not alone dispel differences of opinion, they could create a body of coherent, authoritative and disinterested doctrine around which opinion could mass and become effective. To the task of creating such a core of agreement Marshall brought qualities which were admirably adapted for its accomplishment. His own mind had apparently a clear and well organized concept of the effective government which he believed was needed and was provided by the constitution. He wrote with a lucidity, a persuasiveness and a vigour which gave to his judicial opinions a quality of reasoned inevitability which more than offset what they sometimes lacked in precision of analysis. The 35 years of his magistracy gave opportunity for the development of a unified body of constitutional doctrine. It was the first aspect of Marshall's accomplishment that he and the court which he headed did not permit this opportunity to pass unrecognized.

Prior to Marshall's appointment, it had been the custom of the supreme court, as it was in England, that each justice deliver an opinion in each significant case. This method may be effective where a court is dealing with an organized and existing body of law. With a new court and a largely unexplored body of law, it created an impression of tentativeness, if not of contradiction, which lent authority neither to the court nor to the law it expounded. With Marshall's appointment, and presumably at Marshall's instance, this practice changed. Thereafter, for some years, it became the general rule that there was only a single opinion from the supreme court, and that delivered by the chief justice. This change of practice alone would have contributed to making the court a more effective institution. And when the opinions were cast in the mold of Marshall's clear and compelling statement, growth of the court's authority came as a result which might have been, and presumably was, anticipated.

Marbury v. *Madison* (1803) was the first of Marshall's great cases and the case which established for the court its power to state and expound constitutional law in disregarding federal statutes which it found in conflict with the constitution. President Adams had appointed a number of justices of the peace for the District of Columbia shortly before his term expired. Their commissions had been signed and the seal of the United States affixed in the office of the secretary of state, but some of them, including that of William Marbury, remained undelivered. President Jefferson is believed to have ordered that some of them not be delivered. After unsuccessful application at the department of state, Marbury instituted suit in the supreme court against James Madison, the new secretary. Though the matter was not beyond question, the court found that congress had by statute authorized that such suits be started in the supreme court rather than in a lower court. But the supreme court, speaking through Marshall, held that art. iii of the constitution did not permit this, and that the court could not follow a statute which was in conflict with the constitution. It thereby confirmed for itself its most controversial power, the function of judicial review, of finding and expounding the law of the constitution.

Marshall's emphasis was put on the assertion that if the constitution was to be a lasting and controlling document, judges who were sworn to uphold it could not follow a law which conflicted with it. As Chief Justice John Bannister Gibson of the supreme court of Pennsylvania later pointed out, the problem was not so much whether the court should follow laws which conflicted with the constitution as it was who—court or congress—should determine whether the conflict existed, a matter often as uncertain as it was in Marbury's case. This great power of determining whether there was conflict between a law and the constitution was not explicitly given to the court. As early as 1796 it had held ineffective a state law which it found in conflict with federal law, and in the same year had considered a constitutional challenge to a federal tax, but had left without specific decision its power to disregard a federal statute. Marshall's was the first decision which asserted and acted upon this authority. Though the court's action has been questioned, and even termed usurpation, history lends strong support to Marshall's action. British judges had passed upon the question whether the acts of colonial legislature were consistent with their charters, so the function was not an unfamiliar one. There was some history of state courts having done the same with respect to state laws and state constitutions. Most of the leaders of the Constitutional Convention and many of those in state ratifying conventions appear to have contemplated judicial review and to have assumed that it would be exercised. And the terms of the Judiciary act passed by the first congress in 1789 appear equally clearly to have contemplated that this function would be carried out by judges subject to ultimate review by the supreme court.

Once the power of judicial review had been established, Marshall and the court followed with decisions which assured that it would be exercised, and the whole body of federal law determined, in a unified judicial system with the supreme court at its head. In *Martin* v. *Hunter's Lessee* (1816) the court overruled the court of appeals of Virginia, which had held that the state courts were not subject to review by the supreme court, even in cases where federal questions were involved. Marshall did not participate in this case because the specific point at issue was ownership of the Fairfax estate in which he had a large interest. But in *Cohens* v. *Virginia* (1821), Marshall followed the same reasoning and went a step further in holding that even criminal cases in the state courts, in which a state itself was a party, were subject to review by the supreme court if a question under federal law arose in the case. This decision provoked vigorous opposition by Judge Spencer Roane of Virginia, but it is clear that a unified federal system could hardly have been maintained had Marshall's decision been otherwise. And in *United States* v. *Peters* (1809), Marshall had already closed another possible gap in federal authority by holding that once the federal courts had acted, not even a state legislature could interpose effective authority to nullify or set aside its order or judgment.

After asserting the authority of federal judges to interpret and apply the constitution, Marshall's most important decision in the exercise of this function was in *McCulloch* v. *Maryland* (1819) in which he upheld the authority of congress to create the Bank of the United States. Once again he was dealing with a power not explicitly given, for the constitution did not in so many words empower congress to create a corporation or establish a bank. But Marshall found that if congress determined that a corporation exercising banking powers would be a useful and appropriate means of accomplishing its purpose within the granted powers of regulating commerce, borrowing money, collecting taxes, paying and supporting troops, and the like, its action was authorized by the constitution. In writing "[W]e must never forget that it is *a constitution* we are expounding . . . Let the end be legitimate, let it be within the scope of the constitution, and all means which are appropriate, which are plainly adapted to that end, which are not prohibited, but consist with the letter and spirit of the constitution, are constitutional," Marshall set a standard of judgment of congressional action which would validate the expanding federal legislation of later years. *McCulloch* v. *Maryland* well illustrates that judicial review may have an affirmative aspect as well as a negative. It may accord an authoritative legitimacy to contested government action no less significant than its restraint of prohibited or unauthorized action.

The constitution had been called into being as much by the need for restricting state legislation hostile to the commerce of other states as by any other single factor. It granted to congress the power to "regulate commerce . . . among the several states." It left open the question whether, or to what extent, state regulatory laws could be applied to interstate commerce. In order to encourage the development of the steamboat, New York had granted to Fulton and Livingston, and their licensees, a long-term monopoly of steam navigation on the waters of the state. In *Gibbons* v. *Ogden* (1824), the question was whether this New York statute could operate to exclude vessels propelled by steam and coming from another state. In dealing with the problem, Marshall first set forth the great scope of the power granted to congress by the commerce clause. There remained the dilemma whether this excluded state action in the field when congress had not acted. Marshall saw that many state laws primarily of local concern would be ineffective if they could not be applied to persons and goods from other states. At the same time many others could operate to evoke hostility and reprisals from other states, as indeed New York's steamboat monopoly was doing. In *Gibbons* v. *Ogden*, after an extensive survey of the problem which left it unanswered, Marshall resolved that particular case by invoking federal authority in the form of a federal coasting licence possessed by the New Jersey vessel to override New York's statutory monopoly. Yet in *Willson* v. *Black Bird Creek Marsh company* (1829), Marshall held in a brief and inexplicit opinion that a similar coasting licence could not justify destruction of a dam across a navigable stream which Delaware had authorized in order to drain a marsh. These apparently conflicting decisions showed not contradiction or indecision but rather a recognition that the problem was a complex one incapable of solution by any simple rule or formula. It remained for Marshall's successors to recognize explicitly what Marshall's decisions had foreshadowed, that such problems could

be dealt with only on the particularized basis of appraising the competing interests of the state and of a nationally open market in the circumstances of each case. When Maryland, however, imposed a special tax upon importers, thereby creating a hostile discrimination against foreign goods in the local market, Marshall had little difficulty in deciding, in *Brown* v. *Maryland* (1827), that this taxing statute was unconstitutional. Though the result of that decision was not questioned thereafter, Marshall's opinion in *Brown* v. *Maryland* was not among his happiest. Instead of basing the decision upon the fact that the tax was discriminatory, Marshall held instead that for a time imports must be completely tax exempt. He suggested that this exemption existed during the time they remained in the original package and before the first sale. The opinion, rather than the result of the decision, posed for successor judges many difficult problems in enforcing general nondiscriminatory state taxes insofar as they relate to imported goods.

Marshall's decisions dealing with the authority and organization of the federal government and with federal-state relationships created an organized structure upon which his successors have for the most part built and elaborated. His decisions dealing with the specific restraints upon government, chiefly involving the provision of art. i of the constitution that "No State shall . . . pass any . . . Law impairing the Obligation of Contracts," proved less enduring in establishing the working limits within which state governments must operate. Though *Fletcher* v. *Peck* (1810)—holding that a state could not legislatively revoke an executed sale of land which had subsequently been acquired by innocent purchasers —presumably remains effective (either by virtue of the 14th amendment or the contract clause), other decisions by Marshall under the contract clause have been modified. In *New Jersey* v. *Wilson* (1812), Marshall held that a legislative grant of tax exemption to land occupied by Indians remained effective and could not be denied by the state even after the land had been purchased by others. The construction which interpreted the grant in such sweeping terms was presumably qualified by Marshall himself in *Providence Bank* v. *Billings* (1830). The decision in *Trustees of Dartmouth College* v. *Woodward* (1819), that a grant of a corporate charter constituted a contract which was inviolate against subsequent amendment, was effectively lessened in scope both by more restrictive construction of such charters and by the subsequently developing practice of state legislatures in specifically reserving the power to amend. The decisions in *Sturges* v. *Crowninshield* (1819) and in *McMillan* v. *McNeill* (1819), holding that state laws could not grant a discharge to insolvent debtors, were modified by *Ogden* v. *Saunders* (1827) with respect to debts incurred after the passage of the state law. This decision was one of the few cases decided while Marshall was on the supreme court in which the majority did not agree with him, and in which he dissented. If it was true that Marshall's decisions attempting to mark out the scope of the constitution's specific prohibitions on government have been among his less enduring ones, the same has been no less true of his successors. It is in this area that judicial review has evoked its most vigorous critics.

For the first 30 years of his service as chief justice, Marshall's life was singularly happy. In the autumn of 1831, at the age of 76, he underwent the rigours of surgery for the removal of kidney stones and appeared to make a rapid and complete recovery. But the death of his wife on Christmas of that year was a blow from which his spirits did not so readily recover. In 1835 his health declined rapidly and on July 6 of that year he died in Philadelphia. He lies buried in Richmond, where he had maintained a home for many years. It was said of him by Justice Holmes, "When we celebrate Marshall we celebrate at the same time and indivisibly the inevitable fact that the oneness of the nation and the supremacy of the national Constitution were declared to govern the dealings of man with man by the judgments and decrees of the most august of courts." It is his lasting memorial that when the phrase "the great chief justice" is used, the reference is unmistakably to John Marshall.

See also CONSTITUTION AND CONSTITUTIONAL LAW: *United States;* and SUPREME COURT OF THE UNITED STATES, THE; and references under "Marshall, John" in the Index.

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MARSHALL, LOUIS (1856–1929), U.S. lawyer and Jewish community leader best known for his efforts to extend religious, cultural and political freedom to all racial, religious and linguistic minorities, was born in Syracuse, N.Y., on Dec. 14, 1856. He achieved eminence as an appellate lawyer, and made many important contributions to legal and constitutional reforms. At the Paris peace conference of 1919 he successfully advocated treaties signed by a number of eastern European countries intended to protect minority rights (*see* MINORITIES). His opposition to Henry Ford's *Dearborn Independent,* and particularly to its circulation of the forged "Protocols of the Elders of Zion," helped bring about the discontinuance of this publication. He helped develop many religious and philanthropic Jewish organizations of national and international scope. He died at Zürich, Switz., on Sept. 11, 1929. His writings are collected in *Louis Marshall: Champion of Liberty,* edited by Charles Reznikoff (1957). (A. EN.)

MARSHALL, STEPHEN (*c.* 1594–1655), was a leader among the Presbyterians in England in the mid-17th century. He was born at Godmanchester, Huntingdonshire, and educated at Emmanuel college, Cambridge. Some time before 1629 he became vicar of Finchingfield, Essex, where he continued until 1651, when, on grounds of dissatisfaction with "the parochial way," he became town preacher at Ipswich. Although he thus held no official position in London, beyond a lectureship at St. Margaret's, Westminster, from 1640 onward, Marshall's prominence in religious affairs was recognized and at his death he was buried in Westminster abbey (thence to be exhumed at the Restoration). In 1641 he was one of five writers (the other four being E. Calamy, T. Young, M. Newcomen and W. Spurstow) who, over the nom de plume of their combined initials, Smectymnuus, made a noted attack on episcopacy and liturgy conceived as of divine right and unalterable. In 1643 Marshall became a member of the Westminster assembly. When in 1646 parliament ordered Presbyterianism to be established in England, he was among those nominated to serve as elder in his local classis. He held the Presbyterian polity within each congregation to be of divine right, but was not opposed to a measure of congregational autonomy and was willing for discussion with Independents. Less a man of learning or originality than a *vulgarisateur,* he was a powerful preacher; of more than 30 pieces from his pen, many were sermons preached before parliament. He died in London on Nov. 19, 1655. (G. F. N.)

MARSHALL, THOMAS RILEY (1854–1925), 28th vice-president of the United States, was born in North Manchester, Ind., on March 14, 1854. He attended the public schools of that community and graduated from Wabash college, Crawfordsville, Ind. He studied law in the office of Judge Walter Olds, in Fort Wayne, and was admitted to the bar on his 21st birthday. Between 1875 and 1909 he practised law in Columbia City, Ind. Marshall gained a state-wide reputation as a forceful and entertaining speaker and was elected governor in 1908. He was nominated for vice-president on the Democratic ticket at Baltimore in 1912, following the stormy proceedings in which Woodrow Wilson was finally nominated for president. Marshall was elected that year and re-elected in 1916, the first vice-president to succeed himself in almost a century.

Marshall presided over the senate with fairness, tact and poise. His personal influence on legislation was a powerful aid to the administration. For almost two years following the outbreak of World War I he advocated strict neutrality, a stand he later regretted. Following the war, he proved a strong advocate of the League of Nations, and opposed women's suffrage. He won friends with his kindliness, tolerance and whimsical humour. During a tedious debate in the senate on the needs of the country he was heard to comment: "What this country needs is a really good five-cent cigar." His homespun philosophy and love of fun are

preserved in his book *Recollections of Thomas R. Marshall: a Hoosier Salad* (1925). He served on the U.S. Coal commission in 1922 and died in Washington, D.C., on June 1, 1925.

See C. M. Thomas, *Thomas Riley Marshall, a Hoosier Statesman* (1939). (H. F. Tt.)

MARSHALL, a city of eastern Texas, U.S., seat of Harrison county, is 38 mi. W. of Shreveport, La. It is a historic community, settled in 1839, named for U.S. Chief Justice John Marshall, incorporated in 1843 and chartered in 1848. It adopted the council-manager form of municipal government in 1909. Situated on the Texas and Pacific railway, Marshall is the centre of a farming area (cotton, sweet potatoes, peas, cattle) with considerable oil production. It has large railroad repair shops, and manufactures include steel products, bricks and foundry items.

Marshall is the seat of the East Texas Baptist college (chartered 1917) and two colleges for Negroes, Bishop college (1881) and Wiley college (1873). Considerable tourist trade is derived from nearby Caddo lake, a popular vacation spot. For comparative population figures *see* table in Texas: *Population.* (N. McG.)

MARSHALL ISLANDS are the easternmost group of islands in Micronesia (*q.v.*) and the eastern district of the United States Trust Territory of the Pacific Islands. Two of the atolls, Kwajalein and Eniwetok, were the scenes of heavy fighting during World War II. Later Bikini and Eniwetok became centres for atomic bomb experiments, outside the jurisdiction of the Trust administration. (The islanders were transferred to other atolls by the U.S. navy, and in 1957 were paid $500,000 in reparations.) The administrative centre of the Marshall Islands district is located on Majuro. The islands extend roughly from latitude 3° to 15° N. and from longitude 161° to 172° E. Their land area is 61 sq.mi., and the lagoon area is about 4,500 sq.mi. A reef-enclosed lagoon 70 mi. long with an area of 840 sq.mi. makes Kwajalein the largest atoll in the world. The population increase (from 10,553 in 1948 to 14,163 in 1958) in the face of limited natural resources threatened the economy after mid-century.

The Marshall Islands are arranged in two parallel rows: the Ratak chain to the east and the Ralik chain to the west. These islands are coral caps on great dome volcanoes which rise 18,000 ft. from the floor of the ocean. Cores have been drilled on Eniwetok to depths of 4,222 and 4,610 ft. through coral limestone before reaching the volcanic stone base of olivine basalt. The fossil evidence so obtained indicates that the islands have been sinking slowly since Eocene times. Drills and soundings made on other islands indicate a similar origin. The dome volcanoes have formed in two rows which correspond to lines of weakness in the ocean floor. Most of the Marshall Islands are true atolls with central lagoons enclosed by coral reefs on which storms have piled small islets. Since these islets seldom rise more than 20 ft. above high tide they are easily flooded during storms, typhoons and tidal waves. A few of the islands have undergone recent uplift which has left shallow lagoons or none at all.

Although various Spanish expeditions of the 16th century passed through the Marshall Islands, the lack of wealth discouraged further exploration and mapping. Captain Marshall partially explored them in 1788 but much of the mapping was done by Russian expeditions under Adam Ivan Krusenstern in 1803 and Otto von Kotzebue in 1815 and 1823. Spain's claims to the islands were recognized in 1886. After the Spanish-American War, Spain sold the Marshalls to Germany. Japan seized the islands in 1914 and later administrated them as a mandate from the League of Nations. The United States administration was made a formal United Nations trusteeship, July 18, 1947. *See* also Pacific Islands. (C. A. Mr.)

MARSHALL PLAN, also known as the European Recovery program (ERP), a program of U.S. economic aid to Europe in the post-World War II period. On June 5, 1947, in an address at Harvard university, George C. Marshall, the U.S. secretary of state, advanced the idea of a program of European economic self-help supported by U.S. assistance. On the basis of a unified plan for western European economic reconstruction presented by a committee representing various European powers, the U.S. congress in Dec. 1947 authorized establishment of ERP. It was administered by the U.S. Economic Cooperation administration (ECA) and the Organization for European Economic Cooperation (O.E.E.C.), the European co-ordinating body.

See Foreign Aid Programs; *see* also references under "Marshall Plan" in the Index.

MARSHALLTOWN, a city located near the geographical centre of Iowa, U.S., the seat of Marshall county, is on the Iowa river about 50 mi. N.E. of Des Moines. Large wholesale businesses and diversified industries have been developed, including the manufacture of furnaces, pressure valves, governors, die castings and canned goods. It was named for Marshall, Mich., in 1851 by the first settler, Henry Anson. Marshalltown became the county seat in 1859 and was incorporated as a city in 1863. When hospitalization of Civil War veterans became a matter of state concern, the town donated 128 ac. which became the site of the Iowa Soldiers' home, now a state residence for disabled and aging Iowa veterans of all wars. Its community school district supports a junior college (1927). For comparative population figures *see* table in Iowa: *Population.* (J. F. Wa.)

MARSH MALLOW (*Althaea officinalis*), a Eurasian and north African plant of the mallow family (Malvaceae; *q.v.*). Allied to the hollyhock (*q.v.*), found in Great Britain and sparingly naturalized in the eastern U.S., it grows in marshes, especially near the sea. Sweetmeats and the original marshmallow paste were formerly made from the mucilaginous root, and both roots and leaves have been used in medicine as demulcents.

In the United States marshmallow is a confection of sugar, corn sirup, albumen and gelatin (*see* also Confectionery Manufacture).

MARSHMAN, JOSHUA (1768–1837), English Baptist missionary and orientalist, was born on April 20, 1768, at Westbury Leigh, in Wiltshire. In 1799 he was sent by the Baptist Missionary society to join its mission at Serampur, India. There he translated the Bible into various dialects and, aided by his son, established newspapers, the first in an oriental language, and founded Serampur college. He translated into Chinese the book of Genesis, the Gospels, Romans and Corinthians; in 1809 he published *The Works of Confucius* with an English translation and in 1814 his *Clavis Sinica,* a Chinese grammar. He died at Serampur on Dec. 5, 1837. His son, J. C. Marshman (1794–1877), wrote a history of India and a life of his father (1859).

MARSH MARIGOLD, the name for several small herbs of the genus *Caltha,* plants of the buttercup family (Ranunculaceae). The common species (*C. palustris*), the "winking Mary-buds" of Shakespeare (*Cymbeline,* act ii, scene 3), are found in wet places on both sides of the Atlantic. In the U.S. it is usually called cowslip, and is often known as kingcup or May blob in Great Britain. The stem is thick and hollow; the leaves are shining and kidney-shaped; and the flowers, which bloom in spring or summer, have five yellow sepals. The early shoots and leaves have been used like spinach, and the flower buds preserved in salted vinegar form a substitute for capers. A double-flowered variety is often cultivated and is occasionally found wild. *C. natans,* a large species with white or pink flowers, occurs in ponds and muddy banks from Minnesota northward to Alaska. *C. leptosepala,* with white or bluish, usually solitary flowers, native to the Rocky mountain region from Alaska to New Mexico, is an excellent potherb. *See* Ranunculaceae.

MARSI, an ancient people of Italy, whose chief centre was Marruvium (San Benedetto de' Marsi) on the eastern shore of Lake Fucinus (now drained) in the modern province of L'Aquila. They were racially and politically connected with the Vestini, Paeligni and Marrucini (*qq.v.*) and became allies of Rome in 304 B.C. A short-lived revolt two years later recorded by Livy (x. 3) is improbable. They remained faithful down to the Social War (or "war of the allies"), their contingent being regarded as the flower of the Italian forces. In this war (91 onward), which became known as the Marsic War because of the prominence of the Marsian rebels, they fought bravely under their leader Q. Pompaedius Silo; though they were frequently defeated, the result of the war was the enfranchisement of the allies.

From the beginning of the 3rd century the Marsi were in touch with a Latin-speaking community, as the Latin colony of Alba Fucens (Albe) was founded near the northwestern corner of the lake in the territory of the neighbouring Aequi in 303 B.C. The earliest pure Latin inscriptions of the district seem to date from the second half of the 2nd century B.C., though they may be somewhat earlier. The coins of Pompaedius Silo have Latin legends, whereas the other leaders use Oscan.

The earliest inscriptions in the local dialect date from about 300 to 150 B.C. and include a bronze tablet found in Lake Fucinus in 1877, which seems to record a votive offering to the goddess Angitia, whose chief temple and sacred wood stood at the southwestern corner of the lake near the modern Luco ne' Marsi. She (or they; the name is also found in the plural) was widely worshiped in the central Italian highlands as a goddess of healing, especially the cure of snake bites by charms and the herbs of the Marsian woods. Her worshipers naturally practised the same arts, their country being held by the Romans to be the home of witchcraft. The language of the inscriptions differs only slightly from Roman Latin of the same date. The name of the tribe is derived from the god Mars; its older form (dat. plur. *Martses* = Latin *Martiis* for the later Latin form *Marsis*) shows the assibilation of *-tio-* into *-tso-* proper to many Oscan dialects (*see* OSCAN) but strange to classical Latin.

There was also a Germanic tribe of Marsi, who in the early 1st century A.D. were occupying the land between the Ruhr and Lippe rivers; their shrine of the goddess Tamfana or Tanfana was a religious centre for the neighbouring tribes. The shrine was destroyed and the tribe repeatedly defeated during the campaigns across the Rhine of the Romans under Germanicus in A.D. 14–16. Thereafter they disappear from history.

See R. S. Conway, *The Italic Dialects*, pp. 289 ff. (1897); J. Whatmough, *The Foundations of Roman Italy*, pp. 289 ff. (1937).

MARSILIUS OF PADUA (*c.* 1275–*c.* 1342), Italian political philosopher, was the author of the *Defensor pacis*, one of the most original treatises on political theory produced during the middle ages. Born at Padua, he was educated at the university there and at first studied medicine. He is known to have been rector of the University of Paris on March 12, 1313. While at Paris he met John of Jandun, who assisted him in writing the *Defensor pacis*. This treatise, which was completed on June 24, 1324, had a direct bearing on the controversy between Pope John XXII and Louis of Bavaria (*see* LOUIS IV, Holy Roman emperor), to whose court Marsilius went in 1326. In the following year, when he was condemned as a heretic, Marsilius accompanied Louis on his Italian expedition, which gave practical expression to many of the ideas advanced in the *Defensor pacis*. When Louis entered Rome in Jan. 1328, Marsilius was rewarded by being appointed imperial vicar of the city. After the withdrawal of the imperial forces from Italy, Marsilius spent the remainder of his life in Bavaria, where he died, probably in 1342 and certainly before April 10, 1343. In 1342 Marsilius produced the *Defensor minor*, a brief summary of his earlier work.

Defensor Pacis.—The part played by John of Jandun in the writing of the *Defensor pacis* is a matter in dispute, but most modern scholars hold that Marsilius was almost solely responsible for writing the work.

Marsilius believed that the constant wars which devastated northern Italy were the direct result of the papal policy in furthering its temporal claims. Hence the treatise commences in line with the *De Monarchia* of Dante by affirming that the object of government is the maintenance of peace, but Marsilius went much further than Dante in his Erastian doctrine. He quotes Aristotle to the effect that the state exists for the sake of the good life, but departing from the harmony of church and state which St. Thomas Aquinas had emphasized, Marsilius claims that the church is really part of the state. Although Marsilius did not completely reject the Thomist conception of natural law, he made very little use of it. The law about which he was concerned was the positive law of the state which he averred to be supreme. Implicit in his thought was the distinction between what is legally and what is morally right. Positive law implies a legislator, and Marsilius makes it clear that this is the whole citizen body or the more weighty part of it. He realized, however, that it would be difficult in practice for the whole body of the citizens to legislate and that a more effective method would be to hand over the task of framing laws to a committee who would submit their work to them.

Marsilius thought it essential that the ruler be chosen by the citizens and that the armed forces placed at his disposal be sufficient for maintaining order but not so large that he could make himself a tyrant. The ruler was to be responsible to his subjects and if he betrayed his trust he could be deposed or punished. The state could carry out its proper function only in an atmosphere of peace and tranquility, but the church by interfering with the rights of the emperor had been an aggressor and a disturber of the peace. Marsilius argued that since Christ taught submission to the civil power, the temporal claims of the papacy were completely invalid. He denied, not only to the pope but to all bishops, the right of excommunication and the imposition of an interdict on their own authority. Heretics might be punished, but the right to inflict the penalty was the prerogative of the civil power. All ecclesiastical appointments ought to be made by the state. The power of the clergy should be restricted to spiritual matters and the supreme power in the church should rest in a general council summoned by the ruler in which both clergy and laity should be represented. The council, because it would speak with the will of the whole community, spiritual and temporal, should have power to depose or punish the pope. He believed that the church should return to the holy poverty of the apostolic age. Tithes should be abolished and the state should take over a considerable part of the property held by ecclesiastics.

Condemned by the church in 1327 and in 1378, the treatise was known to Wycliffe and Luther and had some influence at the time of the Reformation. The first printed edition (1517) was studied by both Thomas Cranmer and Richard Hooker (*qq.v.*).

There are editions of the *Defensor pacis* by C. W. Previté-Orton (1928) and by R. Scholz, 2 vol. (1932–33). For an English translation *see* A. Gewirth, *Marsilius of Padua: the Defender of Peace*, vol. ii (1955).

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MARSMAN, HENDRIK (1899–1940), one of the most outstanding Dutch poets and critics between the wars, was born at Zeist near Utrecht, Neth., Sept. 30, 1899. He studied law and practised in Utrecht, but after 1933 was entirely occupied with literature and journalism. After traveling in southern Europe, he settled in France. On June 21, 1940, he was drowned when the ship on which he was trying to reach England was torpedoed in the English channel.

Under the influence of the German expressionists, Marsman made his literary debut in about 1920 with rhythmic free verse which attracted notice for its almost aggressive independence. The collection *Verzen* (1923) expresses a paganism which the poet later described as representing the "vitalist" period of his career. As editor of the periodical *De Vrije Bladen*, he became in 1925 the foremost critic of the younger generation. His next collection of verse appeared in 1927 with the English title *Paradise Regained* and was greeted as a major artistic achievement. Another cycle, *Porta Nigra*, dominated by the idea of death, appeared in 1934. His last book of verse, *Tempel en Kruis* (1940), opposes to prevalent pessimism and sense of disintegration the humanistic ideal of the creative spirit, symbolized by the Greek temple. Marsman wrote also several modernistic tales and a short novel, *De dood van Angèle Degroux* (1934), the action of which takes place in the artistic milieu of Paris and serves as a background to discussions on the attitude to life of the individual striving for independence. His *Verzameld Werk* appeared in 1947.

See W. L. M. E. van Leeuwen, *Drie Vrienden* (1947); A. Lehning, *De vriend van mijn jeugd* (1957). (Gd. W. Hs.)

MARSTON, JOHN (1576–1634), English satirist and dramatist for the boy actors and a prominent opponent of Ben Jonson in the "war of the theatres." He was baptized at Wardington, Oxfordshire, on Oct. 7, 1576, the son of John Marston, an attorney of Shropshire descent who was, in 1592, a lecturer of the Middle Temple. His mother was the daughter of an Italian surgeon, Andrew Guarsi, and to her may be partly owing the strongly Italianate character of his plays. Marston matriculated at Brasenose college, Oxford, in 1592, and gained his B.A. in 1594. He joined the Middle Temple, but disappointed his father who, in 1599, bequeathed his law books to his son, "whom I hoped would have profited by them in the study of the law, but man proposeth and God disposeth."

Marston began his literary career in 1598 with *The Metamorphosis of Pigmalion's Image and Certain Satires*, dedicated to "Good Opinion" and signed "W. K(insayder)." *Pigmalion's Image* is a callow, fashionably erotic poem in the same metre as Shakespeare's *Venus and Adonis*, but Marston later protested that he had intended it as a parody of amorous verse. His *Scourge of Villainy* (1598) was dedicated "To Detraction" and consigned at the end "To everlasting Oblivion." The roughhewn, obscure verses of the "barking satirist," as Marston described himself, attracted immediate notice: Francis Meres praised him in *Palladis Tamia* (1598), and John Weever bracketed him with Horace and Jonson in his *Epigrams* (1599). In 1599 Marston's poems were burned in accordance with the new edict prohibiting satires.

In that year he turned to the stage, apparently beginning as one of Philip Henslowe's hacks, but quickly shifting to the newly established Paul's boys. For them he almost certainly refurbished the anonymous *Histriomastix* (1599; publ. 1610), transforming the pedant Chrisoganus into a portrayal of Jonson. Years later Jonson told William Drummond that "He had many quarrels with Marston, beat him, and took his pistol from him, wrote his *Poetaster* on him; the beginning of them were, that Marston represented him on the stage." As Crispinus in *The Poetaster* (1601), Marston, depicted as having red hair and small legs, is made to cast up his eccentric vocabulary. He is also ridiculed for his "great battering ram of terms" in the anonymous *Return from Parnassus* (*c.* 1603).

For Paul's boys, Marston wrote *Antonio and Mellida* (1599), the sequel, *Antonio's Revenge* (*c.* 1599) and, presumably, *What You Will* (1601). The most notable is *Antonio's Revenge*, a savage melodrama concerned not only with Senecan violence but also, and more originally, with the deadly political power struggle itself. In 1604 Marston became a shareholder in the Children of the Queen's Revels, for whom he wrote his remaining plays. With *The Dutch Courtesan* (1603–04) and *The Malcontent* (1604), he takes his place as a significant Jacobean dramatist of the second rank. Successfully revived on the modern stage, *The Dutch Courtesan* portrays the infatuation of the puritanical Malheureux with the vicious strumpet Franceschina; his friend Freevill, who has a more libertarian sexual code, emerges unscathed. The serious main action is supplemented by coarsely farcical scenes involving the exploits of the prankster Cockledemoy.

In his best-known play, *The Malcontent*, the dramatist found his ideal spokesman in the bitter satirical railer, Malevole, who searches out the iniquities of a lascivious Italian court. The bleak cast of Marston's thought is strikingly shown in Malevole's fourth act speech: ". . . this earth is the only grave and Golgotha wherein all things that live must rot. 'Tis but the draught wherein the heavenly bodies discharge their corruption, the very muckhill on which the sublunary orbs cast their excrement. Man is the slime of this dung-pit . . ."

In 1605 Marston was imprisoned for his share, with Jonson and George Chapman, in *Eastward Ho*, a comedy whose satirical thrusts at the Scots offended the authorities (*see* Jonson, Ben). Another imprisonment, in 1608, marked the end of his theatrical career. Leaving unfinished *The Insatiate Countess*, his most sensationally erotic play, he entered the church. Marston took orders in 1609, and in 1616 he obtained the living of Christchurch, Hampshire. He had, meanwhile, married Mary, daughter of William Wilkes, chaplain to James I. In 1633, "in his autumn and declining age," he apparently insisted upon the removal of his name from the collected edition of his plays. Marston died in Aldermanbury, London, on June 25, 1634. On his tombstone, according to Anthony à Wood, were carved the words *Oblivioni Sacrum*.

The Works of John Marston, comprising six of his plays, was published in 1633, and reissued anonymously the same year as *Tragedies and Comedies*.

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MARSTON MOOR, BATTLE OF, was fought on July 2, 1644, seven miles west of York, between a parliamentarian force of about 27,000 men and a royalist force of about 17,000 men and was the first major royalist defeat in the English Civil War. (*See* Civil War, English.) The royalists suffered heavy losses—4,000 men killed, many prisoners taken and most of their cannon captured.

Before the battle three parliamentarian armies, a Scottish army under the earl of Leven, an army from East Anglia under the earl of Manchester and a Yorkshire army under Lord Fairfax, had been besieging York. The defending royalist garrison was commanded by the marquess of Newcastle and Charles I had ordered Prince Rupert to relieve York. The besieging generals withdrew their armies on June 30 in an attempt to cut off Rupert at Long Marston, on the road from Knaresborough to York. But Rupert turned northeast, outwitted the parliamentarians and relieved York. Rupert then sent a message to Newcastle to say he would march to fight the enemy next morning. Meanwhile a parliamentarian council of war held at Long Marston decided to move southwest to Tadcaster, but when it was learned on July 2 that Rupert was advancing they drew up a line of battle on a mile-and-a-half front, west of Long Marston. On the left was a cavalry force commanded by Oliver Cromwell, supported by Maj. Gen. David Leslie (afterward Lord Newark), with light Scottish horse; in the centre were Scottish and other infantry; on the right were Yorkshire and Scottish cavalry under Sir Thomas Fairfax (*see* Fairfax of Cameron, Thomas Fairfax, 3rd Baron).

The royalist dispositions were not completed until late in the afternoon because Rupert had to await the arrival from York of the tired infantry, whom he placed in the rear. Opposite the parliamentarian cavalry wings were placed royalist forces of about 2,000 horse interspersed with 500 musketeers; in the centre was the bulk of the royalist foot. The parliamentarians stationed in gently sloping fields of rye had the advantage of ground and wind. The royalist front was protected by a long ditch partly screened by a hedge and behind it was a wide, flat moor, ideal for cavalry action. Rupert was in command of the royalists; Leven was the senior parliamentarian general.

The battle did not properly begin until past 7:30 P.M. when Rupert had abandoned expectation of being attacked that day. Having been surprised, he himself took command on the right and inflicted a check on Cromwell's cavalry, but the Scottish reserve under Leslie redressed the balance, and Rupert's men were driven from the field. On the parliamentarian right Sir Thomas Fairfax' troopers were driven back by the royalist cavalry under George Goring. In the centre an infantry contest at first went in favour of the royalists and indeed both the earl of Leven and Lord Fairfax left the field, believing the battle was lost. However, after Sir Thomas Fairfax himself rode across the battlefield to ask Cromwell for help, he reformed his cavalry, wheeled it to the right and defeated Goring's cavalry which was occupying the positions originally held by Fairfax' troopers on the parliamentarian right. Then Cromwell's victorious cavalry went to the

aid of the infantry, which had rallied and thus completed a remarkable victory.

See Austin Woolrych, *Battles of the English Civil War* (1961).

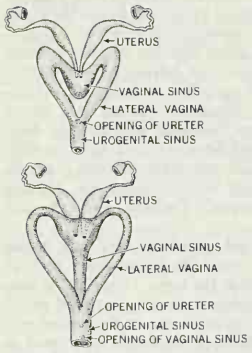
(M. P. A.)

MARSUPIAL, any of the mammals of the order Marsupialia, in which the young, born in a tiny and immature state, are usually kept for some time after birth in a pouch (marsupium) on the lower belly of the female. Among the order the best known are the strictly Australian forms, including the kangaroos, dasyures, wombats, koalas, bandicoots and phalangers; only two groups of American marsupials survive at the present time, the opossums and caenolestids, of which several different kinds inhabit Central and South America and only one, an opossum, ranges as far north as south-central North America.

GENERAL FEATURES

Typical Mammalian Characteristics.—Marsupials share with other mammals the presence of hair and the suckling of young by mammary glands. With minor differences the various systems of the body, such as the muscular and skeletal systems, are those of the placental mammals generally. The brain, however, is not so advanced as that of the placentals. (*See* MAMMAL; BRAIN.)

Distinctive Characteristics.—The most extraordinary features of the Marsupialia are the specializations associated with the reproductive system. In some marsupials the pouch is vestigial, being represented only by slight lateral folds, and in others it is entirely absent. There may be 2 nipples or as many as 27. Epipubic or marsupial bones, which are attached to the front end of the pelvis, are present in both sexes and are therefore not related to the support of the female's pouch. In some marsupials, like the extinct borhyaenids of South America and the marsupial "wolf" (*Thylacinus*) of Tasmania, the epipubic bones are reduced to vestiges or lost.



ADAPTED FROM VANCEBROEK IN A. S. ROMER, "THE VERTEBRATE BODY"; REPRODUCED BY PERMISSION OF W. B. SAUNDERS COMPANY

FIG. 1.—FEMALE REPRODUCTIVE SYSTEMS OF (TOP) THE COMMON OPOSSUM AND (BOTTOM) THE KANGAROO

The female reproductive organs of marsupials differ markedly from those of placental mammals. Most marsupials have a contorted vaginal canal with one median and two lateral passages, the median one being formed from a coalescence of parts of the two laterals. In placental mammals, on the other hand, no trace of the three-way vaginal canal is evident, but the lower parts of the right and left oviducts tend to unite in a single median uterus. The marsupials specialize in an early and brief gestation, the developing embryo deriving its food chiefly from its own yolk-sack. The immature young is then born and completes its development while attached to a teat in the pouch. In the bandicoots (*Perameles*), however, an allantoic placenta (*q.v.*) forms an intimate relationship with the uterine wall, essentially like that in the placental mammals. On the other hand, in the "tiger cats" (*Dasyurus*) only the initial stages of allantoic placenta formation can be detected.

BIRTH AND DEVELOPMENT

The cycle of reproduction differs somewhat in different marsupials. The common American or Virginian opossum (*Didelphis marsupialis*) evidently has one of the most primitive cycles, which will serve for the following discussion. During the first 5½ days the embryos form very slowly, but from that time until their birth the rate of development is remarkably fast. The gestation period is about 13 days.

The mother thoroughly cleans the pouch before parturition.

FROM W. J. HAMILTON, "AMERICAN MAMMALS"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO.

FIG. 2.—SIZE COMPARISON OF A HONEYBEE AND A NEWBORN OPOSSUM (DIDELPHIS)

The young, about the size of honeybees, are released from the vagina; they appear swinging their forelimbs and grasp the first object within reach, which is usually the mother's fur. They are naked, blind and rather grublike in appearance. The forelimbs, however, are large and tipped with claws; the hind legs are hardly more than embryonic buds. Immediately after birth the young use their forelimbs in a swimminglike motion; by wiggling and grasping they make their way to the mammary area within the pouch. This feat is accomplished in about 16 seconds! Only about 60% of those born ever reach and enter the pouch. The more fortunate ones attach themselves to nipples that swell and become fastened firmly in the mouths of the young. Development and early growth then continues in the pouch.

At the age of four or five weeks the young are able to leave the pouch for short intervals. Generally they remain with the mother from 90 to 100 days, oftentimes clinging to her fur. Thereafter they are weaned and begin to look after themselves.

EVOLUTION AND RELATIONSHIPS

Geologically, marsupials were doubtfully present in Asia and are definitely not known from Africa. On the whole they are considered as primitive mammals, but for some 100,000,000 years they have shown a remarkable parallel and convergent evolution with placental mammals in habits, physiological processes and structures. This convergence is so conspicuous that some genera have been referred to as marsupial "wolves," "cats," "rats," "mice" and "shrews." One South American fossil has appropriately been called a sabre-toothed marsupial.

The oldest known marsupials have been found in the Late Cretaceous strata of North America. These specimens are represented mostly by tiny isolated teeth, but parts of jaws have also been found. Until recently all of these have been classified in the American opossum family, Didelphidae. William A. Clemens has observed that these early marsupials were already specialized in different directions. One genus, primarily tiny animals called *Alphadon*, holds the most promise of being correctly classified as Didelphidae. On the other hand the group of small to large creatures, represented by the genus *Pediomys*, seem rather clearly not didelphids. The widely known genus *Eodelphis* is almost certainly not didelphid. Among its more conspicuous differences from the Didelphidae are the single (not double) rooted, much reduced first lower premolar and the presence of three, not four, lower incisors, of which the middle incisor is greatly enlarged. It is likely that this marsupial is not ancestral to any of the known later genera. Another specimen, known as *Thlaeodon*, is the largest known Cretaceous mammal. Its bulbous premolars and large canines are indicative of an omnivorous adaptation. It apparently is referable to another family. *Alphadon* is possibly nearer than any of the other Cretaceous genera to an ideal ancestral position for the marsupials as a whole, but it seems rather obvious there were other groups of Cretaceous marsupials not yet represented in our collections of fossils.

CLASSIFICATION AND SURVEY

The order is currently classified into 6 superfamilies and from 14 to 18 families depending on the authority followed. Various attempts have been made to divide the marsupials into suborders but none of these have been unanimously adopted.

Two earlier and now obsolescent classifications into suborders were based upon the number and arrangement of the front teeth and the appression or separateness of certain toes. "Polyprotodontia" was given to those marsupials having the polyprotodont condition of the presence of at least four upper incisors; "Diprotodontia" was applied to forms having three or (usually) fewer upper incisors and no lower canines. "Didactyla" was

CHARLES PHILIP FOX

FIG. 3.—DEVELOPMENT OF THE COMMON OPOSSUM IN THE POUCH (TOP LEFT) AT THREE WEEKS AND (BOTTOM LEFT) AT SEVEN WEEKS. (RIGHT) MOTHER CARRYING 10-WEEK-OLD YOUNG

given to those marsupials having entirely separate toes on the hind feet; "Syndactyla" was reserved for those forms in which the second and third toes of the hind feet are enclosed in a common envelopment of skin.

The adjectival forms of these terms are still used to describe the dentition and the character of the hind feet; the proper nouns themselves are not particularly valid as indicating phylogenetic relationships, however.

Superfamily Didelphoidea
  Family Didelphidae, American opossums
Superfamily Borhyaenoidea (extinct)
  Family Borhyaenidae
  " Necrolestidae
  " Caroloameghiniidae
Superfamily Caenolestoidea
  Family Caenolestidae, caenolestids or pouched "shrews"
  " Polydolopidae (extinct)
Superfamily Dasyuroidea
  Family Dasyuridae, dasyures, native "cats," etc.
  " Thylacinidae, Tasmanian "wolf," "tiger," "hyena," etc.
  " Myrmecobiidae, banded "anteater" or numbat
  " Notoryctidae, pouched "moles"
Superfamily Perameloidea
  Family Peramelidae, bandicoots
Superfamily Phalangeroidea
  Family Phalangeridae, Australian "opossums," cuscuses, phalangers, etc.
  " Phascolarctidae, koalas, greater gliders, etc.
  " Thylacoleonidae (extinct), marsupial lion
  " Potoroidae, rat kangaroos
  " Macropodidae, kangaroos, wallabies, etc.
  " Diprotodontidae (extinct)
  " Vombatidae, wombats

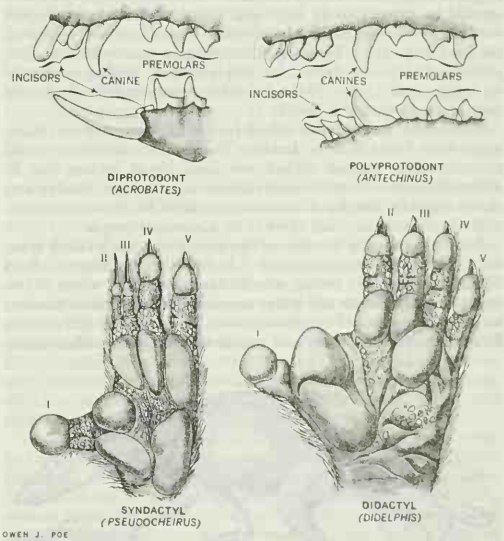
American Opossums (Didelphoidea)

Primitive marsupial characters in the didelphoids have long been recognized by mammalogists. Some of these features in the dentition, skull, body skeleton and soft anatomy may be reasonably expected to be remarkably like those in the Mesozoic ancestors of all later marsupials. Characters in the molars indicate that the Paleocene and Eocene didelphoids and borhyaenoids are closely related, but the lack of enough fossils makes it impossible to trace the lineage of all marsupial superfamilies back to the known North American Cretaceous fossils (possibly the more direct ancestors of some of the other superfamilies existed at that time). Better knowledge of the skeletons and dentitions of Cretaceous and even Early Cenozoic fossil marsupials may eventually alter the present interpretation of their superfamily relationships considerably.

Opossum Family (Didelphidae).—American opossums were observed in 1500 by Vicente Yáñez Pinzón, the first explorer of South America. One of the animals was taken alive, exhibited in Granada and described by Trivigiano in 1504. Later Capt. John Smith in 1612 described the opossum concisely in the following words: "An opossum hath a head like a Swine, and a taile like a Rat, and is of the bigness of a Cat."

One of the largest didelphids is the common North American opossum (*Didelphis marsupialis*), some of which exceed one yard in total length. The colour of the fur over the body is grayish-white, or, in some individuals, nearly black, due to a heavy coat of black-tipped overhair. The rounded, beadlike black eyes stand out prominently against the white, rather wedge-shaped face. The ears are thin and naked. The tail, white throughout most of its length, is long (up to half the total length), naked, scaly and prehensile. All the toes except the opposable inner one on the hind foot bear sharp claws. The female opossum, as in most but not all marsupials, has a fur-lined abdominal pouch, which is laterally located.

The common opossum prefers wooded areas especially near streams or other bodies of water. It is both arboreal and terrestrial, and almost exclusively nocturnal in habits. It



OWEN J. POE

FIG. 4.—DENTITION: (TOP LEFT) DIPROTODONT IN THE PYGMY GLIDERS AND (TOP RIGHT) POLYPROTODONT IN THE BROAD-FOOTED POUCHED MICE. FUSION OF DIGITS OF HIND FOOT: (BOTTOM LEFT) DIGITS II AND III SYNDACTYL, DIGIT I OPPOSABLE, IN THE RING-TAILED OPOSSUMS AND (BOTTOM RIGHT) DIGITS II AND III DIDACTYL, DIGIT I OPPOSABLE, IN THE COMMON OPOSSUM

BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

FIG. 5.—CENTRAL AMERICAN WATER OPOSSUM, OR YAPOK (CHIRONECTES PANAMENSIS)

usually moves about slowly, with an ambling gait, but at times, as when pursued by dogs, it may move with considerable alacrity. The den may be a hole in the ground or in a tree. An opossum may eat almost anything, but eggs and fruit, especially persimmons, are favourite foods.

The greatest adaptive modification is seen in the water opossum (*Chironectes*), the yapok or yapó of Central and South America. This is one of the most colourful opossums. It is about the size of the common opossum. Its most conspicuous feature is an ash gray and nearly black marbled pattern to the fur on the back; the under parts are silvery white. The fur, thick and oily, has few guard hairs. The ears are large, rounded and naked. The toes of the hind feet are much longer than in other opossums and are connected by interdigital membranes, which the yapok uses to advantage in swimming. The oily nature of the pelage, and the ability to constrict the opening of the pouch tightly, makes it possible for the female to swim and to dive without jeopardizing the young, at least in their early stages of development. Five young have been found in the pouch. The water opossum constructs terrestrial nests of leaves in secluded sites near the water. Its food consists primarily of small fish, crustaceans and aquatic insects.

One species of *Philander*—the pouched, four-eyed opossums, called cuicas or guikis—ranges from Mexico to Brazil. Its total length is slightly more than two feet. This opossum may be recognized by two relatively large and widely separated white spots over the eyes, contrasting sharply with the ashy-brown pelage of the head and back. Ventrally, the colour is cream-white or pale yellow. Cuicas are terrestrial and arboreal, feeding primarily on insects and fruit. *Philander* differs conspicuously from the next genus in having a pouch.

Metachirus species, also called four-eyed opossums or cuicas, range from Costa Rica to Brazil. They are frequently confused with *Philander* species. They are about equal in size, but in *Metachirus* the two white spots above the eyes are smaller and closer together, the dorsal coloration reddish to cinnamon brown with the face darker, and there is no abdominal pouch.

Another unusually interesting opossum is the thick-tailed opossum (*Lutreolina crassicaudata*). It may be the largest of all living opossums. It occurs only in South America, where it frequents swampy areas and water courses, but may follow streams into the highlands and semidesert areas. The ears on this stocky-limbed opossum are short and rounded, scarcely extending above the fur. There is no pouch. The pelage is a uniform rich soft yellowish-brown. It is said to build rounded grass nests among the rushes in swampy areas.

A small opossum that shows some interesting adaptations is *Lestodelphis halli*, from the coast of Tierra del Fuego, the southernmost tip of South America. The adult may attain about 9 in. in length. The short head, short jaws and strong molar teeth indicate flesh-eating habits; further conspicuous dentition includes the large canines and small incisors.

A genus that still seems to be undergoing considerable evolution is *Monodelphis*, the short-tailed opossums. The several species occur only in South America. These are among the smallest known of the superfamily, with total lengths ranging from $2\frac{3}{4}$ to 6 in. Evidently they live mostly on the ground and are somewhat shrewlike in habits. They eat insects and other small animals, but also like bananas. The colour on the back is brownish, but the under parts are pale red. Some species have as many as three dark stripes down the back. The ears are short and rounded. There is no pouch, but there are up to 27 teats, as many as are known among marsupials.

No didelphids are more abundant as individuals and certainly not as species than the murine opossums, *Marmosa*. Almost 50 species, occurring from Mexico to Argentina, are currently recognized. In size they range from less than 3 in. to more than 10. The dominant colours are gray, brown, cinnamon and rufous; there is always a contrast between the back and belly colours. A black ring of hair is nearly always conspicuous around the eye. The ears are variable in size and are nearly bare. There is no abdominal pouch, but up to 19 teats may be present. Murine opossums are frequently taken in habitats where there are numerous vines that afford them runways from tree to tree. They are primarily insect and fruit eaters, having a special liking for bananas.

The woolly opossum genus *Gloronia* is known from two species in the Andes of Ecuador and Peru. The long woolly hair is grayish-brown. Black ocular areas cover most of the face and a narrow white stripe extends from the nose to the nape. Perhaps the most distinctive feature of these unusual opossums is the tail, which is covered with hair except on the ventral side of the tip. The total length is more than 17 in.

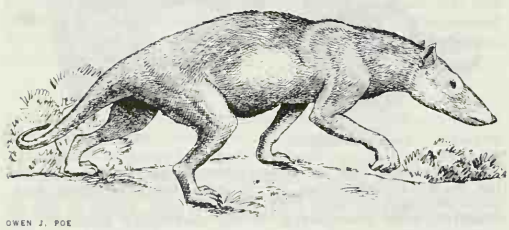
Equally fascinating is *Dromiciops australis*, from the brushy mountain environments of the Valdivian forests of Chile and adjacent areas in Argentina. These little woolly opossums, about 8 in. long, have most of the tail covered with hair. In contrast to *Notodelphis* the canine teeth are small. The external ear is small and covered with short hair. The pouch is lined with deep cinnamon hair, quite in contrast to the whitish belly hair. The fur on the back is dark gray.

Caluromys comprises several species of medium-sized woolly opossums in Mexico and Central and South America. The soft and thick back pelage is dull yellow or rufous gray, whereas the under parts are deep or pale yellow. The pale gray face has darker circles around the eyes and a dark stripe part way down the midline. The ears are large and naked. A pouch is represented by lateral rudiments.

Borhyaenoids (Borhyaenoidea)

The oldest known South American marsupials are Late Paleocene in age. At that time three Neotropical superfamilies, Didelphoidea, Borhyaenoidea and Caenolestoidea, were already in existence. Patterns of the known cheek teeth of the Paleocene and Early Eocene borhyaenoids and didelphoids indicate that these marsupials may have descended from a common ancestor no earlier than the Late Cretaceous.

Borhyaenidae.—The fossil record of the family Borhyaenidae starts in the Late Paleocene and continues into the Pliocene. No genera are known to have occurred outside South America. Borhyaenids were the flesh-eating mammals of the southern continent during nearly all the Tertiary; true carnivores did not reach that region until late in the Pliocene and Pleistocene. The family name is derived from the genus *Borhyaena*, hyenalike specimens found in the Early Miocene strata of Argentina. These carnivorous marsupials had massive skulls with thick crushing teeth.



OWEN J. POE

FIG. 6.—A BORHYAENID (LYCOPSIS) OF THE LATE MIOCENE EPOCH IN SOUTH AMERICA

Some genera, *e.g.*, *Proborhyaena*, were shorter-faced and more robust.

All borhyaenids were not hyenoid, however. There were the wolflike *Prothalycinus* and *Lycopsis*, and the fox- to marten-sized *Cladosictis* and *Amphiproviverra*. The most specialized of all Middle and Late Tertiary genera was the Pliocene sabre-toothed borhyaenid *Thylacosmilus*. It was about the size of a puma and even more specialized as a stabbing mammal than most sabre-toothed cats. In all, more than 20 borhyaenid genera have been described. Those like *Prothalycinus*, *Borhyaena* and *Lycopsis* have converged so closely morphologically with the marsupial wolf of Tasmania (*Thylacinus*) that some students formerly assumed the genera were closely related. It has been revealed, however, that the borhyaenids have had a long evolutionary history in South America and that they descended from a Cretaceous didelphidlike mammal.

Necrolestidae.—One fossil with a molelike adaptation called *Necrolestes* is known from the Miocene of Patagonia. It is the only known genus referable to the Necrolestidae, a family probably basically related to the Borhyaenidoidea or Didelphidoidea.

Caroloameghiniidae.—This family, named for the Argentine fossil collector Carlos Ameghino, is known from two jaw fragments with small teeth of the bunodont type, characteristic of mammals with a mixed diet. This family is tentatively placed in the Borhyaenoidea.

Pouched Shrews (Caenolestoidea)

The other superfamily of South American marsupials is the Caenolestoidea. They too are undoubtedly descendants of a Cretaceous group, but the oldest known caenolestoids are already too specialized to reveal affinities with any of the known Mesozoic fossils. Any resemblances they have to Australian groups apparently are due to convergent evolutionary trends in certain structures.

Pouched Shrew Family (Caenolestidae).—The Caenolestidae has been recorded from Early Eocene deposits, but the genera were more numerous in the Oligocene and Miocene. These little marsupials were long known from fragmentary fossils, but in 1895 Oldfield Thomas announced that this supposedly extinct family was actually represented in the living Andean mammalian fauna of Ecuador and Bolivia by an animal resembling a small rat in size and appearance. This he called *Caenolestes*. (Actually Robert F. Tomes recognized the marsupial relationships of this shrewlike mammal 35 years earlier but did not name it, consequently his work was overlooked.) These terrestrial marsupial shrews are found along boggy streams in humid forests with much undergrowth. They feed on insects and spiders. The head is elongate and with rounded, medium-sized ears. The long and gently tapering tail, thickly set with short stiff hairs, is not prehensile. The diprotodont incisor teeth are suggestive of those in some of the Australian phalangeroids, but the hind feet show no trace of the phalangeroid syndactylism of the second and third toes. Other genera with living species are *Orolestes* in Peru and *Rhyncholestes* in Chile.

Polydolopidae.—This Early Cenozoic family of small specialized marsupials are related to the Caenolestidae. Their fossil remains are abundant in the South American strata of that time. They have transversely compressed and laterally ridged premolars, with serrated crests, and rodentlike incisors. The polydolopids, probably in a large measure, occupied the ecological niches that were later taken over by rodents. The fossil record indicates, however, that the polydolopids were extinct before the rodents appeared in South America.

Dasyures and Allies (Dasyuroidea)

The Australasian dasyuroids show a remarkable similarity to the American opossums in the pattern of the teeth and in the construction of the skull. The range in size of the animals is about the same. The dasyuroids are, however, much more alert and intelligent. They also differ from opossums in being primarily terrestrial. Their progressiveness is further indicated in a longer gestation period—30–33 days in the yellow-footed dasyure (*Antechinus flavipes*). Among the most conspicuous differences between dasyuroids and didelphoids is the number of incisor teeth. The dasyuroids have four above and three below, whereas the American opossums have five above and four below. There are almost 20 genera of these insectivorous and carnivorous dasyuroids, ranging from the tiny pouched "mice" to the marsupial wolf, which is as large as a German shepherd dog. *Dasyurus quoll*, the so-called native cat, was perhaps the first dasyuroid to be encountered by white men. This animal was seen on Bare Island in Botany Bay by Capt. James Cook's party in 1770. Because of superficial resemblances to other mammals dasyuroids have been called marsupial tigers, jerboas, rats and mice.

Dasyure Family (Dasyuridae).—The largest dasyurid, the Tasmanian devil (*Sarcophilus ursinus*), is now restricted in its distribution to Tasmania, although in prehistoric times it also inhabited the mainland of Australia. It is a rather stocky animal with a bushy tail. The black coat is interrupted by a white band across the throat, another across the rump and a white spot on each side of the body. The devils have short powerful jaws with heavy teeth.

The tiger cat (*Dasyurops*) is almost as large as the Tasmanian devil but is slender, about 20 in. long and much more active. Its colour is deep reddish-brown, both the body and tail being covered with white spots. These dasyures are excellent climbers, very seclusive. Their diet consists almost entirely of meat; they stalk birds much like a cat and are extremely destructive of poultry. The lower jaw of another genus, *Glaucodon*, has been found in the Pleistocene of Victoria. It reflects relationships to both *Dasyurops* and *Sarcophilus*.

The native cat (*Dasyurus quoll*) is much smaller, its total length being about 13 in. It is less arboreal than, but otherwise as active as, the tiger cat. There are two colour phases; one is black, the other grayish tan. It differs from the tiger cat in having larger white spots only on the body and not on its bushy tail. The native cat is cunning and is often found near human habitation. *Dasyurus* is distributed along the east coast of Australia and in Tasmania.

In central and western Australia are two genera, *Dasyurinus* and *Satanellus*, that are closely related to *Dasyurus*. These spotted dasyures retain the first digit in the hind foot, whereas in *Dasyurus* that digit is missing. In some classifications *Dasyurops*, *Dasyurinus* and *Satanellus* are included in the genus *Dasyurus*.

Two other rat- or weasel-sized dasyures are the buff to reddish-brown *Dasyuroides* and *Dasycercus*. They are desert forms with large auditory bullae and no spots. *Dasycercus*, the mulgara or crest-tailed pouched "mouse," is distinguished from the other genus in having the tail thick just beyond the peduncle base and the terminal brush developed only on the dorsal side. Members of both genera are primarily carnivorous but also eat insects.

The dibbler or little speckled dasyure of southwestern Australia (*Parantechinus*), so named because the black body hair has long white tips, apparently is extinct. One of its most conspicuous features was the heavy covering of hair over about one-third of the base of the tail. The fat-tailed dasyure (*Pseudantechinus*) is found in the rocky deserts of central and northern Australia. In the mountains of New Guinea are two closely related, dark-coloured genera *Neophascogale* and *Phascolosorex*. *Phascolosorex* may be distinguished by the slender black dorsal stripe. The long faces of these dasyures give them the appearance of tree shrews. *Myoictis*, also restricted to New Guinea, comprises short-faced dasyures, with the pelage usually rufous, chestnut or nearly black and with three, slender, black dorsal stripes.

Planigale ingrami subtilissima (considered by some as referable to the genus *Antechinus*) is probably the smallest of any known marsupial, with a total length of $2\frac{3}{4}$ in. One of the conspicuous features of this tiny, brownish-gray dasyure is the marked dorsoventral flattening of the skull, an adaptation that allows these animals to find shelter in narrow cracks in the ground or between rocks. They have been found in central, northern and northwestern Australia.

Sminthopsis, another genus of small dasyures, are widely distributed in Tasmania, Australia, southern New Guinea and the Aru Islands. These delicately constructed, large-eared forms are ter-

restrial. They may conceal themselves under debris, logs, rocks or in holes in the ground. They are primarily insectivorous, but also are carnivorous and even cannibalistic. In central Australia during favourable seasons, they may be seen in the gibber (gravel) deserts at night, scurrying about in considerable numbers searching for insects.

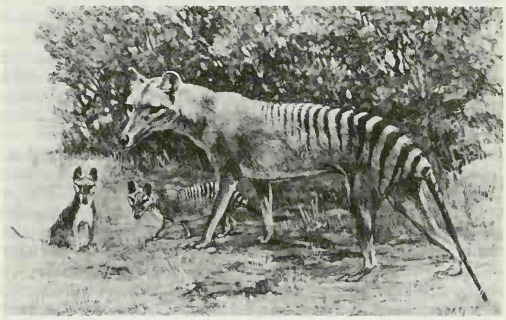
The somewhat larger reddish-brown *Antechinus* species are equally widely distributed but are not as well adapted to desert environments. The skulls are wider than in *Sminthopsis* but not flattened as in *Planigale*, and the median upper incisors are enlarged. The tails have short hairs and are rather ratlike. Antechines are mostly insectivorous but also eat flesh. These terrestrial dasyures seek protection in rock crevices and among rocks and logs.

The arboreal bluish-gray *Phascogale* is about the size of rats or weasels. The terminal half of the tail is covered with long black hairs. The skull is somewhat flattened dorsoventrally and the median upper incisors are larger than in *Antechinus*. In human habitation phascogales are known to kill chickens and ducks and therefore considered pests comparable to weasels and rats. *Murexia*, from the mountains of New Guinea, Japan and the Aru Islands is grayish-brown above, and in one species (*M. rothschieldi*) has a broad black stripe down the back.

In many respects the most remarkable of all dasyurids are the little jerboa dasyures (*Antechinomys*). These leaping, insectivorous marsupials, with large ears, lengthened hind legs and very long tail are found in the Northern Territory and probably elsewhere in the Australian interior.

Except for having only four toes on each hind foot, *Antechinomys* superficially resembles *Sminthopsis*.

Tasmanian Wolf Family (Thylacinidae).—The marsupial wolf (*Thylacinus cynocephalus*) is the largest and most widely known of the dasyuroid marsupials. Although its distribution is



BY COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 7.—TASMANIAN WOLF (THYLACINUS), FROM A PAINTING BY CHARLES R. KNIGHT. IN THE AMERICAN MUSEUM OF NATURAL HISTORY

usually recorded as being restricted to Tasmania, it was represented on the mainland of Australia less than 26,000 years ago, and appears to have lived on New Guinea also. H. C. Reynolds has stated that the last certainly known marsupial wolf was killed in Tasmania in 1932. Laymen usually refer to them as tigers because of the black stripes across their rumps and backs. Originally feeding on kangaroo and wallaby, *Thylacinus*, with the settling of Tasmania, began preying on sheep, which led to its being hunted and killed at every opportunity.

The family relationships of this marsupial are still not fully understood. (Its classification with the extinct Borhyaenidae of South America has almost conclusively been disproved.) However, its characters display a most remarkable convergent evolution with the American borhyaenids. It seems reasonable to assume that the marsupial wolf and the dasyures arose from a common ancestry far back in Cenozoic time. Species from the Pleistocene of Australia have been named, but even if these species are valid they are very closely related to the Recent species. Many authorities place *Thylacinus* in the family Dasyuridae, but until the

VINCENT SERVENTY, COLEMAN & NAYWARD

FIG. 8.—NUMBAT, OR BANDED ANTEATER (MYRMECOBIUS)

Cenozoic ancestry is adequately known this classification cannot be confirmed.

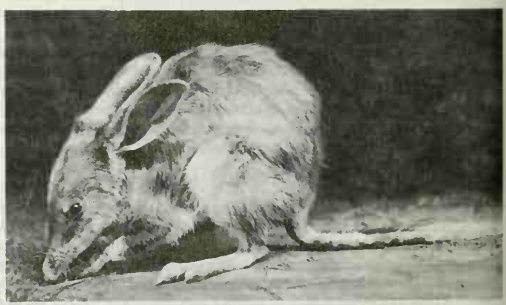
Banded Anteater Family (Myrmecobiidae).—The marsupial anteaters, called also banded anteaters or numbats, are basically related to the dasyures. Nevertheless these animals are so specialized in the skull and in dentition that their family rank seems fully justified. No fossils are known. *Myrmecobius* comprises squirrel-sized forms. The pelage on the back is light to dark rufous, transversely banded with white stripes, and the tail is long and bushy. They are terrestrial marsupials but prefer forest areas where ants are abundant. The teeth are small and degenerate in structure, although there are supernumerary molars.

Pouched Mole Family (Notoryctidae).—The family Notoryctidae represents the marsupial "moles" of Australia. Only one genus, *Notoryctes*, and two species are known. They occur in the sandy deserts of central and western Australia. There they burrow along in the sandy soil about three inches below the surface in search of worms and grubs. These little marsupials display a remarkable convergence in their characters and habits with the placental golden moles (Chrysochloridae) of South Africa and the true moles (Talpidae) of the northern hemisphere.

The pelage of *Notoryctes* ranges from nearly white to a rich golden-red. The eyes are so degenerate they are not visible through the hair and the external ears are only small openings through the skin. A blunt snout and an abbreviated tail are both covered with leathery skin. The pouch opens backwards and there are epipubic bones. Without a fossil record it is not possible to conclude how closely *Notoryctes* is related to the basal stocks of the dasyuroids and to that of the bandicoots, but the absence of syndactyly in the hind feet suggests they are closer to the dasyuroids.

Bandicoots (Perameloidea)

Bandicoots in some respects look like rodents and in other ways resemble small peccaries or pigs. They range in size from that of



PAUL POPPER

FIG. 9.—A RABBIT BANDICOOT, OR BILBY (THYLACOMYS)

a large rat to that of a hare. The face is long, narrow and pointed. The pelage is rather coarse, although some forms have a soft underfur. The tail, usually of medium length—and in most forms sparsely coated with short hair—is not prehensile. Perameloids have one of the most primitive characters seen in any Australian marsupials: the retention of an incisor formula of $\frac{3}{3}$ (polyprotodont) in most of the genera. They have syndactylism in the hind foot: the proximal and median phalanges of the second and third digits are enclosed in the same sheath of skin. The pouch is directed backward. Usually two to four young are raised at a time. Bandicoots are terrestrial and prefer brushy or grassy habitats where they may scratch shallow runways that afford them some protection; the bilbies, however, live in the arid interior. On the whole bandicoots are omnivorous.

Bandicoot Family (Peramelidae).—Three of the most primitive genera (*Peroryctes, Microperyctes* and *Rhynchomeles*) are restricted to New Guinea and adjacent islands; *Echymipera* has dispersed into the northern part of Cape York peninsula, Australia. A fifth primitive genus, *Perameles,* the common long-nosed bandicoots, has experienced a wide distribution. It and a more progressive genus, *Isoödon,* may be found in Australia, Tasmania and New Guinea. The specialized bilbies (*Thylacomys*), or rabbit bandicoots or pinkies as they are sometimes called, occur only in Australia; house cat-sized, they are the largest of the Peramelidae.

Both *Thylacomys* and *Perameles* are represented in the Late Pleistocene faunas of Australia. An extinct genus, *Ischnodon,* has been found in the Pliocene strata of South Australia. The most peculiar of all peramelids, however, is the extinct pig-footed bandicoot (*Chaeropus ecaudatus*). The common name is derived from the construction of the front foot, in which the second and third digits are of equal length and closely united. The nails, of equal size and length, give the appearance of cloven hoofs.

Phalangeroids (Phalangeroidea)

The phalangeroid marsupials of Australasia are here divided into five families. Only a very hypothetical phylogeny, indicating possible ancestral relationships of this group to the other superfamilies, can be outlined until an adequate fossil record from the Late Mesozoic and Early Cenozoic has been compiled. The Phalangeroidea were probably derived from an ancestral stock that also gave rise to the Perameloidea. Evidently in this early stock (in contrast to the Dasyuroidea) natural selection was toward syndactylism of the second and third digits in the hind foot. Subsequently one syndactyl stock led to the ancestors of the rat kangaroos, kangaroos, diprotodontids, wombats, koalas, marsupial lions and phalangers; the other syndactyl stock gave rise to the bandicoots.

Phalanger Family (Phalangeridae).—The phalangers, "opossums" or "possums" in Australia, are distributed throughout Australasia. This family represents one of the most inclusive groups of marsupials. For the most part the genera are readily recognized because of their distinct appearance. Phalangers are primarily but not exclusively arboreal; the big toe is opposable and the tail is prehensile or fringed laterally with stiff hairs.

Eudromicia is the most primitive of all the living genera of phalangers. It comprises in part the "dormouse possums," whose colour is rich brown above and creamy-white below. They feed on insects and blossoms, and construct their nests of soft bark in hollow limbs or sometimes under the linings of bird nests. The retention of the fourth molars and the double rooted first and second upper premolars distinguish them from the other dormouse possums, *Cercaërtus,* to which they show a remarkable resemblance.

Another small phalanger is the pen-tailed phalanger (*Distoechurus*) of New Guinea. The most conspicuous feature in this form is the tail, in which the basal half is covered with hair and the distal half is nearly naked but fringed laterally with stiff hairs. Even more remarkable is the pygmy glider or feather-tail (*Acrobates*). It is readily distinguished from the other small phalangers by flaps of skin that stretch from the elbow to the knee on each side. The back is dark brown and the under parts are white.

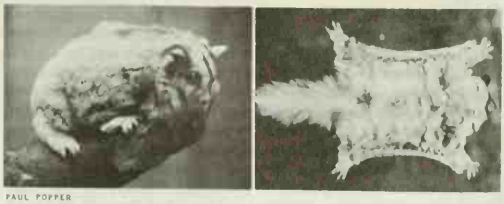


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FIG. 10.—SQUIRRELLIKE FLYING OPOSSUM (PETAURUS) (LEFT) AT REST AND (RIGHT) IN A GLIDE SEEN FROM THE UNDERSIDE, SHOWING THE OUTSTRETCHED MEMBRANE EXTENDING FROM WRIST TO ANKLE

This little acrobat is primarily restricted to the eucalyptus forests in Australia, where it feeds on the nectar from eucalyptus flowers. This diet, however, is supplemented with insects.

The remains of a tiny extinct phalanger called *Burramys* has been found in the Guineacor fissure near the Wombeyan cave in New South Wales. The shape of the skull and the pattern of the molars resemble those in *Eudromicia* and *Cercaërtus,* but the premolars are high and serrated.

The sugar glider or flying possum (*Petaurus*), in its volplaning adaptation, has converged with the flying squirrels of the northern hemisphere. The sugar glider is distributed in the forests of New Guinea, Australia and Tasmania. It varies in colour from dark brown to bluish gray; the gray ones have a brown stripe down the back and a predominantly brown, bushy, nonprehensile tail. The diet consists of insects, blossoms, fruits and buds. The brownish-gray to grizzled-gray Leadbeater's possum, (*Gymnobelideus*), though it has no gliding membrane, is more or less intermediate between the sugar glider and forms more adapted to climbing.

Most unusual is the striped possum (*Dactylopsila*). The longitudinally striped black-and-white coat makes this marsupial a conspicuous occupant of the trees in northern Queensland and in New Guinea. The evenly rounded tail is prehensile at the tip. The most outstanding specialization, however, is the elongation of the fourth finger, which is used primarily for probing grubs from crevices and cavities in wood. The striped possum prefers to eat the larvae of wood-boring beetles but also eats termites. A closely related genus, *Dactylonax,* is recognized from differences in the skull and in having a longer 4th digit.

The common phalangers or bush-tailed, or brush-tailed, possums (*Trichosurus*), which have adapted well to the occupation of their territory by civilized man, sometimes prove annoying at times when they seek shelter among the rafters of houses. These large possums have brown and gray colour phases. The thick bushy tail is naked below the tip and is prehensile. The rather pointed nose, large eyes and prominent ears are other outstanding features. Common phalangers are arboreal and nocturnal, like most marsupials. Normally their nests are constructed in large hollows of eucalyptus trees. They are primarily herbivorous but also will eat other foods. The gestation period in *Trichosurus vulpecula* is 17 to 18 days. One young is usually reared. One of the oldest fossil marsupials of Australasia is part of the skeleton of a brush-taillike possum, *Wynyardia bassiana,* that was found at Fossil Bluff near Wynyard, Tasmania. Fossils more closely related to the Recent species occur in the Pleistocene of Australia; others much older occur in the Middle Tertiary of South Australia.

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FIG. 11.—A COMMON PHALANGER (TRICHOSURUS FULIGINOSUS)

Probably the ugliest of all marsupials are the lemurlike cuscuses (*Phalanger*), from which the family and superfamily names are derived. The unusual appear-

ance of the cuscus is due to the very short ears that scarcely extend beyond the hair. The outer half of the prehensile tail is covered with scales. The Queensland species is light brown with white spots. Other species, found in Timor, the Celebes and New Guinea, may be almost black, or have suggestions of spots; some are even white. *Wyulda,* the scaly-tailed possum, which is terrestrial and lives among rocks in northwestern Australia, is somewhat intermediate between the brush-tailed possums and the cuscuses.

The most extraordinary of all the phalangeroids is the little honey possum or long-snouted phalanger *Tarsipes.* They are found only in Western Australia. There are three dark brown stripes down the back, the sides and face are light brown and the under parts white. The long naked tail is prehensile. Extreme specialization is seen in the long narrow head and almost trunklike snout. In extracting nectar from blossoms the long tongue can be extended nearly an inch beyond the nose. The teeth are greatly reduced in number and are essentially vestigial.

Koala Family (Phascolarctidae).—The Phascolarctidae include the ring-tailed possums, greater gliders and koalas or native "bears." In this family the first and second digits of the hand are opposable to the third, fourth and fifth and the molars are adapted for chewing leaves.

Perhaps the least specialized of the genera in this family is *Pseudocheirus,* the ring-tailed possums. Their common name is derived from the long, tapering sparsely-haired tail that is usually curled in a prehensile manner. Ringtails are usually found in hilly country well above sea level; one species in New Guinea occurs as high as 12,000 ft. They do not extend as far along the forest-lined creeks into central Australia as do the brush-tailed possums. They construct dome-shaped nests in tree tops or may line the smaller hollows in limbs with leaves. The pouch contains two functional nipples and usually two young are raised. Fossils related to these possums have been found in the Middle Tertiary of South Australia.

The greater glider or great flying phalanger (*Schoinobates*) is a spectacular mammal. It is the largest of the gliding marsupials. The body alone is 18 in. long. The pelage is usually black above and white below, but a brown or gray back is not uncommon; others may be white. The tail is bushy and longer than the body. Greater gliders prefer heavily timbered country along the coastal highlands of eastern Australia, where they have been seen to glide as far as 120 yd. Usually they take off from the top of one tree and land on the trunk base of another. Their diet is almost exclusively tender leaves and blossoms. One young at a time is reared, although there are two nipples.

One of the most famous of all Australian marsupials is the koala (*Phascolarctos*). As with the greater glider only one species is known, although a rather distantly related genus, *Perikoala,* from the Tertiary of South Australia has been described. The koala, with its short tail and rather stocky body, so resembles the wombat that the two are considered by some students to have arisen from a common ancestor, perhaps not very far back in Cenozoic time. Others believe, however, that the koala is much closer to the ringtails and greater gliders. In contrast to the other tree-dwelling marsupials, the pouch in the koala opens backwards. Only one young is born at a time. The koala is unique in having functional cheek-pouches. The ashy-gray pelage, fluffy ears, yellow, shoebutton eyes and black leathery nose are among its pronounced features. Koalas are so thoroughly arboreal in habits that they seem comfortable only among the branches of the trees.

The three genera included in this family are sometimes classified as belonging to the family Phalangeridae.

Marsupial Lion Family (Thylacoleonidae).—There has been much discussion on the probable feeding habits and the relationships of the so-called marsupial lion (*Thylacoleo*). Most students of marsupials agree, however, that it belongs in a separate family. Specimens of the cranium and lower jaws are well known, and parts of the limb bones and body skeleton have been found. *Thylacoleo* was about the size of an African lion. Its teeth were even more specialized for meat shearing than those in the true cats. For example, the large posterior premolars were as long as 2¼ in. All the remaining teeth were greatly reduced, except the upper and lower median incisors, which apparently were utilized in capturing other animals. These great carnivorous marsupials became extinct in Australia less than 26,000 years ago.

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FIG. 12.—SKULL AND RECONSTRUCTION OF THE HEAD OF THE MARSUPIAL LION (THYLACOLEO)

Rat Kangaroo Family (Potoroidae).—Although the genera referred to this family are closely related to the kangaroo family Macropodidae and are classified by some as a subfamily of that group, they apparently have represented a distinct lineage since Eocene time. They may be distinguished from kangaroos by, among other features, having conjoined masseteric and inferior dental canals that extend as far forward as the first or second molars and the frontal and squamosal bones of the skull in contact. The female urogenital system is more specialized than in the Macropodidae. The living genera are *Hypsiprymnodon, Potorous, Bettongia, Aepyprymnus* and *Caloprymnus.* A Pleistocene genus, *Propleopus,* was much larger. A species of *Bettongia* and an undescribed genus occur in the Middle Tertiary of South Australia.

Kangaroo Family (Macropodidae).—The most widely known marsupials are the kangaroos. They include the gray (*Macropus*) and red kangaroos (*Megaleia*), euros or wallaroos (*Osphranter*), true wallabies (*Wallabia*), pademelons (*Thylogale*), rock wallabies (*Petrogale*), tree kangaroos (*Dendrolagus*) and the quokka (*Setonix*). The gigantic forms during the Pleistocene were *Procoptodon, Sthenurus, Protemnodon* and two species of *Macropus. Prionotemnus* is from the Pliocene, but the oldest kangaroos come from rocks probably as old as Miocene.

Like the rat kangaroos, the macropodids are adapted for jumping. They have long hind legs and long tails for balance. The forelimbs and hands function somewhat like those in primates, but the digits are equipped with sharp claws and the thumbs are not opposable. The principal digit in the hind foot is the fourth, the fifth being somewhat reduced; the syndactyl second and third are reduced to splinters but still bear tiny claws, and the first is absent. *Procoptodon* and *Sthenurus* differ from the other kangaroos in having lost all but the fourth digit. (*See* KANGAROO.)

Diprotodontidae.—The largest of all marsupials was the extinct, huge *Diprotodon optatus.* It was built something like a huge ground sloth, and rivaled some mastodonts in size. Special dentition included the large, chisel-shaped median incisors and molar teeth, somewhat like those in certain kangaroos or tapirs, composed of two cross-crests. *Diprotodon* was probably abundant in Australia in the Late Pleistocene and subrecent time. Their remains have been found in levels contemporaneous with man. It has been estimated that there are at least 1,000 skeletons of these animals within an area of 20 acres, where they bogged down in an old mound spring at Lake Callabonna in South Australia. At least two other genera, *Nototherium* and *Euowenia,* representing much smaller diprotodontids also occur in the Australian Pleistocene faunas. *Palorchestes* also of the Pleistocene, previously considered as the largest of all kangaroos, is now known to be a diprotodontid.

This family, like the Macropodidae, has had a long Cenozoic history in Australia. *Meniscolophus* is known from the Pliocene, and remains of a rather primitive undescribed genus and species are thought to be as old as Oligocene. It appears that all known diprotodontids were herbivorous. The family may have been an early offshoot of the phalangeroid stock and perhaps was distantly related to kangaroos and wombats.

Wombat Family (Vombatidae).—The wombats are remarkably woodchucklike in appearance and habits. They are, however, considerably larger. Wombats differ from all other marsupials in their single pair of ever-growing upper and lower incisors, and in

their rootless, high-crowned cheek teeth. Some wombats are 15 in. high at the shoulder. They resemble koalas in having no tails; some authorities consider the koalas and wombats to be closely related.

Wombats are powerful diggers, sometimes constructing tunnels 100 ft. long. Colonial nests in these underground excavations are lined with soft bark. Wombats are both diurnal and nocturnal in habit. Their diet is mostly grass, which is grazed short for a considerable distance around their warrens. Although there are two nipples in the pouch, there is usually only one young born at a time. Constituting the family are: the common or naked-nosed wombat (*Vombatus* or *Phascolomis*); the hairy-nosed wombat (*Lasiorhinus*); and the Queensland wombat (*Wombatula*). During the Pleistocene there was a giant wombat, *Phascolonus,* which was as large as a black bear.

See also references under "Marsupial" in the Index.

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MARSUPIAL MOLE (*Notoryctes typhlops*), a small burrowing animal from central South Australia, constituting a family, Notoryctidae, of the pouched mammals or marsupials (*see* MARSUPIAL). It resembles the true mole, family Talpidae, in size and appearance but is not a relative (*see* MOLE). Neither ear conches nor eyes are visible externally. Except for the horny skin on the nose and on the stumpy leathery tail, the body is covered with long, silky, golden-yellow hair. When awake, the marsupial mole is extremely active, searching almost continuously for worms, insects, etc. It feverishly devours its food and abruptly falls asleep, only to awaken shortly and resume its frenetic search. The forefeet are wonderfully adapted to burrowing, the third and fourth toes being armed with enormous claws.

MARSUPIAL MOUSE, a name for small members of the family Dasyuridae (*see* MARSUPIAL); most belong to the genus *Phascogale,* the broad-footed pouched "mice." There are more than 12 species, none larger than a rat. Females of several species have pouches, but there are folds of skin only around the mammae in other forms. Marsupial mice are found throughout Australia, Tasmania, New Guinea and the Aru Islands.

MARSUPIAL WOLF (*Thylacinus cynocephalus*), the largest carnivorous marsupial, resembling a wolf but smaller. Also called Tasmanian "wolf," "tiger" or "hyena," it is confined to Tasmania (perhaps extinct), but fossils show it was on the Australian mainland in the Pleistocene. Its face is sharp and foxlike. Grayish brown, its entire back is marked with transverse, blackish-brown bars. The pouch opens toward the hind quarters; it bears two to four young, carrying them for about three months. It feeds on wallabies, small mammals and birds. When sheep were introduced, it preyed on them; as a countermeasure, the marsupial "wolf" was nearly exterminated by man.

See also MARSUPIAL. (J. E. HL.; X.)

MARSYAS, a legendary Greek figure of Anatolian origin. According to the Greek legend Athena had invented the oboe and threw it away in disgust because it distorted the features. Marsyas found it and, having acquired great skill in playing the instrument, challenged Apollo to a contest with his lyre. Midas, king of Phrygia, who had been appointed judge, declared in favour of Marsyas, and Apollo punished Midas by changing his ears into ass's ears. In another version, the Muses were the judges, and they awarded the victory to Apollo, who tied Marsyas to a tree and flayed him alive. In Rome a statue of Marsyas, a favourite art subject, stood in the Forum, and this was imitated by Roman colonies and came to be considered a symbol of autonomy.

MARTELLO TOWER, a defensive work whose name is a corruption of that of Cape Mortella in Corsica, where a circular tower of this kind was captured only with great difficulty in 1794 by British forces supporting Corsican insurgents against the French. With the threat to England of invasion by Napoleon Bonaparte in 1803, the duke of York, as commander in chief, recommended this type of tower for coast defense, and 74 Martello towers were therefore erected on the most vulnerable stretch of the English channel coast. They were from 30 to 40 ft. high, with walls 9 ft. thick on the seaward side, and surrounded by a deep ditch. Entry was effected by a small, rear door at the head of a 20-ft. ladder. A platform held two howitzers and a swivel gun; a powder magazine and living quarters were below. The French built a few *tours modèles* of similar design, and others were built in the United States and Canada. Martello towers lost most of their value with the advent of powerful naval guns. (R. C. H.)

MARTEN, several species of the weaselike genus *Martes* of the mammalian carnivore family Mustelidae (*see* CARNIVORE). The American marten (*M. americana*) is similar to the pine marten (*M. martes*) of north and central Europe and the British Isles.

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MARTEN (MARTES AMERICANA)

The marten is a cat-sized animal with a long, somewhat bushy tail, and a lithe and slender body. The legs are short, the neck long and flexible and the ears short and rounded. The rich, dense and lustrous fur with stiff and shiny guard hairs is highly valued; the coat is golden brown shading to blackish on the feet and tail tip and to orange on the throat. The pine marten is dark brown with a tawny throat. Martens are bloodthirsty and rapacious, feeding on small mammals, birds and occasionally birds' eggs. They live in forests, especially in rocky areas, and climb trees as easily as a squirrel. Sexual maturity is reached at two years. Most species mate in late summer, one to five young being produced the following spring. In northern species the gestation period is prolonged (from 220 to 358 days according to species and locality). The gestation period may be markedly shortened by increasing the hours of light per day.

In the same genus the dark sable (*M. zibellina*), which inhabits Siberia, has the most valuable fur. The beech or stone marten (*M. foina*), occurring from central and southern Europe to China, is a paler species. *M. melampus* is found in Japan. The large fisher or pekan (*M. pennanti*) occurs in North America. The large yellow-throated marten (*C. flavigula*), occurring from India and China to Java, belongs to the closely related genus *Charronia.* *See* also FUR. (K. R. KN.)

MARTENS, FËDOR FËDOROVICH (FRÉDÉRIC FROMMHOLD DE MARTENS; FRIEDRICH VON MARTENS) (1845–1909), Russian jurist and author of works on the European penetration of Asia and Africa, was born at Parnu, in Livonia, Estonia, on Aug. 27, 1845. In 1868 he entered the Russian ministry of foreign affairs and in 1872 was made professor of public law in the Imperial School of Law and the Imperial Alexander lyceum, a post he held until 1905. In 1874 he started special juristic work for the Russian government. His work on the right of private property in war appeared in 1869, and that on the office of consul and consular jurisdiction in the east in 1873 (German trans., 1874). These were the first of a series of studies which won Martens a world-wide reputation and enhanced that of the Russian school of international jurisprudence.

Recueil des traités et conventions conclus par la Russie avec les puissances étrangères (15 vol., 1874–1909), edited by him, is the greatest of the series; published in Russian and French in parallel columns, it contains not only the texts of the treaties between Russia and other countries but also histories of the diplomatic conditions of which the treaties were the outcome, these being based upon unpublished Russian documents.

Martens' original work includes books on Russia and England in central Asia (1879), on Russia's conflict with China (1881), on the international law of civilized nations (1882), on the Egyptian question (1882) and on the African conference of Berlin and the colonial policy of modern states (1887).

Repeatedly chosen to participate in international arbitrations, Martens acted in the disputes between Mexico and the United States—the first case to be determined by the permanent tribunal at The Hague—and that between Great Britain and France over Newfoundland in 1891. He played an important part in the negotiations between his own country and Japan which led to the peace of Portsmouth (Aug. 1905) and prepared the way for the Russo-Japanese convention. He was employed in laying the foundations for The Hague conferences and was one of the Russian plenipotentiaries at the first conference and president of the fourth committee—that on maritime law—at the second conference. He was judge of the Russian supreme prize court established to determine cases arising during the Russo-Japanese War of 1904–05. He died at Valga, in Livonia, on June 19, 1909.

See T. E. Holland in *Journal of the Society of Comparative Legislation* (Oct. 1909), where a list of writings of Martens appears.
(E. H. LD.; X.)

MARTENS, GEORG FRIEDRICH VON (1756–1821), German jurist and diplomat, the original editor of the principal printed collection of treaties of the world, was born at Hamburg on Feb. 22, 1756. He was educated at the universities of Göttingen, Regensburg and Vienna and became professor of jurisprudence at Göttingen in 1783 and was ennobled in 1789. In 1814 he was appointed privy cabinet councilor (*geheimer Kabinettsrat*) by the king of Hanover and in 1816 went as a representative of the king to the diet of the new German confederation at Frankfurt, where he died on Feb. 21, 1821.

Martens' major work, *Recueil des traités* from 1761, had been preceded by *Histoire diplomatique des traités*, covering the period from the end of the 16th century to the peace of Amiens (1577–1802). The first seven volumes of *Recueil des traités* were published 1791–1801 and were followed by four supplementary volumes partly edited by his nephew Karl von Martens. These were followed by *Nouveau recueil général des traités*, of treaties subsequent to 1808, in 16 vol. (1817–42) edited by G. F. von Martens, K. von Martens, F. Saalfeld and F. Murrhard; this last work was subsequently continued under other editors (2nd series, 20 vol., 1843–75; 3rd series, 35 vol., 1876–1908; 4th series, 41 vol., 1908–44).

Of Martens' other works the *Droit des gens*, first published in 1788, is probably the most famous. (E. H. LD.)

MARTHA'S VINEYARD, an island off the southeastern coast of Massachusetts, about four miles across Vineyard sound from the mainland of Cape Cod. Long a leading fishing and whaling area, the island is now almost entirely devoted to the summer tourist and recreation industries.

The island is nearly 20 mi. long, ranges from 2 to 10 mi. in width and represents largely the terminal moraine of a continental ice sheet. There is rolling to hilly country along the northeastern side, stretching out to nearly level plains in the south and east. The highest point is only 311 ft. above sea level. The ocean has been very active in shaping the coast line, sealing off the many inlets along the south shore and building up long beaches and spits. The many-coloured clay bluffs at Gay Head are among the island's spectacular sights.

Martha's Vineyard probably was sighted by many early explorers, but the first known record was by Bartholomew Gosnold in 1602. Granted to Thomas Mayhew of Massachusetts, the island was first occupied in 1642; it was under the jurisdiction of New York until 1692. There were early attempts at agriculture, salt evaporating, brickmaking and the smoking of fish. Fishing, which became an important source of revenue, led to the development of whaling and foreign trade, the two activities that eventually dominated the 18th and part of the 19th centuries. At one time the island boasted the world's largest sperm oil candle factory.

Advances in technology and a disadvantageous location terminated both of those trades, but the island's quaint old villages, Colonial architecture, scenic beauty and sandy beaches, as well as its protective coves for yachts and sailboats made Martha's Vineyard nearly ideal for summer vacationers and visitors.

The island itself contains six small towns: Tisbury, Oak Bluffs, Edgartown, West Tisbury, Chilmark and Gay Head, the latter occupied almost entirely by Indians. Together with the adjacent Elizabeth Islands and No Mans Land, the island forms Dukes county, Mass. (G. K. L.)

MARTÍ, JOSÉ JULIÁN (1853–1895), Cuban writer and patriot who is considered his country's greatest hero and, like Simón Bolívar, is a symbol of liberty throughout Latin America, was born in Havana on Jan. 28, 1853. He attended the schools of San Anacleto and San Pablo, the latter under the direction of the poet Rafael María de Mendive, who helped him continue his education in the Instituto de Segunda Enseñanza de la Habana and became Martí's main source of inspiration as well as his teacher and benefactor.

Mendive and Martí sympathized with the cause of the Cuban patriots, headed by Carlos Manuel de Céspedes, when fighting broke out on Oct. 10, 1868 (*see* CUBA: *History*). The following year Mendive participated in an uprising at the Teatro Villanueva, as a result of which he was imprisoned and his school closed. A short time later Martí was also detained; after serving six months of hard labour, he was finally deported to Spain on Jan. 15, 1871.

There he continued his education, receiving both his licentiate in law and a master of arts degree from the University of Saragossa in 1874. He fled to France and then in 1875 to Mexico City, where he wrote for the press. He visited Cuba briefly in Jan. 1877 and then went to Guatemala, where he taught literature and achieved fame as an orator. In Dec. 1877 he married Carmen Zayas Bazán, the daughter of an exiled Cuban.

Not happy with political conditions in Guatemala, then ruled by president-dictator Justo Rufino Barrios, Martí and his wife returned to Cuba in Dec. 1878, but because of his continued political activities, Martí was again exiled to Spain, in 1879. This time, however, he remained there only two months, again going to France, and then to New York city. In 1881 Martí went to Venezuela. His articles in the *Revista Venezolana*, which he founded, did not meet with the approval of Venezuela's dictator, Antonio Guzmán Blanco, and, less than five months after he had departed, Martí was forced to return to New York city, where he remained, except for occasional trips to Florida and the Caribbean, until the year of his death.

During those years Martí continued publishing for Latin-American newspapers. In August of 1881 he began to write a regular column for *La Opinión Nacional* of Caracas and in July of 1882 one for *La Nación* of Buenos Aires; his many articles in the latter made him famous throughout Latin America.

As a result of a disagreement with the Cuban revolutionary leaders Máximo Gómez and Antonio Maceo, Martí withdrew from politics for three years. In 1877 he regained their confidence and

returned with renewed energies to the fight for Cuba's independence. In 1892 Martí was elected *delegado* (he refused to be called president) of the new Partido Revolucionario Cubano, which he had helped to form, and, making New York city his centre of operations, began preparing for the invasion of Cuba.

On Jan. 29, 1895, the order was given to start the attack. Martí left New York two days later and went to Santo Domingo, accompanied by Máximo Gómez and other revolutionary leaders. They landed in Cuba on April 11. Shortly after, on May 19, 1895, Martí was killed in the skirmish that took place on the plains of Dos Ríos, Oriente province.

Literary Work.—Martí had neither the time nor the tranquility to create outstanding works of art, but with few exceptions his writings have the enduring quality found in the books of great authors. He began writing at an early age: at 15 he composed several poems; at 16 he published his first newspaper, *La Patria Libre,* and wrote a dramatic poem, "Abdala"; his political essay *El presidio político en Cuba* was published while he was an exile in Madrid, in 1871. Outstanding among his works are his poems, his letters, his literary portraits, and his essays interpreting Latin America and the United States.

As a poet, Martí is recognized as one of the precursors of the *modernistas* (*see* IBERO-AMERICAN LITERATURE: *The Modernists*). His first significant poems, composed for his son, appeared in book form in 1882, under the title *Ismaelillo* ("Little Ismael," his son's name). The 15 poems are given unity by the central theme, paternal love, and by the simplicity of form and the sincerity of expression, characteristic of all of Martí's poetry. Another collection, *Versos libres* (written between 1878 and 1882, published 1913), was devoted to the theme of freedom. Different in tone are the poems of his best-known collection, *Versos sencillos* (1891), in which the themes of love, friendship and resignation predominate.

In *Amistad funesta* (1885), considered the first *modernista* novel, Martí created a sophisticated, refined and elegant atmosphere characteristic of this type of literature, but the work now has only historical value. He also translated Helen Jackson's *Ramona* and Hugh Conway's then popular *Called Back,* under the title *Misterio.* Much more successful than his original novel were his short stories, included in the four issues of *La edad de oro* (1889), a review published by Martí for the children of Latin America. His dramatic works ("Abdala," 1869; *Adúltera,* 1872–74; *Amor con amor se paga,* 1875) lack the high quality of his poetry and his narrative compositions.

It is in the essay, however, that Martí's greatest contribution to Latin-American letters is to be found. Outstanding are those he wrote on *Cecilio Acosta* (1881), *Emerson* (1882), *Juárez* (1884), *General Grant* (1885), *Whitman* (1887), *Heredia* (1889), *Nuestra América* (1881), *San Martín* (1891) and *Bolívar* (1893). His essays, in which original thoughts are expressed in an intensely personal style, were influential in bringing about an innovation in Spanish prose writing. At the same time, they were instrumental in promoting better understanding between the United States and Latin America, as well as between the Latin-American nations themselves. Martí considered himself a citizen of the Americas and his writings on the subject possess permanent value. His works, in general, reflect his exemplary life, his kindness, his originality, his love of liberty and justice and his deep understanding of human nature.

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MARTIAL (MARCUS VALERIUS MARTIALIS) (*c.* A.D. 40–*c.* A.D. 104), Roman epigrammatist, brought the Latin epigram to perfection and provided in his poems a picture of Roman society under the early empire which is remarkable both for its completeness and for its accurate portrayal of human foibles. His birthplace was Bilbilis, in Hispania Tarraconensis, of which he writes (in i, 61, 11–12): *te, Licinianе, gloriabitur nostra/nec me tacebit Bilbilis* ("of thee, Licinianus, our Bilbilis shall boast, nor will she keep silent about me"). His birthday was March 1, *Martem mearum principem Kalendarum* (x, 92, 10). Martial made much use of the mordant epigram bearing a sting in its tail. Frequently this sting consists merely of a single unexpected word. Poems of this kind exercised a great influence on the history of the genre in the literature of England, France, Spain and Italy. Though some of the poems are devoted to scenic descriptions, most are about people—emperors, public officials, writers, philosophers, lawyers, teachers, doctors, fops, gladiators, slaves, undertakers, gourmets, spongers, senile lovers and revolting debauchees.

Life at Rome.—In A.D. 64 he came to Rome, where, apart from a brief visit to Cisalpine Gaul in 88, he made his home for 34 years. There he sought the protection of his fellow Spaniards, the Senecas and Lucan, but, as they were involved in the Pisonian plot of 65, this attachment was of short duration. Virtually nothing is known of his career during the next 15 years. In 80 was published the *Liber Spectaculorum,* containing 33 epigrams celebrating the shows held in the Colosseum, an amphitheatre in the middle of the city begun by Vespasian and completed by Titus in 79. Living at first in rather humble circumstances (i, 117, 7: *scalis habito tribus sed altis,* "I live up three staircases, and high ones too"), he gradually made headway and was able to have, in addition to his town house on the Quirinal (x, 58, 10: *vicinosque tibi, sancte Quirine, lares,* "And my house near to you, sacred Quirinus"), a small country place at Nomentum, in the Sabine territory (vi, 43, 3–4: *me Nomentani confirmant otia ruris/et casa iugeribus non onerosa suis,* "leisure in the Nomentan countryside restores me and a cottage not too big for its acres"). He won the ear of the court and received from Titus and Domitian, though he was not a father, the *ius trium liberorum* (the rights of a father of three children), a privilege which allowed a person to hold a public office before his 25th year and to be exempted from public burdens. *Rumpitur invidia tribuit quod Caesar uterque/ius mihi natorum* ("he is consumed with envy because both Caesars have granted me a father's rights"), he wrote in ix, 97, 5–6. He also, probably without having served in the army, obtained a military tribuneship and, despite his lack of means, the dignities of an *eques Romanus* ("Roman knight"). In 84 or 85 appeared two books of epigrams (in modern editions, books xiii and xiv) entitled *Xenia* and *Apophoreta,* two-line mottoes for presents distributed at the festival of the Saturnalia, in December. In 86 were issued books i and ii of the *Epigrams.* Between 86 and 98, when Martial returned to Spain, new books of the *Epigrams* were brought out more or less at yearly intervals. When the poet left Rome for his birthplace (xii, 18, 7–9: *multos repetita post Decembres . . . Bilbilis,* "Bilbilis sought again after many Decembers") he lived on an estate presented to him by his friend Marcella, a Spanish lady of whom he writes warmly in xii, 21 and 31. There he wrote and published the 12th and last book of his *Epigrams* and soon after died. Pliny the Younger, in a letter of 104, describes his feelings on hearing of the poet's death: "I hear that Valerius Martialis has died and I am grieved. He was a man of ability, sagacity and ardour, whose writing displayed wit, acrimony and no less good-nature. When he was leaving Rome I presented him with a parting gift, a tribute both to his friendship and to the lines he wrote about me." The poem referred to is x, 19, and Pliny quotes the last ten lines (12–21).

Literary Friendships.—At Rome, Martial seems to have enjoyed the friendship of the leading literary men of his time. Pliny, Lucan and the Senecas have already been mentioned. Lucan is eulogized in vii, 22; vii, 21 and 23 are addressed to Polla Argentaria, Lucan's widow. The loyalty of Maximus Caesonius to the exiled Seneca is recorded in vii, 44 and 45. Quintilian is addressed in ii, 90, a poem which seems to express the poet's attitude to life:

> Quintilian, distinguished trainer of our wayward youth, Quintilian, glory of the Roman gown, pardon me if I, though still poor, yet not made useless by the years, am quick to enjoy life. No man is quick enough really to enjoy life. If a man is eager to surpass his father's

income, if he wants to crowd his halls with family busts, let him put off the job of living. My delight comes from the hearth and the roof-tree that does not object to sooty smoke, from a living spring and an untrained grass-plot. Give me a well-fed home-born servant, a wife who is no bluestocking, nights blessed with sleep and days innocent of litigation.

Silius Italicus, addressed in iv, 14, 1 as "pride of the Muses' sisterhood," is mentioned also in vi, 64, 10; vii, 63, 1–2; ix, 86, 1–2; and xi, 48 and 49. To Valerius Flaccus, another epic poet, there are references in i, 61, 4; i, 76; and iv, 42 and 49. For his relations with his true friend Juvenal *see* vii, 24 and 91; xii, 18. Martial never speaks of Statius, nor Statius of Martial. J. Wight Duff has suggested that "incompatibility of temperament" may explain this strange silence.

Form of the Epigram.—Martial wrote 1,561 epigrams in all. Of these 1,235 are in elegiacs, 238 in hendecasyllables and 77 in scazons or "limping iambics." The remainder includes pure hexameters (*e.g.*, i, 53), pure iambic trimeters (*e.g.*, vi, 12), iambic trimeter alternating with iambic dimeter (*e.g.*, i, 49) and scazons alternating with iambic dimeters (*e.g.*, i, 61). Occasionally Martial's epigrams are much longer than those of the Greek anthology (*see* ANTHOLOGY): 51 scazons make up iii, 58, while vi, 64 consists of 32 hexameters.

The elegiacs owe much to Ovid, though Catullian influence is probably to be discerned in the polysyllabic endings of pentameters. On Catullus also are based the hendecasyllables and scazons; but Martial's scazons begin more rigidly with a spondee. "Echoing verses" and involved patterns of various kinds are not uncommon (*cf.*, i, 32, 67, 77, 79; ii, 6, 33, 41, etc.). Puns, parodies, Greek quotations and ingenious ambiguities enliven Martial's pages. A type of epigram familiar to all is illustrated by i, 28, where the apparent contradiction of an insult masks an insult far more subtle: "If you think Acerra reeks of yesterday's wine, you are mistaken. He invariably drinks till morning."

Servility and Adulation.—Many readers of Martial are repelled by his flattery of any, especially the rich and powerful, who could fill his stomach or his purse. His frequent pleas for more and better presents from patrons and above all his use of the official title "Lord and God" toward Domitian cause a disgust not entirely warranted by the facts of history. For Martial, a poet known to the imperial court, to refuse extravagant homage might well have been suicidal. As for his begging verses, objectionable though they are, they must have paid dividends or the practice would have been abandoned. The poems on Domitian, disfigured by grotesque mythological conceits, are utterly foreign to Martial's usual direct style and are among his worst efforts.

Obscenity.—Byron asked, "What proper person can be partial/ To all those nauseous epigrams of Martial?" The Delphin editor abstracted the foulest verses and lumped them together at the end of the book. Opinions are bound to vary on the proportion of the indescribably salacious to the tolerably wholesome; it is certainly more than a tenth and considerably less than a quarter. Martial repeatedly warns his readers that his poems are not for the squeamish. He protests that though his page is licentious, his life is decent: *lasciva est nobis pagina, vita proba* (i, 4, 8). Catullus and Ovid had made similar distinctions before him: Apuleius and Ausonius were to do so in later generations. Martial hints more than once that he is far from being the worst of offenders.

Sentiment in Martial.—A genuine love of natural scenic beauty is seen in iv, 44 (lament for the devastation caused by the eruption of Vesuvius, A.D. 79); iv, 64 (view of Rome from a friend's estate); and x, 30 (seashore at Formiae). Tenderness toward slaves, inherited perhaps from the precept and practice of Seneca and Pliny, marks i, 88 and 101, both of which are funeral epigrams. Other sepulchral poems include v, 34 (on Erotion, a girl not yet six); vi, 85 (on Camonius Rufus, a lad of 20); and xi, 13 (on Paris, a celebrated actor, put to death by Domitian). The warmth of his friendship is to be seen in three famous epigrams, all addressed to Julius Martialis (i, 15; v, 20; and x, 47). The first ends with the advice—*sera nimis vita est crastina; vive hodie*, "live for to-day; tomorrow is too late." The second contains the sundial motto about the fleeting hours—*pereunt et imputantur*, "they perish and are scored against us." The third, which has been translated by a dozen English poets, consists of a comfortable recipe for happiness. Another, iv, 13, is a charming little epithalamium, while x, 23 is a serene picture of the peaceful old age of one who, by reliving his well-spent days, doubles his life's span.

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MARTIAL LAW. This term is one of rather doubtful significance in the English legal system, but is fairly well defined in the United States. It can be argued plausibly, but scarcely with conviction, that the English legal system does not know of, and makes no provision for, martial law, and that it is merely a term relating the common law right to resist force by force to a state of war, whether civil or external. This view seems to be implicit in a dictum of Chief Justice Thomas Molony in *R.* v. *Strickland* (1921 2 Irish Reports 334) that "the term 'execution of Martial Law' is now nothing more than a convenient label for the state of affairs which exists when the military take exceptional measures to suppress an insurrection." In the words of Sir Frederick Pollock, "So-called 'martial law,' as distinct from military law, is an unlucky name for the justification by the common law of acts done by necessity for the defence of the Commonwealth when there is war within the realm."

On the other hand, the learned editors of D. L. Keir and F. H. Lawson's *Cases in Constitutional Law* express the view that the military authorities "have the right not to be interfered with *durante bello*, and this right belongs, it is to be conceived, exclusively to the regularly constituted military forces." If this argument be correct, and this right does indeed belong exclusively to the lawfully constituted military authorities, then martial law is something more than a "convenient label." Indeed, Chief Justice Molony himself, in the case referred to above, gives the most forcible answer to his own definition, for he stated elsewhere in his judgment that, "We hold that when a state of things does exist which justifies the 'execution of martial law,' and is proved to our satisfaction, our hands are tied . . . the courts have recognized frankly that when a state of war exists—and they have not relinquished the right of adjudicating on that point—they must 'accept the consequences.'" It may be that martial law can be defined as a stage intermediate between law and anarchy, in which, the normal administration of the law having broken down, the authority appointed in accordance with law maintains order by summary methods.

In any event, martial law must be sharply distinguished from military law, which is the law governing the armed forces whether in war or peace; confusion has been caused by the fact that some of the older writers, for instance, Sir Matthew Hale in his *History of the Common Law of England*, used the term "martial law" in relation to what is now called "military law."

Martial law, in the modern sense, seems to have three different aspects in the relationship of the military authorities to (1) subjects and nonenemy aliens, (2) enemy aliens at home and (3) enemy aliens abroad. No very serious problems are presented by (2) and (3). As for (2), it is difficult, as Sir W. Holdsworth has observed, to see by what authority these could be tried by English courts, though in practice, and on the authorities, it would appear that, once the ordinary courts were satisfied that a state of war existed at the relevant time, they would not inquire into any acts done by the military authority, at any rate unless it could be established that they were done in ill faith. As for (3), the crown has an "absolutely free hand," though in the light of the Nürnberg trial and the trials of lesser war criminals, the duke of Wellington's remark that martial law merely means "the will of the general who commands the army" requires some qualification: that will must be exercised in accordance with international law and the conventions of civilized warfare—however these may be interpreted from time to time.

Constitutionally and historically, the first aspect, namely the relationship of the military authorities in whom the execution of martial law is vested, toward the subjects and nonenemy aliens who are entitled to the protection of the crown, is the most important. It gives rise to three main questions: (1) What are the circumstances, if any, that lawfully give rise to the suspension of normal civil rights? (2) In what circumstances, if any, will the normal courts review the decisions of tribunals set up by the military authorities to help them in the exercise of their powers? (3) What remedies, if any, has the subject against abuse or excess of their powers on the part of the military authorities?

Circumstances Giving Rise to Martial Law.—As Chief Justice Molony pointed out in the Irish judgment referred to above, the courts have not relinquished the right of adjudicating on the question whether a state of war exists. In older authorities, the test that was applied seems to have been the simple one of whether the ordinary courts were sitting or not; if they were, for this purpose a state of peace was deemed to exist, and there was therefore no room for the declaration or execution of martial law. This rule, if it can be so termed, appears definitely to have been abrogated by the decisions of the judicial committee of the privy council in *Elphinstone* v. *Bedreechund* (1 Knapp. P.C. 316) and *D. F. Marais* v. *The General Officer Commanding the Lines of Communication of the Colony* (*i.e.*, the Cape of Good Hope) (1902 Appeal Cases 109). In the latter case martial law had been proclaimed both in the district in which the petitioner, Marais, had been arrested, and in that to which he had been moved. In giving the judgment of the judicial committee, Lord Halsbury, the lord chancellor, said that they were "of opinion that where war is raging acts done by the military authorities are not justiciable by the ordinary tribunals, and that war in this case was actually raging . . . is sufficiently evidenced by the facts disclosed by the petitioner's own petition and affidavit . . . The fact that for some purposes some tribunals had been permitted to pursue their ordinary course is not conclusive that war was not raging." The conclusion Lord Halsbury drew was that: "The truth is that no doubt has ever existed that where war actually prevails the ordinary courts have no jurisdiction over the action of the military authorities," but that "doubtless cases of difficulty arise when the fact of a state of rebellion or insurrection is not clearly established."

These statements in Marais's case probably represent the high-water mark of the doctrine of the immunity of the military authorities from control by the civil power. But it may be remarked that even here, where the simple test of whether or not the ordinary courts are sitting was discarded probably once and for all, the right of the judiciary to consider whether, as a matter of fact, war was actually raging was vindicated by Lord Halsbury as it has been by other judges both before and since. On what criteria the courts would come to a decision today there does not seem to be much positive guidance. The test of an immediate local emergency seems to have been discarded. On the other hand, the decision of the house of lords in *Johnstone* v. *Pedlar* (1921 2 Appeal Cases 262) that it was "not a good defence to an action of tort brought by a friendly alien resident in the United Kingdom against an officer of the Crown in respect of the wrongful seizure and detention of the alien's property that the seizure and detention have been adopted and ratified by the Crown as an act of State" would seem, in spite of the rather special character of the facts, to warrant the conclusion that a mere state of general war, not involving a suspension of the normal machinery for the maintenance of order and the execution of justice, does not suffice to justify an arbitrary act done under colour of emergency.

Jurisdiction of the Courts Over Tribunals.—It seems to be well established that the normal courts will not review the decisions of tribunals set up by the military authorities to help them in the exercise of their powers because they do not recognize these tribunals as courts of law. Historically, the reason seems to be that acts done in pursuance of martial law were, in the words of Keir and Lawson, "withdrawn from the cognizance of the common law," and in consequence, although the crown's "executive acts escaped the interference of the judges, its power to do them did not in all cases receive judicial acknowledgment. It would accordingly be difficult at the present date to find authority for the view that such acts can legally be done under the Royal Prerogative." The leading authority in this field is the decision of the house of lords in *In re Clifford and O'Sullivan* (1921 2 Appeal Cases 570). In Dec. 1920 the commander in chief in Ireland declared the unauthorized carrying of arms to be punishable by death, and he authorized the general officer commanding in Cork to issue orders for the holding of military courts as might be necessary. In May 1921 Clifford and O'Sullivan, who were civilians, were tried by a military court on a charge of improperly carrying arms, and were convicted and sentenced to death, subject to confirmation; they applied in the chancery division in Ireland for a writ of prohibition against the military court, the commander in chief and the general commanding in Cork on the ground that the court was illegal and had no jurisdiction to deal with the matter. On appeal to the house of lords the application was dismissed, on the ground, among others, that prohibition did not lie, because the officers constituting the court did not claim to act as a judicial tribunal in any legal sense.

Remedies of the Subject.—The question of remedies against the abuse or excess of their powers on the part of the military authorities is one on which there is very little authority. Granted that, as the 16th-century judges declared, "in time of war a man may justify making fortifications on another's lands without licence" (1 Dyer 36 b), what is the position if he does so not for the purposes of defense but to gratify a private spite against the landowner? Keir and Lawson have no doubt but that "evidently the Commander-in-Chief would be liable for acts done *mala fide* and not solely with a view to suppressing insurrection." This view is eminently sensible and accords with the common-law doctrine of using the minimum degree of force that is necessary to repel force. Then there is the question of the character of the necessity. Of this Keir and Lawson say that "Dicey's doctrine, that he [*i.e.*, the military commander] must prove an immediate necessity for every act, is obviously too hard . . . ." This view is not only sensible but accords with the decision in Marais' case that the emergency need not be for these purposes an immediate or local one.

The modern practice of taking emergency powers by statute makes the likelihood of these questions assuming importance in the future somewhat doubtful. But in the past they certainly had considerable importance. (W. T. Ws.)

United States.—In the United States, martial law is the temporary rule by military authority of a designated domestic area in time of an emergency when the civil authorities are unable to function or their attempt to continue functioning for the time being might endanger the state. It may be declared by a proclamation of the president or the governor of a state, but such a proclamation is not necessary. Martial law becomes effective when military authorities supplant the civil authorities. Although neither mentioned in the constitution nor defined by statute, martial law long has been recognized in the United States. Civil courts many times have been called upon to pass upon the validity of acts taken in pursuance of martial law, but they have not precisely defined its limitations.

Martial law, as noted above, is to be distinguished from *military law*, which is the law governing those in the military service; from *military government*, which is the military rule of conquered territories; and from situations in which military forces are called upon to assist the civil authorities in maintaining public order without the existence of martial law. Where the military forces are called upon only to assist, the civil courts continue to function, and members of the civilian population may be punished only for violations of the civil law, not for violations of military orders other than those in implementation of civil law. (*See* also MILITARY GOVERNMENT.)

The use of federal or state military forces to quell a domestic disturbance or to assist in the maintenance of order during a disaster, such as a flood or a tornado, does not of itself bring about a state of martial law. In sending federal troops into Pennsylvania in 1794 to put down the Whisky Insurrection, President Washington specifically admonished the commander of the troops

to enforce the law and deliver the insurgents to the regular courts for trial During the labour trouble in the Coeur-d'Alene area of Idaho in 1899, the president sent federal troops to assist in the maintenance of order but directed that they support the civil authorities in the preservation of peace. Within a few hours after the initial shocks of the San Francisco earthquake of 1906, federal troops from a local garrison were assisting the civil authorities in maintaining order.

There have been cases in which governors of states have improperly declared martial law in order to accomplish political purposes. Such was the case in Texas in 1931 when the governor declared martial law to permit enforcement of a limitation upon the production of oil; his act was declared invalid by the United States supreme court in the case of *Sterling* v. *Constantin*. Two other examples occurred in the 1930s. In South Carolina the governor declared a state of "rebellion, insurrection, resistance and insurgency" in an attempt to depose state highway commissioners; in Oklahoma the governor sought to prevent further construction of a dam until demands of the state highway commission for reimbursement for the closing of roads were met. In both cases, the courts declared the acts of the governors invalid.

The justification for martial law is that civil authorities are unable to function, or that because of impending grave danger, it would be unsafe for them to function. The question as to the continued functioning of the civil courts is particularly important. In an area of active military hostilities, it is a practical impossibility for the civil courts to function. Where it is felt that their functioning should be suspended because of impending danger, a doubt may exist as to the necessity of the suspension. Immediately following the bombing of Pearl Harbor in 1941, for example, martial law was declared in Hawaii, the civil courts were closed and trials were by military courts. Although civil courts later were permitted to operate to a limited extent, martial law was not finally removed until late in 1944. In the case of *Duncan* v. *Kahanamoku*, which involved civilians tried by military courts in Hawaii, the U.S. supreme court found that there was no justification for suspension of the civil court functions at the time the accused civilians were convicted, but did not state the limit of martial law which the court would have found proper.

The U.S. constitution specifically recognizes that the privilege of the writ of habeas corpus may be suspended when in cases of rebellion or invasion the public safety may require it. This privilege requires that a person who is in confinement must be, upon his demand, brought before a court to determine the legality of his confinement. The privilege is suspended as an incident to martial law. During the period of martial law, the military commander rather than a civil court determines the propriety of the confinement. Thus a person believed dangerous to the state may be confined upon mere suspicion, without trial until the termination of martial law. During the Civil War, President Lincoln suspended the privilege in various localities, particularly in the vicinity of the nation's capital.

While martial law is in effect, persons charged with violations of either civil law or military orders may be tried by military courts commonly known as provost courts. The sentences adjudged by such courts are no longer effective after the termination of martial law.

The authority of the military commander, during a period of martial law, is virtually unlimited, but the commander later may be called upon to justify his actions. He may be personally liable to pay damages for acts which do not appear to have been reasonably believed necessary at the time the acts were undertaken. However, the commander is judged according to the facts as they appeared at the time rather than according to the way they appeared in the light of later developments. (J. K. G.)

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MARTIGNAC, JEAN BAPTISTE SYLVÈRE GAY, VICOMTE DE (1778–1832), French statesman who led the government of Charles X from 1828 to 1829 and alienated the king by his moderate policies, was born at Bordeaux on June 20, 1778. In 1798 he acted as secretary to Sieyès; then, after serving for a while in the army, he turned to literature, producing several light plays. Under Napoleon I he practised with success as an advocate at Bordeaux, and in 1818 he became advocate general of the *cour royale* there. In 1819 he was appointed *procureur général* at Limoges and in 1821 he was returned for Marmande to the chamber of deputies, where he supported the policy of the comte de Villèle. In 1822 he was appointed councilor of state; in 1823 he accompanied the duc d'Angoulême to Spain as civil commissary; in 1824 he was created vicomte and appointed director general of registration. In contact with practical politics, his ultraroyalist views were gradually modified in the direction of the Doctrinaires (*q.v.*), and on the fall of Villèle (1827) he was selected by Charles X to carry out the new policy of compromise. On Jan. 4, 1828, he was appointed minister of the interior and, though not bearing the title of president, became the virtual head of the cabinet. He succeeded in passing the act abolishing press censorship and in persuading the king to sign the ordinances of June 16, 1828, on the Jesuits and the minor seminaries. He was exposed to attack from both the extreme left and the extreme right, and when in April 1829 a coalition of these groups defeated him in the chamber, Charles X, who had never believed in Martignac's policy, replaced him by the prince de Polignac (Aug. 1829). His last public appearance was after the July revolution when he defended Polignac in the chamber of peers in Dec. 1830. He died in Paris on April 3, 1832.

Martignac published *Bordeaux au mois de Mars 1815* (1830) and an *Essai historique sur les révolutions d'Espagne et l'intervention française de 1823* (1832).

See E. Daudet, *Le Ministère de M. de Martignac* (1875).

MARTIN, SAINT (*c.* 330–397), bishop of Tours, missionary and father of monasticism in Gaul, and one of the most revered saints of western Europe, was born at Sabaria in Pannonia (now Szombathely, Hung.) of pagan parents, but became a catechumen at an early age. As a youth he had to serve in the Roman army. His disciple and biographer, Sulpicius Severus, tells the famous story, often depicted in art, of how Martin divided his military cloak with a naked beggar at Amiens. In a dream that night he saw Christ wearing the half cloak, and shortly afterward he received baptism. Later, he asked to be released from the army because "I am Christ's soldier: I am not allowed to fight." When taxed with cowardice he offered to stand in front of the battle line armed only with the sign of the cross, but the immediate surrender of the enemy made this superfluous.

On leaving the army Martin settled at Poitiers, where he was made an exorcist by the bishop St. Hilary. Later he lived in retirement, first at Milan, then on the island of Gallinaria, off Albenga. On Hilary's return from exile in 360 Martin also returned and founded a community of hermits at Ligugé, south of Poitiers, the first monastery in Gaul. Later he founded another, Marmoutier, outside Tours, to which he withdrew whenever possible after becoming bishop of Tours in 372, an office which he accepted unwillingly.

As bishop, Martin was an active missionary in Touraine and beyond. Christianity had scarcely penetrated yet into the country districts, where Martin went round preaching, visiting each of his outlying settlements every year and encouraging monasticism. His fame brought him into contact with the imperial court at Trier, where he took part in a conflict between church and state. He protested to the emperor Maximus, who was being induced to condemn the Spanish heretic Priscillian to death, against the killing of heretics and against civil interference in ecclesiastical matters. Priscillian was nevertheless executed, and Martin's continued protests together with his intercession for Priscillian's followers in-

volved him in difficulties with the Spanish bishops.

Martin died at Candes on Nov. 8, 397. He had acquired a great reputation of working miracles, and was one of the first persons not a martyr to be publicly venerated as a saint. His feast day is Nov. 11, and his popularity in medieval England is attested by calendars and church dedications. *See* SEVERUS, SULPICIUS.

See I. Costanza, *La leggenda di San Martino nel medioevo* (1921). (D. AR.)

MARTIN (MARTINUS), the name of three popes, Martin I, Martin IV and Martin V. In the 13th century the papal chancery misread the names of the two popes Marinus (*q.v.*) as Martin, and as a result of this error Simon of Brion in 1281 assumed the name of Martin IV instead of Martin II.

ST. MARTIN I (d. 655), pope from 649 to 655, succeeded Theodore I in June or July 649. He presided over the Lateran synod which condemned the Monothelite heresy. Thereupon by order of the emperor Constans II, Martin was arrested, taken to Constantinople (Sept. 17, 654), publicly humiliated and banished to the Crimea in May 655. He died there the following September. He is honoured as a martyr by the church both in the east (feast day Sept. 16 or the middle of April) and in the west (Nov. 12).

(C. P. L.)

MARTIN IV (Simon of Brie, or Brion) (1210/20–1285), pope from 1281 to 1285, was born between 1210 and 1220 as the scion of a French noble family of Brie. St. Louis IX of France made him a member of his council and, in 1260, chancellor and keeper of the great seal. About a year later the French pope Urban IV elevated Simon to the dignity of cardinal priest of St. Cecilia. He was elected pope on Feb. 22, 1281.

Soon after his coronation at Orvieto on March 23, 1281, Martin IV began to reverse the policy of his great predecessor Nicholas III by restoring Charles of Anjou, king of Sicily, as Roman senator and by favouring his interests in every possible way, even at the expense of the union with the Greeks. Charles apparently convinced the pope that the only guarantee of a permanent union was the conquest of the Byzantine empire by himself, and Martin excommunicated the emperor Michael VIII for lack of sincerity in the cause of the union shortly before the latter's death on Dec. 12, 1282; this led to a new formal break between the churches of Constantinople and Rome under the emperor Andronicus II (1283). After the Sicilian Vespers (*q.v.*) of March 1282 had deprived Charles of Anjou of the island of Sicily, and the Sicilians had chosen Peter III of Aragon as their new ruler, Martin spent the remainder of his pontificate in vain attempts to dislodge him and to reinstate Charles. He excommunicated Peter III, called for a Sicilian "crusade," and declared that Peter had forfeited the kingdom of Aragon, which had been a fief of the Holy See since the 11th century; Philip III of France, Charles of Anjou's nephew, was invited by the pope to take over Aragon for his youngest son, Charles of Valois. However, a Roman uprising against Charles of Anjou cost him his senatorial dignity; a great sea battle between the Aragonese and Angevin fleets resulted in utter defeat of the latter and in the capture of Charles of Anjou's son, the future king Charles II of Naples; while Philip III's campaign in Aragon was likewise to end in disaster in the very year in which the pope died (March 28, 1285) at Perugia. His francophile policy had foreshadowed the Avignonese period of the papacy. Martin IV's successor was the Roman Honorius IV. (G. B. L.)

MARTIN V (Oddone Colonna) (1368–1431), pope from 1417 to 1431, was born at Genazzano. He was unanimously elected pope on Nov. 11, 1417, in a conclave held during the Council of Constance, which had been called to end the Great Schism (1378–1417). Martin, a mild and gentle man, was at the time a cardinal-subdeacon who had helped organize the Council of Pisa.

As pope he faced enormous difficulties. As soon as the council was over he condemned the widely held conciliar theory which would make the pope subject to a council and forbade any appeal from papal judgment on matters of faith. He returned to Rome, which he found in ruins. He restored some of its churches and fortifications and tried to recover control of the Papal States. He worked to mediate the Hundred Years' War between France and England and to organize crusades against the Hussites in Bohemia.

Although he always had a dread of councils lest they try to revive the conciliar theory, Martin called the Council of Pavia in 1423 as prescribed by the Council of Constance. When a plague struck Pavia he moved the council to Siena. Martin's legates dissolved it (1424) when it dragged on in futile discussion of the conciliar theory. Martin neglected the great opportunity offered by church councils to reform the church; his efforts to meet the crying need for reform were halfhearted and proved ineffective. He died on Feb. 20, 1431, shortly after calling the Council of Basel. *See* also COUNCIL: *Council of Constance (1414–18)*; CONSTANCE, COUNCIL OF. (J. A. CT.)

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Martin V: Philip Hughes, *A History of the Church*, vol. iii (1947); Ludwig Pastor, *History of the Popes From the Close of the Middle Ages*, vol. i (1891); Noel Valois, *La Crise religieuse du XVe siècle*, 2 vol. (1909). (G. B. L.; J. A. CT.)

MARTIN, ARCHER JOHN PORTER (1910–), British biochemist, was awarded the Nobel prize in chemistry jointly with R. L. M. Synge in 1952 for the invention of partition chromatography. This effected the partition of a substance between two liquids by very simple means instead of by a series of intricate chemical operations and was subsequently so widely applied in chemical, biological and medical research as to constitute almost a new scientific tool. Martin was born in London on March 1, 1910, and was educated at Bedford school and Cambridge university, where he graduated in 1932. He worked in the Dunn Nutritional laboratory on problems relating to vitamin E from 1933 until 1938 when he was engaged with the Wool Industries Research association at Leeds in a study of the felting of wool. In 1946 he became head of the biochemistry division in the research department of Boots Pure Drug Co., Nottingham, and held the post until 1948 when he was appointed to the staff of the Medical Research council, working first at the Lister Institute of Preventive Medicine and then at the National Institute for Medical Research, where he later became head of the division of physical chemistry. In 1959 he became director of Abbotsbury Laboratories, Ltd. He was elected a fellow of the Royal society in 1950, and he received the Berzelius gold medal in 1951.

(D. MCK.)

MARTIN, GLENN LUTHER (1886–1955), U.S. aircraft designer, a pioneering airplane inventor, pilot and manufacturer, was born Jan. 17, 1886, at Macksburg, Ia. The family later moved to Liberal, Kan., where his "aircraft" business started when Glenn, aged 8, built kites in his mother's kitchen and sold them to his contemporaries. Later, in Santa Ana, Calif., Martin designed his first powered airplane and leased an abandoned church as his first factory. He became one of the outstanding "barnstormers" in the 1910–14 period, and from that experience developed several successful types of military aircraft. The first Martin bomber appeared in 1918–19, too late for active use in World War I, but its success established Martin as one of the leading military airplane manufacturers of the United States. He built a factory in Cleveland, O., and in 1929 moved his manufacturing facilities to Middle River, Md., near Baltimore. Martin bombers and flying boats played important roles all over the world in World War II. Toward the end of his life Martin took great interest in civic affairs, education (he gave large sums to support the engineering schools in the University of Maryland) and wildlife conservation. He died at Baltimore, Md., Dec. 4, 1955. (S. P. J.)

MARTIN, (BON LOUIS) HENRI (1810–1883), French historian, author of a famous history of France, was born on Feb. 20, 1810, at St. Quentin. With Paul Lacroix ("le Bibliophile Jacob") he planned a history of France, to consist of excerpts from the chief chroniclers and historians, with original matter filling up gaps in the continuity. His *Histoire de France*, 15 vol. (1833–

36), was the result. This magnum opus, rewritten and further elaborated (4th ed., 16 vol. and index, 1861–65), gained for the author in 1856 the first prize of the Académie Française and in 1869 the grand biennial prize of 20,000 fr. A popular abridgment in seven volumes was published in 1867 (Eng. trans., 1877–82). This, together with the continuation, *Histoire de France depuis 1789 jusqu'à nos jours* (6 vol., 1878–83), gave a complete history of France and superseded J. C. L. de Sismondi's *Histoire des Français*. A staunch republican, Martin sat in the *assemblée nationale* as deputy for Aisne in 1871 and was elected life senator in 1876, but he left no mark as a politician. He died in Paris on Dec. 14, 1883.

MARTIN, HOMER DODGE (1836–1897), U.S. painter, whose works have given him a place at the culmination of American landscape before Impressionism, was born in Albany, N.Y., Oct. 28, 1836. Martin studied briefly with James Hart, and his early work follows the tradition of the Hudson River school. He became a member of the National Academy of Design in 1874 and in 1877 was one of the founders of the Society of American Artists. The sombreness of his pictures prevented them from being sold, and so Martin's wife turned to journalism for support. Sent to England to make magazine illustrations, he later (1882–86) matured his style in France under Barbizon influence. His best works, such as "The Harp of the Winds," "Ontario Sand Dunes" and "Westchester Hills," were done after his return to the United States; their spacious design and rich colour put them on a level with those of Alexander H. Wyant and George Inness. The artist's sight failed a few years before his death at St. Paul, Minn., Feb. 2, 1897. (Vl. B.)

MARTIN, LUTHER (*c.* 1748–1826), U.S. lawyer, a dissenting member of the Constitutional Convention of 1787 who thereafter became an ardent Federalist opposed to the philosophy of Thomas Jefferson. He was born near New Brunswick, N.J., probably in 1748. After graduating from the College of New Jersey (now Princeton university) in 1766, he taught school for a time and in 1771 was admitted to the Virginia bar. Shortly thereafter he settled in Maryland. He served as attorney general of Maryland from 1778 to 1805 and from 1818 to 1822 and during that entire period had an extensive and lucrative practice, private as well as public. He was leading counsel for the defense in two famous state trials of the Jeffersonian era, the impeachment of Justice Samuel Chase (*q.v.*) and the treason trial of Aaron Burr (*q.v.*), and was of counsel in many of the great constitutional cases of the formative years of the United States. His last and most famous was *McCulloch* v. *Maryland* (1819), involving the right of a state to tax an instrumentality of the federal government (the national bank). Martin, representing the state, abandoned federalism and reverted to his theory of the power of the states for which he had unsuccessfully contended in the Constitutional Convention. He was again unsuccessful.

After his paralysis in 1822 the Maryland legislature passed a unique act requiring each lawyer in the state to pay an annual licence fee to be used by trustees for the financial support of Martin, but he died in poverty on July 10, 1826, at the New York home of his friend Aaron Burr. (A. Dm.)

MARTIN, PIERRE ÉMILE (1824–1915), French engineer noted as the inventor of the Siemens-Martin or open-hearth steel process for the manufacture of steel, was born at Bourges, Cher, on Aug. 18, 1824, the son of Émile Martin, owner of the Sireuil ironworks in the Charente. While the chemistry of the steel-making process was already familiar, no means were available for attaining the high temperature required for its operation. On hearing of Sir William Siemens' development of the regenerative furnace about 1863, Martin obtained a licence to build such furnaces, starting with an experimental furnace of one-ton capacity. His steel products exhibited at the Paris exhibition of 1867 gained the exhibition's gold medal award. Nevertheless, his patents were challenged on the ground that he had merely made use of appliances and processes which were already known, and the development of his invention was delayed by prolonged and costly litigation and by the rapid success of the Bessemer process. Martin was reduced to straitened circumstances but, in 1907, the Comité des Forges de France instituted a fund for his benefit and contributions were received from all the principal steel-making countries. In 1915 he was awarded the Bessemer gold medal of the Iron and Steel institute, but was unable to attend for the presentation in London. Martin died at Fourchambault, near Nevers, on May 23, 1915. (C. W. D.)

MARTIN, VIOLET FLORENCE (pseudonym Martin Ross) (1862–1915), Irish writer and collaborator with Edith Somerville in a series of novels portraying late 19th-century Irish society, was born at Ross house, County Galway, from which she took her pen name, on June 11, 1862, of an old Irish family.

She spent her childhood in Dublin, and was educated privately and at Alexandra college, Dublin. In 1886 she met her cousin Edith Œnone Somerville (born at Corfu, May 2, 1858), and thus began a famous literary partnership. Their first book, *An Irish Cousin*, appeared in 1889, and together they published 14 books including *The Real Charlotte* (1894), a powerful novel of Irish life, and *Some Experiences of an Irish R.M.* (1899), a collection of comic short stories which, with its sequels (*Further Experiences of an Irish R.M.*, 1908; *In Mr. Knox's Country*, 1915, etc.), is their most popular work. Although living mainly at Drishane, County Cork, they traveled abroad, but after a hunting accident, Violet Martin was an invalid. Their stories and essays (*Some Irish Yesterdays*, 1906; *Irish Memories*, 1918, etc.) give a sympathetic and witty picture of Irish society. After Violet Martin's death at County Cork, on Dec. 21, 1915, Edith Somerville continued to publish under their pseudonym "Somerville and Ross," claiming that she was still inspired by her cousin. Primarily an artist, she illustrated their books, and also exhibited. She died at Castle Townshend, County Cork, on Oct. 8, 1949.

See G. Cummins, *Dr. E. Œ. Somerville*, with bibliography (1952).

MARTIN, a name applied to various swallows (family Hirundinidae). The purple martin (*Progne subis*), locally common in Canada and the United States, is the largest of American swallows, about eight inches in length. The male is entirely purplish black; the female and young show considerable gray. This gregarious bird nests in colonies in holes in trees, but will readily inhabit hollow gourds or large apartment-type martin houses provided for the purpose. Its call notes are pleasant, but it has no definite song. The four to six eggs are white; two broods may be reared in a single season. Like most swallows, the purple martin feeds on insects caught in flight and must migrate south in winter. Unfortunately, these welcome summer visitors are intimidated by the more aggressive starlings and house sparrows who often drive them from the garden. Related are the Cuban martin (*P. cryptoleuca*) and the gray-breasted martin (*P. chalybea*) found from central Mexico to central Argentina.

In Europe the house martin (*Delichon urbica*), with its quiet but pleasant song and fluttering flight, nests on buildings and is well known in verse and story. Its presence is thought to add an air of peace and well-being to an estate; thus Shakespeare wrote in Macbeth, "Where they [martins] most breed and haunt, I have observed, the air is delicate."

The bank swallow (*Riparia riparia*) is called sand martin in England. The kingbird, an American flycatcher, is sometimes called bee martin. African martins include the genera *Ptyonoprogne* and *Pseudochelidon*. (Dn. A.)

MARTIN DU GARD, ROGER (1881–1958), French novelist and dramatist, whose works are not only a vast panoramic survey of the society of his time but also a profound exploration of its meaning, was born at Neuilly-sur-Seine on March 23, 1881, into a professional middle-class family. He studied at the École des Chartes, Paris, and qualified as an archivist and paleographer in 1905. He served with a motor-transport unit throughout World War I and, for a brief period before and after, worked with J. Copeau at the Vieux-Colombier theatre, but he spent the remainder of his life in seclusion, wholly devoted to his writing. He received the Nobel prize for literature in 1937 and died at Bellême, Orne, on Aug. 22, 1958.

His first novel, *Devenir!* (1908), depicted a would-be writer whose talents did not match his ambitions. *Jean Barois* (1913; Eng. trans., 1950) traced the development of an intellectual torn

between the Catholic faith of his childhood and the materialism of maturity; it also described the full impact of the Dreyfus case on French minds. In *Les Thibault* (1922–40; complete Eng. trans., 1939–41), a novel-cycle in eight parts, the protagonists are two middle-class brothers. The younger, Jacques Thibault, rebels against his pharisaical Catholic father and the social order of his day and is killed in the first days of World War I while on a pacifist propaganda mission to the armies in Alsace; Antoine, the elder, is a dedicated doctor who sees no reason to reorganize society; he enlists at the outbreak of war, is gassed and dies in Nov. 1918. The outstanding features of *Les Thibault* are the wide range of human relationships patiently explored, the graphic realism of the sickbed and death scenes and, in the seventh volume, *L'Été 1914*, the dramatic description of Europe's nations being swept into war. The vast scale of the work was inspired by the desire to emulate Tolstoi's *War and Peace;* the corrosive pessimism pervading the strictly impersonal narrative recalls Gustave Flaubert.

Martin du Gard also wrote two peasant farces, *Le Testament du Père Leleu* (1913) and *La Gonfle* (1928), as well as a sombre natutalist drama on homosexuality, *Un Taciturne* (1931). His other works include *Confidence africaine* (1931), a short, sober account of an incestuous liaison; *Vieille France* (1933; Eng. trans., 1954), ferociously bitter sketches of French village life; and *Notes sur André Gide* (1951; Eng. trans., 1953). In 1941 he began work on *Le Journal du colonel de Maumort*, a vast novel which he hoped would prove to be his masterpiece, but it was still unfinished at his death and was still unpublished in 1964.

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MARTINEAU, HARRIET (1802–1876), English social and historical writer, a prominent public figure of her day, was born on June 12, 1802, in Norwich. Deaf from an early age, and later a victim of heart disease and other illnesses, she was nevertheless undeterred from an active career in which she mingled with the foremost intellectuals of the time. During a serious illness that she underwent from 1839–44, her friends raised an annuity enabling her to buy a small farm, "the Knoll," at Ambleside, which she cultivated until her death there on June 27, 1876.

A popularizer of economics and a propagandist for religious liberalism and for the abolition of slavery, Miss Martineau first gained a large reading public with an extensive series of stories and dialogues illustrating classical economics, chiefly the ideas of Malthus and Ricardo. After a visit to the United States (1834–36) she espoused the then unpopular abolitionist movement and abandoned her belief in a *laissez faire* economy for a more utopian system. A trip to the near east in 1846 led to a study of the evolution of religious beliefs and an increasing skepticism. Her chief historical work, *The History of the Thirty Years' Peace, 1816–1846* (1849), was a widely read popular volume. Her unorthodox views gained her a reputation for radicalism that alienated some of her friends but failed to impede her pursuit of ideas. She became an adherent of the positivist philosophy of Comte, whose *Positive Philosophy* she condensed and freely translated with the approval of the author. Probably this was Miss Martineau's most scholarly work, but she is equally remembered for her candid autobiography, published posthumously in 1877.

In addition to the autobiography, her works include *Illustrations of Political Economy*, 25 vol. (1832–34); *Poor Laws and Paupers Illustrated*, 10 vol. (1833–34); *Illustrations of Taxation*, 5 vol. (1834); *Society in America* (1837); *Retrospect of Western Travel* (1838); *Eastern Life, Past and Present* (1848); *Letters on the Laws of Man's Nature and Development* (1851); *The Positive Philosophy of Auguste Comte, Freely Translated and Condensed* (1853).

See R. K. Webb, *Harriet Martineau: a Radical Victorian* (1960). (H. E. Bar.)

MARTINEAU, JAMES (1805–1900), English philosopher and Unitarian minister, was born at Norwich, Norfolk, of Huguenot ancestry, on April 21, 1805, one of seven children, Harriet Martineau (*q.v.*) being one of his sisters. Educated at Norwich grammar school and under the Unitarian Lant Carpenter at Bristol, Gloucestershire, in 1822 he entered Manchester college (then at York) to prepare for the Unitarian ministry.

On leaving college in 1827, Martineau taught for one year with Carpenter at Bristol. His first ministerial appointment was as junior minister at the Eustace Street church, Dublin (1828). He left there in 1832, when on the death of his senior the *regium donum* grant, given by the government to Nonconformist ministers, would have been made to him, and he had conscientious objections to this connection with the state. He was now called to Liverpool, and during his early ministry there he saw reason to depart from the traditional scriptural authority. In his *Rationale of Religious Inquiry* (1836) he laid it down "that the last appeal in all researches into religious truth, must be to the judgment of the human mind," thus anticipating in some measure the famous Anglican *Essays and Reviews* (1860)—notably Benjamin Jowett's essay "On the Interpretation of Scriptures." In 1840 he was appointed professor of mental and moral philosophy at Manchester college, which had returned to Manchester from York. His work as a teacher at the college (and from 1869 as principal) was to continue for 45 years, with a break of 4 years when the college moved to London in 1853. He died in London on Jan. 11, 1900.

The reason why Martineau did not immediately follow the college to London was that his repudiation of scriptural authority had caused misgivings among the old-school Unitarians. Martineau's attempt to establish an alternative to biblical authority in the working of a man's own conscience occupies much of his later work, notably *Types of Ethical Theory* (1885), *A Study of Religion* (1888) and *The Seat of Authority in Religion* (1890), three books that had originated in courses of lectures at the college. In the words of G. Dawes Hicks (*see* bibliography), the weakness of his position was that:

> Having discarded the authority of the Church and of the Thirty-Nine Articles, having relinquished an appeal to the infallibility of the Scriptures or to a miraculous revelation as the ultimate ground of religious trust, it has no alternative but to fall back upon a crude individualism, according to which each man is his own Pope.

A similar criticism was made by Henry Sidgwick. It could still, as in the 18th century, be assumed that an erring conscience could be referred to the Bible for its authority and correction and any position like Martineau's was in difficulties until it could find an adequate alternative court of appeal. It would seem to argue some uneasiness on this score that Martineau twice attempted to come to terms with Spinoza, in his *Types of Ethical Theory* and in *A Study of Spinoza* (1882), whose philosophy offers a solution to this problem.

Bibliography.—J. Drummond, *The Life and Letters of James Martineau* (1902); J. E. Carpenter, *James Martineau, Theologian and Teacher* (1905); A. W. Jackson, *James Martineau: a Biography and a Study* (1900); H. Sidgwick, *Lectures on the Ethics of T. H. Green, Mr. Herbert Spencer, and J. Martineau* (1902); G. Dawes Hicks, "The Liberal Principle; Its Justification and Its Danger," *Manchester College, Oxford: Proceedings at the 150th Anniversary* (1936). (H. S. Ca.)

MARTINET, a military term (generally used in a disparaging sense) implying a strict disciplinarian or drillmaster. The term originated in the French army about the middle of Louis XIV's reign, and was derived from Jean Martinet, who as lieutenant colonel of the king's regiment of foot and inspector general of infantry, drilled and trained that arm in the model regular army created by Louis and the marquis de Louvois between 1660 and 1670. Martinet seems also to have introduced the copper pontoons with which Louis bridged the Rhine in 1672. He was killed, as a *maréchal de camp*, at the siege of Duisburg in the same year, being accidentally shot by his own artillery while leading the infantry assault. His death, and that of the Swiss captain Soury by the same discharge, gave rise to a bon mot, typical of the polite ingratitude of the age, that Duisburg had cost the king only a martin and a mouse.

The "martin" as a matter of fact shares with the marquis de Vauban and other professional soldiers of Louis XIV the glory of having made the French army the first and best regular army in

Europe. Great nobles, such as the vicomte de Turenne, Prince de Condé and the duke of Luxembourg, led this army and inspired it, but their fame has obscured that of the men who made it manageable and efficient.

It was about this time that the soldier of fortune, who joined a regiment with his own arms and equipment and who had learned his trade by varied experience, began to give place to the soldier regularly enlisted as a recruit in permanent regiments and trained by his own officers. The consequence of this happening was the introduction of a uniform, or nearly uniform, system of drill and training.

Thus, Martinet was the forerunner of Leopold of Dessau and Frederick William, just as Jean Jacques de Fourilles, the organizer of the cavalry, who was forced into an untimely charge at Seneffe (1674) by a brutal taunt of Condé, and there met his death, was the forerunner of Hans von Zieten and Friedrich von Seydlitz. These men, while differing from the creators of the Prussian army in that they contributed nothing to the tactics of their arms, at least made tactics possible by the thorough drilling and organization they imparted to an army.

MARTÍNEZ CAMPOS, ARSENIO (1831–1900), Spanish soldier and politician, author of the *pronunciamiento* of Sagunto (1874) which restored the Bourbon monarchy in Spain, was born at Segovia on Dec. 14, 1831, and educated as a soldier. He served on the general staff after 1852, took part in the Morocco campaign (1859–60) and in Juan Prim's expedition to Mexico. He fought the Cuban rebels (1869–72) and was promoted brigadier general. When he returned to Spain in 1872, the republican government gave him command of the Catalan brigade which was fighting the Carlists, but he failed because of the indiscipline of his troops. Pres. Nicolás Salmerón put him in charge of the army fighting the cantonalists in Valencia, which he took after a bombardment and then moved against Cartagena and Alicante. He turned against the republic and, at Sagunto, on Dec. 29, 1874, he pronounced for Alfonso XII. In Jan. 1875 he again led the army which was fighting the Carlists in Catalonia and distinguished himself both as a soldier and as a humanitarian who mitigated the brutality of the war. In Navarre he restored law and order. His capture of Baztán (March 1876) earned him the rank of captain general. In Nov. 1876 he arrived in Cuba to put down the rebellion. Again his humane treatment of the enemy won him respect. He forced the rebels to sign the peace of Zanjón (1878). He returned to Spain in 1879 and became, briefly, prime minister. Later, as minister of war under Sagasta, he quelled the republican revolt in Badajoz (Aug. 1883). He was appointed commander of the army in north Africa in Nov. 1893 and negotiated the peace treaty of 1894 with the sultan of Morocco. He was sent to Cuba in 1895 to win over the rebels, but he failed and returned to Spain (1896). He died in Zarauz (Guipúzcoa) on Sept. 23, 1900.

See also SPAIN: *History*. (J. C. J. M.)

MARTÍNEZ DE LA ROSA, FRANCISCO DE PAULA (1787–1862), Spanish statesman and man of letters, whose distinguished career in politics and literature rings strangely hollow in a revolutionary epoch, was born in Granada, March 10, 1787. He was a member of the *Cortes* of Cádiz (1812) and his first prose comedy, *Lo que puede un empleo*, was played there. He was called from exile to be minister in the interregnum (1820–23) and again after further exile in France to be prime minister and creator of a constitution, the Estatuto Real (1834), which pleased nobody; but was happier in later years as ambassador (Paris, 1843, 1846, and Rome, 1847) and president of the Ateneo and academy. In literature, similarly, he progressed elegantly but without intimate conflict from Moratinian comedy, Alfierian tragedy and an unexceptional *Arte poética* to the presentation of the first violently romantic drama, *La conjuración de Venecia* (April 23, 1834), a startling amalgam in prose of conflicts, passions, vengeance and cemeteries. His abundant neoclassical poetry reveals a lifelong interest in national history. He died at Madrid, Feb. 7, 1862.

See J. Sarrailh, *Un homme d'état espagnol* (1930). (R. F. B.)

MARTÍNEZ RUIZ, JOSÉ: *see* AZORÍN.

MARTÍNEZ SIERRA, GREGORIO (1881–1947), one of the outstanding Spanish dramatists and producers of the 20th century, was born at Madrid on May 6, 1881. He published his first work, *El Poema del Trabajo*, at the age of 17, and although his true vocation was the theatre, he first won recognition as a poet and critic with *La Tristeza del Quijote* (1905) and *Tú eres la Paz* (1906). His best plays were *Canción de Cuna* (1911; *Cradle Song*), *Primavera en otoño* (1911; *The Romantic Young Lady*), *El Reino de Dios* (1916; *The Kingdom of God*) and *Los Pastores* (1913; *The Two Shepherds*). These owed much of their success in London and New York to the translations by Harley Granville-Barker. His *Un Teatro de arte en España* (1926) describes his work at the Teatro Eslava, Madrid, of which he was director from 1917 to 1928. He died at Madrid on Oct. 1, 1947. (W. F. SE.)

MARTÍNEZ ZUVIRÍA, GUSTAVO: *see* WAST, HUGO.

MARTINI, FRANCESCO DI GIORGIO: *see* FRANCESCO DI GIORGIO.

MARTINI, GIOVANNI BATTISTA (called PADRE MARTINI) (1706–1784), Italian composer, theorist and teacher was born at Bologna on April 24, 1706. He learned the rudiments of music from his father, a violinist, and later studied singing, harpsichord and organ with Luc' Antonio Predieri and counterpoint with Antonio Ricieri. On Sept. 11, 1722, he was ordained, and in 1725 he was appointed *maestro di cappella* of the church of S. Francesco at Bologna. He opened a school of music, and the fame of his teaching made Bologna a place of pilgrimage for musicians from all countries. Among his pupils were Giuseppe Sarti and J. C. Bach. He died at Bologna on Oct. 4, 1784.

Martini was a zealous collector of musical literature; his library, which Charles Burney estimated at 17,000 volumes, passed at his death to the Imperial library at Vienna and to the city of Bologna. He was a prolific composer of sacred and secular music; his works include the *Litaniae* (1734), 12 *Sonate d'intavolatura* (1741), 6 *Sonate per l'organo ed il cembalo* (1747) and the *Duetti da camera* (1763). His most important literary works are the *Storia della musica* (1757–81), unfortunately never completed, and the *Saggio di contrappunto* (1774–75). (Cs. Ch.)

MARTINI, JEAN PAUL EGIDE (1741–1816) (real name JOHANN PAUL AEGIDIUS SCHWARTZENDORF), known as Martini il Tedesco, was born at Freystadt on Aug. 31, 1741. When he was only ten he became organist of the Jesuit seminary at Neustadt. In 1760 he went to Nancy, where he changed his name from Schwartzendorf to Martini. He entered the service of Stanislaw I of Poland, then living in France. After the king's death Martini settled in Paris, where he remained for the rest of his life. He produced his highly popular opera *L'Amoureux de quinze ans* in 1771. A later opera, *Henri IV* (1774), is chiefly remembered for its once popular overture. Martini was conductor of the Théâtre Feydeau, and later became inspector of the Paris conservatoire and professor of composition there. He was forced to retire in 1802, but, at the restoration of the Bourbons, Martini became superintendent of the court music. He died in Paris on Feb. 10, 1816. Besides his considerable output of music, both secular and religious, he wrote *Mélopée moderne* (1792), a study of vocal music. (Cs. Ch.)

MARTINI (DI MARTINO), **SIMONE** (*c.* 1284–1344), Italian painter, incorrectly called Simone Memmi by Giorgio Vasari, was an early and important exponent of Gothic painting who did more than any other artist to spread the influence of Sienese painting. He was very possibly a pupil of Duccio di Buoninsegna (*q.v.*), from whom he inherited his love of harmonious, pure colours and most of his early figure types. To these he added a gracefulness of line and delicacy of interpretation which were inspired by French Gothic works, which the young artist studied in Italy. He carried to perfection the decorative line of the Gothic style, and he subordinated volume to the persuasive rhythm of this line, giving his figures a transcendental beauty and grace.

Simone's earliest documented work is the large fresco in the Sala del Mappamondo of the Palazzo Pubblico, Siena, representing the "Madonna Enthroned with the Child, Angels, and Saints." This painting, signed and dated 1315, but retouched by Simone himself in 1321, is a free version of the main representation in Duccio's "Maestà" of 1308–11. However, the abstract character and lack of setting of the earlier work has given way to con-

crete concepts: Simone's Virgin, crowned and splendidly attired, is a Gothic queen who holds court under a Gothic canopy. About 1317 the artist painted in Naples the highly spiritual altarpiece "St. Louis of Toulouse Crowning His Brother, King Robert of Anjou," now in the Museo di Capodimonte in that city. Two or three years later he composed for Sta. Caterina, Pisa, a colouristically magnificent Madonna polyptych, which is now in the Museo Nazionale, Pisa. Perhaps in the middle of the 1320's he began the ten scenes, full of chivalrous ideals, from the life of St. Martin of Tours in this saint's chapel in the lower church of S. Francesco, Assisi. More down to earth is the equestrian portrait of 1328 in the Palazzo Pubblico representing Guidoriccio da Foligno, general of the Sienese republic. On the other hand, deliberately unreal is the "Annunciation" triptych, painted for the Cathedral of Siena, but now in the Uffizi gallery, Florence. Simone signed this work in 1333 with his brother-in-law, the Sienese painter Lippo Memmi, an associate for many years. The exquisite rhythm of the lines and dematerialized forms of Gabriel and Mary in the central part of the "Annunciation" led many artists to imitation, but none of them achieved as vibrant contours and as spirited forms as did Simone in this great masterpiece.

ALINARI

SAINT CLARA AND SAINT ELIZABETH BY SIMONE MARTINI. IN THE CHURCH OF S. FRANCESCO, ASSISI

In 1339 the painter settled at the papal court in Avignon, where he remained until his death in 1344, and where he made the acquaintance of Petrarch. He executed for the poet a portrait of his beloved Laura, as is known from two of Petrarch's sonnets, in which Simone is eulogized.

Simone was the most important Sienese painter after Duccio. His influence in Siena was great in the 14th century and considerable in the 15th. His art was imitated by local painters in Naples, Pisa, Orvieto, Assisi, and Avignon.

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(G. M. Cr.)

MARTINIQUE (LA MARTINIQUE), an island and French Overseas *département* of the Antilles, is located in the eastern Caribbean between the British islands of Dominica and St. Lucia.

Relief and Geology.—The island, 431 sq.mi. in area, has mountainous topography typical of the inner, volcanic arc of the Lesser Antilles, at the centre of which it lies. In the north the gently sloping cone of Mt. Pelée, an active volcano, rises to 4,554 ft.; the centre is dominated by the older volcanic massif of Pitons du Carbet (3,911 ft.) and to the south, beyond the Lamentin Plain, low hills rise to between 1,000 and 2,000 ft.

The rocks of the centre and south are mainly Miocene volcanics (andesite, labradorite and dacite) which, in the extreme southeast, are interbedded with tuffs and limestones of the Oligocene period. The Mt. Pelée massif is made up of recent volcanic ashes and lavas, the product of successive eruptions. The most devastating of these occurred on May 8, 1902, when the town of St. Pierre was destroyed and about 40,000 people were killed. Ravines score the flanks of Mt. Pelée and the steeper, western slopes of the Pitons du Carbet. The remainder of the island is drained by numerous streams and by several larger rivers which flow to the west coast. The northern coasts are steep, cliffed and relatively smooth but to the south of the Pitons du Carbet the coast line becomes lower and more indented with the large bays of Fort-de-France and Le Marin on the west and many headlands, coves and coral reefs on the east.

Climate.—The temperature on Martinique remains equable throughout the year. In the lowlands it varies from a maximum monthly mean of 28° C. (83° F.) in June to a minimum of 25° C. (77° F.) in January, while in the mountains somewhat lower temperatures prevail. Most of the island receives between 60 and 100 in. of rainfall annually. The rainy season normally lasts from July to November and occasional hurricanes also occur during that period. The months of January to April are usually dry.

Vegetation and Animal Life.—Tropical rain forest clothed the mountains of Martinique before European settlement began, but it has since been extensively cleared for agriculture and no virgin forest remains. In the lower and drier south scrub woodlands occupy uncultivated lands while the slopes of Mt. Pelée and Pitons du Carbet support more luxuriant secondary forest. The variety of animals native to Martinique is small and has been further reduced by man, through clearance of the forest, hunting and the introduction of alien animals. The Indian mongoose was introduced about 1880, with the hope of controlling the spread of rats and exterminating the deadly fer-de-lance (*Bothrops atrox*), but it failed to eradicate this poisonous snake and instead brought about the extinction of several species of harmless reptiles, birds and mammals.

History.—When Martinique was discovered in 1502 by Columbus on his fourth voyage it was occupied by Carib Indians who had recently migrated from South America and had driven out a pre-existing population of Arawak Indians. The Spaniards did not

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ST. PIERRE AND MT. PELEE, MARTINIQUE

settle the island and it remained unoccupied by Europeans until 1635, when Pierre Belain, sieur d'Esnambuc, established the first colony for the French Compagnie des Îles d'Amérique. In 1637 Dyel Duparquet, D'Esnambuc's nephew, became captain general of the colony and later purchased the seigneury of the island from the company. In 1674 it passed to the French crown. Life on the island in the 17th century is vividly described in the writings of R. P. du Tertre and R. P. Labat.

In the latter half of the 17th century Martinique was repeatedly attacked by the English and Dutch but it was not captured until 1762, when the English held it for one year. It was again in British hands from 1793 to 1800 and from 1809 to 1814, after which it was permanently restored to France. The empress Josephine was born there in 1763. In 1848 slavery was abolished and about 74,000 slaves were freed. During World War II Martinique adhered to the Vichy government of France and in 1946 became an integral part of the French union.

Population.—In 1658 the settlers on Martinique numbered about 5,000. Warfare and assimilation gradually eliminated the Caribs, and the racial mixture of the population was increased by the large-scale importation of Negro slaves. Today all degrees of racial commixture exist, though Negroes predominate. In 1954 the total population was 239,130 and by 1961 it had risen to 292,062, of whom about 85,000 lived in the capital city,

Fort-de-France; other major towns are Le Lamentin on the plain east of Fort-de-France and La Trinité, Le Robert and Le François on the east coast. The density of population is high—677 per square mile—and because of its rapid increase, together with the progressive mechanization of sugar production, the island faces acute overpopulation.

Administration.—Martinique has been an Overseas *département* of France since 1946. It is divided into two *arrondissements* comprising 34 communes, each administered by an elected municipal council. Executive government is conducted by a prefect and other appointed officials and legislative authority is vested in a general council of 36 members elected by popular vote. Martinique is represented in the French national assembly by three deputies and in the senate by two senators. There are more than 200 primary and 2 secondary schools providing free public education, as well as a technical college, a law school and several private schools.

Economy.—The economy of Martinique is overwhelmingly agricultural. At first cotton and tobacco were the principal crops but in 1650 sugar planting began and sugar has since remained the dominant crop. The principal exports of the island are bananas, sugar and rum. Nearly all external trade is with France; imports consist primarily of foodstuffs, petroleum products and textiles.

Martinique is served by French, U.S., Canadian and British shipping and air lines which use the harbour at Fort-de-France and the airport at Le Lamentin. A large majority of the visitors arrive by air. Local communication is by small coastal steamers and by automobiles and buses on about 400 mi. of national and district roads.

See also references under "Martinique" in the Index.

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MARTINUZZI, GYÖRGY (properly JURAJ UTIESENOVIC) (1482–1551), whose political achievements in Hungary and in Transylvania finally won him elevation to the cardinalate, but who was known during most of his career simply as FRATER (Brother) GYÖRGY, was born at Kamicic in Croatia, the son of Grgur Utiesenovic and a Venetian lady of the patrician family of Martinuzzi. In his youth he was attached to the court of John (János) Corvinus; and subsequently he saw military service under John Zápolya. Tiring of this life, he entered the Paulist order in his 28th year, becoming the prior of their Czestochowa monastery in Poland. In 1528, however, his old patron John Zápolya, who had been elected king of Hungary but had been put to flight by his rival Ferdinand of Austria, sent him on a diplomatic mission to Hungary. It was due to his efforts that John recovered Buda (1529), and henceforth Martinuzzi became his treasurer and chief counselor.

In 1534 Martinuzzi became bishop of Nagyvárad (Oradea Mare) in Transylvania; and in 1538 he concluded with Ferdinand the peace of Nagyvárad, which left Zápolya with the royal title and most of Hungary. On Zápolya's death in 1540 Martinuzzi acted as guardian and regent for his infant son John Sigismund. For the latter he concluded the treaty of Gyalu with the Ottoman sultan, Suleiman I (Dec. 29, 1541), which made Transylvania an independent principality under Turkish suzerainty. For a time Martinuzzi kept Transylvania neutral and on friendly terms with both Austria and Turkey. Though John Sigismund's mother, Isabella, who hated Martinuzzi, contrived against him with the hospodars of Moldavia and Walachia and the Turks in 1550, Martinuzzi defeated all his enemies and concluded an agreement, confirmed by the diet of Kolozsvár (Cluj) in 1551, whereby Isabella renounced her rights over Transylvania, in her son's name, to Ferdinand.

Martinuzzi retained the governorship of Transylvania and was subsequently consecrated cardinal and archbishop of Esztergom. Thus Hungary was once more reunited. Ferdinand, however, was unable to defend the country against the Turks, so that Martinuzzi had to resume payment of tribute to the Porte in Dec. 1551. Then, suspecting the cardinal's loyalty, Ferdinand had him assassinated at Alvincz (Dec. 17, 1551). Assuming responsibility for the murder, Ferdinand sent an accusation of treason against Martinuzzi in 87 articles to Pope Julius III, who after long hesitation and the testimony of 116 witnesses, exonerated Ferdinand of blame. There is an edition of Martinuzzi's letters from 1535 to 1551 by A. Károlyi (1881).

See O. M. Utiešenović, *Lebensgeschichte des Cardinals Georg Utiešenović* (1881). (T. K.)

MARTUCCI, GIUSEPPE (1856–1909), Italian composer, pianist and conductor who helped establish the 20th-century Italian instrumental school, was born at Capua on Jan. 6, 1856. He appeared as a pianist at the age of eight and in 1867 entered the S. Pietro a Maiella conservatory in Naples. After touring with the cellist A. Piatti he became professor of the piano at Naples and founded the *Società orchestrale di Napoli*. He popularized Wagner in Italy, conducting the first Italian performance of *Tristan und Isolde* (Bologna, 1888). As a composer he was influenced by Schumann, Brahms and Wagner. His works include two symphonies, two piano concertos (one unpublished), numerous piano pieces and transcriptions, chamber works and songs. He died at Naples on June 1, 1909. (DY. H.)

MARTYN, HENRY (1781–1812), English missionary to India, was born on Feb. 18, 1781, at Truro, Cornwall. He was educated at Truro grammar school and St. John's college, Cambridge, of which he became fellow in 1802. He obtained a chaplaincy under the East India company and left for India in 1805. Martyn translated the whole of the New Testament into Urdu, and into Persian twice, and the Psalms into Persian. Ordered to take a sea voyage for reasons of health, he went to Persia to correct his Persian New Testament. He set out from Bombay in Jan. 1811 for Bushire. After an exhausting journey from the coast he reached Shiraz and was soon plunged into discussion with disputants of all classes. Having made an unsuccessful journey to Tabriz to present the shah with his translation of the New Testament, he fell ill with fever and had to seek a change of climate. On Sept. 12, 1812, he started a journey across Asia Minor with two Armenian servants. Although the plague was raging at Tokat, he was compelled by prostration to stop there. On Oct. 6, he died. His New Testament was later presented to the shah by the English ambassador, printed and put into circulation.

See his *Journals and Letters* (1837), ed. by Samuel Wilberforce; C. E. Padwick, *Henry Martyn, Confessor of the Faith* (1953).

MARTYN, JOHN (1699–1768), English botanist, author and translator of Virgil, was born in London on Sept. 12, 1699. From 1733 to 1761 he was professor of botany at Cambridge and from 1730 to 1752 a physician at Chelsea, where he died on Jan. 29, 1768.

His reputation rests chiefly upon his translations, with critical notes, of the Georgics (1741) and Bucolics (1749) of Virgil and his *Historia plantarum rariorum* (1728–37), describing and illustrating in colour noteworthy plants. The work was discontinued after five parts were published.

See G. C. Gorham, *Memoirs of John Martyn and Thomas Martyn* (1830). (J. W. TT.)

MARTYR. The original meaning of the Greek word *martys* was "witness"; in this sense it is often used in the New Testament. Since the most striking witness which Christians could bear to their faith was to die rather than deny it, the word soon began to be used in reference to one who was not only a witness but specifically a martyr. This usage is present, at least implicitly, in Acts xxii, 20 and Rev. ii, 13.

Early Christian Martyrs.—The first Christian martyrs were St. Stephen (Acts vi, 8–vii, 60) and St. James (Acts xii, 2). Of the apostles the most important martyrs were SS. Peter and Paul, both put to death at Rome (I Clement v). Clement of Rome describes them as God's athletes, contending for the heavenly prize, and mentions a "great multitude" executed at the same time (probably under Nero; *cf.* Tacitus, *Ann.*, xv, 44). Early in the 2nd century Ignatius of Antioch described his own prospective martyrdom as a way of "attaining to God" and urged the Roman Christians not to make any effort to have him spared. In the sporadic persecutions of the first two centuries martyrdoms were not especially frequent, but the martyrs were highly regarded by

Christians (the emperor Marcus Aurelius viewed their constancy as theatrical). The earliest authentic "Acts of Martyrs" surviving are those of Justin at Rome *c.* 165, of Polycarp at Smyrna *c.* 167, of about 50 Christians at Lyons and Vienne (Gaul) in 177 and of a few at Scillium in Africa in 180. In addition, from the Roman side there are letters exchanged by Pliny the Younger, legate in Bithynia-Pontus, and the emperor Trajan in the year 112 (Pliny, *Ep.*, x, 96–97). From all these accounts something of the procedure involved can be made out. The government's position was not entirely clear. Were Christians to be condemned as Christians because of specific criminal charges or because of crimes inherent in the profession of Christianity? In any event, they were ordered to prove their abandonment of Christianity by offering sacrifices to the Roman gods; when they refused to do so, they were executed. Veneration of a martyr's relics is first attested in the *Martyrdom of Polycarp*.

With the passage of time and with a fresh emphasis on martyrdom (often regarded as a substitute for baptism) in the persecutions under Decius (A.D. 250) and Diocletian (A.D. 303–311), the authentic acts of the early martyrs were often replaced by legendary accounts (for instance, none of the versions of the death of Ignatius is genuine). Though doubts about these new narratives had arisen earlier, it was not until the late 19th century that the study of martyr acts was placed on a secure foundation, above all by the writings of the Bollandist Hippolyte Delehaye (*q.v.; see* also BOLLANDISTS), who applied literary and historical criticism to these acts with significant success. After his time the study was advanced by the work of Herbert Musurillo, who carefully examined the papyrus fragments that record the difficulties of Alexandrian "martyrs" before various Roman emperors. These accounts do not provide prototypes of the martyr acts (closer parallels are found in such Hellenistic Jewish writings as IV Maccabees), but they reflect the kind of situation out of which martyr acts arose. (*See* also SAINT.) (R. McQ. G.)

Christian Martyrologies.—A martyrology is an official catalogue or calendar of martyrs and saints arranged in the order of their feast days; in the Greek Church the equivalent is called a *synaxarion*. Simple martyrologies or calendars, which consist of an enumeration of martyrs and saints according to the days of the month and year, are to be distinguished from historical martyrologies, which add hagiographical details. Martyrologies are also classed as local (giving the feasts of a particular church or group of churches) and general (compiled by combining local martyrologies). The name martyrology points to the fact that in the earliest Christian centuries martyrs alone figured in these lists. Later, mention was made of bishops, the dedication of churches, founders of churches, confessors, etc. Among early calendars which have survived is the Philocalian, that of the Roman Church in 354.

The development of the calendar into a martyrology was a natural process. The most ancient surviving are the Syrian martyrology (*Breviarium Syriacum*, A.D. 411) and the Hieronymian of the middle of the 5th century. The latter purports to be the work of St. Jerome, a claim rejected by critics. The 8th and 9th centuries saw the development of historical martyrologies in England, at Lyons in France, and elsewhere. The martyrology of Usuard, a Benedictine monk, was widely used.

The Roman martyrology (*Martyrologium Romanum*), the official martyrology of the Roman Catholic Church, compiled at Rome and issued by Gregory XIII in 1584, is based on the historical martyrologies, some Greek menologies, the Dialogues of St. Gregory the Great, and the calendars of many churches, particularly Italian churches. It has been frequently re-edited and improved but critically still leaves much to be desired. (*See* also HAGIOLOGY.) (E. A. R.)

Jewish Martyrs and Martyrologies.—The ideal of martyrdom is deeply imbedded in Jewish consciousness. It begins with Abraham, who according to legend was cast into a lime kiln and saved from the fire by divine grace. The tradition was continued by Isaac, who consented to be sacrificed by his father. Many Jewish commentators interpreted Isaiah's vision of the "Suffering Servant" as referring to the destiny of the people Israel (Isa. liii). The Book of Daniel made the ideology of martyrdom explicit and popular. Readiness for martyrdom became a collective Jewish ideal during the Antiochene persecution and the Maccabaean rebellion of the 2nd century B.C. The best-known episode was that of the mother and her seven sons (II Macc. vii). The readiness of even the common peasants to die for the "sanctification of the Name" was demonstrated when Petronius, the Roman governor of Syria, encountered a numberless mass gathered in the valley of Acco, barring his way to the Temple (A.D. 40). Martyrdom was preferred to the desecration of the Sabbath by the early *Hasidim*. In Hadrian's time, pious Jews risked death to circumcise their children, and Rabbi Akiba embraced martyrdom to assert the right to teach the Law publicly. The Talmud cites the majority opinion that one should prefer martyrdom to three transgressions—idolatry, sexual immorality and murder (*Sanhedrin* 74a).

The Midrash on Lam. ii, 2 contains what is probably the oldest Jewish martyrology, the list of the "Ten Martyrs" under Trajan and Hadrian. It was repeated in later *midrashim* and formed the theme of several liturgical elegies, including the *Eleh Ezkerah*, included in the Yom Kippur service. During the European persecutions of the later middle ages, chronological registers of martyrs were drawn up for use in synagogue commemorative services. In 1296 Isaac ben Samuel of Meiningen began to collect these in the *Memorbuch* of Nürnberg, published by S. Salfeld in 1898; it covers the years 1096–1349.

In a sense, Jewish life was a nearly continuous training in martyrdom. Martyrs are honoured as *kedoshim* ("the holy ones"). Rabbi Shneur Zalman of Ladi, founder of HaBaD Hasidism, considered the spirit of martyrdom (*mesirut nefesh*) to be the distinguishing quality of the Jewish people. (J. B. A.)

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MARUTS, the storm-gods of Hindu mythology, prominent in the Rigveda, which makes them sons of Rudra but associates them with Indra, the goddesses Indrani and Sarasvati and more closely with Rodasi, their beauteous bride. Yet they are sometimes hostile to Indra and rend Vritra, the "drought," in pieces. In the epic era they appear to be the Maruta, the winds, sons of the benevolent earth-goddess, Aditi. *See* also VEDIC RELIGION: *Mythology*.

MARVEL, IK: *see* MITCHELL, DONALD GRANT.

MARVELL, ANDREW (1621–1678), English poet, whose political reputation overshadowed appreciation of his unique gifts as a poet until the 20th century, was born on March 31, 1621, at Winestead, Yorkshire, where his father was rector. The latter moved in 1624 to become master of the Charterhouse, an almshouse (with a garden) just outside the city wall of Hull, and preacher (not incumbent) at the parish church. The boy attended Hull grammar school, and in his 13th year (like other boys from schools which did not carry education very far) proceeded to the university. He was a sizar at Trinity college, Cambridge, from 1633 to 1638, when he became a scholar, and took his B.A. in 1639. In Jan. 1641 his father was drowned when crossing the Humber, which may account for Marvell's departure from the university. Otherwise he would have proceeded M.A. and, being a first-rate scholar without great worldly ambition, would probably have enjoyed a distinguished academic career. One Greek and one Latin poem survive from his university days and also a well-authenticated story that he was temporarily led away by the Jesuits.

He had his living to earn. His brother-in-law Edmund Popple, a Hull merchant, probably took him into his office, but for four years, almost certainly 1642–46, he traveled on the continent, to Holland, France, Italy and Spain, thus missing the Civil War. He can only have done this as a tutor, almost certainly to one of the Skinner family of which Milton's friend Cyriack is the best

known. At Rome he met Richard Flecknoe (*q.v.*), whom he satirized in a style reminiscent of both Horace and Donne. Back in England he may have contemplated a literary career in royalist circles, as the poems on Richard Lovelace, Lord Hastings and Lord Francis Villiers, younger brother of the 2nd duke of Buckingham, suggest; but Yorkshire drew him, and about 1651–52 he was tutor at Nun Appleton to Lord Fairfax's daughter Mary. Perhaps his political views were changing, but in neither religion nor politics was he ever a bigoted partisan. A moderate man, he was more influenced by persons than principles. His one firm persuasion was English patriotism. Now, though he admired Charles I's demeanour on the scaffold and though in 1651 he wrote scathingly about the Puritan historian Tom May, Oliver Cromwell's strength of character won him over ("An Horatian Ode upon Cromwell's Return From Ireland" 1650). In 1653 Milton made an abortive attempt to get him appointed his assistant in the Latin secretaryship. Instead he became tutor to Cromwell's ward William Dutton from 1653 to 1657, at first at Windsor in the house of John Oxenbridge who had been to Bermuda (*cf.* "Bermudas"), later at Saumur, France, where there was a noted Protestant academy. In 1657 Marvell was himself appointed Latin secretary (*i.e.*, foreign secretary) under John Thurloe, the secretary of state, an office he held till the Restoration. Though poems on "The First Anniversary" (1655) and "On the Death of O.C." show his continued and growing admiration of Cromwell, his role was that of the civil servant, not the politician. His political career began with his election as M.P. for Hull in Richard Cromwell's parliament (1659). He was re-elected in 1660 and 1661 and was a house of commons man for the rest of his life. Dissatisfaction with Clarendon's government, especially the disastrous conduct of the Dutch War of 1664–67, appears in the long, witty and still most readable "Last Instructions to a Painter," written in 1667 but, like all but one of his political satires, not published till after the Revolution. In the next decade alarm about the king's intentions produced the anonymous *An Account of the Growth of Popery and Arbitrary Government in England* (1677), purporting to have been printed at Amsterdam. Traces survive of his close touch with the leaders of the Country party, but the long series of newsletters to the Hull corporation is concerned mostly with bare facts. The corporation paid him 6*s.* 8*d.* for each day's parliamentary attendance and also sent presents in kind. The only long break in attendance was in 1663–65 when he went as secretary on an embassy to Russia.

In 1678 Marvell, who seems to have been unmarried, had an attack of fever at his London lodgings and died on Aug. 18 through medical incompetence. He had in his charge £500 belonging to two Hull friends who hoped thereby to save something from their bankruptcy. They arranged with his housekeeper-servant, Mary Palmer, to claim that she was his widow and entitled to his property. Marvell's Hull relations took out letters of administration for his property there, but Mary Palmer, finding his manuscript poems, had them published as "of my late dear Husband" (*Miscellaneous Poems by Andrew Marvell, Esq.*, 1681): the object was probably not to make money by poems quite out of fashion but to bolster up the claim to widowhood. Otherwise most of the poems might have been lost for ever, or, like Thomas Traherne's, accidentally discovered two centuries later.

The 1681 volume was accurately described as miscellaneous. Its 58 items even include a letter and four prose epitaphs. Whatever poems, early or late, have not survived, the variety of Mary Palmer's haul suggests that it included what Marvell thought his best. There are, for example, a few dialogues, moral, pastoral or pastoral-moral; a few poems full of "metaphysical" conceits ("The Definition of Love" is as intellectual as anything of Donne's, and "To His Coy Mistress" sets playfulness against a sternly sublime background); two characteristically 17th-century "weeper" poems ("Eyes and Tears," "Mourning"); one narrative ("The Nymph Complaining for the Death of Her Faun") in a unique way reminiscent of the Civil War; one meditative description of a portrait ("The Picture of little T.C."); two personal satires ("Flecknoe" and "Tom May's Death"), one without and one with venom. The group of Mower poems probably belongs to the Nun Appleton period, as the two local poems ("Upon the Hill and Grove at Bill-borow" and "Upon Appleton House") and "To Doctor Witty" certainly do. The moment of deepest experience in "Upon Appleton House" is similar to that in "The Garden" ("My Soul into the boughs does glide"), which on the evidence of its last stanza can also be ascribed to the two years of bliss with Fairfax: but a poet's maturest expression is based on repeated experiences, and it is not fanciful to trace to the Charterhouse garden the beginning of Marvell as the garden-loving poet.

Other poems of the 1650s can be dated by their subject-matter. "An Horatian Ode" (Horatian, *i.e.*, not Pindaric), the two other Cromwell poems and "Bermudas" have been mentioned above. *The Character of Holland*, a satire of more than Hudibrastic wit, was occasioned by the Dutch War of 1652–54; "On a Victory Obtained by Blake" (1657) by the Spanish War; "Two Songs" by the marriage of Cromwell's daughter Mary (1657). Latin poems for diplomatic occasions indicate the aspirant to scholarly government service. Much later (1674) is the poem prefixed to the second edition of Milton's *Paradise Lost*. It occurs, oddly, near the middle of the volume. The arrangement of the contents cannot have been Marvell's but, with exceptions, it is intelligent and systematic, and is presumably the publisher's. He misplaced "Bermudas" through ignorance, and the pastoral "Dialogue Between Thyrsis and Dorinda" perhaps because it was a late find while the book was in the press. Though not a great poem, it is interesting: first, because in part at least it is known to have been in existence in 1643; secondly, because it was published (without the author's name) as words to music in 1659. At the last moment the publisher of the folio took fright about the three English Cromwell poems ("An Horatian Ode," "The First Anniversary," "Upon the Death of O.C.") and cut them out.

Though it cannot be proved that none of the *Miscellaneous Poems* (except that to Milton and Latin suggestions for an inscription on the Louvre) were written after the Restoration, it is improbable both for stylistic reasons and because it is known that Marvell became more and more absorbed by politics. He did from 1667 onward write anonymous verse satires, but, with exceptions, it is not easy to be sure which of those popularly (or conveniently) ascribed to him after his death in 1678 were really his. They circulated in manuscript and were printed after the Revolution in *Poems on Affairs of State* (1689–1716). His acknowledged success was in prose, *The Rehearsal Transpros'd* (1672–73). This was a witty best-seller and laughter-causer of the day, an attack on an ecclesiastico-political adversary, Samuel Parker, later James II's bishop of Oxford and president of Magdalen college.

In the same vein as *The Rehearsal Transpros'd* was *Mr. Smirke: or the Divine in Mode* (1676; again a title taken from a current play). Marvell at this time developed an interest in the origins of the early church which produced *A Short Historical Essay Touching General Councils, Creeds, and Impositions in Matters of Religion* (1680), a pamphlet cutting the ground from the usual Protestant view of the first four centuries and well on the way to the deism of his nephew William Popple, author of *A Rational Catechism* (1687).

Achievement and Reputation.—While Marvell's controversial prose is now interesting only to specialists, and while his verse satire is far inferior to Dryden's and no better than that of dozens of his contemporaries, his small but exceptionally varied collection of miscellaneous poetry has continued to rise steadily in the estimation of general readers ever since Charles Lamb may be said to have discovered it. After Donne, perhaps even together with Donne, he is the finest of those many fine amateur poets of the earlier 17th century who wrote, not for publication, but for their own pleasure and that of their friends, and whose poetry reflects so much of what is most attractive in the culture and society in and out of which it was written. While no poetry could well be more original, could more unmistakably reveal the hand of its author, than Marvell's, it is at the same time continuously dependent on the example and stimulation of predecessors and contemporaries. This is one of the great differences between Marvell and Donne; for, while Donne seems to have resolved to write in a manner in which no English poet had ever

written before, Marvell, it might almost be said, was willing to accept, to exploit and to re-combine anything that had ever made poetry enjoyable. He is the only great metaphysical poet who did not break with the Elizabethan past, and who combines something of Donne's dialectic and ingenuity with a pastoral, pictorial and descriptive content which may be regarded as a development both of Elizabethan pastoralism and of those "catalogues of delights" (they seem to begin with Theocritus' description, imitated by Ovid, of Polyphemus' wooing of Galataea) of which Marlowe's *Passionate Shepherd* inspired so many imitations and of which even Milton's *L'Allegro* and *Il Penseroso* may be regarded as examples. Marvell, in fact, is the most eclectic of all 17th-century poets, and his originality consists very largely in the beauty and piquancy of his various combinations of old and new.

In spite of two 18th-century editions no one before Charles Lamb took any real interest in Marvell's poetry. He was revered as an incorruptible Whig, a republican of complete integrity. Wordsworth linked him with Algernon Sidney and James Harrington. In the 19th century he was republished and anthologized, but not till the 20th was he fully recognized as nature-mystic, meditative patriot, wit of great depth and superb master of the octosyllabic couplet. (H. M. MA.; J. B. LN.)

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MARX, JOSEPH (1882–1964), Austrian composer, known for his songs in an impressionist style, was born at Graz on May 11, 1882. He studied music and the history of art at Graz and from 1911 onward wrote about 150 songs on poems of Albert Giraud ("Valse de Chopin" from Pierrot Lunaire, set also by A. Schoenberg), Paul Heyse, T. Löngen and others. They show the influence of Hugo Wolf, whose songs he orchestrated, of Scriabin and of the French impressionist composers. In 1914 he was appointed professor of the state academy of music at Vienna, becoming director in 1922. In 1924 he was director of the Hochschule für Musik in Vienna. He was music critic of the *Neues Wiener Journal* (1931–38) and later of the *Wiener Zeitung*. Some of his essays were published in book form under the title *Betrachtungen eines romantischen Realisten* (1947). He also wrote symphonic and chamber works. Marx died in Graz on Sept. 3, 1964.

See A. Liess, *Joseph Marx: Leben und Werk* (1943).

MARX, KARL HEINRICH (1818–1883), German philosopher of history and the most important figure in the history of socialist thinking, was born, May 5, 1818, of Jewish parents in the town of Trèves (Trier) in Rhenish Prussia. In 1824 his father, a lawyer with a keen interest in philosophy, embraced Christianity and all members of the family were baptized as Protestants. During his student days at the universities of Bonn and Berlin, Marx studied history and philosophy and was strongly influenced by the works of Georg Wilhelm Friedrich Hegel (*q.v.*), an influence that always remained one of the most important elements in his thinking. In 1841 he received a doctor's degree from the University of Jena. His liberal political views led him to consider journalism as a career and in 1842 he became an editor of the *Rheinische Zeitung* in Cologne. The following year he married Jenny von Westphalen, close friend of his boyhood and daughter of a high government official. It was a marriage of deep love that withstood the vicissitudes of all the subsequent years. Shortly after his marriage, Marx's newspaper was suppressed and he emigrated to Paris with his wife. There he became acquainted with French socialist writers and established his lifelong friendship with Friedrich Engels. Both these influences led Marx to become a socialist.

In 1847, at a new place of exile in Brussels, Marx wrote a reply to P. J. Proudhon's book *Philosophie de la misère* ("Philosophy of Poverty") and entitled it *Misère de la philosophie* (Eng. trans., *Poverty of Philosophy*, 1935). In it he developed the fundamental propositions of his economic interpretation of history. Against Proudhon's (and the utopian socialists') quest for the morally most desirable social order he put his own search for the inevitable; *i.e.*, the system that would by necessity result from the operation of historical forces. Another even more important document originated from Marx's (and Engels') pen during the stay in Brussels—*Manifest der Kommunistischen Partei* (1848, many reprints; Eng. trans. by Samuel Moore, 1888), which contains a summary of his whole social philosophy. It was written to serve as the platform of the Communist league. *The Communist Manifesto* appeared at a moment most favourable to its effectiveness: on the eve of the February (1848) revolution in France during which socialism showed its power.

The revolutionary atmosphere in Germany in 1848 made it possible for Marx to return to Cologne and revive his newspaper, now under the title of *Neue Rheinische Zeitung*, but in 1849 he was expelled. This time he settled in London, where he spent the rest of his life—most of it in dire poverty. Journalistic activity for the *New York Tribune*, whose managing editor was Charles A. Dana, a Fourierist, at times alleviated the distress, but only the generosity of Engels, who worked in the Manchester affiliate of his father's textile firm, protected the Marx family from starvation. Several of Marx's children died, among them his only son, Edgar. Of his three daughters who reached adult life, two married French socialists (Paul Lafargue and Charles Longuet); the third, after Marx's death, established an unhappy association with the British Marxist Edward Aveling and ended by suicide. Marx died on Mar. 14, 1883, 15 months after the death of his wife. He was buried at Highgate cemetery.

In spite of poverty and persistent illness, Marx proved himself a prolific writer. Anxious to apply his philosophy of history to the events in France, where civil war had broken out between the workers and the middle class in the summer of 1848, Marx wrote his booklet *Die Klassenkämpfe in Frankreich 1848 bis 1850* (1850/1859; Eng. trans., 1942) and followed it up with *Der Achtzehnte Brumaire des Louis Napoleon Bonaparte* (1852–1885; Eng. trans. by Eden and Cedar Paul, 1940)—both of them masterpieces of historiography. He gave a critical history of economic literature in his book *Zur Kritik der politischen Ökonomie* (1859, Eng. trans. by N. I. Stone, 1904). His most famous work was *Das Kapital*. (The first volume appeared in 1867; second and third volumes were published posthumously in 1885 and 1894 edited by Engels. An English translation of the first volume by Samuel Moore and Edward Aveling appeared in 1886; a translation of the second and third volumes by Ernest Untermann, 1907 and 1909.) In this book Marx developed a theory of the capitalist system and its dynamism, with emphasis on its self-destructive tendencies.

The only important organizational activity Marx ever undertook was his leadership of the International Workingmen's association, (the First International) beginning in 1864. Most of the time his own followers were only a minority among the members, but he balanced the various factions against each other with great skill and infinite patience and held out to them their common goals, until the conflict with the anarchists put an end to the International. With the British labour movement Marx had little contact, although in the International some British trade-unionists were for a time among his strongest supporters. In France, his influence during his lifetime was overshadowed by that of Proudhon (*q.v.*) and in Germany—at least up to the late 1870s—by that of Ferdinand Lassalle (*q.v.*) but Lassalle and his successor, J. B. von Schweitzer, were interpreters rather than opponents of many of Marx's ideas. (*See* MARXISM.)

Marx regarded tsarism as the greatest enemy of freedom in all of Europe, and he wished for a strengthening of British imperial power as a counterweight to Russia. He also had a great hatred of Napoleon III. He was opposed to Prussian hegemony over Germany as established by Bismarck but asserted the right of the German people to unity; some utterances to the contrary notwithstanding, Marx respected and even shared national feelings. Marx took a passionate interest in the American Civil War as a partisan of the North. In spite of his merciless criticism of bourgeois

liberalism, Marx treasured the liberal-humanitarian tradition from which the socialist movement had sprung, and in all probability would have abhorred the antihumanitarian practices of present-day Communism. Marx did not live long enough to co-ordinate the strands in his great fund of ideas, and the unreconciled contradictions became a source of dissension among his intellectual heirs.

With the exception of Engels, Marx had no close, lifelong friend. To many of his contemporaries he appeared coldly arrogant, conceited and full of hate. Whether these traits were part of his nature or merely a response to his many frustrations, is a question which none of his many biographers has convincingly answered.

See also references under "Marx, Karl Heinrich" in the Index.

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Writings.—An exhaustive bibliography of those of Marx's writings which have been translated into English is given in the second volume of Donald D. Egbert and Stow Persons (eds.), *Socialism and American Life* (1952). In an appendix to his biography, Mehring gives a fairly complete list of the originals. The collected edition of Marx's and Engels' writings planned by the Institut Marxisma-Leninisma has remained incomplete; the collection contains (in original German) the earliest works, the complete correspondence between Marx and Engels in four volumes (1929–31) and an annotated edition of the *Anti-Dühring* (1935), including all preparatory notes that could be found, and also Marx's comments on the draft. (C. L.)

MARX, WILHELM (1863–1946), German statesman, leader of the Centre party and twice chancellor of the *Reich* during the Weimar republic was born in Cologne on Jan. 15, 1863, the son of the headmaster of a primary school. He studied law and rose from a judgeship in the county court at Elberfeld (1894) through successive promotions to the presidency of the senate of the court of appeal at Berlin (1922). He joined the Centre party and was a deputy to the Prussian *Landtag* from 1899 to 1918 and to the *Reichstag* from 1910 to 1932. A Roman Catholic, Marx was founder and first president of the Catholic Schools organization (Düsseldorf, 1911), and worked constantly for it. After World War I he also became president of the People's Union for Catholic Germany.

Marx was chairman of the Centre party from 1921 to 1928 as well as its leader in the *Reichstag*. At the end of Nov. 1923 he took Gustav Stresemann's place as chancellor of the *Reich*, heading a minority government based on support from the middle-class parties. This government secured the acceptance of the Dawes plan in Aug. 1924 (*see* GERMANY: *History*), but Marx resigned in the following December. He was prime minister of Prussia from February to April 1925. The "Weimar coalition" put him up as candidate for the presidency of the *Reich* in 1925, but he was defeated by Paul von Hindenburg. Having been minister of justice and of the occupied territories from Jan. 1926, Marx became chancellor of the *Reich* again in May. He inclined his government toward the right in Jan. 1927 by taking the German Nationalists into it and therefore resigned in June 1928 in view of the success of the Social Democrats in the elections of May. In Dec. 1928 he also resigned from the chairmanship of the Centre party and withdrew from politics. He died in Bonn on Aug. 5, 1946. *See* GERMANY: *History*.

See histories of the Centre party; also E. Matthias and R. Morsey (eds.), *Das Ende der Parteien* (1960). (R. Mo.)

MARXISM, a body of social doctrine worked out by Karl Marx in co-operation with his friend Friedrich Engels and systematized later by some of Marx's followers, especially Karl Kautsky. Marxism is a philosophy of history, implemented by an elaborate economic theory. This philosophy purports to demonstrate the inevitability of socialism (*q.v.*) and eventually of full communism (*q.v.*), the latter to be understood as a classless, collectivist order in which the social product is distributed according to needs and in which the state, law, money and the concept of economic value have lost their functions and therefore have "withered away." The following are the most important elements of Marxist doctrine:

Determinism.—Fundamentally, Marxists believe that history is governed by laws which the human mind can recognize and which offer man a possibility to foresee the future of society in its most important characteristics. Marxist determinism has been expressed with particular vigour by Rosa Luxemburg, one of the most original minds among the Marxists, who spoke of the "granite foundation of objective historical necessity," on which Marxism has built the socialist creed, in contrast to the "fog of pre-Marxian systems and schools of thought which wanted to derive socialism merely from the injustice and wickedness of the present world and relied merely on the revolutionary determination of the workers" (from an appendix to the second German edition of her book *Die Akkumulation des Kapitals*, p. 37).

Marxist determinism promises victory to the working class and thus is apt to strengthen the latter's self-confidence in the class struggle, but at the same time the question arises as to why workers should make sacrifices in order to bring about developments which are inevitable in any event. This problem is related to, though not identical with, the issue of free will versus causal necessity as known to general philosophy. For Marxists, this fundamentally insoluble dilemma is particularly important because they regard themselves not only as scholars but also as active promoters of social change.

Economic Interpretation of History.—What are the laws that govern history and can be made the basis of social prognosis? The first of these laws is supposed to determine the direction of the historical process. In its general form, the law says that economic developments are basic to social evolution in other areas. Ideas and institutions, law and politics, even religious concepts and artistic expression are parts of the social "superstructure," inevitably changing with the gradual transformation of the economic foundation. Since technological development leads to production units of ever increasing size, bringing together ever greater masses of workers in one enterprise and requiring ever larger amounts of capital per unit of labor, only the community at large will finally be able to provide the organizational frame work of production. This conclusion is supported by the theorem that the rate of profit will inevitably decline (*see* below).

Marxism does not contend that ideas exercise no influence on history, but merely that they are not independent agents; as intermediary links between economic developments and outward events, ideas may be very important from a Marxist point of view. Nor do Marxists believe that man is exclusively motivated by selfish or "material" interests; they do maintain that altruism, religious devotion, patriotism or other "idealistic" feelings are themselves the products of economic conditions and of their direct and indirect effects on the human mind.

The most problematic point in the economic interpretation of history is the ambiguity of the concept of *economic* change. If all the developments in the field of production, distribution and consumption were included, it would seem true enough that in this wide field some causes of practically all ideological and institutional developments can be found, but also that many economic facts in this broad sense are just as much effects as they are causes of changes in the "superstructure"; for instance, changes in artistic tastes, in political institutions, in social traditions and even in religious doctrines influence consumption of commodities and thereby become determinants of production, and law is as much a determinant as it is a product of economic life. Thus a maze of mutual causal relationships results and, with cause and effect undistinguishable in many instances, no social prognosis could be built on this foundation. Marx himself nowhere gave an explicit and comprehensive presentation of his economic interpretation of history, although fragmentary expositions and allusions are dispersed over all his writings. Engels, with Marx's endorsement, supplied more extensive explanations, especially in his polemical book *Herr Eugen Dühring's Revolution in Science*, but even he did not quite clear up the meaning of the term "economic" as used in this context.

To read as much consistency as possible into the Marxist system, it must be assumed that those changes which are regarded as basic to all others are physical and for the most important part,

technological. Technological progress, although its speed is influenced by political, legal and other developments in the "superstructure," is very nearly irreversible. Under all sorts of institutional arrangements and irrespective of prevailing religious creeds and philosophies, man has improved his control over nature, although with varying degrees of effectiveness. This gradual perfection of technology depends on physical experiment and its mathematico-philosophical interpretation. Since the results can be recorded—either in memory and tradition or in books and laboratory files—the stock of knowledge about nature is certain to grow, and thus technology moves along a one-way road: toward greater human command over nature. To the extent that the social consequences of this movement can be foreseen, the Marxist claim to forecasts of social evolution has indeed a firm foundation.

The assumption that Marx meant physical change when he designated economic change as basic to all social evolution is supported by a number of examples through which Marx and Engels tried to elucidate their basic proposition. This version of the economic interpretation of history is accepted by some Marxist writers, especially Georgy Plekhanov and Nikolai Bukharin, but rejected by others, for instance by Sidney Hook.

Whatever version is accepted, one weakness remains in the economic interpretation of history. True as it is that we think in a particular way because we happen to live in an age with a particular state of technology, we also think as we do because the dominant ideas of the present age were preceded by other ideas which had exhausted their fruitfulness or were discovered to be without an adequate basis in facts. The Renaissance followed the middle ages not merely because improved shipping and perfection of all sorts of tools had increased trade, improved the crafts, opened new sea lanes and led to new discoveries, and thereby created a new type of man, but also because men by mere intellectual and spiritual effort had found the limitations of medieval thinking and feeling. The economic interpretation of history overstates its case by denying that man's intellectual and spiritual development possesses any autonomy; but this part of Marxism has greatly enriched all social sciences by drawing attention to technological progress as a cause of some very important aspects of cultural and institutional development.

The economic interpretation of history, although called "historical materialism" by Marx himself and many Marxists, has no essential relationship to philosophical materialism, and only a vague analogy exists between the two concepts.

Dialectics.—Marx tended to believe that all important historical progress is achieved through an all-out conflict between an old and a new principle of social organization, and that consequently progress would be impeded if the tension between these two principles were "prematurely" reduced by limited reforms of the old system. This belief is based on dialectic philosophy, which Marx took over directly from the German philosopher Hegel and indirectly from ancient Greek philosophers. For the consistent Marxist dialectician, straight-line, gradual progress can never lead to worthwhile results; for him, reforms represent progress only if they operate as a foreign body within the existing system and thus accelerate its death, for instance, when taxation of profits within a capitalist system is raised so high as to destroy entrepreneurs' incentive. Since true reform, which does not destroy the present system but gradually transforms it, is ruled out, revolution becomes necessary, and to a consistent believer in dialectics the suffering and sacrifices of violent change constitute the price that mankind has to pay to have any essential progress at all.

This was the philosophy that Marx professed, but he failed to show complete consistency in dealing with its implications. Apparently he was not prepared to rule out peaceful progress unconditionally, and he may also have found it difficult to reconcile dialectic philosophy with the economic interpretation of history, since technological progress is the very model of "straight-line" gradual evolution.

Class Struggle.—Marx stressed the obvious truth that social groups have conflicts of interest that are often reflected in antagonistic political creeds. He tends to go beyond this truism by implying that the classes have no common interests at all, and that their struggle, in which he sees the great motive power of history, is essentially illimitable.

The basis of this more far-reaching belief is the connection Marxism established between the class struggle concept and dialectic philosophy. In the course of history, Marx saw each principle of social organization represented by a social class: feudalism by the nobility, capitalism by the entrepreneurs, socialism by the workers. The struggle of the classes is identical with the dialectic conflict of organizational principles. Consequently, the class struggle is governed by the law of dialectics; it is necessarily an all-out conflict—it cannot be limited by the rules of democracy, which substitute "ballots for bullets" and require respect for the inalienable rights of the opponent. The victory of the new class must be followed by repression of the former ruling class until the last vestiges of the old order are extinguished. In the struggle of the workers against the capitalists, this repression will result in the "dictatorship of the proletariat," as the political form of society in the period of transition from capitalism to full communism.

As Marx was not a consistent dialectician, he wrote many passages that are incompatible with the belief in the illimitable class struggle. There exists, therefore, a cleavage in the Marxist system between the belief in democratic evolution and the contrary belief in the inevitability of revolution ending in dictatorship. This cleavage has transmitted itself to Marx's disciples and is reflected by the conflict between the supporters of democratic socialism, many of whom still treasure the Marxist tradition, and those of modern Communism. Intermediate positions between these two extremes were once held by writers like Kautsky, but this old Marxist "centre" has in the main joined the democratic camp. Some developments within the Communist camp, especially but not exclusively in Poland and Yugoslavia, indicate a possibility that a new Marxist centre may arise.

Labour Value Theory.—Marx accepted the explanation of value as given by the classical economists of his day, especially David Ricardo (*q.v.*). According to the classical doctrine, the value of a commodity depends on the amount of labour time necessary for its production. Marx applied this theory with some refinements to human labour power. According to him a worker's labour power is sold like any other commodity, at a price determined by the labour time necessary to produce it (the time necessary to produce the means of subsistence and education). Labour power, however, is the only commodity that can produce a value greater than its own, because a worker can work more hours than are necessary to keep him alive and in a position to reproduce his kind. The product of this "surplus labour" is called "surplus value" and is appropriated by the employer who has acquired the legal right to the full use of labour power by paying the worker the labour-time value of that power. This surplus value is the source of all nonwage income: profit, rent and interest. The purchase of labour power at a price corresponding to its labour-time value and therefore inevitably smaller than the labour-time value of the products is called "exploitation of labour" by Marx—a term which, according to Marx's own allegation, was not intended as an ethical condemnation but which he nevertheless often used in a sense implying a moral judgment.

In elaborating the theory that "exploitation of labour" is the only source of profit, (in the third volume of *Das Kapital*), Marx ran into difficulties that caused him to deviate from the logical consequences of the labour value theory on which he had based his initial propositions. This widely discussed self-contradiction, however, merely adds one more argument to the body of proofs by which modern theory has refuted the explanation of value from labour time. Yet the labour theory of value, and its derivative, the surplus value theory, cannot be eliminated from the Marxist system as some recent Marxists and semi-Marxists have suggested, for these theories are indispensable for the support of the proposition that capitalism is doomed by objective economic necessity —a proposition that belongs to the very essence of Marxism.

Since all profit results from "exploitation of labour," the rate of profit—the amount per unit of total capital outlay—depends

largely on the number of workers employed. Machines cannot be "exploited"; they can therefore not contribute to total profits, although they help labour produce more useful things. Only payroll capital—"variable capital"—is productive of surplus value and consequently of profit. The introduction of machines is profitable for the individual entrepreneur, to whom they give an advantage over his competitors, but as outlay for machinery grows in relation to outlay for wages, profit declines in relation to total capital outlay. The capitalist will receive less and less per hundred dollars of capital and can only try to postpone his bankruptcy by pressure upon the workers; finally, the "capitalist class becomes unfit to rule, because it is incompetent to assure an existence to its slave within his slavery." Consequently the system collapses and the working class inherits the power.

Theory of Alienation.—One of the many subsidiary doctrines contained in Marx's writings has recently attracted much interest: the contention that, for the worker under industrial capitalism, work is merely a means to protect himself from starvation, whereas for the medieval craftsman, or even the peasant, work was also a means of self-expression. To the extent that this "alienation" of man from his work really exists, it is obviously a result of the fragmentation of the work process through division of labour. Marx does not wish to return to medieval methods of production, but he believes that modern technology when freed from the fetters of capitalist profit calculation will liberate modern man from the tie to one particular occupation, will permit him to change his activities frequently enough to make him visualize every phase of his work as part of the social process of production and thus find new satisfaction. There is nothing in technological development, however, or in collectivist experience since Marx's days to support these particular expectations; on the other hand, the replacement of manual labour by machines in some of the most tedious jobs and the shortening of the working day have certainly alleviated the alienation problem.

Appraisal of Marxism.—In spite of its weaknesses, Marxism has played a role greater than any other recent system of social philosophy; its effects cannot be summarized by a simple formula. Marxism has strengthened the workers' movement which has been the greatest single force operating for social justice; it has reconciled the workers to modern technology, imbued them with a great respect for intellectual accomplishment and strengthened their desire for education; more effectively than any other school, it has called attention to the role of economic and especially of technological factors in history. On the other hand, it has supplied totalitarian enemies of freedom with important intellectual weapons. Marxism is the only admissible social doctrine in the Soviet Union and the "People's Democracies," although more recently the inadequacies of the labour value theory as a basis for rational planning have caused important, if tacit, modifications of Marxism.

Austro-Marxism.—In its orthodox form, Marxism denies the existence of any "super-class ethics": all moral rules are considered reflections of the social position of either the dominant class or of the oppressed class. In opposition to this view, an effort was made, mainly by Austrian socialists, to return to the pre-Marxian idea that the socialist postulates should be based on an ethical code binding on all humanity while most other elements of Marxist thought were retained. This open acknowledgment of the ethical basis of socialism was incompatible with the more extreme versions of the class struggle concept, since ethical rules which determine the ultimate ends of a movement also have a bearing on the legitimacy of means. Austro-Marxism might therefore have supplied the right-wing of the socialist movement with a badly needed theoretical basis, but most of the Austro-Marxists, as, for instance, their most prominent leader, Otto Bauer, kept politically close to the Marxist centre group.

Neo-Marxism.—In his analysis of capitalism, Marx had been concerned almost exclusively with a highly competitive kind of capitalist system in which the entrepreneurs were in the main opposed to state intervention. The decades after Marx's death produced a kind of capitalism that was permeated with monopoly and in which the majority of businessmen desired state intervention for the protection of monopolies, for protective tariffs and for the opening of foreign markets and promotion of foreign investments. A number of Marxists writers tried to modify Marxist theory in order to account for these new facts and to exploit them for the strengthening of Marxist policy arguments.

The first of these Neo-Marxists was Rudolf Hilferding (*q.v.*) who in his book *Das Finanzkapital* (1910) maintained that the increasing influence of the banks over industry was mainly responsible for cartelization—because the banks wanted to prevent their industrial customers from ruining each other through competition—and also for the search for foreign capital outlets. For the latter phenomenon, Rosa Luxemburg (*q.v.*) offered a new explanation in her book *Die Akkumulation des Kapitals* (1913). From Marx's discussion of the interdependence of consumer and producer goods industries she drew the conclusion that capitalism was threatened with a glut of consumer goods and maintained that this threat was the motive power behind the imperialist ventures of capitalist states—ventures which she regarded as temporarily successful but necessarily futile in the end. Fritz Sternberg, in his book *Der Imperialismus* (1926), tried to clear up the many obscurities in Luxemburg's reasoning and supplemented it with an argument which, from a Marxist point of view, seemed more convincing: since the colonial areas use more manual labour and less machinery, the decline of the rate of profit has not advanced as far there as in the old industrial countries; therefore, investment in colonies and semicolonies offers the western capitalists a temporarily higher profit rate. This latter argument was further expounded by the Polish writer Henryk Grossmann in his book *Das Akkumulations-und Zusammenbruchsgesetz des kapitalischen Systems* (1929). Finally, E. J. Strachey gave a comprehensive presentation of the Neo-Marxist theory of imperialism and capitalist doom in *The Nature of Capitalist Crisis* (1935), using mainly the argument of the higher profit rate in noncapitalistic areas.

The historic significance of Neo-Marxism rests upon its utilization by Lenin in his book *Imperialism, the Highest State of Capitalism* (1916). Lenin did not commit himself to the details of Rosa Luxemburg's analysis but took from it the general idea that western capitalism had prolonged its life by expanding into colonial areas; he drew the conclusion that capitalism would perish if deprived of its colonial domains. Under the spell of this thought, Bolshevism staged its anti-imperialist campaign in which it achieved major successes but also encountered conflicts with the rising nationalism of the ex-colonials—conflicts which seem to increase as "capitalist" imperialism becomes a thing of the past.

See CAPITALISM; LENIN; MARX, KARL HEINRICH; STALIN, JOSEPH VISSARIONOVICH; DIALECTICAL MATERIALISM; *see* also references under "Marxism" in the Index.

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(C. L.)

MARY (THE VIRGIN MARY), the mother of Jesus. Out of the sparse details of her life as portrayed in the Gospels, Christian piety and theology have constructed a picture that fulfills the prediction ascribed to her in the Magnificat (Luke i, 48): "Henceforth all generations will call me blessed."

It would be impossible to write a biography of Mary based upon biblical accounts, in spite of the fact that the span of time covered by those accounts is longer than the life of Jesus. The first mention of her is the story of the annunciation, which reports that she was living in Nazareth (Luke i, 26 ff.); the last mention of her (Acts i, 14) includes her in the company of those who devoted themselves to prayer after the ascension. Between these two references are several scenes of a rather occasional character: the visit with Elizabeth, her cousin and the mother of John the Baptist (Luke i, 39 ff.); the birth of Jesus and the pres-

entation (Luke ii, 1 ff.); the coming of the Magi and the flight to Egypt (Matt. ii, 1 ff.); the Passover visit to Jerusalem (Luke ii, 41 ff.); the marriage at Cana in Galilee (John ii, 1 ff.); the attempt to see Jesus while he was teaching (Mark iii, 31 ff.); the station at the cross, where, apparently widowed, she was entrusted to John (John xix, 26 ff.). Even those interpreters for whom these scenes have represented a series of literal historical accounts have found it difficult to draw a portrait of Mary on the basis of them.

But since the early days of Christianity, the themes which these scenes symbolize have been the basis for thought and contemplation about Mary, developing and expanding through the centuries. Christian communions and theologians differ from one another in their interpretation of Mary principally on the basis of where they set the terminal point for such development and expansion. To a considerable degree, therefore, a historical survey of that development is also an introduction to the state of contemporary Christian thought about Mary.

Guarantee of the Incarnation.—Probably the earliest allusion to Mary in Christian literature is the phrase "born of a woman" in Gal. iv, 4. As parallels like Job xiv, 1 and Matt. xi, 11 suggest, the phrase is a Hebraic way of speaking about the essential humanity of a person. When applied to Jesus, therefore, it was intended to assert that he was truly a man, in opposition to the attempt, later seen in the Docetists, to deny that he had a completely human life (*see* DOCETISM). It seems unwarranted to read anything further into the phrase, as though "born of a woman" necessarily implied "but not of a man and a woman." Thus the phrase made of Mary the guarantee of the reality of the incarnation. For the ancient world, one human parent was necessary to assure that a person was genuinely human, and one of the roles assigned to Mary from the beginning has been that of providing this assurance. Some historians have even maintained that the primary connotation of the phrase "born of the Virgin Mary" in the Apostles' Creed was this same insistence by the church upon the reality of the incarnation. That insistence has been the irreducible minimum in all the theories about Mary that have appeared in Christian history. Those who deny the virgin birth usually claim to do so in the name of this insistence upon true humanity. Those who defend the virgin birth usually maintain that the true humanity was made possible when the Virgin accepted her role as the guarantee of the incarnation (Luke i, 38): "Let it be done to me according to thy word." This is the original source of the title "coredemptress" assigned to Mary in Roman Catholic theology, though the term has come to connote a more active participation by the Virgin in the redemption of mankind; the precise nature of this participation is still a matter of controversy among Catholic theologians.

Virgin Mother.—By far the most voluminous narratives about Mary in the New Testament are the infancy stories in Matthew and Luke. In their present form, both accounts make a point of asserting that Jesus was conceived in the womb of Mary without any human father (Matt. i, 18 ff.; Luke i, 34 ff.); the many textual variants in Matt. i, 16, some of them with the words "Joseph begat Jesus," have caused some scholars to question whether such an assertion was part of Matthew's original account. The most voluminous discussions of Mary in postbiblical Christian literature have also been those dealing with her virginity. The narratives in Matthew and Luke seem to be the only references to the matter in the New Testament, unless John i, 13 is taken to read ". . . who was born" rather than ". . . who were born." On the basis of these narratives, it was the unanimous teaching of all the orthodox fathers of the church that Mary conceived her Son with her virginity unimpaired, a teaching enshrined in the Apostles' Creed and concurred in by the classical Reformers as well as by most Protestant believers since the Reformation. Only with the rise of Protestant theological liberalism did this teaching begin to lose the universal support it had enjoyed. One of the major points in the attack by fundamentalism upon this liberalism was its insistence upon the literal accuracy of all the miracle stories in the Bible, including and especially those dealing with the miraculous conception of Jesus.

Mother of God.—The first major theological controversy over Mary had to do with the propriety of applying to her the title of *Theotokos*, "God-bearer" or "mother of God." The title itself was a logical deduction from the dogma of the full deity of Christ as this was established during the 4th century, and those who defended that dogma were also the ones to draw the deduction. By the end of the 4th century, therefore, it had successfully established itself in various sections of the church. Because it seemed to him that the supporters of the title were confounding the divine and the human in Christ, Nestorius objected to its use, preferring the less explicit title *Christotokos*. Along with other aspects of his teaching, Nestorius' objections were condemned at Ephesus in 431, and *Theotokos* was unconditionally approved (*see* COUNCIL: *Councils to the 9th Century*). In the devotion of Eastern Christendom the *Theotokos* (Russian *Bogoroditsa*) has played a major role, also becoming one of the favourite subjects for icon painters. Through its incorporation in the Ave Maria, the title "mother of God" has been circulated throughout western Catholicism. By the approval it received in both Lutheran and Reformed confessions during the period of the Reformation, the title assured itself a place in the theology, if not in the piety, of orthodox Protestantism. It is as mother of God that the Virgin is also termed mediatress. The official teaching of the Roman communion has sought to make clear that this latter term is not intended to detract from the glory of Christ as sole Mediator, but that Mary mediates between Christ and mankind as she did at Cana in Galilee (John ii, 3).

Ever Virgin.—One corollary that could be deduced from the New Testament assertion of Mary's virginity in the conception of Jesus was the doctrine of her perpetual virginity, not only "before birth" but "in birth and after birth," to use the usual phrases. The Apostles' Creed appears to teach at least her virginity "in birth" when it says "born of the Virgin Mary." Although the earliest mention of the doctrine occurs in the apocryphal Protevangelium Jacobi, its origins and extent are not easy to trace, Roman Catholic historians and Protestant historians coming to contradictory conclusions. The doctrine had no explicit warrant in the New Testament, and Old Testament passages such as Ezek. xliv, 2 and Song of Sol. iv, 12 were probably convincing only to those who already believed the doctrine. In addition, the doctrine posed two problems of biblical interpretation, both of which were discussed in detail by defenders of the doctrine from Jerome to Luther. To the argument from words such as "until" (Matt. i, 25), "before" (Matt. i, 18) and "first-born" (Luke ii, 7) that Mary must have borne further children, the defenders of the perpetual virginity have replied that none of these words speaks at all about what followed: an only child is a first-born child, and a man who "died before repenting of his sins" did not necessarily repent thereafter. The other biblical problem was that of the "brothers" of Jesus referred to in 1 Cor. ix, 5, Gal. i, 19, and several times in the Gospels and in Acts. Defenders of the perpetual virginity have explained these either as "kinsmen" or as children of Joseph by a previous marriage or as children of another Mary and of Cleophas. Partly because of these problems, the doctrine of the perpetual virginity of Mary has not been supported as unanimously as has the doctrine of the virginal conception or the title "mother of God." It achieved dogmatic status at the Council of Chalcedon in 451, and is therefore binding upon Eastern Orthodox and Roman Catholic believers; in addition, it is maintained by many Anglican, some Lutheran and a few other Protestant theologians.

Immaculate.—As the doctrine of her perpetual virginity implied an integral purity of body and soul, so, in the opinion of many early theologians, she was also free of other sins. In a discussion aimed at proving the universality of sin, Augustine spoke for the western church when he wrote: "We must except the holy Virgin Mary. Out of respect for the Lord, I do not intend to raise a single question on the subject of sin. After all, how do we know what abundance of grace was granted to her who had the merit to conceive and bring forth Him who was unquestionably without sin?" (*Nature and Grace*, ch. 36). But it was the distinction between original sin and actual sin, firmly established in western theology by the same Augustine, that eventually compelled a

further clarification of what the sinlessness of Mary meant. Certain eastern theologians in the 4th and 5th centuries were willing to attribute actual sins to her, but most theologians in both east and west came to accept the view that she never did anything sinful, a view that found expression even among the Reformers. But was she free from original sin as well? And if so, how? Thomas Aquinas took a representative position when he taught that her conception was tarnished, as was that of all men, but that God suppressed and ultimately extinguished original sin in her, apparently before she was born. But this position was opposed by the doctrine of the immaculate conception (*q.v.*), systematized by Duns Scotus and finally defined as Roman Catholic dogma in 1854. According to this dogma, Mary was not only pure in her life and in her birth, but "at the first instant of her conception was preserved immaculate from all stain of original sin, by the singular grace and privilege granted her by Almighty God, through the merits of Christ Jesus, Savior of mankind."

Assumed Into Heaven.—When the immaculate conception was promulgated, petitions began coming to the Vatican for a definition regarding the assumption of the Virgin into heaven, as this was believed by most Roman Catholics and celebrated in the feast of the assumption (*q.v.*). During the century that followed, more than 8,000,000 persons signed such petitions; yet Rome hesitated, the doctrine being difficult to define on the basis of Scripture and early witnesses to Christian faith. No account of the place and circumstances of Mary's death was generally accepted in the early church, no burial place acknowledged, and no miracles credited to relics of her body. But such arguments from silence did not suffice to establish a dogma, and on the positive side even the earliest doctrinal and liturgical tradition appeared relatively late in history. Pope Pius XII made the dogma official in 1950, declaring "that the immaculate mother of God, the ever Virgin Mary, when the course of her earthly life was run, was assumed in body and in soul to heavenly glory." As it was formulated, the dogma left open to speculation the question of Mary's death.

In addition to these official titles and roles assigned to her by Catholic Christianity, the Virgin has served to symbolize the redemption of the life of nature and to provide a bridge between Christianity and those religions of nature that have spoken of this redemption. In the secular life and literature of the west since the day of the *Minnesänger,* she has symbolized the nobility of woman. Even those non-Roman churches which have most vigorously criticized the "Mariolatry" they claimed to find in the dogmas of the immaculate conception and the assumption have frequently addressed praises to her in their hymnody that they would have hesitated to express in the prose of their dogmatic theology. Thus, in ways she could never have anticipated, all generations have called her blessed.

See also references under "Mary" in the Index.

BIBLIOGRAPHY.—Juniper Carol, O.F.M. (ed.), *Mariology,* 3 vol. (1955 *et seq.*), deals successively with the sources of Marian doctrine, with Marian theology and with Marian devotions. For individual Marian prerogatives, studied from the viewpoint of Scripture and of positive and speculative theology, *see* the annual *Marian Studies* (proceedings of the Mariological Society of America) (1950 *et seq.*). The Eastern Orthodox view is presented, though from a Roman standpoint, by Maurice Gordillo, *Mariologia Orientalis* (1954). Anglican, Lutheran, Protestant and Orthodox reactions to the assumption, as well as a detailed Marian bibliography, are in Friedrich Heiler (ed.), *Das neue Mariendogma* (1951). (J. J. PN.)

MARY I (1516–1558), queen of England from 1553 to 1558, was the daughter of Henry VIII and Catherine of Aragon. Mary was born at Greenwich, on Monday, Feb. 18, 1516, and she was baptized on the following Wednesday, Thomas Cardinal Wolsey standing as her godfather. She seems to have been a precocious child and is reported in July 1520, when scarcely four and a half years old, as entertaining some visitors by a performance on the virginals (a 16th-century spinet). When she was little over nine, she was addressed in a complimentary Latin oration by commissioners sent over from Flanders on commercial matters and replied to them in the same language "with as much assurance and facility as if she had been twelve years old." About that time her father, who was proud of her achievements, was arranging that she should learn Spanish, Italian and French. A great part, however, of the credit for her early education was undoubtedly due to her mother, who not only consulted the Spanish scholar Juan Luis Vives upon the subject but was herself Mary's first teacher in Latin.

When Mary was two years old, she was proposed in marriage to the dauphin, son of Francis I. Three years later the French alliance was broken off and she was affianced to her cousin, the young emperor Charles V, by the treaty of Windsor in 1522. However, after his great victory over Francis at Pavia in 1525, Charles released himself from this engagement and made a more convenient match. Later in the same year Mary was given an establishment of her own and was sent to Ludlow with a council which was designed to secure the better government of the marches of Wales. For several years she accordingly kept her court at Ludlow, while new arrangements were made for the disposal of her hand. She was now proposed as a wife, not for the dauphin as before, but for his father Francis I, who had just been redeemed from captivity at Madrid, and who was only too glad of an alliance with England to mitigate the severe conditions imposed on him by the emperor. When the Anglo-French alliance was finally concluded, however, by a treaty dated Westminster, April 30, 1527, it was provided that Princess Mary should be married either to Francis himself or to his second son, Henry, duc d'Orléans.

The Succession Problem.—It was immediately after this treaty that Henry VIII began the proceedings for his "divorce" from Catherine that were to make the next nine years perhaps the most miserable period of Mary's life. From the end of 1531 mother and daughter were kept apart. Possibly Queen Catherine had the harder trial, but Mary's was scarcely less severe. On the birth of Anne Boleyn's daughter Elizabeth (Sept. 1533), Mary was required to give up the dignity of princess and acknowledge the illegitimacy of her own birth. On her refusal her household was broken up, and she was sent to Hatfield to act as lady-in-waiting to her own infant half sister. Nor was even this the worst of her trials; she feared that her very life was in danger from the hatred of Anne Boleyn. Mary's health, moreover, was indifferent, and even when she was seriously ill, although Henry sent his own physician, Dr. Buttes, to attend her, he declined to let her mother visit her. At her mother's death in Jan. 1536 she was forbidden to take a last farewell of her.

But in May following another change occurred. Anne Boleyn, her bitterest enemy, fell under the king's displeasure and was put to death. Mary was then urged to make a humble submission to her father as the means of recovering his favour, and after a good deal of correspondence with the king's secretary, Thomas Cromwell, she eventually did so. The terms exacted of her were bitter in the extreme, but Mary, alone and at the mercy of her imperious father, at length subscribed an act of submission, acknowledging the king as "Supreme Head of the Church of England under Christ," repudiating the pope's authority, and confessing that the marriage between her father and mother "was by God's law and man's law incestuous and unlawful."

Henry was reconciled to her and gave her a household in some degree suitable to her rank. During the rest of the reign her position was less difficult. She appeared at the court and a number of new marriage projects for her were made, though all of them came to nothing. Her privy purse expenses for nearly the whole of this period have been published and show that Hatfield, Beaulieu or Newhall in Essex, Richmond and Hunsdon were among her principal places of residence. Although she was still treated as of illegitimate birth, in 1544 she was restored by statute to a position in the succession next after Edward and any other legitimate children who might be born to the king, but under conditions to be regulated by Henry's will.

Under Edward VI.—During the reign of her brother, Edward VI, Mary was again subjected to severe trials, which at one time made her seriously meditate escaping abroad. Edward himself seems to have been personally kind to her, but the religious innovations of his reign soon brought her into conflict with the government. She had done sufficient violence to her own convictions in submitting to a despotic father and was not disposed to yield an equally tame obedience to authority exercised by a factious council in the name of a younger brother not yet come to years of dis-

cretion. Besides, the cause of the pope was naturally her own. In spite of the declaration formerly wrung from herself, most people did not regard her as a bastard although the full recognition of her rights implied the recognition of the pope as head of the church. Hence, when Edward's parliament passed the Act of Uniformity in 1549, enjoining services in English and communion in both kinds, she insisted on having mass in her own private chapel under the old form. When ordered to desist, she appealed for protection to her cousin, the emperor Charles V, who intervened for some time not ineffectually, threatening war with England if her religious liberty was infringed.

But Edward's court was composed of factions of which the most violent eventually carried the day. Lord Seymour, the admiral, was attainted of treason and beheaded in 1549. His brother, the protector Somerset, met with the same fate in 1552. John Dudley, duke of Northumberland, by then paramount in the privy council, easily obtained the sanction of the young king to those schemes for altering the succession which led immediately after Edward's death (July 6, 1553) to the usurpation of Lady Jane Grey. Northumberland had, in fact, overawed the rest of the privy council, and when Edward died, he took such energetic measures to give effect to his scheme that Lady Jane was actually recognized as queen for some days, and Mary had to flee from Hunsdon into Suffolk. But the country was devoted to her cause, as indeed her right in law was unquestionable, and before many days she was royally received in London and took up her abode within the Tower of London.

Queen 1553–58.—Her first acts as queen displayed a character very different from that which she still holds in popular estimation. Her clemency toward those who had taken up arms against her was remarkable. She released from prison Lady Jane's father, the duke of Suffolk, and had difficulty even in signing the warrant for the execution of Northumberland. Lady Jane herself she fully meant to spare, and did spare till after Sir Thomas Wyat's formidable insurrection in 1554. Her conduct, indeed, was in most respects conciliatory and pacific, and so far as they depended on her personal character the prospects of the new reign might have appeared altogether favourable.

But her position was one of peculiar difficulty, and the policy on which she determined was far from judicious. Inexperienced in the art of governing, she had no trusty councilor but Stephen Gardiner, bishop of Winchester; and she was naturally led to rely even more on the advice of her cousin, the emperor, who had been her mother's friend in adversity and had helped Mary in the preceding reign. Following the emperor's guidance, she determined almost from the first to make his son Philip her husband, though she was 11 years his senior. She was also strongly desirous of restoring the old religion and wiping out the stigma of illegitimacy upon her birth.

Of all these objects her marriage was the most unpopular. Restoration of the old religion might deprive the new owners of abbey lands of their comfortable acquisitions; and it was only with an express reservation of their interests that the thing was actually accomplished. A declaration of her own legitimacy necessarily cast a slur on that of her sister Elizabeth and cut her off from the succession. But the marriage promised to throw England into the arms of Spain and place the resources of the kingdom at the command of the emperor's son.

The commons sent her a deputation to entreat that she would marry an Englishman, and when her resolution became known early in 1554, insurrections broke out in different parts of the country. Suffolk, whose first rebellion had been pardoned, proclaimed Lady Jane Grey again in Leicestershire, while Wyat raised the county of Kent and, though denied access by London bridge, led his men around by Kingston-upon-Thames to the very gates of London before he was repulsed. In the midst of the danger Mary showed great intrepidity and the rebellion was presently quelled. Thereupon she married Philip (July 25, 1554), restored Catholicism and admitted Reginald Cardinal Pole to absolve the kingdom from its past disobedience to the Holy See (Nov. 30, 1554).

It was a more than questionable policy thus to ally England with Spain—a power then actually at war with France. By the treaty, indeed, England was to remain neutral; but in the end it was drawn into the quarrel. Meanwhile the country was full of faction, and seditious pamphlets of Protestant origin inflamed the people with hatred against the Spaniards. Philip's Spanish followers met with ill-usage everywhere, and violent outbreaks occurred. A year after his marriage Philip went over to Brussels to receive from his father the government of the Low Countries and afterward the kingdom of Spain. To Mary's distress, his absence was prolonged for a year and a half and when he returned in March 1557 it was for the purpose of getting England to declare war on France. As soon as this purpose was achieved he went back to Brussels in July, to return no more to England.

In spite of the encouragement that France had given to disaffection among Mary's subjects, there had been strong opposition to Philip's demands among Mary's advisers. But an attempt by Thomas Stafford and other English refugees in France to seize Scarborough played into her hands, and she was able to declare war against the French on June 7, 1557. In this war Mary found herself opposed by the pope, who took part with France against Spain; Scotland, too, soon declared war upon her; and on Jan. 5, 1558, she suffered the final calamity of the loss of Calais.

Religious Policy.—The persecution of the Protestants, which has cast so much infamy upon her reign, did not begin until Mary had been more than a year and a half on the throne. When the kingdom was reconciled to Rome and absolved by Cardinal Pole, it was natural and logical that the old heresy laws should be revived by act of parliament. But Mary must bear the final responsibility for the severity of their enforcement, which was unprecedented in England. Merciful and kindly by nature, she yet seems to have felt that the Protestants' stern fanaticism and ill will to the old religion made them dangerous, even to the public peace; and that the persecution was necessary if the old faith were to be preserved in England. John Rogers, the first of the martyrs, was burned on Feb. 4, 1555. John Hooper, bishop of Gloucester, had been condemned six days before and suffered the same fate on Feb. 9. From this time the persecution went on uninterrupted for almost four years, numbering among its victims Nicholas Ridley, Hugh Latimer and Thomas Cranmer. It came to an end at last on the death of Mary. Nearly 300 victims are known to have perished at the stake, and their fate created a revulsion against Rome that nothing else was likely to have effected and earned Mary the nickname of "Bloody Mary." Mary was of weak constitution and subject to frequent illnesses, both before and after her accession. One special infirmity caused her to believe a few months after her marriage that she was with child, and thanksgiving services were ordered throughout the diocese of London in Nov. 1554. The same delusion recurred in April 1558 when, though she did not make her expectation public, she drew up a will in anticipation of the dangers of childbirth, constituting her husband regent during the minority of her prospective heir. To this she added a codicil on Oct. 28 following, when the illness that was to be her last had set in, showing that she had ceased to have much expectation of maternity, and earnestly entreating her "next heir and successor by the laws" (whom she did not name) to allow execution of the instrument. She died on Nov. 17, 1558.

Her name perhaps deserved better treatment than it has generally met with; her kindness to the poor is undoubted, and the severe execution of her laws seemed to her a necessity. Moreover, she was alive to the injustice with which the law was usually strained in behalf of the prerogative; and in appointing Sir Richard Morgan chief justice of the common pleas she charged him "not to sit in judgment otherwise for her highness than for her subjects," and to avoid the old error of refusing to admit witnesses against the crown. Mary's conduct as queen was governed by the best possible intentions; and it is evident that her religious zeal caused most of the trouble she brought upon herself. Her subjects were entirely released, even by papal authority, from any obligation to restore the confiscated lands of the church. But she herself made it an object, at her own expense, to restore several of the monasteries; and courtiers who did not like to follow her example encouraged the fanatics to spread an alarm that it would

even yet be made compulsory. So the worldly minded joined hands with godly heretics in stirring up enmity against her. Her unpopular foreign marriage and the national humiliations which followed upon it made their task all too easy.

See also references under "Mary I" in the Index.

BIBLIOGRAPHY.—Sir Frederic Madden, Introduction to *The Privy Purse Expenses of the Princess Mary* (1831); J. M. Stone, *History of Mary I, Queen of England* (1901); H. F. M. Prescott, *Mary Tudor* (rev. ed. of *Spanish Tudor*) (1952). (R. B. WM.)

MARY II (1662–1694), queen of England and wife of King William III; elder daughter of James, duke of York (afterward King James II) by his first wife, Anne, daughter of Edward Hyde, 1st earl of Clarendon, was born in London on April 30, 1662. She was brought up as a Protestant and in Oct. 1677 was betrothed to her cousin, William, prince of Orange; they were married in London on Nov. 4. Despite her status as heir presumptive to the crown after her father, Mary had little influence in English politics between 1677 and 1687; she did not visit England and devoted herself instead to her duties as a princess of Holland. She became much beloved by the Dutch people, and she returned their affection and devotion. Her childlessness and her husband's relations with Elizabeth Villiers naturally caused her pain, but she and William remained a devoted and united couple; her religious and political beliefs led her to defer to him at all times.

In 1687–88 the open quarrel between her husband and her father over James's religious policy brought her more into the public eye, but she continued to leave the initiative to William and his advisers. In the autumn of 1688 she agreed to support his invasion of England, because she conceived it to be her duty as a Protestant and because she suspected that her half brother James Edward, born in June 1688, was a supposititious child. After James II's flight she went to England, in Feb. 1689, and at once rejected the proposals of those who wished to make her sole monarch or sole regent, to the exclusion of her husband. Thus she and William were proclaimed joint sovereigns and crowned on April 11, 1689.

During her husband's yearly absences in Ireland and Flanders, Mary administered the government in her own name but always on his advice; and though she enjoyed great popularity as an Anglican and an Englishwoman, in contrast to the Dutch Presbyterian king, she never encouraged the formation of any party round her, and when William was in England she was glad to retire from politics altogether. She was unhappy at leaving Holland and never settled down in England, and she was deeply troubled by her anomalous position with regard to her father. A bitter quarrel with her sister Anne, and the hostility to the regime of her maternal uncles, the earls of Clarendon and Rochester, weighed further on her mind, and she aged rapidly. She died of smallpox at Kensington palace on Dec. 28, 1694, at the age of 32, and was buried in Westminster abbey.

Her husband's bitter grief was matched by the nation's, and her people sincerely mourned a selfless, deeply Christian woman whose kindness, sweetness of temper and good nature never degenerated into weakness. Her relations with the Anglican Church and with many of its leaders, such as Thomas Tenison and Gilbert Burnet, were particularly close, and her death robbed it of a valuable patron. Among her many charitable works was Greenwich Hospital for Seamen, completed after her death as a memorial. Her Dutch tastes had a marked influence on English pottery, garden layout and interior decoration, and she was closely associated with the rebuilding of Hampton Court and Kensington palaces by Wren and the redesigning of their gardens.

See also references under "Mary II" in the Index.

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MARY (MARY TUDOR) (1496–1533), queen consort of Louis XII of France, was the younger surviving daughter of Henry VII of England and Elizabeth of York and was born, probably in March, in 1496. The treaty of Calais (Dec. 21, 1507) arranged for her marriage with the future emperor Charles V when the prince reached the age of 14, and the wedding was celebrated by proxy in 1508. The contract was renewed (1513) by Henry VIII, but the emperor Maximilian I was then in treaty for a marriage with Renée of France for his son and evinced an intention to withdraw from the contract. He was forestalled by Thomas (later Cardinal) Wolsey, who arranged, by the peace of 1514, the marriage of Mary with Louis XII of France. The marriage was celebrated at Abbeville on Oct. 9. The bridegroom was a broken man of 52; the bride a beautiful, well-educated and charming girl of 18, who was already in love with Charles Brandon, duke of Suffolk. Mary was crowned queen of France on Nov. 5, 1514; on Jan. 1, 1515, King Louis died. Mary had only been induced to consent to the marriage with Louis by the promise that, on his death, she should be allowed to marry the man of her choice. But the dukes of Lorraine and Savoy were mentioned as possible suitors, and meanwhile the new king, Francis I, was making advances to her.

Suffolk himself was at the head of the embassy which came from England to congratulate the new king, and he used the opportunity to win the hand of the queen. Mary feared opposition, and, in spite of Suffolk's promise to the king to delay any action until after his return, she persuaded him to marry her secretly before he left Paris. Suffolk was ultimately pardoned through Wolsey's intercession, on payment of a heavy fine and the surrender of all the queen's jewels and plate. The marriage was openly solemnized at Greenwich on May 13, 1515. Mary died on June 24, 1533. By the duke of Suffolk she had three children: Henry, born on March 11, 1516, created earl of Lincoln (1525), who died young; Frances, born on July 16, 1517, the wife of Henry Grey, 3rd marquess of Dorset, and mother of Lady Jane Grey (*q.v.*); and Eleanor.

MARY (MARY STUART) (1542–1587), only surviving child of James V of Scotland and his second wife, Mary of Lorraine, was born at Linlithgow palace on Dec. 7 or 8, 1542. Her father died on Dec. 14 and Mary therefore inherited the crown of Scotland when she was only a week old. Five and a half years later her mother sent her to be brought up in France; she set sail in Aug. 1548, accompanied by four little girls, the "Maries"—Mary Beaton, Mary Fleming, Mary Livingstone and Mary Seton. For the next ten years she lived at the gay and elegant French court, where she was betrothed to the dauphin and was the protegée of her mother's brothers, the all-powerful family of Guise. Her intelligence was great, her charm and natural grace extraordinary, and her education made her subtle and sophisticated.

On April 24, 1558, she was married to the sickly young dauphin, (who became King Francis II in July 1559), but queen consort of France and queen regnant of Scotland were not the only destinies Mary had in view. Catholics denied the validity of Henry VIII's marriage to Anne Boleyn; Elizabeth Tudor in their view was illegitimate, and the rightful queen of England, on the death of the childless Mary Tudor (Mary I), would, therefore, be Mary Stuart, the granddaughter of Henry VII's daughter Margaret, who had married James IV of Scotland. When Mary Tudor died (Nov. 1558), Mary Stuart and her husband assumed the royal arms of England, and eight months after the accession of Elizabeth I, the English ambassador at Paris heard the heralds cry at Mary Stuart's approach: "Make way for the queen of England." Mary was queen of France for less than 18 months. On her young husband's death in Dec. 1560, she saw no future for herself with her inimical mother-in-law Catherine de Médicis acting as regent for the child Charles IX, and her Guise uncles in eclipse. She therefore accepted the invitation of her nobility to return to Scotland.

Personal Rule in Scotland.—Her mother, the queen regent, had died in June 1560, after being defeated in the struggle between the Catholic, pro-French faction and the Protestant-nationalist faction. The latter had been aided by Elizabeth I, who feared that the French stronghold in Scotland would be used as a base for the French invasion of England. The civil war had been concluded by the treaty of Edinburgh (July 1560), one of the clauses of which acknowledged Elizabeth as rightful queen of England. Mary made excuses not to sign this treaty; Elizabeth, therefore, refused her a passage through England, and Mary performed the journey by sea, arriving at Leith on Aug. 19, 1561, in a dark sea

fog. The contrast of the scene she had left with that to which she had come was almost overwhelming, but her courage rose at the challenge, and her youth, beauty and graciousness made at first a most favourable impression.

Of the dominant Protestant faction, the three outstanding figures were Mary's bastard half brother, Lord James Stuart whom she created earl of Moray; William Maitland of Lethington, the ablest man in Scotland; and the Calvinist preacher John Knox, whose ferocious rudeness to his queen, on account of her religion, Mary met with a remarkable blend of simplicity and dignity. Though a devout Catholic, Mary was not by temperament a religious persecutor and when she afterward (Oct. 1564) promised the pope to root out heresy in Scotland, it was to secure his help in her designs on England. At first she made no attempt to injure the Protestant religion, only demanding freedom to practise her own.

Mary was faced by unavoidable difficulties; power had shifted from the crown to the nobles, the heads of powerful clans, and the majority of the nation now abhorred Catholicism, but her first years of rule, in which she was guided by Moray, were marked by sense, good will and courage. But her obsession with the idea of becoming queen of England detracted from her chances of success as queen of Scotland. She spoke of that kingdom as her "small portion," with which she must needs be content till the greater one came her way, and she showed increasingly in her private conduct a contemptuous disregard for Scots prejudices. Worse still, by claiming the English throne, Mary obliged Elizabeth to regard her as an acutely dangerous enemy and therefore to take every opportunity of diminishing her power.

Mary's second marriage was a consideration of paramount importance. She was ready to take any Spanish or French husband who would invade England on her behalf. Elizabeth, knowing this, told her that any such match would be regarded by England as a declaration of war. Mary, though prepared to take the English crown by force whenever a chance should offer, was at present only asking to be officially recognized as Elizabeth's heiress presumptive. She was told that if she accepted Elizabeth's favourite, Lord Robert Dudley (afterward earl of Leicester), as a husband whose alliance would threaten no danger to England, this status might be accorded her. Mary pretended to consider this proposal, in order to mask her real intention. She had determined to marry her cousin Henry Stewart, Lord Darnley (*q.v.*), who, descended from Margaret Tudor by a second marriage, had in Catholic eyes a claim to the English crown second only to Mary's own. Darnley's father, the earl of Lennox, who had been in England since 1544, was in Scotland on business connected with his Scottish estates and got leave from Elizabeth for his son to join him. Mary, it is safe to say, would have married Darnley whatever he had been like; actually, his great height and athletic grace and the good manners he knew how to assume, charmed her into a brief personal liking for him. The match was approved by the king of Spain, who wanted the stronghold of Protestantism in England destroyed because its example menaced his government in the Netherland provinces. He promised (1565) that if Mary and Darnley would wait for a time convenient to him, he would support their invasion of England.

The prospect of a Catholic marriage for their queen alarmed the Scots Protestants, and Moray, who knew that Elizabeth must regard Darnley's defection as treason, feared the collapse of the Anglo-Scottish alliance. He attempted to arouse the citizens of Edinburgh against Mary's authority, but failed. Mary, who had married Darnley on July 29, 1565, probably at Holyrood, called to her side James Hepburn, earl of Bothwell (*q.v.*), an able soldier who had been a loyal servant of her mother. With a force which she led in person, she drove Moray and his supporters over the Border (in an action known as the "chase-about-raid"), proclaiming them outlawed, and their estates forfeit. The exiles took refuge in England, and Elizabeth, who had secretly encouraged Moray, reproached him in a public interview for taking arms against his sovereign.

Mary, exhilarated by her success, had declared publicly that she would lead her army to the walls of London. In a secret interview with the spy Christopher Rokeby, she told him that she was confident that the English Catholics would rise to support her. She meant with Spanish and papal help to create a disturbance in Ireland; then she would enter England at the head of her army and proclaim herself queen. She asked him meantime for a list of the English Catholics upon whom she could rely. Mary never understood how strongly Elizabeth's government was supported by England as a whole, and that the majority, even of the Catholics, did not want to see Mary on the throne at the expense of foreign invasion and civil war.

To her great misfortune, Darnley turned out to be a thoroughly bad bargain; stupid, arrogant and vicious, he soon forfeited even the tolerance of his wife. Mary showed her usual disregard of Scots feelings by the unwise familiarity with which she treated her Italian secretary David Rizzio, a lowborn man whom she allowed, because he was congenial to herself, to behave with insane presumption toward the haughty and vindictive Scots nobles. The nobles not only detested Rizzio for his conduct but also feared and loathed him because he managed Mary's correspondence with the pope. Darnley, treated with neglect and coldness by his wife, became jealous of Rizzio, and fell a prey to a conspiracy headed by his kinsman Lord Ruthven. The confederates made a pact with him that the exiled lords should be recalled and their estates restored to them. Rizzio should be put to death, the queen imprisoned and Darnley given the crown matrimonial. Darnley on his part signed an undertaking to protect the conspirators from the consequences of their deed, as the murder was done at his behest. His father Lennox went down to England to get the exiled lords to approve of the plan, thus joining them with the conspiracy.

The famous scene of Rizzio's murder, in Holyrood palace, when he was dragged shrieking from the queen's presence and dispatched with 56 stab wounds, took place on the night of March 9, 1566. Mary, who was six months' pregnant, behaved with brilliant courage and resource. Seducing her craven husband to her side again, she escaped with him out of the conspirators' hands and they fled to Dunbar. There Bothwell brought troops to her aid and she returned to Edinburgh surrounded by 2,000 soldiers.

Darnley denied all responsibility for Rizzio's murder, which so much enraged the exiles that they showed the queen the "band" (agreement) he had signed. Henceforward Mary regarded him with virulent contempt and loathing. A temporary reconciliation at the birth of her son James in June 1566 soon broke down. Shunned, humiliated and demoralized, the wretched young man threatened to leave Scotland, which would have caused an embarrassing scandal. Mary's pardon granted to the exiled lords and their return to Edinburgh filled him with apprehension, but what made his situation desperately dangerous was that Mary now succumbed to an infatuation for Bothwell. How soon or by what evidence this showed itself is disputed, and the authenticity of some, at least, of the Casket Letters (*q.v.*) has been denied. These were a collection of verses and letters apparently written by Mary Stuart to Bothwell, and kept by him in a silver box. If "Letter II" be genuine, it proves Mary's passion for Bothwell and that she was in league with him to have Darnley murdered. The reason for believing her to be implicated in this design does not, however, rest on the authenticity of the Casket Letters, but on the presumptive evidence of her conduct.

In Nov. or Dec. 1566 she held a council at Craigmillar castle, near Edinburgh, in which she discussed with her nobles, including Maitland and Bothwell, the possibility of freeing herself from her odious husband. Maitland told her to leave it to them; they would find a means. In Jan. 1567 Mary visited Darnley who had developed an illness described as smallpox and was in the care of his father at Glasgow. Reconciling herself to him by a display of affection, she brought him back to Edinburgh, not to Holyrood lest he should infect their child, but to a half ruined house in the city wall (on the site of the present university buildings) named Kirk o'Field. There he was lodged on the upper floor while the queen slept in the room below. On the night of Feb. 9, Mary appeared suddenly to remember that she had promised to attend a wedding festivity at Holyrood. She departed by torchlight, sending back a page to bring away a rich coverlet from her bed.

Between 2 and 3 A.M. a terrific explosion laid Kirk o'Field in ruins. Darnley and his page, it was concluded, had received the alarm and tried to escape. Their bodies were found strangled in the garden.

On the evidence of his comings and goings, public opinion immediately credited Bothwell with the deed, and placards denouncing him as the murderer were put up in the market place. Lennox demanded an immediate investigation. Mary temporized, but the outcry against Bothwell was so fierce that it was conceded he should stand his trial, not, however, in a prosecution by the crown but merely in a private action at the hands of Lennox. The latter was given no time to collect his witnesses, and when told that he must not bring with him more than 6 retainers, while 4,000 of Bothwell's men invested the streets of Edinburgh, he decided in self-protection not to attend the trial in person. Bothwell rode to the courthouse on Darnley's favourite charger, and the farcical trial at which no witnesses were called ended in a verdict of not guilty. Subsequently Bothwell, at a supper at Ainsley's tavern, told more than 20 nobles that the queen had consented to marry him, and produced a document asking her to reward his services with her hand, to which he demanded their signatures.

The period of royal mourning was a long one, so the queen and Bothwell devised a scheme to make their immediate marriage seem desirable. With her connivance, he waylaid her cavalcade as she traveled from Stirling to Edinburgh on April 24, 1567, and carried her off to Dunbar, of which she had made him castellan. On May 3 Bothwell's wife was given a divorce for his infidelities. On May 6 the queen and Bothwell returned to Edinburgh, where Mary announced that though Bothwell had handled her "roughly," she was convinced of his loyalty and good meaning toward her, and that she intended to grant the request of her nobles by marrying him. The minister of St. Giles' church published the banns only when Bothwell threatened to hang him for his refusal, and the wedding was celebrated with Protestant rites at Holyrood palace on May 15, 1566, three months and a week after Darnley's murder.

Every mistake that Mary had so far made, she might have lived down. Many of the lords were as deeply concerned in Darnley's murder as herself and had she been content merely to be rid of him and had she then resigned herself to the guidance of Moray, she might have had a second chance, but the Protestant lords would not endure to have Bothwell set over them. The risings against the Queen began less than a month after the marriage. On June 15, 1567, her forces were drawn up against those of the rebels on Carberry hill (Midlothian), but her men would not fight. On condition that Bothwell should be allowed to go free, she gave herself up to the lords, expecting them to return to their allegiance. The insults of the soldiers and of the mob in the Edinburgh streets shouting "Burn the whore," drove her to a frenzy of anger. Finding that she was attempting to communicate with Bothwell, the lords moved her to the island fortress of Lochleven, where it has been said that she miscarried of a child or twins by Bothwell. The casket of letters fell into the hands of the lords on June 20, when it was captured from a servant whom Bothwell had sent to bring it from Edinburgh to Dunbar. After examining the contents, three lords went to Lochleven, where they offered Mary the choice between abdication or standing trial for murder. She signed a deed of abdication which she afterward repudiated, and her one-year-old son became King James VI of Scotland, with Moray as his regent. Just over nine months later she escaped from Lochleven and joined the marquess of Hamilton and his brother Claude (later Baron Paisley), who like the Lennoxes were descended from King James II and who were prepared to reinstate her that they might rule through her. Their forces were routed by Moray's at Langside, near Glasgow, on May 13, 1568, and Mary with a handful of followers fled through three days and nights to the shore of Solway. On May 16 she crossed the inlet and landed at Workington in Cumberland. Two days later she moved to Carlisle.

Captivity in England.—Mary's choice of England as a refuge rather than France was easily understood. The French court could not help her, for it was engaged in a religious civil war; and its attitude toward her had been shown when it sent no embassy of condolence on Darnley's death. Elizabeth had offered help when the rebellion began, and Mary meant now to claim it. She believed Elizabeth would not dare to withhold it from a fellow monarch against rebels, and she was further supported by her conviction that the English Catholics would acclaim her as their queen.

The situation in which Mary was a potential storm centre in her realm, and in which Mary and Moray were both appealing to her for help, was of the utmost complexity and danger for Elizabeth. While Mary was detained (July 13, 1568–Feb. 26, 1569) at Bolton castle in Yorkshire, Elizabeth set up an inquiry which was opened at York (Oct. 4, 1568) and afterward moved (Nov. 25) to Westminster, in the course of which Moray ultimately produced all the evidence against Mary's misgovernment and unofficially showed the commissioners the Casket Letters. Mary through her representatives declared that it was beneath her to make any defense. Her opponents were rebels, on trial for treason; it was for them to defend their conduct. This attitude she maintained for the rest of her life. When Mary had been publicly discredited by the production of Moray's evidence, Elizabeth closed the proceedings, saying Mary had not been proved guilty of complicity in the murder, and Moray had not been proved guilty of treason. The latter returned to govern Scotland. Mary was kept in England, ostensibly because Elizabeth had recognized Moray's regency; and his government (as it stated at the council of Perth in 1569) refused to have Mary back in Scotland even to live as a private person. Actually, considering what Sir William Cecil (afterward Baron Burghley) called "her appetite to the crown," Mary was too dangerous to let go. She was transferred to the keeping of the earl of Shrewsbury and was moved in Jan. 1569 to his castle at Tutbury in Staffordshire. For almost all the remainder of her life she lived in his various houses and castles, with a household of 30 of her own servants, her French dowry at her own disposal, and treated with the ceremony due to a queen. In Aug. 1584 Sir Ralph Sadler succeeded Shrewsbury as Mary's custodian, but was himself replaced by the cold and unbending Sir Amyas Paulet in Aug. 1585.

Apart from the mere want of liberty, her conditions were easy, but her insatiable ambition and lust for vengeance made them almost intolerable. She now embarked on 19 years of plotting to secure her freedom and to attain Elizabeth's throne. Of the three major plots in which her complicity was proved, each was based on the assassination of Elizabeth and the bringing over of a Spanish army from the Netherlands. The first of these began with the rising of the earls of Northumberland and Westmorland in 1569, whose aim was merely to marry Mary to the duke of Norfolk and restore the Catholic religion. The rebels marched toward Tutbury and Mary was removed (Nov. 25) to Coventry. When this rising had been put down, Norfolk was discovered in the much more serious plot of Roberto Ridolfi (*q.v.*), who was trying to gain Spanish help in a scheme which was to begin with the murder of Elizabeth. Mary, who was moved in May 1570 to Chatsworth (Derbyshire) and in Nov. 1570 to Sheffield castle, was kept *au courant* with all the details and wrote to the Spanish ambassador in London: "Tell your master that if he will help me I shall be queen of England in three months." The discovery of the plot led to the execution of Norfolk (1572) and only Elizabeth stood between Mary and the demand of the houses of parliament that she should be put to death. The second large-scale conspiracy based on the murder of Elizabeth and an invasion known as "the Enterprise" was engineered by the duke of Guise, and was discovered in 1583 (*see* THROCKMORTON, FRANCIS). The third one came to light when Sir Francis Walsingham, who managed Elizabeth's secret service, devised a method of tapping Mary's correspondence and thus learned of plans for another invasion. Mary, who had returned to Tutbury early in 1585, was moved to Chartley castle, Staffordshire, in Jan. 1586. While she was there, Walsingham discovered that Mary was in communication with Anthony Babington (*q.v.*), the English agent of a conspiracy with the usual features, and that Babington had told Mary that Elizabeth's assassination was to be undertaken. When a reply from Mary of a compromising nature was in his hands, Walsingham accused her of conspiring to compass the death of the English queen.

She was brought to trial in the great hall of Fotheringhay castle (where she had been moved on Sept. 25) on Oct. 14–15, 1586. By modern standards the trial was unfair to the accused, and the courage and virtuosity with which Mary defended herself can but arouse sympathy and admiration; but evidence was brought against her which her mere denials did not outweigh. A verdict of guilty was returned, but it was more than three months before Elizabeth could be induced to sign the death warrant.

The execution was carried out in the great hall at Fotheringhay on the morning of Feb. 8, 1587. The memory of Mary's superb demeanour in the last hour of her life; her debonair courage; the graciousness with which she gave the headsman the pardon he knelt to ask; the memory of the tragic eclipse of her early brightness, and of the long endurance of her captivity, in the end effaced the significance of her actions and made her the heroine of a melancholy and thrilling romance. The interest of her story has never waned; it has those elements that are always found romantic. The fact that she ruined herself by uncontrolled sexual passion has brought her a host of sympathizers, as also has her unfailing energy and courage in the face of misfortune. The unwaning appeal of her story is perhaps explained by the combination of that story, full of bold action and secret motive, with the fact that though she lost the great stake for which she played, she never lost her courage and determination, and above all by her extraordinary personal charm, which survives death and time.

See also references under "Mary (Mary Stuart)" in the Index.

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MARY OF THE INCARNATION (BARBE JEANNE AVRILLOT, MME ACARIE) (1566–1618), French mystic who was also unusually active and influential in religious affairs and who inspired, if she did not direct, nearly all the French religious leaders of her day, was born in Paris on Feb. 26, 1566, the daughter of a wealthy bourgeois family. She early showed signs of exceptional piety and wanted to enter a convent, but in obedience to her parents she married Pierre Acarie, vicomte de Villemore in 1582 and became a model wife and mother of six children. Mme Acarie, who wrote nothing and died in her early 50s, was instrumental in introducing into France the Discalced Carmelites founded by St. Teresa of Ávila; she worked for the expansion of the Ursulines; she encouraged Pierre de Bérulle in founding the Oratory; and the reform of the Benedictine convents in France owed much to her. After the death of her husband (1613), Mme Acarie was received as a lay sister in the Carmel at Amiens and was professed in 1615 as Mary of the Incarnation. She transferred in 1616 to Pontoise to reform the finances of that convent, where she died on April 18, 1618. She was beatified in 1791 (feast day April 18).

Blessed Mary of the Incarnation was an ecstatic visionary in whom her contemporaries found a perfect type of that sublime life to which many souls of the time felt themselves called. Her message was based on the statement of the Gospel "The kingdom of God is within you," interpreted in a mystical sense.

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MARY OF LORRAINE (MARY OF GUISE) (1515–1560), was regent of Scotland for her daughter, Mary Stuart, during the critical early years of the Scottish Reformation, and was born at Bar-le-Duc in Lorraine on Nov. 22, 1515, the eldest child of Claude, duc de Guise. By her first marriage, to Louis d'Orléans, 2nd duc de Longueville on Aug. 4, 1534, she had one son, François, 3rd duc de Longueville. Widowed in 1537, she was sought in marriage by Henry VIII of England and James V of Scotland. The latter married her by proxy in France and in a second ceremony at St. Andrews, soon after her arrival in Scotland in June 1538. Their infant sons, James and Arthur, both died in 1541 and the king himself died on Dec. 14, 1542, a few days after the birth of their daughter, Mary (*q.v.*) Stuart. Though the earls of Bothwell and Lennox both aspired to be her third husband, Mary's chief ambition was to oust the heir presumptive, James, 2nd earl of Arran (*see* ARRAN, EARLS OF), from the regency. The question of her daughter's marriage also complicated Scottish politics. A council, of which Mary of Lorraine was the principal member, was appointed to direct the regent in Sept. 1543, but her attempt to supersede Arran in 1544 was unsuccessful. Nevertheless, the death of Cardinal David Beaton on May 29, 1546, left her as the leading figure in Scotland.

The conclusion of peace with England in 1550 enabled Mary of Lorraine to visit her children in France, where Mary Stuart had been sent in 1548, and on her return journey she also visited Edward VI of England. In a further unsuccessful attempt to induce Arran to resign the regency, she persuaded the French king to confirm the duchy of Châtelhérault (Châtellerault) to him, but Arran insisted on his right to retain office until the queen completed her 12th year. However, he resigned in a parliament held in Edinburgh on April 12, 1554, and Mary of Lorraine took his place. At first her rule was successful and beneficial, despite resentment at the introduction of Frenchmen into the high offices of state. She had to withdraw a proposal for a standing army and the Scottish nobles refused to invade England in 1557. To offset Arran's power, she had to rely on the anticlerical lords and show favour to the Protestant preachers with whose support she arranged her daughter's marriage in 1558 to the dauphin (later Francis II of France). Apparently under pressure from France, the regent abandoned her policy of toleration and attempted the suppression of Protestantism in Scotland. Legal proceedings against a number of preachers in 1559 led to an uprising at Perth, in which the mob sacked churches and religious houses. Civil war was averted temporarily by an agreement, which the lords of the congregation then asserted the regent to have broken, by garrisoning Perth with Scottish troops in French pay. Reassembling their forces they drove Mary from Edinburgh and on Oct. 21, 1559, issued a proclamation that she had been deposed. Although hampered by the defection of Châtelhérault, his son, James, 3rd earl of Arran, and her secretary, William Maitland of Lethington, Mary and the French defended Leith and recaptured Edinburgh. An English army helped the Protestants by laying siege to Leith in April 1560. The ailing regent took refuge in Edinburgh castle and on her deathbed summoned the nobles of both parties, urging them to dismiss the armies of France and England and to return to their allegiance to her daughter. She died on June 11, 1560, and in March 1561 her body was taken to France for interment in the abbey of St. Pierre at Reims.

The historian, John Leslie, described Mary of Lorraine as "a noble, wise and honourable princess and chaste lady, ever well and virtuously employed," a character more credible than John Knox's malicious slanders against her. Although mindful of French and family interests, she was equally solicitous for the welfare of Scotland. It was her misfortune, rather than her fault, that her regency ended in civil war and foreign invasion.

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MARY OF MODENA (MARIE BEATRICE D'ESTE) (1658–1718), queen consort of James II, king of Great Britain, and daughter of Alfonso IV, duke of Modena, and the duchess Laura, of the Roman family Martinozzi, was born at Modena on Oct. 5 (new style; Sept. 25, old style), 1658. She was married by proxy to James, then duke of York, on Sept. 30 (N.S., 20 O.S.), 1673, and reached England in November. By the public she was regarded as an agent of the French and papal interests, but her influence on her husband's political or religious thinking appears to have been negligible. At court she was popular enough, and on terms of intimate friendship with her elder stepdaughter, the future Mary II. But between 1675 and 1682 she bore five children, none of whom survived, and when her second son, James Francis Edward, was born on June 10 (O.S.), 1688, it was widely rumoured that the child was not really hers but had been imposed on the nation to insure a Catholic succession. This was ostensibly the principal reason for William of Orange's coming to England that autumn. At the outbreak of the revolution, Mary made the mistake of consenting to escape to France with her son (Dec. 20, 1688). She urged James to follow when it was to his manifest interest to stay in England, and when he went to Ireland in 1689 she pressed for his return. Another child, Louisa Maria, was born to her at St. Germain on June 28, 1692. Her influence over her husband increased markedly in their exile. She survived him by 17 years, at St. Germain and at Chaillot, in a house of the Visitation, where she died on May 7, 1718. (J. P. K.)

MARY OF TECK (1867–1953), queen consort of George V of Great Britain, was born at Kensington palace in London on May 26, 1867. She was the eldest child of Francis, prince (later duke) of Teck, of the royal house of Württemberg, and of Princess Mary of Great Britain, a granddaughter of George III. After spending her early years in London, she lived in Florence from the age of 16 to 18 and there acquired a taste for the arts which was to distinguish her throughout life. In 1891 she became engaged to the elder son of the prince of Wales, the duke of Clarence, who died a few weeks before the marriage was to have taken place. A year later her engagement was announced to the duke's younger brother, afterward George V. They were married on July 6, 1893. As duchess of York (during Queen Victoria's reign) and princess of Wales (during Edward VII's reign) she was active with her husband in a variety of public duties, including a journey to Australia in 1901, for the opening of the federal parliament, and a long tour in India during 1905.

With the accession of King George in 1910 she became queen, and brought to her high position gifts of taste and intellect that quickly made their mark on court life. Her bearing showed how accurate Queen Victoria had been when she wrote that May (the name by which Queen Mary was known in the family circle) was so sensible and *distinguée*. Her good taste showed itself in the mastery of the royal collections and her concern that they should be displayed to the best advantage. In the 1920s she encouraged the publication of an account of the inside of Buckingham palace. During World War I the queen was especially concerned with the welfare of servicemen and with nursing and after the war appeared increasingly in public, particularly after the decline of the king's health in 1928. His gratitude to her was expressed in his speech in Westminster during his silver jubilee in 1935, and the king asked that that passage be placed last in the speech because he was afraid that he might be overcome "when I think of all that I owe her."

In widowhood the queen moved to Marlborough house. To her eldest son, King Edward VIII, she was singularly devoted, and his abdication was a severe test of her courage. During World War II she retired to Badminton, the home of her niece, the duchess of Beaufort. She became a familiar figure in the west country, visiting bombed towns and service centres and delighting in giving lifts to soldiers and airmen in her car. In 1945 she resumed her life in London. Her health began to fail after the shock of the death of King George VI in 1952 and although she attended his lying in state in Westminster hall she was thereafter seldom seen in public. She died at Marlborough house on March 24, 1953.

Although Queen Mary in her dress and manner retained something of the habit of the Victorians—she never made a speech in public and never spoke on the telephone—her spirit moved with the times, and this helps to explain her popularity with all classes. Queen Mary had five sons—King George VI, the duke of Kent and Prince John, who predeceased her, and the dukes of Windsor and Gloucester, who survived her—and one daughter, the princess royal.

See J. Pope Hennessy, *Mary, Consort of George V* (1960).
(R. T. B. F.)

MARY (1457–1482), duchess of Burgundy from 1477, whose marriage has been called the most important in history, was born in Brussels on Feb. 13, 1457, the daughter of Charles the Bold (*q.v.*), later duke of Burgundy, and his wife Isabelle de Bourbon. Many princes were willing to marry her for the Burgundian succession; and in 1476 it was finally agreed that she should marry the archduke Maximilian, heir to the Habsburgs of Austria (*see* MAXIMILIAN I, Holy Roman emperor). Charles, however, was killed at Nancy on Jan. 5, 1477, whereupon Louis XI of France sent his armies into the duchy of Burgundy, Franche-Comté, Picardy and Artois. Mary summoned the estates-general of her dominions to Ghent, but had to grant them the *Grand Privilège* of Feb. 11, 1477, whereby her predecessors' work of centralization was undone; and on April 3, two of her ministers, Guillaume Hugonet and Guy d'Humbercourt, were executed. Louis XI meanwhile was demanding the marriage of Mary to his son, the future Charles VIII of France; but Maximilian sent his proxy to marry Mary at Bruges on April 21 and married her in person at Ghent on Aug. 18. Through this marriage Franche-Comté, Artois and the Netherlands eventually passed to the Habsburgs; and the elder son of it, Philip the Fair (1478–1506), was later married to Joan, heiress to Castile and Aragon, so that Spain also came to the dynasty. Mary died in Bruges on March 27, 1482, after a fall from her horse. *See* HABSBURG; NETHERLANDS, THE: *History*.

See L. Hommel, *Marie de Bourgogne, ou le Grand Héritage* (1951).

MARY, a town in the Turkmen Soviet Socialist Republic of the U.S.S.R., situated on the delta of the Murgab river and at the junction of the Tashkent-Krasnovodsk railway with the branch line to Kushka. Pop. (1959) 48,125. The town of "New" Merv was founded in 1884, 18½ mi. W. of the site of the ancient city of Merv (*q.v.*) as the Russian military and administrative headquarters of the Merv district (*uyezd*). It developed as an important cotton-ginning centre with cotton-spinning factories and light industries (fish smoking, dairy produce, leather goods). There is a women's teacher-training college, a medical institute and a theatre. It was renamed Mary in 1937. (G. E. WR.)

MARYBOROUGH, an industrial city of Queensland, Austr., situated on the Mary river 190 mi. N. of Brisbane by road and 167 mi. by rail; the altitude is 27 ft. Pop. (1961) 19,126. It is the administrative centre of the Wide Bay-Burnett district, which has a population of approximately 100,000. The construction of heavy machinery, shipbuilding and sawmilling are major industries. The dairy and sugar industries also are important. There is a modern airport with daily services north and south. Maryborough is the outlet of the Burrum coal fields and Gympie and Kilkivan districts; the deep-sea port is on the coast 20 mi. downstream at Urangan.
(R. W. LU.)

"MARY CELESTE," a 282-ton U.S. brig that sailed from New York city on Nov. 5, 1868, and was later found mysteriously abandoned. Aboard the vessel when it sailed from New York were Capt. B. S. Briggs, his wife and daughter, and a crew of seven. "We enjoy our melodeon and have some good songs," wrote the captain before leaving. This was the last ever heard from any of those on board. A month later the "Mary Celeste" was sighted off the Azores by a British craft. Receiving no response to her signals, the British vessel sent a boarding party to investigate. It found the "Mary Celeste" deserted but in excellent shape except for weather damage. The log was on the mate's desk, the pantry was intact and the melodeon was unharmed. Why the ship was abandoned has never been satisfactorily explained. One theory is based on the fact that the ship had a cargo of alcohol. Perhaps Captain Briggs opened a hatch that had been closed for several days and was blasted by outrushing gases. Frightened into a panic, every-

one crowded into the lifeboat, with a line to the "Mary Celeste." Their boat capsized, drowning all. This theory is supported by the fact that the lifeboat was missing and a fragment of line dangled from the stern of the "Mary Celeste." (F. O. Br.)

MARY IMMACULATE, OBLATES OF (Congregatio Missionariorum Oblatorum B.M.V. Immaculatae; O.M.I.), one of the largest missionary congregations of the Roman Catholic Church, was inaugurated at Aix-en-Provence, France, on Jan. 25, 1816, as the Missionary Society of Provence by Charles Joseph Eugène de Mazenod (1782–1861), later bishop of Marseilles. By preaching to the poor, Mazenod wished to counteract the irreligion resulting from the French Revolution. On Feb. 17, 1826, Pope Leo XII approved the society as a religious congregation. Its members (numbering over 7,500) bind themselves to common life by the simple vows of poverty, chastity, obedience and perseverance. A superior general in Rome directs activities on every continent. Where the church has been long established, the task of this congregation is to strengthen the faith, especially by preaching parish missions and retreats, teaching and directing national shrines. Pioneering missionary efforts in Africa, South America, the orient and the arctic have been among its most important works.

(G. F. McL.)

MARYLAND, one of the 13 original states of the United States, extends along both sides of Chesapeake bay on the Atlantic coast. It is bounded on the north by Pennsylvania; on the east by Delaware, the Atlantic ocean and a small section of Virginia; on the south and west by the District of Columbia and the Potomac river; and on its extreme west by West Virginia. In area it ranks 42nd among the states, having a total area of 10,577 sq.mi., of which 9,874 sq.mi. are land, 703 inland water excluding 1,726 sq.mi. of the Chesapeake bay. In population it ranks 21st among the states, with 3,100,689 inhabitants in 1960. Since 1694 Maryland's capital city has been Annapolis, which is also the seat of the U.S. Naval academy and St. John's college. Baltimore, a thriving port on Chesapeake bay, is the state's largest city.

Maryland was named in honour of Queen Henrietta Maria, wife of Charles I of England, who granted the territory to Lord Baltimore (Cecil Calvert) on June 20, 1632. It is popularly known as the "Old Line state" because of the distinguished service of Maryland's regular "troops of the line" during the American Revolution. The state flower is the black-eyed Susan, the state bird the Baltimore oriole, and the state tree the white oak. The state flag is a colourful one, bearing the arms of both the Calvert family and the Crosland family, to which the mother of the first Lord Baltimore belonged.

"Maryland, My Maryland" is one of the best known of all state songs. The words, written in 1861 by James Ryder Randall, a Marylander living in the south, are sung to the German tune "O, Tannenbaum." The national anthem was written in Maryland by another Marylander, Francis Scott Key (*q.v.*), while Fort McHenry was under attack during the War of 1812.

PHYSICAL GEOGRAPHY

Physical Features.—Maryland, which lies between approximately 37° 53′ and 39° 43′ N. and approximately 75° 4′ and 79° 29′ W., possesses a great diversity of surface features. It is crossed from north to south by each of the leading topographical regions of the eastern portion of the United States—the coastal plain, the piedmont plateau and the Appalachian system. The part within the coastal plain includes nearly all of the southeastern half of the state and is commonly known as tidewater Maryland. It is marked off from the piedmont plateau by the fall line, a zone in which a descent of about 100 ft. or more occurs in many places within a few miles, creating waterfalls and rapids in the streams. The fall line extends northeast from Washington, D.C., through Baltimore to the northeast corner of the state. Chesapeake bay divides the coastal plain into two main sections: all of Maryland east of the bay and south of the Elk river is known as the eastern shore; the western shore or "Maryland main" extends westward from the bay to the fall line.

The eastern shore is a low, level plain, rising northward to a height of only about 100 ft. above sea level. Along its Atlantic coast extends the narrow sandy Sinepuxent beach, formerly enclosing the Sinepuxent bay on the north and Chincoteague bay on the south. A storm in the 1930s cut an opening into Sinepuxent bay at Ocean City, making available a fine harbour for fishing fleets and other boats at the seaside resort. The eastern shore is drained by the Northeast, Elk, Sassafras, Chester, Miles, Tred Avon, Choptank, Nanticoke, Wicomico, and Pocomoke rivers. It is connected with the western shore by the Chesapeake bay bridge.

The western shore is somewhat more undulating and higher than the eastern shore, sloping generally from northwest to southeast. Along the western border are points 300 ft. or more above sea level. The Patuxent and Potomac are the principal rivers crossing this section, but the Severn, Magothy, Patapsco, Gunpowder and Bush rivers also drain it.

The piedmont plateau or foothill region extends west from the fall line to the crest of the Blue Ridge mountains. In general, it has a broad rolling surface and rises gradually to heights of over 1,000 ft. Its principal streams wind their way toward the southeast in narrow steep-sided gorges and broad limestone valleys.

Appalachian Maryland lies in the area extending from the crest of the Blue Ridge mountains to the western boundary of the state. It includes most of Washington and Allegany counties. To the eastward it abounds in mountains and valleys but is a rolling plateau in the extreme western portion. Antietam creek to the east and Conococheague creek to the west flow through its eastern portion in trenches that in places exceed 75 ft. in depth.

The Appalachian ridges of the western portion begin with North mountain on the east and end with Wills mountain on the west. Overlooking these ridges are the higher ranges of the Alleghenies among which the Savage, Backbone and Negro mountains reach elevations of 3,000 ft. or more. The highest peak in the state is Backbone mountain (3,360 ft.) in Garrett county. Located in the extreme western part of the state, these mountains merge into the rolling Appalachian plateau. The mean elevation of the state is 350 ft. All rivers of western Maryland flow south into the Potomac except the waters of the Youghiogheny and its tributaries in the extreme west, which flow into the Monongahela.

Chesapeake bay is 193 mi. long, with 115 mi. in Maryland and 70 mi. in Virginia. It is from 2.6 to 25 mi. wide and is navigable for ocean-going ships. It has two outlets to the Atlantic ocean, one through the Chesapeake and Delaware canal built at the northern end of the bay in 1829, and the other through the mouth of the bay between the Virginia capes.

Climate.—The Atlantic ocean, Chesapeake bay and Appalachian mountains greatly influence the climate of Maryland. Prevailing winds are westerly—generally northwesterly in winter in the western section and southwesterly in summer in the southern area. In the south the winter is usually mild and the summer rather hot; in the west the winter is usually cold, the summer cool. The normal average annual temperature for the entire state is between 53° and 54° F. (about 12° C.). The average precipitation is about 43 in. (1,100 mm.).

Soil.—Maryland has a great variety of soils that provide rich farmland in most of the coastal and piedmont regions. The upper eastern shore has a light marly loam while the lower area has a stiff soil with light-coloured clay. In southern and central Maryland, sandy and tidal marsh loam prevails. Along the lower edge of the fall line is a belt so heavy with clay that it is of little agricultural value. Soils of the eastern piedmont plateau are variable but most are heavier with clay than those of the coastal plain and better for general agriculture. Limestone and sandstone provide the soil in the western piedmont area. Much of the far western part of the state is too rugged for agriculture.

Vegetation.—The state's 2,900,000 ac. of forested areas are mostly farm woodland or other private holdings. They comprise about 46% of the land surface, but contain virtually no virgin timber. The state administers 12 state forests with a total area of approximately 120,000 ac. There are about 150 species of trees in the state, including black and white oak, beech, poplar, locust, hickory, ash, gum, elm, spruce, hemlock and dogwood. The most numerous types are pine and oak; chestnut and walnut have

become rare. Blackberry and raspberry bushes are common in some areas. Wild flowers include roses, goldenrod, honeysuckle, trailing arbutus, mountain laurel, azalea and violets.

Animal Life.—Occasional bobcats and bears are the state's most imposing animals in the mountainous areas, while deer, foxes, opossums, raccoons, squirrels, chipmunks and rabbits may be found elsewhere in the state. The copperhead and the timber rattler are the only poisonous snakes. The Japanese beetle and the 17-year locust are among the most destructive insects.

Wild ducks and geese of many kinds abound in the Chesapeake bay area in season. The Chesapeake bay retriever, used for hunting water fowl, is native to the state. Game birds found in the inland regions include quail, partridge, wild turkey and ruffed grouse. Songbirds are plentiful, especially Baltimore orioles, thrushes, finches, warblers and whippoorwills. Hawks, bald eagles, herons and owls are fairly common.

The Chesapeake bay and coastal waters contain some 200 species of fish and large quantities of oysters and crabs. Both commercial and sports fishing are important.

Historic Sites, Parks and Forests.—Maryland has many attractions for persons interested in early U.S. history. Annapolis, the site of the oldest state capitol in continuous use, has more original colonial buildings standing than any other city in the United States. Here also are St. John's college, established as a secondary school in 1696; the United States Naval academy dating from 1854; and such splendid examples of colonial architecture as the Hammond-Harwood house and the Chase home.

Doughoregan Manor in Howard county and Homewood in Baltimore were built by Charles Carroll of Carrollton, a signer of the Declaration of Independence. The homes of Roger B. Taney, famed chief justice of the United States, and of Barbara Fritchie, a Union patriot, are in Frederick. Antietam National battlefield and National Cemetery in Washington county are dedicated to soldiers of that Civil War battle. Near Boonsboro stands the rough stone monument, now restored, erected on July 4, 1827, in honour of George Washington. The Washington monument in Baltimore was completed in 1829 in modified form. Fort McHenry and Mount Clare station, the first railroad passenger and freight station to be erected in the United States, are in Baltimore. (*See* BALTIMORE.)

The eastern shore abounds in historic sites. At Chestertown in Kent county is Washington college, Maryland's oldest. It was founded in 1782 by the Rev. Dr. William Smith. George Washington contributed financially and gave the use of his name. In Kent county also is St. Paul's church, dating to the late 17th century. At Easton in Talbot county is Third Haven meeting house, built by the Quakers in 1682–83 and said to be the oldest frame structure for worship in the United States. A replica of the original capitol of the colony has been built at St. Mary's City on the St. Mary's river about 6 mi. N. of Blakistone Island. Tours of these and other historic sites are conducted annually.

Maryland has more than 25 state parks, state forests and recreational areas, including ocean beaches, bay shore, dense forests and mountains. Their total area is nearly 150,000 ac. Among the better known state parks are Elk Neck, Fort Frederick, Gambrill, Patapsco, Sandy Point and Washington Monument. Camp David is located in the Catoctin Recreational Demonstration area, a federal project near Thurmont. Ocean City is a popular summer resort on the Atlantic coast.

HISTORY

Establishment and Early History.—The colony of Maryland owed its existence to George Calvert, first Lord Baltimore, who petitioned for a charter from Charles I of England in 1632. (*See* BALTIMORE, GEORGE CALVERT, 1st Baron.) A man of stature and high position, Calvert had been converted to Roman Catholicism and desired, among other things, to establish a haven for the Roman Catholics. Earlier, he had attempted without success to found a colony at Avalon, Newfoundland.

George Calvert died in 1632 before the charter was sealed. The king then made the grant to Calvert's oldest son, Cecil, second Lord Baltimore. The charter, which granted to Calvert the territory that lay between the Potomac river and the 40th parallel, also granted him broad powers and extensive rights such as were not conferred upon any other single proprietor. Nearly 200 colonists sailed from England in the "Ark" and the "Dove" in Nov. 1633, under the colony's first governor, Leonard Calvert, brother of the proprietor. They reached Maryland four months later, landing first at St. Clement's Island (now Blakistone Island) on March 25, 1634.

The colony was launched under favourable circumstances. For more than 60 years it centred around St. Mary's City. There was no great trouble with the Indians, no period of starvation or widespread disease and the climate was not severe. Maryland was well planned and profited from the experience of earlier colonies. Difficulties, however, arose with William Claiborne and other Virginians who regarded the Marylanders as trespassers upon soil originally granted to Virginia. Claiborne was interested in personal possession of Kent Island on the eastern shore where he had established a trading post and claimed also to have cultivated the soil. A phrase in the Maryland charter, *hactenus inculta*, permitted Lord Baltimore to settle only territory that had not hitherto been cultivated. A series of petty conflicts, invasions and naval battles ensued. Claiborne was eventually dispossessed of Kent Island in 1638 when ruled against in England, but he remained a thorn in Maryland's side for several decades. Richard Ingle, a vigorous partisan of parliament, also offered trouble and temporarily seized St. Mary's City in the mid-1640s.

Maryland's Act Concerning Religion, passed by the assembly in 1649 and usually called the Toleration act, was a pioneer statute and gave Maryland claim to being the first civil regime in America to recognize freedom of conscience. From the beginning Marylanders had a large measure of freedom of conscience and the proprietor had endeavoured to separate church and state in the colony. Although the Toleration act limited tolerance to Christians, the record is bare of any persecution of Jews. However, with Cromwell seated firmly in England, zealous Maryland Puritans swept away toleration in 1654 when Lord Baltimore was deprived of his government and Anglicans, Catholics, Jews and all dissenters were placed under disabilities as oppressive as any imposed in America.

The return of Charles II to the throne in 1660 and the reestablishment of Lord Baltimore's government inaugurated a period of surface tranquillity in Maryland that lasted for nearly 30 years. The proprietor's position was stronger despite the ordeal through which he had passed under the Commonwealth. The period 1660–89 witnessed the settlement of new areas along the Chesapeake bay and the principal rivers. Most of the great estates as well as the smaller plantations shipped their produce from their own wharves. All land was held feudally, each 100 ac. having a quitrent of four shillings imposed on it.

Despite surface quiet, a constitutional revolution was developing. It involved a conflict between the governor and his council on the one hand and the lower house representing the voters on the other. In essence, it was the proprietary party versus the popular party, the rights of the proprietor set against the rights of the people. Through his appointments, the proprietor was generally able to hold the upper hand. He had tactfully surrendered his claim to the sole right of initiating legislation in 1638. With opposition mounting, however, Gov. Charles Calvert foolishly sought to strengthen the government by disfranchising all freemen who possessed less than 50 ac. or a personal estate of less than £40 sterling. The right to vote was thus limited to freeholders and was taken away from freemen. The plan of representation in the assembly also became the subject of heated controversy. Resistance in Charles and Calvert counties plus Indian molestations harassed the proprietor. Further, he was accused of prejudice against Roman Catholics and of resistance to royal customs collectors.

While Lord Baltimore sought to defend himself in England, boundary disputes flared in Maryland. The first involved the Maryland-Virginia line across the Potomac river and the Chesapeake bay to the mouth of the Pocomoke river on the eastern shore. This line was not clarified until 1785 and revised in 1877.

The other dispute was the bitter and prolonged one between the Baltimores and Penns over the Maryland-Pennsylvania boundaries and the boundaries of Delaware, which had originally been a part of the Maryland grant. In 1682 England transferred it to the Duke of York and in 1685 it was denied to Lord Baltimore on the grounds that Christians had inhabited it before the Maryland grant was made. After decades of disagreement and litigation, the fifth Lord Baltimore (the second Charles Calvert) came to an agreement with the sons of William Penn. For reasons unknown, except possibly ignorance of the facts, he surrendered his claims to the three lower counties (Delaware). He also relinquished Maryland's northern boundary, specified in the charter as the 40th parallel, which ran north of Philadelphia, and agreed to a line 15 mi. S. of Philadelphia. When he realized his error, Lord Baltimore repudiated his agreement but after more years of bickering, it was held binding in 1750 by Lord Chancellor Hardwicke, who ruled that original boundaries were too uncertain to be relied upon. Frederick, the sixth Lord Baltimore, refused to accept the chancellor's decision until 1760. Finally, after surveys by Charles Mason and Jeremiah Dixon between 1763 and 1767, the line was fixed at the parallel 39° 43′ 19.9″. At one point the distance between this line and the Potomac river, the state's southern boundary, is less than two miles.

In England Lord Baltimore was charged with mismanaging the customs situation. To make matters worse, in Baltimore's absence, the acting governor had murdered the royal customs collector. This and other problems—insurgent uprisings, poverty, religious friction, the uncertainty of the tobacco trade and the bothersome use of tobacco as a medium of exchange—led to the overthrow of proprietary government in Maryland in 1692. A royal government was established which allowed the proprietor to retain only his land rights.

The end of the 17th century saw the capital moved from St. Mary's City to Annapolis near the mouth of the Severn river on the western shore in 1694 and an act passed which led to the establishment of King William's school in Annapolis, the third oldest of its kind in the colonies. Eleven counties had been established. The chief commerce was in tobacco and the landed gentry were strong. During the royal period the Anglican Church was established as the official church in Maryland, supported by the taxpayers. The period saw an increase in the powers of the lower house as the assertion of liberty was finding expression. The royal period ended in 1715 when the fourth Lord Baltimore, Benedict Leonard Calvert, who had renounced Roman Catholicism, had full proprietary rights restored to him.

Following the Restoration and until about 1765, Maryland was generally well governed. The colony was not drawn heavily into the French wars, experienced only sporadic warfare with Indians and was left alone by England to manage its own affairs. However, there was no end to disputes as Maryland's distinguished lawyers were opposing proprietary prerogatives and insisting upon the privileges and rights of a free people. Daniel Dulany led the fight for the extension of English statutes to the colony. The proprietor contended that only those statutes directly mentioning the dominions were in force there.

There were numerous points of difference and most of them were economic at base. The agricultural classes attacked the privileged classes—the lawyers, the clergy and officers of state—many of whom were also large landowners. Fees and salaries came in for special criticism. The limitations of the one-crop tobacco economy in Maryland were always pressing. The paper currency act of 1733 provided a second medium of exchange to supplement tobacco and also helped to diversify the Maryland economy and finance the colony's share of the French wars.

The American Revolution.—After gaining a victory over France in 1763, Great Britain tightened the reins upon the colonies. Debts to British merchants, the lack of a proper colonial currency and taxes on imports led Maryland citizens to action. When the Stamp act of 1765 was imposed, Maryland cited the charter rights which exempted the colony from all taxes except those imposed by the colonial assembly. Resistance with other colonies helped define the colony's ideas of popular liberty, the rights of Englishmen and clarified its attitude toward England.

The Boston Tea Party of 1773 had its counterpart in Maryland when a tea ship, the "Peggy Stewart," was burned in Annapolis harbour on Oct. 19, 1774. The Association of the Freemen of Maryland on July 26, 1775, one year before the Declaration of Independence, passed resolutions protesting against British practices and asserting colonial rights. The revolutionary movement in Maryland was led principally by the group that had fought proprietary prerogatives; it consisted of men of wealth and social position as well as those learned in the law. On the other hand, Maryland had a large body of loyalists, especially on the eastern shore.

Statesmen of Maryland played leading roles in both the first and second continental congresses and in signing the Declaration of Independence, while the colony's troops and individuals distinguished themselves in the war that followed. The first state constitution, adopted in Nov. 1776, replaced the colonial charter. It was far from democratic by modern standards. It established property qualifications for voting which were not abolished until 1810. The Maryland general assembly refused to ratify the Articles of Confederation when they were adopted by congress in 1777, holding out until 1781 when other colonies agreed to surrender to the federal government their claims to western land.

Problems of Independence.—Postwar problems included the disposition of confiscated loyalist property, the struggle for paper money and debtor relief. Maryland's controversy with Virginia over the use of the Potomac and lower Chesapeake bay resulting in the compact of 1785 was a step leading toward the constitutional convention. Such was also the Annapolis convention (*q.v.*) of 1786 at which, however, Maryland was not represented. Luther Martin distinguished himself as a representative of Maryland at the Philadelphia convention of 1787. Maryland ratified the constitution on April 28, 1788, and became the seventh state to do so. It also ceded territory and advanced money for public buildings to help form the District of Columbia (1791).

As a member of the union, Maryland was confronted with questions of slavery, agriculture, education, religion and others which required diligence and wisdom in their solution. The constitution of 1776 allowed free Negroes to vote for members of the lower house of the legislature, but this privilege was canceled by an amendment in 1810. The Napoleonic Wars adversely affected the state's commerce and during the War of 1812 Maryland was the scene of several engagements, at Havre de Grace, Caulk's Field in Kent county, Bladensburg and at Baltimore.

After 1815, Maryland was absorbed in its own problems but still active in the affairs of the nation. The national road was completed to the Ohio river in 1818, and 11 years later the Chesapeake and Delaware canal was opened. In 1829 work was begun on the Baltimore and Ohio railroad and the Chesapeake and Ohio canal. The state suffered severely in the depression of the 1830s.

Civil War and Reconstruction.—In 1860, as the Civil War approached, Maryland was a sharply divided state for it had social, economic and political ties with both North and South. Its population included approximately 87,000 Negro slaves and 84,000 free Negroes. As the state's geographical position made its adherence to the Union a necessity, President Lincoln and the military authorities prevented its secession by suspending the writ of habeas corpus, establishing martial law, controlling elections, suppressing pro-Southern newspapers and by making arbitrary arrests and imprisonments. Members of the legislature were arrested and imprisoned to prevent steps that might lead to secession. The majority of the people were Union sympathizers but opposed coercion of the South. The state was invaded several times during the war. (*See* AMERICAN CIVIL WAR.) Frederick was occupied by Lee's forces, and the battles of South Mountain, Monocacy and the crucial engagement at Antietam (*q.v.*), were fought with heavy loss. In 1864 Maryland adopted its third constitution; it freed all slaves in the state and provided an iron-clad loyalty oath. Lincoln, whose vote in the state was negligible in 1860, carried the state in 1864.

Problems of education and the administration of justice characterized the period of self-reconstruction in Maryland. The Demo-

cratic party regained power and held dominance for many years but did little before the turn of the century to effect civil service reforms, ballot reform and stricter corporation control. There was a boom in industry and commerce, with rail and water facilities increasing. Large philanthropic gifts were made by George Peabody for a conservatory of music, Johns Hopkins for a hospital and university and Enoch Pratt for a library.

Two-party government was restored in 1896 when the Democratic Gorman-Rasin machine was defeated. A period of extreme conservatism followed, but even the Baltimore fire of 1904 (*see* BALTIMORE) did not retard economic development. The Progressive movement in Maryland was expressed in the administration of Gov. Austin L. Crothers, 1908–12, when a direct primary law, an improved corrupt practices act, a good roads bill and the important Public Utilities commission act were passed.

20th Century.—In the 20th century, shipbuilding and steel manufacturing replaced the manufacture of men's clothes, boots and shoes as chief concerns. Agriculture progressed but the seafood and fisheries industry began to decline because of inadequate conservation measures due in part to the continuing boundary disagreement with Virginia over the Potomac river and Chesapeake bay. In 1956 the Maryland legislature abrogated the compact of 1785 and Virginia carried the matter to the U.S. supreme court. On Dec. 20, 1958, representatives of the two states signed an agreement to set up a commission to regulate the removal of oysters from the Potomac river and thus put an end to the so-called oyster war between the two states. The Maryland legislature, however, refused to ratify the agreement.

Among the notable military, naval and air force establishments in the state are the U.S. Naval academy, Aberdeen Proving Ground, Ft. George C. Meade, the Army Chemical centre, the Naval Ordnance laboratory, the Naval Medical centre and Andrews air force base. Among noted civilian government establishments in Maryland are the National Institutes of Health in Bethesda and the Agricultural Research centre at Beltsville.

Throughout the 1920s, and until 1935, the governor of Maryland was Albert C. Ritchie, a Democrat, who served for four terms. He won national acclaim for his administrative ability, for his opposition to prohibition and for various steps he took to improve the efficiency and economy of the state government.

A notable post-World War II development was construction of the Chesapeake bay bridge after many years of delay and frustration. William Preston Lane, Democratic governor from 1947 to 1951, laid the groundwork for this mammoth project which crosses from the mainland to Kent Island and the eastern shore. He also instituted the retail sales tax that aided greatly in coping with the state's fiscal problems and he extended its road-building program. Gov. Theodore Roosevelt McKeldin, his successor, saw many of these projects through to completion and inaugurated others. The Baltimore harbour tunnel was opened in Nov. 1957. As the fourth Republican governor since 1860, McKeldin served two terms and greatly expanded state services. In the election of 1958 McKeldin was succeeded by the Democratic candidate, J. Millard Tawes, re-elected in 1962.

GOVERNMENT

Maryland is governed by the constitution of 1867 which succeeded constitutions of 1776, 1851 and 1864. This constitution gave the governor increased powers, including a veto over acts of the legislature, called the general assembly. This veto may be overridden by a three-fifths vote of the members of each house. The governor is elected by popular vote for a four-year term. An amendment adopted in 1948 limited the governor, henceforth, to two terms. Maryland has no lieutenant governor. A vacancy in the governorship is filled by the legislature, with the president of the senate serving during the interim. The constitution may be amended by a three-fifths vote of all members of each house of the legislature and a majority of votes cast in a state referendum.

The constitution of 1867 established a general assembly consisting of a senate of 29 members and a house of delegates of 123 (later 142) members, all serving four-year terms. Each county elects one senator and the city of Baltimore elects six. After the U.S. supreme court ruled (March 26, 1962) that metropolitan residents were entitled to court hearing of complaints against denial of representation in legislatures, the assembly increased house membership from 123 to 142, with the new seats going to the metropolitan areas, which in 1963 gained control of the house for the first time in the state's history. The county unit rule applied to primary elections since 1910 was declared unconstitutional by a federal court in 1963. From 1948 the legislature met annually, with a 90-day session in even years. The short session is limited to budgetary matters and emergency legislation for the general public welfare.

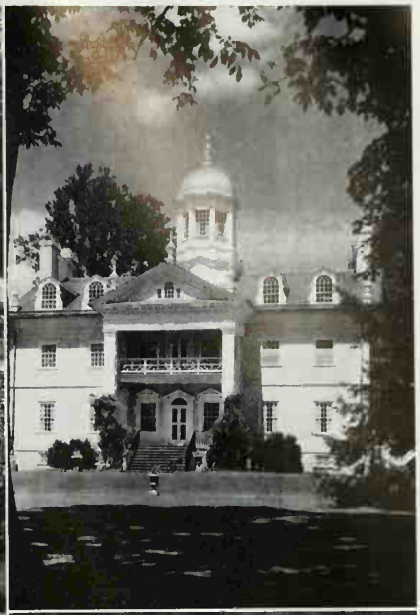
In 1922 the administrative branch of the state government was completely reorganized. A merit system was established and by the mid-20th century more than 70% of the state employees were in the classified service. The Maryland state planning commission was established in 1933 to prepare a long-range capital improvements program as well as to recommend a program of needed improvements each year. A legislative council was created in 1939 to give continuous study to the state government and to sponsor a legislative program for each session of the assembly. Other notable advances include the creation of the department of public improvements to lend technical advice and assistance to the board of public works.

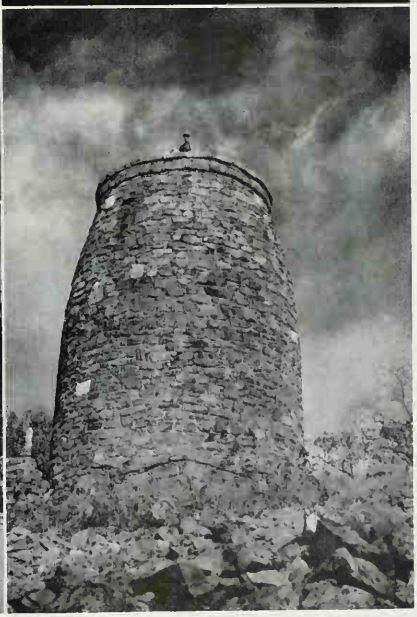
Justice is administered by the court of appeals (supreme court), four appellate circuits, intermediate circuit courts in the counties and the city of Baltimore, orphans' courts, trial magistrates' courts and peoples' courts. The state is divided into eight judicial circuits, one comprising the city of Baltimore and the other seven comprising two or more counties. In each circuit there is a chief judge and a varying number of associate judges, all elected for 15-year terms. Under the reorganization act of 1943, the court of appeals consists of five judges, one elected from each of three appellate circuits and two from the fourth appellate circuit (Balti-

*Maryland: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	3,100,689	2,343,001	1,821,244	1,449,661	1,188,044
Aberdeen	9,679	2,944	1,525	1,067	600
Annapolis	23,385	10,047	13,069	11,214	8,525
Arbutus-Halethorpe Relay	22,402	—	—	—	—
Baltimore	939,024	949,708	859,100	733,826	508,957
Bethesda	56,527	—	—	—	—
Cambridge	12,239	10,351	10,102	7,467	5,747
Catonsville	37,372	—	—	—	—
Cheverly	5,223	3,318	996	—	—
College Park	18,482	11,170	—	—	—
Cumberland	33,415	37,679	39,483	29,837	17,128
District Heights	7,524	1,735	392	—	—
Dundalk	82,128	—	—	—	—
Easton	6,337	4,836	4,528	3,442	3,074
Elkton	5,989	5,245	3,518	2,660	2,542
Essex	35,205	—	—	—	—
Frederick	21,744	18,142	15,802	11,066	9,296
Frostburg	6,722	6,876	7,659	6 017	5,274
Greenbelt	7,479	7,074	2,831	—	—
Hagerstown	36,660	36,260	32,491	28,064	13,591
Havre de Grace	8,510	7,809	4,967	4,377	3,423
Hillcrest Heights	15,295	—	—	—	—
Hyattsville	15,168	12,308	6,575	2,675	1,222
Langley Park	11,510	—	—	—	—
Lansdowne-Baltimore Heights	13,134	—	—	—	—
Laurel	8,503	4,482	2,823	2,239	2,079
Lexington Park	7,039	—	—	—	—
Loch Raven	23,278	—	—	—	—
Middle River	10,825	—	—	—	—
Mount Rainier	9,855	10,989	4,830	2,462	—
Overlea	10,795	—	—	—	—
Parkville-Carney	27,236	—	—	—	—
Pikesville	18,737	—	—	—	—
Rockville	26,090	6,934	2,047	1,145	1,110
Salisbury	16,302	15,141	13,313	7,553	4,277
Seat Pleasant	5,365	2,255	1,553	—	—
Silver Spring	66,348	—	—	—	—
Sparrows Point-Fort Howard-Edgemere	11,775	—	—	—	—
Stoneleigh-Rodgers Forge	15,645	—	—	—	—
Suitland-Silver Hills	10,300	—	—	—	—
Takoma Park	16,799	13,341	8,938	3,168	756
Timonium-Lutherville	12,265	—	—	—	—
Towson	19,090	—	—	—	—
Westminster	6,123	6,140	4,692	3,521	3,199
Wheaton	54,635	—	—	—	—
Woodlawn-Rockdale-Millford Mills	19,254	—	—	—	—

*Populations are reported as constituted at date of each census.
Dash indicates place did not exist during reported census, or data not available.





BY COURTESY OF A. AUBREY BODINE

HISTORIC SITES AND MONUMENTS OF MARYLAND

Top left: Reproduction of house at Frederick from which Barbara Fritchie (1766–1862) is said to have waved a Federal flag at Confederate soldiers en route to Harper's Ferry during the Civil War

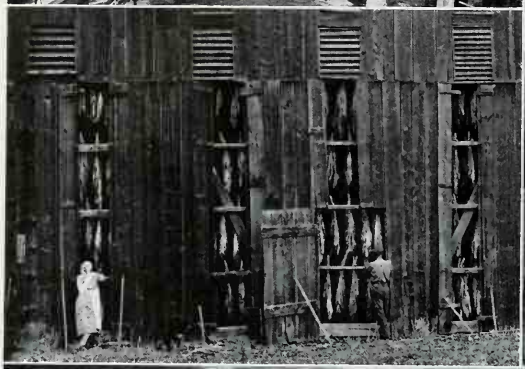
Centre left: Burnside bridge over Antietam creek, near Hagerstown, named in honour of Gen. Ambrose E. Burnside (1824–81) who led Federal troops over it during the battle of the Antietam, Sept. 16–17, 1862

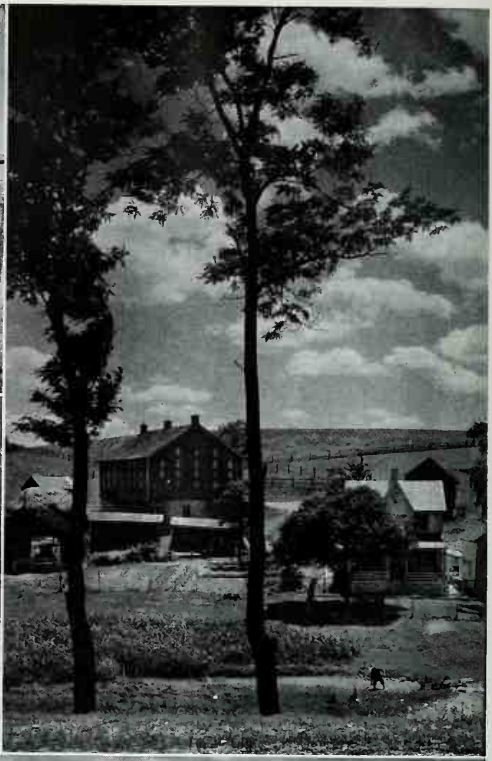
Top right: Hampton National Historic site, near Towson and north of Baltimore, was built by Charles Ridgely in 1783–90

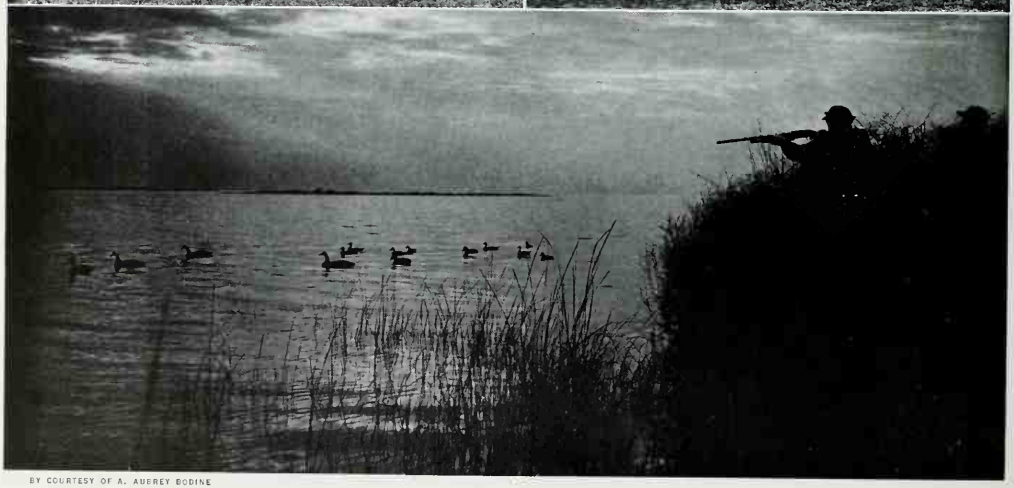
Bottom left: Midshipmen parading in front of Bancroft hall, dormitory at the U.S. Naval academy, Annapolis. The building was named for U.S. Secretary of Navy George Bancroft (1800–91) who founded the academy in 1845

Bottom right: Restoration of first completed monument to George Washington at state park near Boonsboro. The original was completed in one day, July 4, 1827. It was rebuilt in 1936

MARYLAND







BY COURTESY OF A. AUBREY BODINE

VIEWS OF MARYLAND

Top left: Oyster dredges at anchor in Cambridge, southeastern Maryland. State law permits dredging only from sailboats

Centre left: Drying tobacco in southern Maryland, on the western shore of Chesapeake bay. Five counties on the western shore grow about 30,000,000 lb. of tobacco a year

Top right: View of rich dairy and wheat farmland in Frederick county, along the Piedmont plateau in the western section of the state

Bottom: Duck hunting on the eastern shore of Chesapeake bay

more) for 15 years. The chief judge of the court of appeals is the administrative head of the state's judicial system. Judges of the court of appeals have no original jurisdiction.

In 1916, by constitutional amendment, Maryland became one of the first states to adopt the executive budget. Under this system the governor submits the budget to the legislature in the form of a budget bill. The legislature can reduce or eliminate appropriations for executive and administrative purposes, increase but not decrease judicial appropriations and either increase or decrease legislative appropriations. The budget bill becomes law as soon as passed by the legislature.

A separate agency, the department of budget and procurement, was established in 1939 to assist the governor in preparing the budget. The form of the budget remained unchanged until 1951 when the recommendations of the commission on administrative organization of the state were submitted and then approved. During fiscal year 1953, the change was effected from the then line-item budget to a program or performance-type budget, which for the first time included in one comprehensive budget all funds—general, special, federal and capital collected and disbursed by the state. The first budget adopted under the new system was for fiscal year 1954. The comptroller's department administers most revenue of the state. Exceptions are the property tax, which is administered by the state tax commission through Baltimore city and the counties, and certain fees and licences.

Principal sources of income for the state in the 1960s were the state income tax, about 21%; federal funds, 21%; gasoline taxes and motor vehicles revenues, 20%; and the state sales and use tax, 15%. Expenditures in order of importance were for public education, about 30%; highways and nonhighway transportation, 27%; payments to civil divisions of the state, 12%; health, hospitals and mental hygiene, 10%; and public welfare and employment security, 8%.

POPULATION

Maryland's population, approximately 200 in 1634, increased to 8,000 by 1660, to 43,000 by 1710, to 319,728 by 1790, to 687,049 by 1860, to 1,295,346 by 1910, to 2,343,001 by 1950 and to 3,100,689 by 1960. The population per square mile by 1960 was 293.2 as compared with 49.6 for the United States as a whole. The urban population was 2,253,832 or 72.7%, while the rural population was 846,857, or 27.3%. All of the Baltimore standard metropolitan statistical area (Baltimore city and Anne Arundel, Baltimore, Carroll and Howard counties) and part of the Washington, D.C., area (Montgomery and Prince Georges counties) are in Maryland. The two areas comprise 78% of Maryland's population.

Maryland's population was distributed by colour and nativity in 1960 as follows: 80% native white; 3% foreign-born white; and 17% nonwhite, practically all Negro. There were 98 males per 100 females in the native white population and 97 in the nonwhite population; 7.3% of the population was 65 years of age or older; and 57.6% of the population 14 years old or over was in the labour force.

EDUCATION

Maryland's public-school system was established in 1865 and completely revised in 1916. It is headed by a state board of seven lay members appointed by the governor for seven years. Their principal functions are to formulate policy and provide leadership to local units. The state board appoints a state superintendent for a four-year term. He directs the department of education and administers the school system in general.

In 1947 a comprehensive program was launched for building schools, increasing salaries, raising standards and improving the curriculum. In 1951 complete transition to a 12-year system was effected. During the 1950s and 1960s about 900 new public-school classrooms were added each year. Local taxes and funds from the state school building incentive fund made this expansion possible. Maryland made rapid progress, particularly in Baltimore, in integrating white and Negro pupils in its public schools in accord with the supreme court decision of 1954.

The University of Maryland, dating from 1807, was enlarged in 1920 by the merger of the university, consisting of the schools of law, medicine, nursing, pharmacy and dentistry at Baltimore, with Maryland State college (formerly known as Maryland Agricultural college) at College Park. The Negro branch, Maryland State college, at Princess Anne, was also included.

The university made rapid strides after World War II, increasing from 10,104 students in 1951 to nearly 15,000 by 1960. There was an additional increase in off-campus enrollment, including overseas branches, from 16,737 to nearly 34,000. Capital improvements and many valuable services were pushing the university toward top rank among the nation's land-grant institutions.

Johns Hopkins university in Baltimore, often described as the first true university in America, was established from a fund of nearly $7,000,000 bequeathed by Johns Hopkins, a wealthy Baltimore merchant, in 1873 for the founding of a university and hospital. A leading educational institution, it comprises the hospital, the school of medicine, the school of hygiene and public health, the faculty of philosophy (conferring A.B., M.A., and Ph.D. degrees), school of engineering, school of business and industrial management, McCoy college, the school of advanced international studies and other units.

Other institutions of higher learning in Maryland are: Washington college (nonsectarian), Chestertown (dating to 1707 as a secondary school and chartered in 1782 as a college); St. John's college (nonsectarian), Annapolis (established as King William's school in 1696 and chartered as a college in 1784); Western Maryland college (Methodist) in Westminster (established in 1868); Mount St. Mary's (Catholic, 1808) and St. Joseph's college (Catholic, 1809), both in Emmitsburg; and in Baltimore, St. Mary's seminary and university (Catholic, 1791), Loyola college (Catholic, 1852), College of Notre Dame of Maryland (Catholic, 1873), Mount St. Agnes (Catholic, 1890), Goucher college (nonsectarian, 1885), Morgan State college (founded in 1867 as a private Negro college, taken over by the state in 1939); Hood college in Frederick (United Church of Christ, 1893); Woodstock college at Woodstock (Catholic, 1867).

State teachers' colleges are located at Towson, Salisbury, Frostburg, Bowie and Baltimore (Coppin state). Junior colleges are at Baltimore, Takoma Park, Hagerstown, Frederick, Bel Air, Catonsville and Essex. Other institutions include the University of Baltimore and miscellaneous business and professional colleges.

Other outstanding institutions of an educational and cultural nature are Peabody Conservatory of Music (1868), Maryland Institute for the Promotion of Fine and Mechanic Arts (1825) and the Enoch Pratt free library (with numerous branches), established in 1866.

PUBLIC HEALTH AND WELFARE

The state department of health, governed by the state board of health and mental hygiene, administers Maryland's public health program. Each county also has its health board and health officer. The county is the functional unit. Some municipalities in the counties also make financial contributions to the health program.

The department operates four tuberculosis hospitals (the Victor F. Cullen, Henryton, Mount Wilson and Pine Bluff state hospitals) and three chronic disease hospitals (Montebello, Deer's Head and Western Maryland state hospitals). The department of mental hygiene controls mental hospitals at Cambridge, Sykesville, Catonsville, Crownsville and Owings Mills. In 1955 the Patuxent Institution for Defective Delinquents was opened. Two other institutions were authorized in the late 1950s: the Institution for Criminally Insane at Jessups and the Long Term Care colony near Pikesville.

The state department of public welfare co-ordinates and directs all welfare activity in the state. It supervises and controls the county welfare boards; investigates public and private institutions, organizations and agencies of a charitable nature; administers the child labour laws; and licenses agencies and institutions having care and custody of minors. It controls the state's four training schools—Boys' Village, Maryland Training school, Barrett school and Montrose school. Other state agencies in welfare activities are the state industrial accident commission, the department of

employment security and those supervising the state penitentiary and other penal institutions.

THE ECONOMY

Occupations and Employment.—The total labour force in Maryland exceeds 1,200,000, about 3% of whom are agricultural workers. Nonagricultural employment is as follows: manufacturing employs about 25%; trade about 18%; public administration about 11%; service industries about 8%; and all others, 38%. Total personal income in Maryland rose steadily during the 1950s and exceeded $7,000,000,000 in the 1960s. Thousands of men and women in Maryland, particularly in the rapidly growing suburbs of Washington, D.C., such as Bethesda–Chevy Chase, Silver Spring and Takoma Park, are employed by the federal government in a great variety of occupations.

Agriculture.—Although its small size and the diversity of its farm crops prevent Maryland from becoming an important factor in the national agricultural picture, the state nevertheless has a thriving farm population. The state has a variety of good soils and a climate adaptable to a wide range of production. There are also excellent transportation facilities, readily accessible markets and fine agricultural services of the University of Maryland.

Tobacco production predominates in southern Maryland. Hay, grain, livestock and dairy production typify the central counties, while the eastern shore excels in poultry raising and truck farming. In the state as a whole, the 1950s saw a marked decline in the production of corn, Irish potatoes, horses and sheep, but the decade brought a steady increase in the production of milk, eggs and chickens. Maryland ranks high nationally in commercial broiler production, and in its output of tomatoes and strawberries. The state produced approximately 400,000,000 eggs annually in the 1960s.

Of the 6,323,840 ac. of land area in Maryland, about 60% is in farms. The harvested acreage totals about 1,500,000. The number of farms declined from about 42,000 before World War II to fewer than 32,000 in the second half of the 20th century. The number of acres in farms declined for the same period from about 4,000,000 to about 3,500,000. Meanwhile, the average size of farms increased from approximately 100 to 120 ac., while the average farm increased in value from about $6,500 to more than $20,000. The value per acre jumped from $65 to $177. Principal crops are corn, wheat, oats, barley, rye and hay. Crops rank first in terms of income, followed by livestock and livestock products, dairy products and commercial broilers.

Manufacturing.—Maryland's leading source of wealth, manufacturing, steadily increased in importance during and after World War II. Although centred mainly in Baltimore, substantial industrial gains were made in Cumberland, Hagerstown, Frederick, the central counties generally, and Salisbury and Cambridge on the eastern shore. Extensive vegetable, poultry and fish processing developed on the eastern shore. The number of industrial establishments in Maryland increased rapidly during the 1950s and 1960s. In terms of number of employees, Maryland's major industry groups were primary metals, food and kindred products, transportation equipment, chemicals, machinery, apparel and related products, lumber and wood products, furniture and fixtures, paper products, printing and publishing, and some mining.

Fisheries.—Maryland is known everywhere for its seafood and has developed a substantial fishing industry. The commercial fish catch from the Atlantic ocean and the Chesapeake bay and its tributaries exceeds 17,000,000 lb. annually. The leading types of fish are striped bass, roe shad, menhaden and river herring. The commercial catch of shellfish exceeds 42,000,000 lb. annually. The most valuable catch is that of oysters, which totals approximately 2,250,000 bu. The oyster industry, after a marked decline due to lack of proper conservation measures, has made a comeback as a result of shell planting or seeding and other measures. Approximately 280,000 bu. of seed oysters were made available to private planters by the state during the 1950s, and 1,400 additional acres of barren bottom were leased to private planters. The annual hard crab catch exceeds 20,000,000 lb. The new soft-shell clam industry made rapid progress after World War II.

Trade and Finance.—With a constantly expanding economy, Maryland developed a large retail and wholesale trade. By 1960 it had approximately 25,000 retail establishments with an annual sales volume of about $3,500,000,000. More than half of this total was accounted for in the Baltimore metropolitan area. Wholesale trade was conducted by about 3,000 establishments.

During the 1960s Maryland had about 150 active banks (including national, state, commercial, savings and private banks). The state also had many chartered credit unions and industrial finance companies.

Transportation and Communication.—Maryland was a pioneer in road building in the early 20th century, but fell behind other states during the 1930s and was compelled to begin a great road- and bridge-building program at the end of World War II. The Chesapeake bay bridge was built between 1949 and 1952 at a cost of $45,000,000, financed by a bond issue. The Washington-Annapolis freeway was opened and a new Severn river bridge filled the last gap in a direct link between the Chesapeake bay bridge and the freeway. The Baltimore-Washington expressway was opened in its entirety early in 1954. Dual highways were built between the Delaware line and Washington, between Washington and Frederick, and between Baltimore and Frederick. In 1957 an under-harbour tunnel from Fairfield to Canton, costing $130,000,000 including approach roads, further facilitated traffic through Baltimore. By the 1960s there were more than 1,000,000 motor vehicle registrations in the state and about 20,000 mi. of roads and highways. There were no toll roads in Maryland, but tolls were paid to use the Chesapeake bay bridge, the Baltimore harbour tunnel, the Susquehanna river bridge at Havre de Grace and the Potomac river bridge in southern Maryland.

The state is traversed by three main railroads. Altogether, railroads operate about 1,500 main-line track miles within the state. Bus lines serve all parts of the state and major airlines serve Baltimore and other parts of the state.

The state's first radio station began to operate in 1922 and its first television station in 1947, both in Baltimore.

Maryland has about 70 weekly newspapers, the oldest being the *Maryland Gazette-Glenburnie News* (Annapolis, 1727), first published as the *Maryland Gazette*. The *Baltimore Sun* is the oldest daily newspaper.

See also references under "Maryland" in the Index.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition. (C. B. CL.)

MARYLEBONE: *see* SAINT MARYLEBONE.

MARY MAGDALENE, SAINT, a disciple of Jesus mentioned in all four canonical Gospels as one of the first witnesses to the empty tomb (Mark xvi, 1; Luke xxiv, 10) or to the risen Lord (Matt. xxviii, 9; John xx, 1; Mark xvi, 9). In Luke viii, 2 and Mark xvi, 9 she is described as having had seven demons expelled

from her; for this reason the anti-Christian writer Celsus attacked her as an "insane" witness to the resurrection (for some reason she is not included in the "official" list of witnesses in 1 Cor. xv, 5–7). Gnostics, on the other hand, regarded her as a favourite disciple of Jesus and a medium of secret revelation (she is so described in the Gnostic works Gospel of Mary, Gospel of Philip and Pistis Sophia). Origen and other early exegetes usually viewed her as distinct from the woman or women who anointed Jesus' head or feet (named Mary in John xii, 3; *cf.* Mark xiv, 3; Matt. xxvi, 6–7; Luke vii, 36–38), but this identification gradually gained ground and was emphatically set forth by Gregory the Great. After his time the cult of St. Mary Magdalene flourished in the west (feast day July 22). In late legend she accompanied St. John to Ephesus, where she died and was buried. The primary theme related to her cult was that of the repentant sinner (Luke vii, 44–50) witnessing the risen Christ.

See U. Holzmeister in *Zeitschrift für katholische Theologie*, 46:402 ff., 556ff. (1922); V. Saxer, *Le culte de Marie Madeleine en occident* (1959). (R. McQ. G.)

MARYSVILLE, a city of northern California, U.S., is located in the centre of the Sacramento Valley, 42 mi. N of Sacramento, at the confluence of the Yuba and Feather rivers. Settled about 1842, it was an important wholesale and retail centre for the northern gold mines. After 1884, however, mining was gradually replaced by farming as the mainstay of the economy. For comparative population figures *see* table in CALIFORNIA: *Population.*

MASACCIO (TOMMASO DI GIOVANNI DI SIMONE GUIDI) (1401–1428), the first and greatest Florentine Renaissance painter, was born at San Giovanni Valdarno, near Florence, on Dec. 21, 1401. His father, a notary ser, Giovanni di Monte Vassai, died in 1406. In 1422, Masaccio was enrolled in the Arte dei Medici e Speziali in Florence, and in 1424 became a member of the Compagnia di S. Luca. According to Giorgio Vasari, he owed his early training as a painter to Masolino da Panicale (*q.v.*) and this is probable, since Masolino came from the same region and Masaccio's earliest surviving work was painted in collaboration with the older artist. This is the "Virgin and Child with St. Anne," painted about 1420 and now in the Uffizi gallery, Florence, to which Masaccio contributed the uppermost angel on the right, the foreshortened left hand of St. Anne, and the seated Virgin and Child. The marked contrast between the contributions of the two artists, one soft and lyrical, the other recessive and sculptural, continues throughout their whole collaborative careers. About 1424 they again worked side by side on a double-sided altarpiece, commissioned from Masolino for Sta. Maria Maggiore in Rome, to which Masaccio contributed at least one lateral panel with SS. Jerome and John the Baptist, now in the National gallery, London.

ALINARI

"EXPULSION FROM PARADISE," FRESCO BY MASACCIO; BRANCACCI CHAPEL, THE CARMINE CHURCH, FLORENCE, ITALY

In Dec. 1426, Masaccio completed an altarpiece for the church of the Carmine at Pisa, of which a central panel, of the Virgin and Child enthroned, is in the National gallery, London; a central pinnacle of the Crucifixion is in the Museo di Capodimonte at Naples; two panels of saints in half-length are in the Lanckoronski collection, Vienna, and the Kaiser Friedrich museum, Berlin; and four pilaster panels and three predella panels are also in the latter gallery. By this time, Masaccio, despite his youth, was a mature artist, and the altarpiece is the first panel painting in which a Renaissance style is fully employed. Among the many novel features of this revolutionary painting may be noted the accomplished use of linear perspective in the central panel, the Brunelleschan architecture of the throne, and the illusionistic modeling of the figures, in which the forms are suffused in light. At the same time, the work far transcends what is normally understood by the term naturalism, and the panel in Naples is one of the most moving representations of the Crucifixion in Italian painting. A fresco of the Trinity, commissioned for Sta. Maria Novella in Florence, probably in 1427, shows a barrel-vaulted hall, closed on its outer face by columns and pilasters, with a representation of the crucified Christ supported at the back by a standing figure of God the Father and accompanied by the Virgin and St. John; the two donors kneel to right and left outside the scene. The spatial scheme is the first example of the application of linear perspective to the art of fresco painting. The fresco is without precedent also in its iconography, which recalls certain works executed by the sculptor Donatello.

Masaccio's most important work is the decoration of the Brancacci chapel in the Carmine church in Florence, for which he executed what are possibly the greatest Italian frescoes and certainly the greatest frescoes of the 15th century. There are no documents relating to Masaccio's activity in the Brancacci chapel, and a number of widely differing hypotheses respecting it have been advanced. It seems probable that this decoration (which consisted of scenes from the life of St. Peter) was first entrusted to Masolino, who about 1425 executed the frescoes in the upper register (destroyed). After an interval, work was resumed in the summer of 1427 jointly by Masaccio and Masolino. Masaccio is generally agreed to have been responsible for the frescoes of the "Expulsion from Paradise," the "St. Peter and the Tribute Money," and "St. Peter Enthroned" (unfinished) on the left wall, and for the "Baptism of the Neophytes," the "Distribution of the Goods of the Community" and "SS. Peter and John Healing the Sick With Their Shadows" on the altar wall. The contrast between the styles of Masaccio and Masolino appears most forcibly in the magnificently virile "Expulsion From Paradise" of Masaccio and the fresco of "Adam and Eve" by Masolino on the wall opposite. The most impressive of these astonishing frescoes is the "Tribute Money," where the figures, with their heavy drapery, are set against a background of seemingly limitless depth in a foreground area defined by a receding building on the right. In this and in the other frescoes the effect of overwhelming grandeur is partly induced by the rapt absorption of the participants in the event that is portrayed. The portrayal of the sick men in "SS. Peter and John Healing the Sick With Their Shadows" and of the dead Ananias in the "Distribution of the Goods of the Community" forms one of the most momentous advances in representation in western art.

In about 1428, Masolino began work on the decoration of the Branda chapel in S. Clemente in Rome. The frescoes in this chapel were ascribed by Vasari to Masaccio, and it is possible that he accompanied Masolino to Rome, where he died, at the age of 27, in the autumn of 1428. Since his death the supreme importance of Masaccio's contribution to the development of painting has never been in doubt, and his frescoes in the Carmine have been copied by Michelangelo and countless other artists. Though all of his known works were produced in a period of eight years, he occupies in his own art a position analogous to those of Brunelleschi in architecture and Donatello in sculpture.

See J. Mesnil, *Masaccio et les débuts de la Renaissance* (1927); M. Pittaluga, *Masaccio* (1935); M. Salmi, *Masaccio* (1948). (J. W. P.-H.)

MASADA, a natural hill fortress in the eastern Judaean Desert, on the Dead Sea coast in Israel, where the Jews made their last stand against the Romans in the Jewish revolt of A.D. 66–73. The hill is situated about 32 mi. (51 km.) S of Khirbet Qumran, where most of the Dead Sea Scrolls were found. The boat-shaped fortress covers 20 ac. (8 ha.).

Probably first used as a fortress by Alexander Jannaeus, Hasmonaean ruler of Judaea (103–76 B.C.), Masada also served as a stronghold in the contest between the Hasmonaeans and Herod the Great. Herod completely rebuilt the fortress (*c.* 35 B.C.). After the exile of his son Archelaus (A.D. 6) a Roman garrison was established at Masada. It was massacred by Jewish Zealots in A.D. 66, and by A.D. 72 Masada was the last Jewish stronghold resisting the Romans. The Roman tenth legion, with auxiliaries,

besieged the fortress during A.D. 72–73 and, using siege machines, broke into the fortress from the west. The defenders (numbering 960, with women and children), led by Eleazar ben Jair (Yair), preferred to die as free men and took their own lives, after having burned their possessions. In the 5th and 6th centuries monks built a church and cells there.

Herod's buildings on the summit of Masada were excavated mainly in 1963 and after under the auspices of the Hebrew University, the Israel Exploration Society, and the Department of Antiquities of the State of Israel, under the direction of Yigael Yadin. The main features revealed by the excavations were a strong casemated wall encircling the flat mountain top; Herod's villa ("the hanging palace"); a well-appointed bathhouse; an administrative palace; and storehouses, some with remnants of their original contents. Huge cisterns supplied water collected, by means of aqueducts, from the flood waters that swept past nearby.

The Jewish Zealots who massacred the Roman garrison in A.D. 66 settled mainly in the casemates. They built a synagogue and ritual baths as well as household installations. The extreme dryness helped to preserve their possessions and, above all, scroll and papyrus fragments. The scroll fragments discovered include parts of Genesis, Leviticus, Deuteronomy, Ezekiel, Psalms, Ecclesiasticus, and a sectarian scroll of the Qumran type, "The Song of the Heavenly Sabbath Sacrifices." These finds predate the year A.D. 73 and thereby render probable the early date of the similar finds at Qumran (*see* DEAD SEA SCROLLS). Eight camps built by the tenth legion at the foot of the hill in A.D. 72 are well preserved.

(G. Fo.)

MASAI is a name commonly but erroneously used to identify a single tribe in east Africa. However, it is essentially a linguistic term referring to several tribes that together numbered about 225,000 in the 1960s and speak Maa, a Nilo-Hamitic language. Only the Pastoral Masai, who number about 115,000 and range along the Great Rift valley of Kenya and Tanganyika, are called IlMaasai by Maa-speaking peoples. The others use their tribal names, including the Samburu (22,000) of Kenya and the semi-pastoral Arusha (68,000) and Baraguyu or Kwavi (20,000) of Tanganyika. Failure to distinguish among these groups, with their different origins and modes of life, has tended to impede their accurate description. The Arusha, for example, do some mixed farming, practise ancestor worship and have a segmentary lineage system—traits absent among the Pastoral Masai.

The Pastoral Masai are the largest and perhaps best known of the Maa-speaking tribes. They are tall and slender with good features and well-defined noses. The heads of women, and of married and uninitiated men, are shaved. Young unmarried men, who are organized into warrior groups, wear their hair plaited into queues hanging down the back and over the forehead. Males wear very little clothing, but women are scrupulously clothed from childhood on with dressed skins or, increasingly today, red-ochred cotton cloth. Beads, metal armlets and leg bands, necklaces and bracelets are popular with both sexes.

The Pastoral Masai are proud seminomads who try to subsist entirely on the milk, meat and blood of their livestock. Cattle of the humped zebu type are the mainstay, though sheep, goats and pack donkeys also are kept. The Pastoral Masai neither hunt nor grow crops. Although most are permitted to eat grains and vegetables in periods of want, warriors may not. An intoxicating honey beer is drunk by men and women, and most adults except the warriors chew tobacco or use snuff. Their principal weapons are long-bladed spears, wooden knobkerries and short swords. Smelting and ironwork are held ritually unclean and metal objects are imported.

The basic residence unit for the Pastoral Masai is the kraal camp, consisting of a large circular thornbush fence within which mud-dung igloolike houses are built on the perimeter by women. Each head of a polygynous family has his own gate to the camp, and his wives build separate houses to the right or left of the gate in order of seniority. Livestock, branded on the ear according to the owner's clan, are taken into the camp at night as protection against predatory animals. Cattle are herded and watered by boys and men but milked mainly by women and girls. Warriors may not yet marry and, during their period of military service, live in separate villages (*manyata*) where they are visited by unmarried girls.

Socially, the Pastoral Masai form a number of patrilineal exogamous clans grouped into moieties. A most distinctive feature is their highly formalized age set (*q.v.*) system consisting of groups of coevals who were initiated (circumcised) into adult life during the same open-initiation period. These hierarchical age sets not only delimit groups authorized to make decisions for the tribe but also provide groups to act on the decisions. The centre of political authority lies with the set of elders separated by one intervening age set from the existing senior warriors, over whom they have special right of command; judicial and legislative functions reside in a council of elders headed by this age set. Traditionally there were no chiefs; however, in 1958 Pastoral Masai of Tanganyika elected one of their young educated men as a sort of paramount chief of the Tanganyika Masai Federal council.

Ceremonial events are directed by a ritual expert (*oloiboni*) who, although he has no political power, is religious head of his tribe. Masai traditionally hold that earth and sky were once one; only after their separation did God (Ngai) leave men to reside in the sky, from which he let down cattle for Pastoral Masai as a divine gift. As a result of this separation the earth and things associated with it are regarded as unpropitious and Masai are reluctant to dig in the soil, plant seed or bury their dead, which even today are left out to be eaten by hyenas.

Today the Pastoral Masai are perhaps most remarkable for their resistence to cultural changes occurring around them, as in their attempt to subsist entirely on livestock. In the 1960s fewer than 1,000 of their young men and women had the equivalent of a secondary (high school) education; their older folk adhere strongly to traditional ways.

See also references under "Masai" in the Index.

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(AL. H. J.)

MASANIELLO (properly TOMMASO ANIELLO) (1620–1647), a fisherman who became the nominal head of the popular insurrection of July 1647 in Naples, was born in Amalfi in June 1620. Under Spanish rule, the government of Naples had long been controlled by the nobility, and the common people were exasperated when a tax on fruit was announced (Dec. 1646) to raise money for the biennial tribute to Spain. Giulio Genoino, a former *eletto* or nominated spokesman of the people, planned demonstrations to persuade the Spanish viceroy, Rodrigo Ponce de León, duque de Arcos, to remit the tax and chose Masaniello to lead a band of urchins in starting them. A riot that began on July 7, 1647, grew into an insurrection against noble rule, but expressly not against Spain. The people demanded the democratic "privileges" granted by the Holy Roman emperor Charles V (Charles I of Spain) and the withdrawal of all imposts. Prisons and armouries were attacked, excise booths and noble houses were fired and the viceroy, having revoked the tax on fruit, took refuge in the Castelnuovo fortress. The insurgents proceeded to the summary execution of unpopular persons. A settlement negotiated between the insurgent leaders and the cardinal archbishop of Naples, Ascanio Filomarino, was approved by the viceroy on July 10 and submitted to the people in the Carmel church. Though an attempt was then made on Masaniello's life, the settlement was ratified next day, and Masaniello, dressed in cloth of gold, was recognized as captain general of the people by the viceroy. More nobles were put to death. On July 13, however, when an oath was sworn in the cathedral between the viceroy and the people, Masaniello was drunk; and on July 15, raving madly for more slaughter, he was taken into custody by Genoino. On July 16, having escaped to the Carmel church, he was shot outside the monks' dormitory by assassins hired by the nobles. The people mutilated his body, and the viceroy rewarded the assassins; but on July 17 a new riot drove the viceroy back to the Castelnuovo and the people gave Masaniello a solemn funeral.

Masaniello's life was made the subject of an opera, *La Muette de Portici* (1828), by Daniel Auber and Eugène Scribe.

See M. Schipa, *Masaniello* (1925).

MASARYK, JAN GARRIGUE (1886–1948), Czechoslovak statesman, the son of T. G. Masaryk, was born in Prague on Sept. 14, 1886. He went to the United States in 1907 and undertook a variety of jobs; he returned to Prague before the outbreak of World War I. During the war he served in a Hungarian regiment, mostly in Poland. When Czechoslovakia became independent he went into the foreign office; in 1919 he was sent as *chargé d'affaires* to Washington, but was soon transferred to London, where he became counselor of legation. In 1921 he returned to Prague to become secretary to the foreign minister, Edvard Beneš.

In 1925 Masaryk was appointed Czechoslovak minister in London; he resigned after the Munich agreement of Sept. 30, 1938. In World War II, when the Czechoslovak government was provisionally reconstituted in London in July 1940 (after the fall of France), he became its foreign minister. His broadcasts to occupied Czechoslovakia from London throughout the war made him for the first time a popular figure in his own country, from which he had been so long absent. In the spring of 1945 he accompanied President Beneš to Moscow, then went to San Francisco for the inauguration of the United Nations, returning to Prague in July. Although he found relations with Moscow increasingly difficult, especially after the Soviet veto on the acceptance of aid through the Marshall plan, he remained foreign minister until his death. He was one of the three non-Communist ministers to whom bombs were sent by post on Sept. 11, 1947. After the Communist *coup d'état* of Feb. 25, 1948, he remained at his post at Beneš' request. His body was found on March 10; it appeared that he had thrown himself out of the window of his room at the foreign office. His wartime broadcasts were published under the title *Speaking to My Country* (1944).

See Sir R. H. Bruce Lockhart, *Jan Masaryk* (1951); Robert Powell (J. Emlyn Williams), "Jan Masaryk," *Slavonic and East European Review* (April 1950). (E. Wi.)

MASARYK, TOMAS GARRIGUE (1850–1937), philosopher, Czechoslovak patriot and first president of Czechoslovakia, was born on March 7, 1850, near the town of Hodonin in Moravia, on the frontier with Hungarian Slovakia. His father was a coachman employed on one of the Austrian imperial estates, a native of Kopcany in Slovakia; his mother came from a half-Germanized Czech family in Hustopece, in Moravia. As a child Masaryk spoke Czech and a smattering of German; he began his education at a Czech school at Cejkovice. Then his parents sent him for two years to a German *Realschule* in Hustopece, intending that he should become a teacher; but when he was 14 this idea was dropped, and the young Masaryk became a locksmith's apprentice in Vienna, then a blacksmith at Cejc. A year later, however, in 1865, a former schoolmaster of his persuaded his parents to return to the original plan of a teaching career. Accordingly Masaryk entered the German grammar school in Brno and began to study there. In Brno he earned money by tutoring in the family of a director of the police.

It was at this time that Masaryk developed a rebellious disposition, taking exception to some of the dogmas of the Roman Catholic Church and refusing to go to confession. As a result he was obliged to leave the grammar school. Yet he was able to continue his studies in Vienna with distinction, obtaining his doctorate in philosophy from the university in 1876. He then studied for a year in Leipzig where he met an American student of music from New York, Charlotte Garrigue, whom he married in 1878.

In 1879 Masaryk returned to the University of Vienna as a lecturer in philosophy; he was already well known as a Platonist. In 1881 he published in German his first important sociological work, *Der Selbstmord als soziale Massenerscheinung der modernen Zivilisation* ("Suicide as a Mass Phenomenon of Modern Civilization"). In 1882, when the University of Prague was divided into separate Czech and German institutions, Masaryk was appointed to one of the Czech professorships. In 1885 he published an important work, *Zakladove konkretni logiky* ("The Bases of Concrete Logic"; Ger. trans. 1887).

In 1883 Masaryk had founded a critical monthly review, *Athenaeum*. It was here that the famous manuscripts of Kralovy Dvur and Zelena Hora (Königinhof and Grünberg), produced in the early 19th century by two overzealous Czech patriots in order to provide proof of the literary achievements of medieval Bohemia, were exposed as forgeries. The authenticity of the manuscripts had already been questioned by Slavonic philologists, but it was only in 1886 that they were conclusively proved to be forgeries after a philological analysis by the great Czech expert, Jan Gebauer, and an examination in sociological terms by Masaryk himself. Another monthly review, *Naše Doba* ("Our Epoch"), was founded by Masaryk in 1893.

During the last two decades of the 19th century Masaryk's activities were tireless and varied. He was an instructor in the Sokol Czech nationalist gymnastic association. He lectured to the clubs and societies of Prague on unconventional subjects and published unpopular books. He was an advocate of the eight-hour day and of education for women. His sociological work led him to a study of Marxism: in *Otazka socialni* ("The Social Question," in Czech and German, 1898) he criticized historical materialism.

Meanwhile, in 1889, Masaryk had transformed a review called *Čas* ("Time") into a political weekly. This was the beginning of his political career. At this time the Old Czech party, led by Vladislav Rieger, was losing ground to the more intransigent nationalist Young Czechs, who invited Masaryk to campaign with them in the elections to the Vienna *Reichsrat* in 1891. The Young Czechs won handsomely over the Old Czechs and Masaryk became, together with Karel Kramař, one of their deputies in Vienna. This was perhaps the only obvious political mistake that he ever made, and he resigned his seat in 1893 in order to escape from emotional nationalism in favour of his gospel of what he called "realism." For him the national cause was linked with the tradition of moral integrity of the Bohemian Brethren. For this reason he had struggled to dissociate the national cause from the forgeries and now set about, through the Realist party which he founded, to identify it with a scientific, humane and liberal approach to all the questions of the day. This was a period of rising anti-Semitism in Austria, and it was characteristic of Masaryk that in 1899 he condemned the trial of the half-witted Jewish youth Leopold Hilsner on a charge of ritual murder. His moral courage gave him a great name with the younger generation, not only of Czechs and Slovaks but also of Croats and Serbs, for whom Prague became a favourite meeting place.

In 1900 Masaryk's followers founded what they called the Progressive party, though they continued popularly to be known as Realists. Elections to the *Reichsrat* were held in 1907 immediately after the franchise had been made general for men over 24, and Masaryk was elected with a notable following. In 1908 he attacked the formal annexation of Bosnia-Hercegovina by Austria-Hungary. He later played a great part in relation to the Zagreb treason trial of 53 Serbs of Croatia-Slavonia and to the libel action against the pro-Austrian writer Heinrich Friedjung which ensued: thanks to his own investigations he was able to show that the case for the prosecution in the Zagreb trial rested on documents forged at the Austro-Hungarian legation in Belgrade. His disclosures in the *Reichsrat* (1909) and in the Austro-Hungarian delegations (1910) caused the proceedings in the Zagreb trial to be quashed and obliged Friedjung to retract his accusations against the Serbs. Inevitably Masaryk incurred the intense displeasure of official circles in Vienna, but among the Slavs and in the world at large his reputation was enhanced. In 1911 he was re-elected to the *Reichsrat*.

It was as characteristic of Masaryk to expose the forgeries of Austrian diplomacy as of Czech romantics, and it should be emphasized that before 1914 he never thought of the Czechs and Slovaks as anything other than a nation within Austria-Hungary. With the outbreak of World War I the outlook seemed to him transformed. Having left Austria in Dec. 1914, he launched a campaign of propaganda in favour of Czechoslovak liberation from the Habsburg monarchy, which he now condemned as an oppressive and outmoded relic of the past. It was in Zürich, Switz., at the commemoration of the quincentenary of the burning of John Huss,

on July 4, 1915, that Masaryk first openly declared against Austria: he was supported on this occasion by the great French historian of the Czechs, Ernest Denis. (*See* CZECHOSLOVAKIA.) Finding his work in Switzerland hampered by enemy spies, Masaryk settled in London, where, at the invitation of Ronald Burrows, the principal, he joined the staff of King's college in Sept. 1915 and inaugurated the school of Slavonic studies in the University of London. In Nov. 1915 he formed a Czechoslovak Foreign committee which in Jan. 1916 was transformed into the National Czechoslovak council. Meanwhile, with the help of Wickham Steed and R. W. Seton-Watson, he worked to combat German and Magyar propaganda and to make western opinion familiar with Czechoslovak aspirations.

The Russian Revolution of 1917 enabled Masaryk to go to Russia. Several thousand Czech soldiers had gone over to the Russians and wanted to organize themselves into active military units. After some difficulty Masaryk induced the revolutionary Russian government to agree to the formation and equipment of an independent Czechoslovak army.

Masaryk went to the United States in May 1918. The result was Secretary of State Robert Lansing's declaration (May 29, 1918) of sympathy with the cause of Czechoslovak and Yugoslav independence. The Allied governments associated themselves with that declaration on June 3, 1918. The ice being thus broken, the Allied powers and the U.S. recognized the National council as the leading body of the Czechoslovak movement and also of the army that was fighting on the Allied side.

On Nov. 14, 1918, Masaryk was elected first president of the Czechoslovak republic. He was re-elected in May 1920, in May 1927, and again in May 1934, but in Dec. 1935 he resigned. Having seen his beloved pupil, Edvard Benes, elected to succeed him, he died at Lany on Sept. 14, 1937, mourned by the nation. His wife had died in 1923.

Masaryk ranks equally high as a philosopher and as a statesman. His "realism" was a reaction against the Teutonic idealism which developed moral speculation without reference to the practical affairs of life and against the Tolstoian philosophy of nonresistance to evil. Masaryk, as philosopher, stood for an integrated conception of life, in which the spiritual and religious took their place with the political aspects of the whole.

The following are the chief of Masaryk's many philosophical, sociological and political works (excluding those mentioned above): *Theorie Pravdepodobnosti a Humeova Skepse* ("The Theory of Probability and Hume's Scepticism"; 1882; Ger. trans., 1884); *Blaise Pascal* (1883); *Theorie dejin vedle zasad T. H. Buckle* ("The Theory of History According to T. H. Buckle"; 1884); *Slavjanofilism I. S. Kirejevského* (1889); *Česka Otazka* ("The Czech Question"; 1895); *Karel Havlíček* (1896); *Zaklady marxismu filosoficke a sociologicke* ("The Philosophical and Sociological Foundation of Marxism"; 1898, also in German); *Jan Hus* (1899); *Rusko a Evropa* (1913; Eng. trans., *The Spirit of Russia*, 1919, reprinted with additions, 1955); *The Problem of Small Nations in the European Crisis* (1916); *The New Europe* (1918); *Světova Revoluce za valky a ve valce, 1914–1918* (1925; Eng. trans., *The Making of a State: Memories and Observations 1914–18*, 1927).

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MASAYA, the smallest department in Nicaragua (area 232 sq.mi.), located northwest of Lake Nicaragua, and the name of its capital city. The department is the most densely settled in the country; pop. (1959 est.) 101,273. With fertile soils derived chiefly from volcanic ash and lava, Masaya is important agriculturally, producing especially tobacco, corn, beans and other vegetables, flowers and, on the slopes of Masaya volcano, coffee.

The city of Masaya, pop. (1959 est.) 29,449, on the shore of a crater lake of the same name, is famous for its flower gardens. It is on the main line of the Pacific railway of Nicaragua; branch roads and railways connect the city with rich agricultural districts. It manufactures foodstuffs, leather, footwear, cigars, soaps, starch, rugs and hats. (C. F. J.)

MASBATE, an island in the Philippine archipelago, centred 30 mi. S.W. of the southern tip of Luzon. Area 1,262 sq.mi. The island is adz-shaped, with mountain ranges along each axis, probably representing the intersection of the two main lines of Philippine faulting. Gold was mined for centuries near Aroroy in the north. Before World War II this area produced about 12% of the Philippine output; operations had ceased by the 1960s. The province of Masbate includes the much smaller Burias and Ticao islands. Total area 1,571 sq.mi. Pop. (1960) 335,971. The capital and principal trading town is Masbate (pop. [1960] 31,613), on the northeast; Cataiñgan, on the southeast, is also a trading centre. (R. E. HE.)

MASCAGNI, PIETRO (1863–1945), Italian operatic composer, one of the principal exponents of the realistic (*verismo*) style. Born at Leghorn on Dec. 7, 1863, he studied at the conservatory at Milan but, unable to submit to the discipline of his master, Amilcare Ponchielli, he left to join a traveling opera company. In 1889 he won the first prize in a competition with his one-act opera, *Cavalleria rusticana*, a setting of a Sicilian melodrama by Giovanni Verga. Produced at the Teatro Costanzi, Rome, on May 17, 1890, it was an instant success and subsequently maintained its popularity, usually being given with Leoncavallo's *I pagliacci* as a companion piece. *Le maschere* (1901), reviving the *commedia dell'arte*, is musically superior, though it had little success. He succeeded Arturo Toscanini as musical director of La Scala, Milan, in 1929. Among Mascagni's other operas are *L'amico Fritz* (1891), *Iris* (1898) and *Nerone* (1935), the latter glorifying Benito Mussolini. He died in Rome on Aug. 2, 1945. (DY. H.)

MASCARA, chief town of an *arrondissement* in the *département* of Mostaganem, Algeria, 60 mi. S.E. of Oran. Pop. (1960) 44,839. It lies on the southern slope of Beni-Chougran and occupies two small hills separated by the Wad Toudman. The main European-built town is to the northeast and the Muslim town to the northwest. On the south the Eghriss plain is well cultivated (cereals, tobacco, vineyards, olive trees). The town is served by railway and is an important road junction. Mascara was long a typical north African garrison town, but it has become chiefly an administrative and commercial centre. Administrative buildings predominate; the town also has hospitals and clinics, as well as a theatre and stadium. The progressive disappearance of the ramparts has made possible the extension of the suburbs, with villas, gardens and apartment houses. The principal industry is the making of wine, the red and white wines of Mascara being held in high repute. There is also a considerable trade in grains and olive oil.

Mascara (*i.e.*, "mother of soldiers") was the capital of a Turkish beylik during the Spanish occupation of Oran from the 16th to the close of the 18th century; but for most of that period it occupied a site about two miles distant from the present position. On the removal of the bey to Oran its importance rapidly declined. It was an insignificant place when in 1832 Abd-el-Kader (*q.v.*), who was born in the neighbourhood, chose it as the seat of his power. From one of its mosques he preached the Jihad. It was laid in ruins by the French in 1835, Abd-el-Kader retreating southward. He reoccupied Mascara in 1838, but lost it again in 1841. (AE. G.)

MASCARENE ISLANDS (occasionally MASCARENHAS), the collective title (derived from their discoverer, a Portuguese navigator named García Mascarenhas) of a group in the Indian ocean east of the Malagasy Republic (Madagascar), viz., Mauritius, Réunion and Rodrigues (*qq.v.*).

MASCARON, JULES (1634–1703), French Roman Catholic preacher, the son of a barrister at Aix-en-Provence, was born at Marseilles in 1634. He early entered the French Oratory and obtained a great reputation as a preacher. In 1666 he was asked to preach before the court, and he became a favourite with Louis XIV, who said that Mascaron's eloquence was one of the few things that never grew old. In 1671 he was appointed bishop of Tulle and in

1679 bishop of Agen. He continued, however, to preach regularly at court, being especially in request for funeral orations. A panegyric on Turenne, delivered in 1675, is considered his masterpiece. Mascaron died at Agen on Dec. 16, 1703.

Six of his most famous sermons were edited, with a biographical sketch of their author, by the Oratorian Borde in 1704.

See J. Lehanneur, *Mascaron d'après des documents inédits* (1878).

MASCART, ÉLEUTHÈRE ÉLIE NICOLAS (1837–1908), French physicist who applied photography to the mapping of spectra, was born on Feb. 20, 1837, near Valenciennes. He was educated at the École normale, obtaining his doctorate in 1864, and taught physics in *lycées* at Metz, Paris and Versailles. He became director of the central bureau of meteorology in 1871 and in 1872 succeeded Henri V. Regnault as professor of physics at the Collège de France. He also served as permanent secretary of the Academy of Sciences. Mascart retired in 1907 and died at Poissy on Aug. 26, 1908.

His early investigations were on optics; he constructed a quartz spectrograph and investigated a number of spectra farther into the ultraviolet. He also made determinations of standard wave lengths. His memoir on the effect of the proper motion of the earth on optical phenomena was awarded the Grand Prix des Sciences Mathématiques in 1874. Mascart made a number of determinations of electrical units and determined the electrochemical equivalent of silver. He was interested in the teaching of practical electricity and in its application to industry, and acted as adviser to the government in many matters. He wrote *Éléments de mécanique* (1866); *Traité d'électricité statique* (1876); *Traité d'optique*, 4 vols. (1889–93); *Leçons sur l'électricité et le magnétisme*, with J. J. Joubert (1882–86); and *Traité du magnétisme terrestre* (1900).

MASEFIELD, JOHN (1878–), English poet and novelist, who succeeded Robert Bridges as poet laureate in 1930, was born at Ledbury, Herefordshire, on June 1, 1878, and was educated at King's school, Warwick, and on the training ship H.M.S. "Conway." He was apprenticed aboard a windjammer, but when he was in New York he decided to abandon the sea and for several years earned a living in the United States. The activity of these early years was reflected in his work from the first, as in *Salt-Water Ballads* (1902); which contains the famous "Sea Fever," *Ballads* (1903) and *Ballads and Poems* (1910). His novels, *Captain Margaret* (1908), *Multitude and Solitude* (1909) and *Jim Davis* (1911), were excellent tales of action and spirit, but he found his best expression in narrative poetry and drama. "The Everlasting Mercy" made a literary sensation by its use of coarse language and detail when it appeared in the *English Review* in 1911; it was followed by *The Widow in the Bye Street* (1912), *Dauber* and *The Daffodil Fields* (both 1913), all sternly realistic narrative poems. Meantime Masefield had written two plays, *The Tragedy of Nan* (1909) and *Pompey the Great* (1910), the first allied in subject and setting to his long poems of village life, the second historical. *Lollingdon Downs and Other Poems* (1917) included a noteworthy sonnet sequence, and *Reynard the Fox* (1919) proved one of his most successful verse narratives. Here the country life that he knows so well is reflected faithfully and vividly, without the gloom of *Nan* and *The Everlasting Mercy*. The gradual awakening of the village on the morning of the meet, the gathering of the hunt, the stir and movement of horses and hounds, make up scenes that are perhaps his most sparkling. Later works include the novels *Sard Harker* (1924), *The Hawbucks* (1929) and *Badon Parchments* (1947); *A Macbeth Production* (1945); a book of verse, *On the Hill* (1949); and the autobiographical *So Long to Learn* (1952). He published some memorable war narratives in *Gallipoli* (1916) and *The Nine Days Wonder* (1941), about Dunkerque. He was awarded the Order of Merit in 1935. (O. M. W. W.)

MASER, a device used for the amplification or generation of radio waves, usually in the microwave region. A device analogous to the maser, but which operates at optical frequencies, is called the laser (*q.v.*). The maser takes its name from an acronym coined by C. H. Townes from the descriptive phrase, "microwave amplification by stimulated emission of radiation." As the phrase implies, the operation of the device depends on radiant energy emitted from a suitably activated material, the material being stimulated by incident energy at the same wave length.

A solid-state maser can be activated by storing energy supplied by a microwave source in a paramagnetic crystal (*see* PARAMAGNETISM). The stored energy is released from the crystal by the triggering action of an incoming resonant signal. Satisfactory performance ordinarily requires operation at low temperatures (−270° to −200° C.).

A gaseous maser can be activated by an electric field arranged to remove ground-level (unexcited) particles that would absorb incident energy from a molecular stream passing through it. (For an explanation of energy levels of atoms, *see* ATOM.) The remaining excited-level particles are then stimulated to emit energy as they pass through a resonant cavity. The power corresponding to the rate at which energy is emitted is greater than the power lost in the cavity, resulting in a net power gain (*see* ATOMIC AND MOLECULAR BEAMS).

The quantum-mechanical description of the properties of matter prescribes both discrete energy levels and the average number of particles occupying those levels. Normally, lower energy levels have a greater occupancy than do higher levels; therefore, matter absorbs a net amount of energy as a result of induced transitions from lower to higher levels (absorption) in excess of the amount of energy involved in transitions from higher to lower levels (emission). Maser activation produces greater occupation in the higher levels. Spontaneous emission, a source of random noise, also occurs, but the relative improbability of this at very short wave lengths accounts for the desirable low noise characteristic of maser amplifiers.

Because the energy-level spacing of certain gases is little affected by external forces, the gaseous maser produces power at a precisely maintained frequency corresponding to that spacing, a property that is useful for accurate measurement of time (*see* TIME MEASUREMENT). Since paramagnetic energy levels are more easily affected, solid-state masers have been more important as tunable preamplifiers for supersensitive microwave receivers used, for example, in radio telescopes.

See J. R. Singer, *Masers* (1959). (J. W. M.)

MASERU, the capital town of Basutoland, Africa, is situated 4,950 ft. above sea level on the eastern bank of the Caledon river and near the territory's western border with the Orange Free State. Pop. (1956) 5,739, including 590 Europeans. The annual rainfall is about 30 in. Only a few of the early mud-walled buildings remain, many having suffered in the "Gun War" of 1880. The residency, the home of the resident commissioner of Basutoland, incorporates the pre-1880 building but has been extensively enlarged. The octagonal National Council chamber, erected in 1910 when the council was first established, is the best-known architectural feature. There are several churches and schools including an African high school and a technical school which was opened in 1906, and a well-equipped hospital. The high court of Basutoland is housed in an imposing sandstone building. Maseru is linked to the South African railway system and by road to the various district headquarters, or "camps," in the western and northern lowland border country of Basutoland; it also has air services to administrative and trading centres in the mountainous interior.

The town is one of the oldest and most historic capitals in southern Africa, having been established in 1869 when the famous paramount chief of the Basuto, Moshesh, asked for the capital to be moved there from Mokema. (Js. W.)

MASHAM, LADY ABIGAIL (d. 1734), favourite of Anne, queen of England, was the daughter of Francis Hill, a Levant merchant, who was ruined by speculation. He left four children for whom their cousin, Sarah Jennings, duchess of Marlborough, sought to provide. Through her influence Abigail entered the household of Queen Anne, and began, by compliant temper and Tory views, to supplant Sarah in the queen's affection. In June 1707 Marlborough suspected her of using her influence with the queen to further the political ends of her cousin, Robert Harley (*see* OXFORD, ROBERT HARLEY, 1st Earl of). Already Abigail had been married secretly in the queen's presence to Samuel Masham, a groom of the bedchamber to Prince George of Denmark. Grad-

ually an irreparable breach developed between Sarah and Abigail. After Harley fell from office (Feb. 1708) he contrived to negotiate with the queen through Abigail and in 1710 he arranged through her for the queen to dismiss her ministers. Abigail succeeded to the charge of the privy purse; her brother Jack became colonel and her husband was among the 12 Tory peers created in 1712 to secure approval of the treaty of Utrecht. In 1714 she deserted the earl of Oxford, accused him bitterly of being useless for the queen's service and procured his dismissal in favour of Lord Bolingbroke. After the queen's death she lived in retirement with her husband and died on Dec. 6, 1734. The fact that Abigail turned against both her patrons, the duchess of Marlborough and the earl of Oxford, has led historians to write harshly of her, but Jonathan Swift, who knew her intimately, spoke highly of her character and abilities.

The most useful work to consult on Lady Masham is W. S. Churchill, *Marlborough, His Life and Times,* 4 vol. (1933–38). (W. R. Wd.)

MASHAM, SAMUEL CUNLIFFE LISTER, 1ST BARON (1815–1906), English inventor of wool-combing and silk-combing machines, was born on Jan. 1, 1815, at Calverley Hall, near Bradford, Yorkshire, the son of a wealthy manufacturer. Starting at Manningham in 1838 with his elder brother John as spinners and manufacturers, Samuel devoted considerable attention to devising efficient mechanical wool-combing methods. He finally produced and patented a machine which performed this operation remarkably well. In time he had nine combing mills operating at once—five in England, one in Germany and three in France. In 1855 he turned his attention to finding a way of working up waste silk (*i.e.,* the residue remaining after reeling silk cocoons). After spending about ten years and an enormous amount of money, he perfected means by which silk yarn could be made from a cheap raw material and sold at many times the cost. His velvet loom was another important textile machinery development.

He was awarded an Albert medal in 1886 and created a baron in 1891. Lord Masham died at Swinton Park, Yorkshire, on Feb. 2, 1906. (A. Dr.)

MASINISSA (Massinissa) (*c.* 240–148 B.C.), ruler of much of Africa north of the Sahara in the 2nd century B.C. He was the son of the chieftain of a Numidian tribal group, the Massyli, centred on Cirta (Constantine in northeastern Algeria). Brought up at Carthage, of which his father was an ally, he fought for Carthage against the Romans in Spain at the head of a cavalry force from 212 to 206. When the Carthaginians were driven from Spain in 206 Masinissa changed sides and promised to assist the Romans in an invasion of Carthaginian territory in Africa. To make his promise effective he returned to Numidia, where his father had died and his succession was disputed. Before he could assert his rights, his kingdom was overrun by Syphax, ruler of another substantial tribal group, the Massaesyli, extending west to the Mulucha (Moulouya) river with a centre at Siga on the river of the same name (modern Tafna); Syphax, after a brief flirtation with the Romans, had remained loyal to Carthage. Masinissa escaped with a loyal following and after joining the Romans at Utica rendered them great assistance in the next two years. In return, with Roman help he became king of both Massyli and Massaesyli after the defeat of Syphax and the Carthaginians and married Syphax's Carthaginian wife Sophonisba. This action was viewed with disfavour by the Romans; according to tradition he therefore sent her poison, with which she killed herself. He showed unconditional loyalty to Rome and his position in Africa was strengthened by a clause in the peace treaty of 201 between Rome and Carthage prohibiting the latter from going to war even in self-defense without Roman permission. This enabled Masinissa to encroach on the remaining Carthaginian territory as long as he judged that Rome wished to see Carthage weakened. By the end of his reign he had extended his kingdom as far east as the Cyrenaican border and reduced Carthaginian territory to the area northeast of a line from Thabraca (Tabarka) to Thaenae (near Sfax).

This, however, was only the outward manifestation of Masinissa's ambitious and vigorous policy. His chief aim was to build a strong and unified state from the seminomadic Numidian tribes. This involved the introduction of Carthaginian techniques, particularly agricultural, and the forcible settlement of many Numidians as peasant farmers. His respect for Carthaginian civilization was also shown by his favourable treatment of Carthaginian settlements along the north African coast which were in his territory. He probably looked forward to ruling all north Africa, including Carthage, in which there grew up a party favourable to him. Such hopes were dashed when a Roman commission headed by the elderly Marcus Porcius Cato came to Africa about 155 to decide a territorial dispute between Masinissa and Carthage. Animated probably by an irrational fear of a Carthaginian revival, but possibly by suspicion of Masinissa's ambitions, Cato thenceforward advocated, finally with success, the destruction of Carthage. Masinissa showed his displeasure when the Roman army arrived in Africa in 149, but he died early in 148 without a breach in the alliance. He was the greatest figure of native north African stock in antiquity, with a lasting influence; Rome's later achievement in Numidia was partly based on his civilizing activity.

See S. Gsell, *Histoire ancienne de l'Afrique du nord,* vol. iii, pp. 171–365 (1918). (B. H. Wa.)

MASJED SOLEYMAN (Masjid-i-Sulaiman), the major oil town of Khuzistan *ostan* (province), Iran, lies 115 mi. N.E. of Ahvaz within the barren foothills of the Zagros mountains, at an elevation of 3,220 ft. The climate is extremely hot in summer but mild and rainy in winter. The town began to develop after oil was struck in May 1908 by William Knox d'Arcy's exploration team in the vicinity of the old village Masjid-i-Sulaiman, and production started in 1913. Pop. (1956) 44,655. About two-thirds of the employed population are in the oil business, the rest in trade and services. Labour supply comes largely from the Bakhtiari tribes. The town is a 12-mi.-long chain of clusters of workshops, pumping stations, tanks, small refineries, stores and depots, compounds of different grades, and bazaars, the only larger agglomeration being round the old village. The town is connected by asphalt road with Shushtar (37 mi.), Ahvaz (95 mi.) and the other oilfields. A pipeline carries the oil via Ahvaz to Abadan or to Bandar-e Ma'shur. (H. Bo.)

MASK is a form of covering for the face employed as a protective screen or disguise; the term also refers to a facial portrait in three dimensions. As a protective device, the mask has been used by medieval horsemen, by fencers, by welders and, in modified form, by participants in competitive athletic events. The practice of reproducing the features of memorable living or dead persons by a mask molded directly from the subject's face has been reported among ancient Phoenicians, Egyptians, Greeks and Assyrians. The Romans are reported to have invented a technique of casting in wax. During the 19th century, three-dimensional portraiture enjoyed great popularity in the United States and Europe. With liquid plaster of Paris, a negative cast of the human face could be produced which in turn acted as a mold for the positive image. The features of such notables as Henry Clay, De Witt Clinton and Presidents Adams, Madison and Van Buren have been preserved in life masks. Death masks of Newton, Cromwell, Bonaparte, Keats, Schiller, Washington, Lincoln, Beethoven and other well-known figures are in existence.

The principal use of the mask, however, has been as a device of disguise, serving: (1) as part of the paraphernalia in primitive ritual; and (2) as a convention in theatrical representation.

PRIMITIVE RITUAL

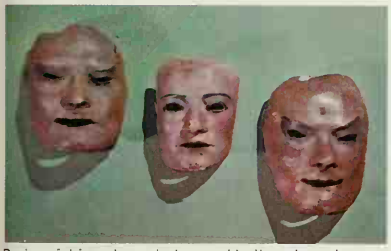
Primitive men believe that spirits govern the world. Spirits in the living and in the dead, animate and inanimate, human and bestial, real and mythological, must be cajoled, exorcised, fooled, coerced, soothed, frightened and worshipped. They must be propitiated and given concrete form by idolization. To accomplish this, elaborate rituals and ceremonies, in which masks play a dominant role, have been invented.

The origin of the mask is obscure. It may have existed first as a grotesque symbol on battle shields to frighten enemies. Some authorities point to the hunt, claiming that disguise masks were first used in stalking prey and, later, to house the slain animal's spirit in the hope of placating it. Some Africans maintain, however, that the first mask was an admonitory one. A child, re-

Clay figurines of masked Greek comedians, 3rd century B.C.

Miniature Greek mask of tragedy. Clay, 3rd century, B.C.

Twentieth-century leather *commedia dell'arte* masks, made in the Italian Renaissance tradition



Papier-mâché masks made to resemble the actors who wore them in the 1926 production of Eugene O'Neill's *The Great God Brown*

Masked musicians in a production of *The Dreaming of the Bones*, by W. B. Yeats, presented at the Abbey Theatre, Dublin

Japanese nō drama masks of lacquered wood

THEATRICAL MASKS

BY COURTESY OF (CENTRE, CENTRE RIGHT) MR. CARLO MAZZONE-CLEMENTI, (CENTRE LEFT) HARVARD THEATRE COLLECTION, PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) GJON MILI, (CENTRE, CENTRE RIGHT) THOMAS M. HILL, JR., (BOTTOM LEFT) TOM HOLLYMAN—PHOTO RESEARCHERS, INC., (BOTTOM RIGHT) PAUL HUFNER FROM SHOSTAL

MASK

Hippopotamus mask made by the Kalabari Ijo, Nigeria. This kind of mask, worn only once every 25 years, is used to honour water spirits in an elaborate pantomime ritual during which the wearer wades in chin-deep water, his mask turned skyward in imitation of a ghostly vision. Wood; 18¾ in. high

Totemic fish mask from the Orokolo Bay area of Papua, New Guinea. Painted bark cloth over a rattan frame with a fringe of dried grass. 64¼ in.

SOME REPRESENTATIVE MASKS

Carnival mask worn by a performer in the Dance of the Conquistadors, Guatemala. Papier-mâché

Female *tumbuan* mask of the Dukduk secret society, New Britain. This kind of mask was worn once a month by members of the society during ceremonies in which justice was dispensed to the tribe. The head is of sacking with tuft of feathers and skirt of leaves. 4 ft. 11 in. high

BY COURTESY OF (TOP LEFT) THE TRUSTEES OF THE BRITISH MUSEUM, (TOP RIGHT) THE PITT RIVERS MUSEUM, OXFORD, (BOTTOM RIGHT) THE MUSEUM FÜR VOLKERKUNDE, BASEL; PHOTOGRAPHS, (TOP RIGHT) J. R. FREEMAN CO., (TOP LEFT) THOMAS—PHOTOS, (BOTTOM LEFT) GEORGE HOLTON—PHOTO RESEARCHERS, INC., (BOTTOM RIGHT) "ART OF THE WORLD," HOLLE VERLAG

Balinese mask representing the witch Rangda, from the *Tjalon-Arang* dance-drama. Lacquered wood, cloth, and horsehair

Modern dance mask from Kenu on the Dahomey-Nigeria border. The carved man seated at a sewing machine on top of the mask is evidence of the influence of modern subject matter on traditional African art. Painted wood

Dance mask, representing a water demon, from New Caledonia. Cylindrical basketwork with face of blackened wood and feather fringe

Clan initiation mask from the middle Sepik region of New Guinea. Upper portion is of basketwork with faces modeled of red earth mixed with coconut oil; the mask is trimmed with shells and cassowary feathers with a skirt of bark fibres Height 70$\frac{3}{4}$ in.

BY COURTESY OF (TOP LEFT) THE TROPENMUSEUM, AMSTERDAM, (BOTTOM LEFT, BOTTOM RIGHT) THE MUSEUM FÜR VOLKERKUNDE, BASEL; PHOTOGRAPHS, (TOP RIGHT) MARC AND EVELYN BERNHEIM FROM RAPHO—GUILLUMETTE, (BOTTOM LEFT, BOTTOM RIGHT) "ART OF THE WORLD," HOLLE VERLAG

MASK

Eagle mask made by the Kwakiutl Indians, northwest coast of North America. Strings through the eyes moved the winglike side pieces to produce a frightening effect. Painted wood; breadth with side pieces extended 71½ in.

Gold funeral mask, placed over the face of an unknown Mycenaean ruler. Greece; 13th century B.C.

Aztec mosaic mask, of cedar wood inlaid with turquoise and shell. The mask may be a representation of the god Quetzalcoatl. Mexico; height 6½ in.

Ashanti gold mask from the treasure of King Kofi Kobari, Ghana. A ring beneath the beard (not visible) suggests that the mask may have been a trophy of war, attached to the king's throne. Height 6⅞ in.

BY COURTESY OF (TOP) THE BROOKLYN MUSEUM, (LEFT CENTRE) THE NATIONAL ARCHAEOLOGICAL MUSEUM, ATHENS, (BOTTOM LEFT) THE TRUSTEES OF THE BRITISH MUSEUM, (BOTTOM RIGHT) THE TRUSTEES OF THE WALLACE COLLECTION. PHOTOGRAPHS: (TOP) WOLFGANG R. HARTWANN, (BOTTOM LEFT) J. R. FREEMAN AND CO.

peatedly told not to, persisted in following its mother to fetch water. To frighten and discipline the child, the mother painted a hideous face on the bottom of her water gourd. Others say the mask was invented by a secret African society to escape recognition while punishing marauders.

Primitives have designed masks of innumerable varieties from the simplest of crude "false faces" held by a handle, to complete head coverings with ingenious movable parts and hidden faces. Masklike carvings, expected to accomplish the mask function, range in size from tiny amulets to huge totem poles and house posts. Native mask makers have shown great resourcefulness in selecting and combining available materials. Among the substances utilized are woods, metals, shells, fibres, ivory, clay, horn, jade, onyx, stone, feathers, leather, furs, paper, cloth, and corn husks. Surface treatments have ranged from rugged simplicity to intricate carving, from polished woods and mosaics to gaudy adornments.

Because everything was believed to possess a spirit, it was natural for primitive man to become selective, to find authority for himself and his family by identifying with a specific nonhuman spirit. He adopted, therefore, an object of nature as the resting place for his own spirit, and mythologically tracing his ancestry back to the chosen object, he pre-empted the leopard or elephant, the hawk or serpent as the emblem of himself and his clan. This is the practice of totem, and it is the basic religious conception of the primitive hunter. He puts a taboo on his totem, forbids himself and his totem brothers to kill or eat it, makes masks to house the totem spirit, dances for it and invents ritual to honour it. The totem ancestor, he believes, actually materializes in its mask; so masks are of the utmost importance in securing protection and bringing comfort. Totemism consolidates family pride and distinguishes social lines.

The Papuans of New Guinea build mammoth totem masks attaining 20 ft. in height. Made of wood or bark cloth, these man-animal masks are given large, painted eyes and a frightening aspect. When placed against the wall of the men's secret clubhouse they serve to protect the members of the totem clan. Similar is the practice among the Indians of the American northwest coast where painted masks three or four feet long signifying the clan are placed before individual members' homes. The totem pole of the Eskimo and British Columbian Indian fulfills the same function. The African totem mask is most often carved from ebony or other hard woods, designed with graceful lines and showing a highly polished surface. Deer, antelope, gorilla, elephant, panther and leopard masks, their features elongated and beautifully formalized, are common. Generally, the South Pacific masks are more grotesque than the African, less attention being given to realism in concept or execution. Dried grass, woven palm fibres, coconuts and shells, as well as wood, are employed in the masks of New Guinea, New Ireland and New Caledonia. Represented are fanciful birds and animals with distorted or exaggerated features.

The high priest among most primitives was the *shaman* or medicine man. Frequently he had his own very powerful totem, in whose mask he could exorcise evil spirits, punish enemies, locate game or fish, predict the weather and, most importantly, cure disease. Usually, the medicine man's mask was sacred, more mythological, elaborate and fantastic than others.

The northwest-coast Indians in particular devised mechanical masks with movable parts to reveal a second face—generally a human image. Believing that the human spirit could take animal form and *vice versa*, the makers of these masks fused man and bird or man and animal into one mask. Some of these North Pacific articulating masks acted out entire legends as their parts moved. One, called the mask of the first dawn, represents night when its black wings are closed. When the wearer pulls a string and the wings open, a red, beaked sun appears; another string, and the sun mask rises on small iron rods to reveal the face of the light-maker painted white. A device on top scatters tiny feathers to represent mist or fog.

The *shaman* of the North American Pueblo Indians, the Hopi, the Zuñi and Keres, is primarily concerned with rain making. Together with masked dancers representing clouds, rain spirits, stars, Earth Mother, sky-god, etc., he takes part in elaborate ceremonies designed to assure bumper crops. Spirits, called *Kachinas*, who first brought rain to Pueblo tribes, are said to have left their masks behind when sent to dwell in the bottom of a desert lake. Their return to help bring the rain is incarnated by the masked dancer. Cylinder- and postlike masks, covering the entire head and resting on the shoulders, are of a primal type. They are made of leather, old saddles or rawhide, humanized by hair and a variety of adjuncts. Eyes are represented by incisions or by buckskin balls filled with deer hair and affixed to the mask. The nose is commonly of rolled buckskin or corncob. Frequently the mask has a projecting wooden cylinder for a bill or a gourd stem cut with teeth for a snout. Horns are attached to some masks and the datura, a flower which has the power to induce hallucinatory visions, is generally a part of the adornment. Many colours are used in their painting; plumes and beads are attached and the sex of the mask is distinguished by its shape: round head for male and square for female.

The magic of the mask has been employed extensively to cure sickness, usually by the medicine man wearing a mask representing the fever or specific disease; he devil dances the illness out of the patient into the mask. Chinese children have long been made to wear measle masks to protect them from that common ailment, and both the Chinese and Burmese have had cholera masks. The disease mask reached its zenith in Ceylon where 19 distinct disease devil masks were devised. Even deafness was thought curable by use of the mask. The Sinhalese disease masks are of ferocious aspect, fanged, and with starting eyes. Sometimes having articulating jaws and, gaudily coloured, they present a dragonlike appearance.

In some primitive cultures, secret societies, whose members were masked, could drive disease demons from entire villages and tribes. Most familiar is the False Face society of the Iroquois Indians from the American northeast coast. These professional medicants wear long-haired, grimacing, twisted masks representing the *Gahadogoka gogosa*, demons who plague the Iroquois. Violent pantomimes are performed to exorcise them. According to legend the False Face masks must be carved from a living basswood tree, so they will possess life. Permission, which is sought through incantations and ritual, must be granted by the tree.

Like disease-curing, the art of demon-chasing and of admonishing women, children and criminals has had wide practice. Discipline masks are common in China, Africa, the South seas and North America. Towering false faces, mumbo jumbo, screaming giants and identically masked men maintain order and exact punishment among tribes in the Congo. The Dukduk, a secret society in New Britain, appear in their monstrous five-foot masks once a month to police, to judge and to execute offenders.

The Dukduk, like other secret societies, also preside at initiation ceremonies, an important function throughout the primitive world. Totem and spiritualistic masks are donned at these ceremonies, and some elaborate, precious masks of gods and demons are reserved for appearance only at initiation, the most important ceremony in the male's life. The Great Cannibal Spirit dominated the Kwakiutl Indians' initiation rites in British Columbia, a strange, heavily carved wooden face with four pipelike eyes and horns and an extended pipe as mouth. Most impressive of initiation masks are the exquisitely carved human faces of the west coast Africans. Among the Bapendes of the Republic of the Congo, after a lengthy ordeal of teaching and rites of initiation, the youth appears in a mask representing the ghost of his childhood. The mask is later cast aside and replaced by a small ivory duplicate which is worn as a charm against misfortune and as a symbol of his manhood.

Ceremonies associated with the dead and with departing spirits exist in every known culture. Totem ancestors, demon spirits, benevolent shades and mythological characters are all represented by masks at funerals and spiritual festivals. Primitive men believed it necessary to entice or force spirits of the newly dead to depart for the spirit world. Money, food, means of transportation and other travel accessories were placed with the body to assist the spirit to the nether world. Obstreperous and obstinate spirits had to be exorcised with masks designed to frighten and coerce.

The Donegon tribe of Africa has a six-day funeral ritual performed by masked dancers to drive away reluctant spirits. Curiously, some of these African masks have white complexions and non-Negroid features.

Some primitives, particularly those of the South seas and Africa, set aside certain times of the year to honour and placate departed spirits. On these occasions recognizable masks of dead chieftains, relatives, foes and friends are worn or exhibited. Gifts are made to the spirits incarnated in the masks while professionals, wearing stylized mourning masks, dance the ritual. In parts of Africa spiritualism flourishes much like a sport. The youths of the tribe do not even need a funeral in order to make "juju," the practice in which the community is presented with returning spirits, in the form of masks, who exact gifts from relatives as the price for re-departure.

Burial masks to protect spirits and guide them on their way have been widely excavated. In Mycenae were found seven of beaten gold which appear to be portrait masks. Gold masks were regularly placed on the faces of dead kings in Cambodia and Siam, and burial masks of silver and gold, bronze and terra cotta have been discovered in Japan, Greece, Italy, the Crimea, Mexico, South American countries, Phoenicia, Mesopotamia, France, Britain and in the Danube valley, suggesting that similar practices were universal. For 3,000 years, the Egyptians placed a stylized, impersonal mask of painted plaster, gold or silver upon the face of important dead persons in order that the spirit might find its final resting place, the mask serving to guide the spirit back to the body. In Mexico masks were often placed upon idol statues to animate them. Made of jadeite or onyx, the Toltec and Aztec masks, whether of idols, chieftains, or village leaders, are marked by great simplicity, formalism and symbolic realism. They seem to be generic representations of the tribe rather than portraits of individuals, and they are still carved by Indian craftsmen. Masks made from skulls have been found in Mexico and in Melanesia. Believing that the skull was the home of the spirit, the Aztecs took great care of those inhabited by important personages. Like their wooden masks, the Aztec skull masks are inlaid with turquoise mosaic bands alternating with bands of lignite. Eye sockets were filled with pyrites, and holes were drilled in the back so the mask might be hung as an idol.

In Melanesia ornamented skull masks were often hung in front of a dead man's statue to give it life, just as ashes of a dead Alaskan chief were put in the abdominal hole of his ancestor post to animate it and give it potency.

Among the special uses of masks other than those mentioned are the widely used war masks, worn not for protection but to frighten the foe. War masks are now ordinarily worn only in dances and rituals, especially among the Africans, Javanese and northwest coast Indians. The primitives of New Ireland devised "peace masks" worn at victory festivals in which even the enemy participated.

Still another special mask is the Dionysiac mask of fertility. Often out-and-out clowns such as the "Mud Heads" of the American Pueblos, masks of this sort are common in *fiestas* and are among the forerunners of Halloween, Mardi gras and other festival masking. Ludicrous, grotesque or superficially horrible, festival masks are usually conducive to good-natured licence, release from inhibitions, and ribaldry.

Not to be overlooked are the masks used throughout Mexico for storytelling and caricature, such as those seen in the Dance of the Old Men and the Dance of the Moors and the Christians. Many "art for art's sake" masks, made with no religious connotations but simply for decorative purposes, are made available to tourists. Japan and Mexico, Kenya and Indonesia are among the leading producers of these handsome artifacts.

THEATRE

Greek and Roman.—The mask as a device for theatre first emerged in western civilization from the religious practices of ancient Greece. In the worship of Dionysus, god of fecundity and the harvest, the communicants' attempt to impersonate the deity by donning goat skins and by imbibing wine eventually developed into the sophistication of masking. When a literature of worship appeared, a disguise, which consisted of a white linen mask hung over the face (a device supposedly initiated by Thespis), enabled the leaders of the ceremony to make the god manifest. Thus symbolically identified, the communicant was inspired to speak in the first person, thereby giving birth to the art of drama. In Greece the progress from ritual to ritual-drama was continued in the highly formalized theatrical representation, which, although still concerned with religious and semireligious subjects and performed in connection with religious exercises, was maintained by the state and performed by professionals and is understood as the beginning of secular drama in the west. Masks used in these productions became elaborate headpieces made of leather or painted canvas and depicting an extensive variety of personalities, ages, ranks and occupations. Heavily coiffured and of a size to enlarge the actor's presence, the Greek mask seems to have been designed to throw the voice by means of a built-in megaphone device and, by exaggeration of the features, to make clear at a distance the precise nature of the character. Moreover, their use made it possible for the Greek actors—limited by convention to three speakers for each tragedy—to impersonate a number of different characters during the play simply by changing masks and costumes.

In his encyclopaedia, *Onomasticon,* Julius Pollux, Greek sophist and grammarian of the 2nd century A.D., described in detail the catalogue of comic and tragic masks used in the earlier Greek theatre, but no clear visual picture of these masks emerges. Several manuscripts of the plays of Terence contain illustrations of masks used by comic actors of the Roman theatre, a theatre heavily influenced by the style and practices of the Greek. Their comic mask appears to have been a grotesque affair with the mouth fashioned in the form of a huge bivalve generally fringed with a stylized beard. Details from frescoes, vase paintings and fragments of stone sculpture complete what is known of these ancient theatrical masks. The tendency of the early Greek and Roman artists to idealize their subjects throws doubt, however, upon the accuracy of these reproductions. Some authorities, such as Olive L. Riley, maintain that the masks of the ancient theatre were crude affairs with little aesthetic appeal.

Medieval.—After the interval of the Dark Ages, the mask makes its appearance again in the mystery plays of the late middle ages. In plays dramatizing portions of the Old and New Testaments, grotesques of all sorts, such as devils, demons, dragons and personifications of the seven deadly sins, were brought to stage life by the use of masks. But again, no reliable pictorial record has survived. Costume and property lists for the English cycle plays contain scattered references. For example, the Norwich *Creation* play notes "a face [mask] and hair for the Father." Other references suggest that Lucifer wore a false head painted black and that actors impersonating God and probably Christ had masks covered with gilt. Masks used in connection with present-day carnivals and Mardi gras and those depicting dragons still used by Tyrolean peasants are most likely the inheritors of the tradition of medieval masks. Constructed of papier-mâché, the masks of the mystery plays were evidently marvels of ingenuity and craftsmanship, being made to articulate, and to belch fire and smoke from hidden contrivances.

Renaissance.—The Renaissance in Italy witnessed the rise of a theatrical phenomenon that spread rapidly to France, to Germany and to England, where it maintained its popularity into the 18th century. Comic plays improvised from scenarios based upon the domestic dramas of Plautus and Terence and upon situations drawn from anonymous Roman mimes flourished under the title of *commedia dell'arte* (*q.v.*). Adopting the Roman stock figures and situations to their own usages, the players of the *commedia* characterized types such as Pantalone, Dottore, El Capitano, young lovers and a variety of *Zanni* with such names as Arlecchino, Brighella, Scaramuccia, Scapino, Pedrolino and Pulcinella. Most of these characters were masked. Sometimes the masking was grotesque and fanciful; but generally a heavy leather mask, full or half face, with beaked nose and wrinkles, with a wart on the forehead to distinguish particular *Zanni,* disguised the *commedia* player. Excellent pictorial records of both *commedia* costumes and masks

exist; some sketches show Harlequin and Colombina wearing black masks covering merely the eyes from which the later masquerade mask is certainly a development. Mask making has remained a fine art in Italy.

Modern.—Except for vestiges of the *commedia* in the form of puppet and marionette shows, the drama of masks all but disappeared in western drama during the 18th, 19th and first half of the 20th centuries. In revivals of Greek plays masks have occasionally been employed, and such plays as Gerhart Hauptmann's *The Sunken Bell* and dramatizations of *Alice in Wonderland* have required masks for the performers of grotesque or animal figures. But the mask as a convention has lost its importance. W. B. Yeats revived the convention in his *The Dreaming of the Bones* and in other plays patterned upon the Japanese nō drama, and in 1926 theatregoers in the United States witnessed a memorable use of masks in Eugene O'Neill's *The Great God Brown*, wherein actors wore masks of their own faces to indicate changes in the internal and external lives of their characters.

Japanese.—In many ways akin to the Greek drama in origin and theme, the nō drama (*q.v.*) of Japan has remained a significant part of national life since its beginnings in the 14th century. Inspired by the Buddhist priests of the Zen sect and by the pleasure-loving Shogun Yoshimitsu, 210 nō dramas are still in existence. The nō mask, of which there are about 125 named varieties, are rigidly traditional and are classified into five general types: old persons (male and female), gods, goddesses, devils and goblins. The material of the nō mask is wood with a coating of plaster lacquered and gilded. Colours are traditional. White is used to characterize a corrupt ruler; red signifies a righteous man; a black mask is worn by the villain who epitomizes violence and brutality. Nō masks are sharply characterized and exquisitely carved by highly respected artists known as *Tenka-ichi*, "the first under heaven." Tranquility, wrath, cunning and mirth, as well as more subtle shades of feeling, are portrayed with beautifully sublimated realism. It is said of these masks that when in movement they appear to change in expression.

Tibetan.—In Tibet, sacred dramas illustrating the former births of Buddha and similar events are performed by masked lay actors. A mystery play with manifestations of gods and demons by awe-inspiring masks is performed exclusively by the priests or Lamas at fixed seasons of the year and is still called "Dance of the Red Tiger Devil." This play appears to have been originated by a devil-dancing cult and is performed for the exorcising of demons. Masks employed in this play are made of papier-mâché, cloth and occasionally gilt copper. In Sikkim and Bhutan, where wood is abundant and the damp climate destructive, they are carved of durable wood; in all cases they are fantastically painted and provided with a wig of yaktail in various colours. They take the forms of hideous tusked ogres, animals, ghouls and skeletons; the jester or buffoon has a blue mask and cowls.

Chinese.—Masks, usually made of papier-mâché, are employed in the religious or admonitory drama of China, but for the greater part the actors in popular or secular drama make up their faces with cosmetics and paint to resemble masks. The sacred drama, which in China is highly didactic, is peopled with devils, madonnas, kings and court attendants of the ten purgatories; all are masked fancifully and grotesquely. Akin to this "morality" drama are the congratulatory playlets, pageants, processions and dances of China. Masks employed in these ceremonies include animal gods, sky-gods, mythological heroes, dragon kings and ancestors. They are highly ornamented masks, with jeweled and elaborately filigreed headgears. In the lion dance of both China and Japan, a red mask of a lion is carried on a pole by itinerant players whose bodies are concealed by a dependent red cloth. The mask and cloth are manipulated violently, as if the animal were in pursuit, to the taps of a small drum. The lower jaw of the mask is movable and is made to emit a loud continuous clacking by means of a string.

Javanese.—In Java, wooden masks, *tupeng*, are used in certain theatrical performances that are extremely popular. These plays developed from the shadow puppet plays of the 18th century and are performed not only as amusement but as a safeguard against calamities. The stories are in part derived from ancient Sanskrit literature, the Mahabharata and the Ramayana, although the Javanese are now Muslims. The masks are ordinarily held in the teeth by means of a strap of leather or rattan fastened across the inside. Occasionally an actor interrupts the unseen Dalang who is speaking the play. The mask is then held in front of the face while the player says his line. The use of masks in Java is exceptional; for masks, being forbidden under the prohibition of images, are practically unknown in the Islamic east. *See* also references under "Mask" in the Index.

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MASK, LOUGH (Loc Measia), a lake which, like Lough Corrib (*q.v.*), 3 mi. S., has the Irish Central lowland to the east and the towering mountains of Connaught to the west. It is mainly 4 to 5 mi. wide, with offshoots into the mountain valleys, and 10 mi. long. Some of its shores are marshy pastures, but there are also small hills of well-drained soils, known as drumlins, all of which are farmed. The lake, 62 ft. above sea level, receives the drainage of the smaller Lough Carra, at 69 ft., and of various rivers. In the 19th century a canal was dug to connect Mask with Corrib but all the water sank through the limestone. Lough Mask is 191 ft. deep, perhaps owing to the scouring action of ice, though its origin is mainly due to solution of the limestone so widely developed in this western part of the Irish lowland. Beside a ruined castle on the lake shore, a few miles southwest of Ballinrobe, is Lough Mask house, famous as the residence of Capt. Charles Cunningham Boycott (*q.v.*). (T. W. Fr.)

MASKELYNE, NEVIL (1732–1811), 5th English astronomer royal, whose chief aim was the practical improvement of the art of navigation, was born in London on Oct. 6, 1732. He was educated at Westminster school and Trinity college, Cambridge, where he graduated as 7th wrangler in 1754. He was ordained in 1755, but his interest in astronomy had been aroused by the eclipse of July 25, 1748, and in 1761, on James Bradley's recommendation, he was deputed by the Royal society to observe the transit of Venus in St. Helena. During the voyage he experimented upon the determination of longitude by the method of "lunars," and introduced this method into navigation by publishing, in 1763, *The British Mariner's Guide*. In 1765 Maskelyne succeeded Nathaniel Bliss as astronomer royal. In 1766 he published the first volume of the *Nautical Almanac*. He continued the superintendence of this, his greatest work, until his death on Feb. 9, 1811.

Maskelyne's first contribution to astronomical literature was "A Proposal for Discovering the Annual Parallax of Sirius," published in 1760 (*Phil. Trans.*, li, 889). Subsequent volumes of the same series contained his observations of the transits of Venus (1761, 1769), on the tides at St. Helena (1762) and on various astronomical phenomena at St. Helena (1764) and at Barbados (1764). In 1772 he suggested to the Royal society the famous Schiehallion mountain experiment for the determination of the earth's density, and he carried out his plan in 1774. From Maskelyne's observations Charles Hutton deduced a density for the earth 4.5 times that of water.

MASKS, GAS: *see* Gas Mask.

MASOLINO DA PANICALE (Tommaso di Cristoforo Fini) (1383–after 1435), one of the principal Florentine painters of the early Renaissance, was born at Panicale near San Giovanni Valdarno in 1383. He thus came from the same district as his younger contemporary Masaccio (*q.v.*), with whom his career was closely linked. Trained in a Florentine studio, possibly that of Gherardo Starnina, he appears before 1407 to have been a member of the workshop of Lorenzo Ghiberti. He was enrolled in the Arte dei Medici e Speziali in Florence in 1423. In 1424 he received payment for frescoes in S. Stefano at Empoli (in large

part destroyed); a half-length "Virgin and Child With Two Angels" in S. Stefano and a "Pietà" in the Collegiata at Empoli also date from this time. A panel of the "Virgin and Child" in the Alte Pinakothek at Munich was probably painted before 1420, and a "Virgin and Child" in the Kunsthalle at Bremen is dated 1423.

The earliest work executed in collaboration by Masolino and Masaccio, a "Virgin and Child With St. Anne" (Uffizi, Florence), painted about 1420, illustrates the fundamental antithesis between the decorative late Gothic style of Masolino and the more progressive style of his pupil Masaccio. In this work Masolino was responsible for the cartoon and for executing the figures of St. Anne and four of the five angels.

A double-sided altarpiece for Sta. Maria Maggiore in Rome (now distributed between the Pinacoteca Nazionale in Naples, the Philadelphia Museum of Art and the National gallery, London) seems also to have been commissioned from Masolino about 1424 and was executed in conjunction with Masaccio. The two central panels of this altarpiece, representing the foundation of Sta. Maria Maggiore and the Assumption of the Virgin, are Masolino's most distinguished panel paintings.

The influence on Masolino of the stronger and more decisive personality of Masaccio reached its climax in the frescoes of scenes from the life of St. Peter in the Brancacci chapel in the church of the Carmine in Florence. There have been many opinions about the respective shares of the two artists in this important cycle. It is likely that the frescoes were commissioned from Masolino about 1425 and that at this time he painted some lost scenes in the upper register of the chapel walls. Thereafter he worked in Hungary, from which he returned in 1427 to undertake, jointly with Masaccio, the remaining frescoes in the chapel. By this time the balance of emphasis within the studio had shifted toward Masaccio, and Masolino was responsible for only one fresco, that of "St. Peter Preaching," on the altar wall and three scenes on the right wall, the "Fall of Adam and Eve," the "Healing of the Lame Man" and the "Raising of Tabitha," where the perspective scheme seems to have been worked out and in part realized by Masaccio. The figures in the latter fresco reveal Masolino as an artist of great suavity and as a consummate colourist.

Work on the Brancacci frescoes was abandoned in 1428, and probably at this time Masolino received the commission for a fresco cycle in the Branda chapel in S. Clemente in Rome. The death of Masaccio in Rome in the autumn of 1428 marks a turning point in Masolino's career, and the story of his later development is that of a progressive return to the international Gothic idiom of his youth. This is evident initially in the S. Clemente frescoes (where the space construction is once more decorative) and subsequently in a frescoed "Virgin and Child" in S. Fortunato at Todi (1432) and in fresco cycles in the Baptistery and Collegiata at Castiglione d'Olona (Lombardy). The decoration of the Baptistery (which contains scenes from the life of St. John the Baptist) was completed in 1435, and makes use of the same deep but imperfectly systematized space constructions as the S. Clemente frescoes. The extensive panoramas in the backgrounds of the "Crucifixion" on the altar wall in S. Clemente and the "Baptism of Christ" at Castiglione d'Olona are milestones in the history of landscape painting. An important landscape fresco by Masolino also exists in the Palazzo Castiglione at Castiglione d'Olona. With their light tonality and elegant, rhythmical figures, the scenes by Masolino in the Baptistery and Collegiata form two of the most fascinating fresco cycles of the 15th century. Like the sculptor Ghiberti, Masolino achieved a compromise between the Gothic past and the advanced style of his own day, and owes his prominence in the history of Florentine art not to his innovations but to his lyrical style and his unfailing artistry. Masolino's death is generally assigned to the year 1447, but may have occurred at any time after 1435.

See P. Toesca, *Masolino da Panicale* (1908); M. Salmi, *Masaccio* (1948). (J. W. P.-H.)

MASON, the name of a distinguished family of U.S. musicians in the 19th and early 20th centuries.

LOWELL MASON (1792–1872) was a pioneer of musical education in the U.S. and a composer of hymn tunes. Born at Medfield, Mass., on Jan. 8, 1792, he founded the Boston Academy of Music in 1832 and later trained music teachers. He promoted festivals of choral music and published many successful song collections and hymns; among the latter, "Nearer My God to Thee" became famous. He died at Orange, N.J., on Aug. 11, 1872.

WILLIAM MASON (1829–1908), son of Lowell Mason, was born at Boston, Mass., on Jan. 24, 1829. He was a pupil of Ignaz Moscheles and Liszt and became known as a concert pianist, piano teacher and composer of light piano pieces. He died in New York city on July 14, 1908.

DANIEL GREGORY MASON (1873–1953), a grandson of Lowell Mason and nephew of William Mason, was born at Brookline, Mass., on Nov. 20, 1873. His father, Henry Mason, was a cofounder of the firm of Mason and Hamlin, piano manufacturers. Daniel Gregory Mason studied with John K. Paine at Harvard university and later took lessons from Vincent d'Indy in Paris. In 1910 he joined the faculty of Columbia university and taught there until his retirement in 1942. His music was written in the manner of the German romantic composers but it also employed devices of French impressionism and Russian modernism. He wrote three symphonies, a festival overture *Chanticleer,* chamber music and several books of essays and teaching guides. He died on Dec. 4, 1953, at Greenwich, Conn.

See W. Mason, *Memories of a Musical Life* (1901); D. G. Mason, *Music in My Time, and Other Reminiscences* (1938). (N. Sy.)

MASON, GEORGE (1725–1792), author of the Virginia constitution of 1776 with its influential declaration of rights, and member of the federal Constitutional Convention of 1787, was born in Fairfax county, Va., in 1725. His father died when George was ten years old, leaving him in the care of his mother and John Mercer, a relative and a prominent attorney. As the eldest son he inherited the family estate but received little formal education. He was privately tutored and read law in Mercer's office but did not take up law as a profession, preferring the life of a planter.

As a landowner and near neighbour of George Washington, Mason took a leading part in local affairs, serving as vestryman of Truro parish and justice of Fairfax county. He became deeply interested in the Ohio company, which had been organized in 1748 by his friends and neighbours to develop trade and sell land on the upper Ohio river. At about the same time Mason helped to found the town of Alexandria, Va. In 1759 he was elected to the Virginia house of burgesses; except for his membership in the Constitutional Convention of 1787, this was the highest office he ever held—yet few men did more to determine the original shape of American political institutions.

A leader of the Virginia patriots on the eve of the American Revolution, Mason served on the committee of safety and in 1776 drafted the constitution for Virginia, his declaration of rights being the first authoritative formulation of the doctrine of inalienable rights. Mason's work was known to Thomas Jefferson and influenced his drafting of the Declaration of Independence. Mason's model was soon followed by most of the other states and was also incorporated, in a watered-down form, into the federal constitution. He was a member of the Virginia house of delegates from 1776 to 1788.

As a member of the Philadelphia Constitutional Convention of 1787, Mason strenuously opposed the compromise permitting the continuation of the slave trade until 1808. Because of this and because he objected to the large and indefinite powers vested in the new government, he joined Patrick Henry and Richard Henry Lee in opposing adoption of the federal constitution. A Jeffersonian Republican, he believed that local government should be kept strong and central government weak. His criticism of the proposed new constitution helped bring about adoption of the Bill of Rights, as the first ten amendments came to be known. Mason declined election to the senate and retired to his home, Gunston Hall, where he died on Oct. 7, 1792.

See K. M. Rowland, *The Life and Writings of George Mason* (1892); H. D. Hill, *George Mason: Constitutionalist* (1938). (T. P. A.)

MASON, JAMES MURRAY (1798–1871), U.S. political leader, whose seizure with John Slidell (*q.v.*) precipitated the famous "Trent affair" during the American Civil War, was born in

Fairfax county, Va., on Nov. 3, 1798. He was a member of the Virginia house of delegates (1826–32), of the state constitutional convention of 1829, of the national house of representatives (1837–39) and of the U.S. senate from 1847 until the outbreak of the Civil War when he resigned to take part in the Virginia secession convention. A staunch Democrat, he upheld state's rights and slavery and was the author of the Fugitive Slave act of 1850.

In Aug. 1861 he was appointed commissioner of the Confederate states to Great Britain. The British ship "Trent," upon which he and John Slidell, the commissioner to France, sailed, was intercepted by a U.S. ship-of-war, and the two commissioners were seized and carried as prisoners to Boston but were released two months later through the demands of Great Britain. Arriving at London, Mason was unable to secure official recognition, and his commission to Great Britain was withdrawn late in 1863.

He died at Alexandria, Va., on April 28, 1871.

See Virginia Mason, *The Public Life and Diplomatic Correspondence of James M. Mason, with some Personal History* (1903).

MASON, JOHN (1586–1635), founder of New Hampshire, was born in King's Lynn, Norfolk, Eng. He was governor of the English colony in Newfoundland (1615–21) and published the first map of that region. In 1622 he obtained from the council for New England a grant of the territory (Mariana) between the Salem and Merrimack rivers, and with Sir Ferdinando Gorges, a grant of the region between the Merrimack and Kennebec rivers extending 60 mi. inland (Province of Maine).

In 1629 Mason and Gorges agreed upon a division of their joint holdings, Mason receiving the tract between the Merrimack and the Piscataqua, which he named New Hampshire. With Gorges and a few associates, he also secured a grant of the region named Laconia, including Lake Champlain, and in 1631 the Pescataway grant, bordering on the Piscataqua river.

He was vice-president of the council for New England in 1632, and in 1635 was appointed vice-admiral for New England, but died in London in Dec. 1635, before he could return to North America. He was buried in Westminster abbey.

See *Captain John Mason, the Founder of New Hampshire,* published by the Prince Society (1887).

MASON, JOHN YOUNG (1799–1859), U.S. political leader and diplomat who helped frame the Ostend manifesto (*q.v.*) calling for the annexation of Cuba by purchase or war, was born in Greensville county, Virginia, on April 18, 1799. He served in the Virginia house of delegates (1823–27), the national house of representatives (1831–1837), and as judge of the U.S. district court for Virginia (1837–44). From 1844 to 1849 he was a member of the cabinets of Presidents Tyler and Polk, as secretary of the navy, and served for a time as attorney general. He was president of the Virginia constitutional convention of 1850, and from 1853 was minister to France. In 1854 Mason joined with James Buchanan and Pierre Soulé, ministers to Great Britain and Spain respectively, in drawing up the manifesto, which was disavowed by the U.S. state department. He died at Paris, Oct. 3, 1859.

MASON, MAX (1877–1961), U.S. mathematical physicist and educator, president of The University of Chicago from 1925 to 1928, was born at Madison, Wis., on Oct. 26, 1877. He completed his undergraduate work at the University of Wisconsin in 1898 and received the Ph.D. degree from the University of Göttingen in 1903. His special interests and contributions lay in mathematics (differential equations, calculus of variations), physics (electromagnetic theory), invention (acoustical compensators, submarine detection devices) and administration of universities and foundations. Following brief appointments in mathematics at the Massachusetts Institute of Technology and Yale university, Mason taught mathematical physics at the University of Wisconsin (1908–25). In 1925 he turned to administration, first as president of The University of Chicago, then as director of natural sciences of the Rockefeller foundation (1928–29) and as president of the foundation (1929–36). In 1936 he joined the California Institute of Technology as chairman of the observatory council and member of the executive council, retiring in 1949, and later taught at Claremont (Calif.) Men's college. He died at Claremont on March 23, 1961. (J. G. H.)

MASON, WILLIAM (1725–1797), English poet, friend and first editor of Thomas Gray, was born in Hull, Feb. 23, 1725, and educated at Hull grammar school and St. John's college, Cambridge. At Cambridge he published *Musaeus* (1747), a lament for Pope, and in 1749 was made a fellow of Pembroke college through the influence of Gray, whom he admired. Mason's poem *Isis* (1749), attacking Jacobitism in Oxford university, provoked Thomas Warton's *Triumph of Isis* (1749), generally considered superior. His two pseudoclassical plays *Elfrida* (1752) and *Caractacus* (1759) were performed in 1772 and 1776 respectively. Horace Walpole called *Caractacus* "laboured, uninteresting and no more resembling the manners of Britons than of Japanese": Gray wrote that he had read it "not with pleasure only but with emotion." Gray also said that Mason, whose verses he corrected and whom he nicknamed "Scroddles," "reads little or nothing, writes abundance, and that with a design to make a fortune by it."

Ordained in 1754, Mason received many preferments, including a canonry of York and a royal chaplaincy (1757–73). On Gray's death in 1771 Mason, his literary executor, began to edit and in 1775 published *Memoirs . . . and Poems of Mr. Gray,* including only such poems as he thought fit for a definitive edition. Contemporaries described this as an "inimitable edition," "a new species of biography," but modern editors have condemned his silent mutilation of Gray's letters. He had been helped by Walpole, with whom he corresponded regularly until 1784, when they quarreled, but the correspondence was later renewed. Mason died at Aston, April 5, 1797. His collected works, in four volumes, were published in 1811; his correspondence with Gray was edited by J. Mitford in 1853.

See W. S. Lewis (ed.), *H. Walpole's Correspondence,* vol. 28 and 29 (1955); J. W. Draper, *W. Mason* (1925).

MASON AND DIXON LINE, the boundary in the United States between Maryland and Pennsylvania, popularly regarded as the dividing line between the north and the south, although it does not extend west of the Ohio river. The line was drawn by two English surveyors, Charles Mason and Jeremiah Dixon, in 1763–68, to settle a lengthy dispute between the Penns and the Baltimores, proprietors respectively of Pennsylvania and Maryland. The dispute arose over conflicting claims to the territory from the Delaware river westward. In 1632 Lord Baltimore had been given the land north of Virginia to that point "which lieth under the Fortieth degree of north latitude" and westward to the source of the Potomac. In 1681 William Penn had been granted the area between 43° N. and a line extending westward from "a Circle drawne at twelve miles distance from New Castle . . ." to "the beginning of the fortieth degree. . . ." In 1682 Penn received a grant in the Delaware peninsula, which Baltimore claimed.

In 1685 the crown ordered this territory divided equally, the western half going to Baltimore. After years of bitter controversy Lord Chancellor Hardwicke ruled (1750) that the southern boundary of Pennsylvania should be a line running westward from the point at which the line dividing the Delaware peninsula was tangential to a circle with a radius of 12 mi. from the centre of Newcastle. Mason and Dixon resurveyed the Delaware tangent line and the Newcastle arc and in 1765 began running the east-west line from the tangent point, at approximately 39° 43′.

Along this line the surveyors set milestones brought from England, every fifth stone in the eastern portion a "crown stone" bearing the arms of Penn on one side and of Baltimore on the other. The 233-mi. line was completed in 1768 at a cost of $75,000. In 1779 Pennsylvania and Virginia agreed to extend the line westward to a point five degrees from the Delaware river, a line running north from that point to be the westward boundary of Pennsylvania. (H. L. S.)

MASON BEE, the name given generally to several genera of bees of the subfamily Osmiinae (family Megachilidae), which construct earthen cells, sometimes mixed with sand, pebbles or wood, each cell containing a single egg, together with honey and pollen as food for the larva. These bees are called solitary to distinguish them from the social Hymenoptera. *See* Bee; Hymenoptera.

MASON CITY, a city of north-central Iowa, U.S., the seat of Cerro Gordo county, is located on the Winnebago river, midway between Des Moines and the twin cities of Minneapolis-St. Paul, Minn. An 80-mi. radius of rich corn belt farm land produces large quantities of livestock, dairy products, poultry, eggs and a variety of farm crops.

The school system includes Iowa's first and largest junior college, Mason City junior college, founded in 1918. There are 270 ac. of public parks and two golf courses. Excellent recreational facilities are also found at Clear lake and at two state parks 10 mi. W. There are adequate accommodations for tourists and conventions.

Underlain by deposits of clay and limestone 30 ft. deep, and with sand and gravel available, Mason City supports a substantial cement industry and has one of the largest brick and drain tile plants west of the Mississippi. Other industries include meat packing, beet-sugar refining, creameries, soybean processing, fertilizer processing, millwork, founding and natural gas and gasoline pipelines.

Mason City owes its name to settlement (1853) by Freemasons. First platted in 1855, it was incorporated as a town in 1870 and as a city in 1881. For comparative population figures *see* table in Iowa: *Population.* (Hu. H. S.)

MASONRY, the craft of building with stone. The English word "mason" is from the French, which appears in two forms, *machun* and *masson* (from the last comes the modern French form *maçon,* which means either "bricklayer" or "mason"). This article deals with the history of masonry and illustrates the work of the craftsman and his tools, the machinery and processes used in modern masonry production, technical terms and types of stone.

HISTORY

The period at which wrought stone was first used architecturally is quite unknown; the earliest records of masonry worthy of the name are found in the ancient temples of Egypt, Chaldea, Phoenicia, India, China, Babylon, Assyria and Crete.

The remains of the Egyptian pyramids and vast temples are proof that the craft of masonry was in a very advanced state, hardly to be surpassed by modern craftsmen. The skill of the early Egyptian masons was quite incredible. For example, the masonry joints of the stones on the great pyramid of Khufu are under 1/100 in. thick, and some of the stones weigh up to 60 tons. Their great size and the fact that they were quarried about 140 mi. from the site indicate that vast armies of labourers were employed on the pyramid's construction, which, it has been calculated, required the continuous labour of 100,000 men for more than 20 years.

From Egypt the craft of masonry passed into Phoenicia, Asia Minor, the Aegean Islands and Greece. Greece developed the mason's craft and gradually the three well-known orders of architecture, Doric, Ionic and Corinthian, were evolved, culminating in the buildings on the Acropolis at Athens around 450 B.C. (*See* Order.) In this period we find the highest standard of masonry. The Greek architectural style, as that of Egypt, is known as *trabeated; i.e.,* horizontal beams and upright posts. The arch was known at this time but never used above ground.

The Romans had little original architectural style and copied Greek forms but used stone for surface, nonconstructional treatment. However, they developed the Etruscan semicircular arch, the vault and the dome, which enabled them to increase the open span of their buildings. Being a practical people, they devised institutions, known as *collegia,* to foster and protect their arts and crafts, including masonry. These *collegia* are believed to be the parent bodies from which medieval trade guilds derived their origin. The Roman conquest of Britain probably began the history of real masonry in England, and the spirit of building encouraged by the Romans so increased the numbers of masons that in A.D. 296 the rebuilding of the city of Autun in Gaul was chiefly carried out by craftsmen from Britain and at the end of the 3rd century British masons were used in the rebuilding of Constantinople.

With the departure of the Romans from Britain in the early 5th century A.D. and under the domination of the Saxon invaders, the use of wrought stone for building was discontinued, and it was not until about 200 years later with the revival of Christianity that efforts were made to reintroduce the craft of masonry. Masons from Italy and France were induced to come to Britain to re-establish the craft. In 926 King Aethelstan granted a charter to the masons at York, and in the reign of Henry II no fewer than 157 abbeys, priories and other religious buildings were erected. This period saw the beginning of the Gothic style of building, which reached its zenith during the 14th and 15th centuries. The many beautiful cathedrals built then are evidence of the supreme skill of the craftsmen of that time, and undoubtedly the climax of the mason's craft was the introduction of the fan vault where the stonework hangs down like stalactites in inverted cone shapes. One of the finest examples of vaulting in the world can be seen in Henry VII's chapel in Westminster abbey, London.

From the 15th century onward stone was used extensively as a building material and masonry played an important part in an expanding building program. The introduction of large-scale brick production reduced the demand for stonework, but it opened up another field for masonry in the form of stone dressings in brick façades, the best examples being perhaps in Georgian architecture. Brick was also used, and indeed still is, as a backing to masonry in solid-wall construction. (*See* Brickwork.) In time stone became an ornamental veneer and not a constructional part of the building.

In modern construction, where steel or reinforced concrete forms the frame of the building, masonry is essentially a thin veneer, supported on the frame. With style tending toward plain and unadorned façades, the need of the mason's craft has been reduced. Much work can be produced by machines and indeed, were it not so, the high cost of working stone manually would prohibit its use almost completely. There still is, however, a demand for skilled masons. In fashioning stone it is not possible to mechanize every operation, however plain the work may be, and there is always repair and maintenance work to be carried out on historical and similar buildings. This work, particularly, requires skilled craftsmanship, if the heritage left by earlier generations of builders is to be preserved.

APPRENTICESHIP AND TRAINING

The skill essential to a good mason can only be acquired through years of practice. The requirements are a sound basic education, manual dexterity, an "eye" for line and contour and an aptitude for creative work.

Initial training in most countries is by apprenticeship for a period of five years. Under the British National Apprenticeship scheme, for example, boys usually enter the trade from school at the age of 15 or from technical college at 17, and one day and two evenings a week are then spent at technical school where the apprentice pursues studies in workshop practice, building construction, craft science, solid geometry and draftsmanship. His practical training with the master mason includes, in addition to working stone, the use of machines and mechanical aids, fixing the worked stones on the building and instruction in the drawing office and setting-out shop.

The apprentice is encouraged to take the craft examinations set by the City and Guilds of London institute, after which he has a wide choice of further studies and examinations fitting him for foremanship or management responsibility within the building industry.

MASONS' TOOLS

There is a great variety of masons' tools according to the type of stone to be worked. For convenience they may be classified under five heads: granite tools; hard-stone tools; soft-stone tools; marble tools; and fixing tools. Certain of the tools are common to two or more of the classifications.

Masons tend to specialize on particular types of stone depending on the locality of their initial training. A mason from the granite districts, for instance, would not ordinarily be trained to work on hard stone or soft stone. A mason trained on hard stone would

get some instruction on working soft stone, but he would not be expected to work granite. A marble mason is usually trained on that material only and develops a technique which would be unsuitable for either granite, hard stone or soft stone. Some masons are competent on all classes of stone, but they are the exception rather than the rule. Fixers are mostly masons who, having trained with the tools, then specialize on the fixing of worked stone on the building.

The following descriptions are of tools normally used by masons, but inevitably each craftsman accumulates special tools for carrying out difficult operations such as intersections and undercut moldings.

Hammer.—This is made in various sizes and weights. The weight for granite is about three pounds; for hard stone between four and six pounds; for marble about two pounds. The head is of cast steel and the striking face inclines toward, instead of being parallel to, the handle. A malleable iron hammer, used in conjunction with "cup-headed" chisels for carving, letter-cutting and delicate enrichments, has a short head and large striking faces. A spall hammer, used for removing large quantities of rough stone and also for breaking up stones, has faces that are concave to form cutting edges; it is made of cast steel and weighs from 10 to 15 lb.

Mallet.—This is made of hickory or beech wood or sometimes of selected pear wood. It is used in conjunction with mallet-headed chisels and weighs from three to six pounds. It forms a very important item of a mason's kit and a good mallet will last almost a lifetime and is a prized possession (fig. 1[B]).

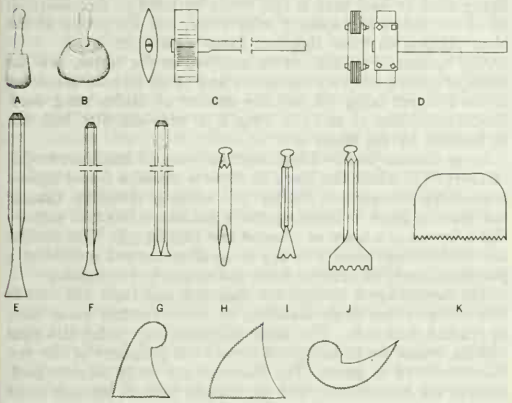

FIG. 1.—EXAMPLES OF MASONS' TOOLS: (A) DUMMY; (B) MALLET; (C) AXE; (D) PATENT AXE OR BUSH HAMMER; (E) LEWISING TOOL; (F) JUMPER FOR GRANITE; (G) STAR JUMPER; (H) POINT, OR CLOURER; (I) WASTER; (J) CLAW CHISEL; (K) DRAG; (L) COCKS' COMBS

Dummy.—This is for use with wooden-handled chisels on soft stone and is made of a mixture of zinc and lead. Dummies are made in different weights up to three pounds (fig. 1[A]).

Axe.—This tool is used on granite for reducing surfaces to the correct level. It is made of cast steel and has a long handle for two-handed operation (fig. 1[C]).

Patent Axe or Bush Hammer.—This is used on granite to form the final or "dressed" surface. The head is fitted with a series of four to ten chisel plates and, according to the grading of these plates, different types of finish are obtained; *i.e.*, fine axed, medium axed, etc. (fig. 1[D]).

Hammer-Headed Tools.—These tools are used in conjunction with the mason's steel hammer in working granite, marble and hard stone. They are made of cast steel and in various sizes.

The *punch* is used for roughly shaping a stone prior to tooling. When sharpened for granite or marble it is drawn out to a definite point, but for use on hard stone a narrow cutting edge is formed instead of a point. The *drafting chisel* is usually $\frac{1}{4}$ in. to 1 in. wide and used for working drafts or margins on a stone preparatory to punching and tooling. The *pitching tool* is made with a beveled cutting edge and in various widths and weights. It is for cutting off superfluous stone in fairly large pieces. The *lewising tool* (fig. 1[E]) is made in the form of a mortising chisel, the cutting edge being wider than the stem. It is used for forming undercut slots to accommodate the two-legged or three-legged type of lifting lewis. The *quirking tool* is similar in design to lewising tools, but small and lighter. The cutting edge ranges from $\frac{1}{4}$ to $\frac{3}{4}$ in. wide, and the tool is used for cutting narrow grooves. *Jumpers* (fig. 1[F] and 1[G]), two tools, are used for forming holes in stone. They are lifted and turned with one hand and struck with the hammer after each turn. The type shown in fig. 1(F) is mainly used on granite; the type in fig. 1(G), known as a star jumper, is used on hard stone. The *cup-headed chisel* is used in conjunction with the iron hammer on delicate work such as carving, letter-cutting, etc. It is made in various shapes and sizes: points, chisels and gouges from $\frac{1}{16}$ to 1 in. wide. *Marble tools* are similar in shape and detail to the cup-headed tools but made with hammerheads for use with a light (two-pound) steel hammer.

Mallet-Headed Tools.—These are made for use with the mallet for working on hard stone. They must never be used with a steel hammer, as the mushroom head will snap off. They are made of cast steel, hardened, tempered and sharpened to a knife edge.

The *point*, or *clourer* in Scotland (fig. 1[H]), is sharpened to a narrow cutting edge and is used for taking off, almost to the level required, the rough stone in a series of furrows. The *waster* (fig. 1[I], has its cutting edge formed into a series of teeth and is used as an alternative to the point. The *claw chisel* (fig. 1[J]), from $1\frac{1}{2}$ to 2 in. wide and formed with teeth, is used for forming drafts on the surface of the stone after roughing down with the point or the punch. The toothed cutting edge prevents the stone plucking or pitting. The *chisel* is made in widths of from $\frac{3}{4}$ to 2 in.; the wider types are known as boasters. They are used for forming margins or drafts and for finishing the surface of the stone to a comparatively smooth texture.

A *batting tool*, or *broad tool*, is similar to a boaster but is made up to $4\frac{1}{2}$ in. wide. It is for forming a finish known as batted on the surface of a stone. This comprises a series of regularly spaced parallel cuts or grooves. The *gouge* is a chisel with a curved cutting edge. Gouges of various sizes and curves are used for working moldings. The *patent claw tool* is similar in shape to a chisel but has a slotted end into which fits a toothed steel cutter. The cutters can be changed and are of various widths up to two inches. It is used for the same purpose as a claw chisel.

Wood-Handled Chisels and Gouges.—These are similar to carpenters' chisels but are stouter at the neck. They are used in conjunction with the dummy for working soft stone and are made in a variety of widths and shapes.

Other Masons' Tools.—*Drags* (fig. 1[K]) are used for producing a finished surface on soft stone. They are made from plate steel varying in thickness from 8 B.G. (Birmingham gauge) for coarse to 18 B.G. for fine and are half elliptical in shape, varying in length up to eight inches and having teeth along the straight edge. They have 4 to 5 teeth per inch for coarse, 8 to 10 for medium and 16 to 20 for fine. They are also made with convex, toothed edges for finishing circular work. *Cocks' combs* (fig. 1[L]) are thin steel plates with finely toothed edges in various shapes and are used for cleaning up the face of molded work on soft stone. *Masons' saws* are used for cutting soft stone and are similar to carpenters' saws but of heavier gauge and with coarser teeth. There are three main types: the crosscut saw, of various lengths for sawing large blocks of stone (worked by two men); the handsaw, available in different sizes, for sawing smaller blocks and ordinarily used by the mason; the whipsaw, a narrow saw of flexible steel from $2\frac{1}{2}$ to 4 ft. long and from 1 to 2 in. wide with a wooden handle at each end in line with the blade that is used for sawing around curves. The *bevel*, or *shiftstock*, consists of a double stock between which is inserted a thin blade that can be set at any desired angle and secured with a thumbscrew. It is used for testing bevels, chamfers, sinkings, etc. The *sinking square* is a tool in which a blade passes through the stock and can

be adjusted. It is used for gauging the depth of sinkings. With the addition of an extra blade the tool becomes a double sinking square. The *mitre square* is made of thin steel plate or hard wood with one edge formed at an angle of 45° and 135° with the long edges. This tool is used for positioning a straightedge at the correct angle for marking out the line of mitres. The *plumb rule* is a wooden straightedge with a pear-shaped hole at one end. A thin cord to which is attached a bob is fixed to the end of the rule so that the bob hangs in the hole. The mason-fixer uses the plumb rule for testing whether the stonework he is fixing is upright.

In addition to the above tools, the mason and the fixer need such items as folding rule, steel squares, steel set-squares, steel wing compasses, scriber, steel straightedges, trowels, rasps, brace and bits, pinch bars and spirit level.

Lifting Appliances.—There are various types of equipment for handling stone, which by virtue of its weight usually has to be lifted by mechanical means. In the ordinary way, cranes of different sorts are used at the quarry and masonry works for moving the large blocks of rough stone. On building sites, the worked stone is unloaded from transport by cranes and hoisted to the various floor levels, but thereafter the individual stones are handled by different forms of light hand tackle. It is necessary to provide attachments to the stone for hooking on to the crane or tackle and these take different forms to suit the size and type of stone to be lifted:

Sling chains are made in varying lengths and capacities. They are mostly used at the quarry or masonry works for lifting large unwrought blocks of stone weighing up to 20 tons or more. At one end is a ring and at the other a hook. The chain is placed around the block, so that it passes through the hook; the ring is attached to the lifting apparatus. If sling chains are used on wrought masonry the clean edges of the stone must be protected with slats of wood to prevent chipping and damage.

Webbing slings are used in the masonry works during the various stages of processing. They comprise two endless solid woven cotton straps attached to shackles which are fitted with rollers to allow the straps to rotate. They prevent damage to edges of stones that are being lifted and they also enable the stone to be turned over while suspended. They are capable of handling loads of up to two tons and range from 10 to 20 ft. in length.

Dogs comprise two steel hooks with rings attached, and are designed so that the greater the weight the tighter they "bite." They are used in conjunction with a chain. A small "dog-hole" is cut at each end of the stone to be lifted to receive the point of the hook. Normally dogs are limited to handle stones weighing not more than six tons.

Lifting pins are single steel pins with rings connected by a chain (fig. 2[A]) which are used for heavy stones. Holes to accommodate the pins are drilled inclined so that the pins cannot pull out. A similar type has the pins connected by a ring and is used on smaller stones.

Three-legged lewis comprises two dovetailed pieces and a centre parallel piece connected together by a shackle and pin (fig. 2[B]). The two dovetailed pieces are first inserted into an undercut mortise in the stone and then the centre piece is placed in position. The shackle and pin are then assembled ready for lifting.

Chain lewis has two curved legs linked by three rings. The legs are placed into a slightly undercut mortise in the stone (fig. 2[C]). The design is such that the rings tend to pull the top portions of the legs together, thus opening out the bottom portions which bite into the stone. These lewises are only suitable for comparatively light stones.

Split-pin lewises are used for light stones and fit into a single round hole in the stone. The cranked legs, connected by three rings, act on the scissors principle and spread at the bottom, thus gripping the sides of the hole.

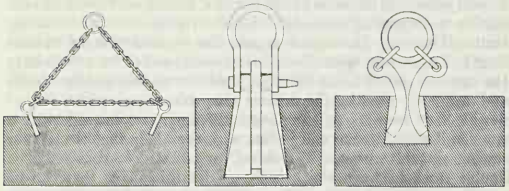

FIG. 2.—THREE TYPES OF LIFTING APPLIANCES: (A) LIFTING PINS; (B) THREE-LEGGED LEWIS; AND (C) CHAIN LEWIS

STONE-WORKING MACHINERY

Machines play an important part in the conversion of the rough quarry block into finished masonry. They can be classified into the following types: primary saws; secondary saws; molding machines; surfacing machines; lathes; light hand tools (pneumatic or electric).

Primary Saws.—These are used for the initial cutting of blocks into slabs of required thickness. They are of three types: frame saw; large circular saw; and wire saw.

Frame Saw.—This machine has a heavy steel frame which is made to swing or reciprocate horizontally by a power-driven crank via a connecting rod. The frame is suspended on four corner pendulum arms or four slides, which in turn are mounted on four vertical pillars suitably braced for rigidity. The frame, while swinging or reciprocating, can be lowered or raised mechanically on the pillars. Into the frame, thin steel blades are tensioned and positioned to suit the thickness of stone slab to be cut. The blades do not have teeth, the cutting being obtained by abrasion. Sharp sand or steel shot is fed, either by hand or mechanically, on to the blades and sprayed with water, and the action of the blade rubbing on these abrasives forms a thin cut.

Any number of blades can be mounted in the frame, and the speed of cutting can vary between 1 and 12 in. an hour according to the material being cut and the number of blades being used. Blocks measuring up to 12 ft. long, 6 ft. wide and 6 ft. high can be handled by the frame saw.

Large Circular Saw.—There are two types of machines in this category: (1) where the block of stone is made to travel against a revolving circular saw blade; (2) where a revolving circular saw blade is made to travel against a stationary block of stone—this is known as a beam or crosscut saw (*see* fig. 5). The circular saw blades range from 5 to 11½ ft. in diameter and revolve at a peripheral speed of between 8,000 and 10,000 ft. per minute.

The cutting agent is industrial diamonds and these are used in two forms: either single diamonds of about one-half carat each, or crushed diamonds. The single diamonds are welded into steel sockets, which are in turn fixed around the periphery of the saw blade about 1½ in. apart. The diamonds are set in different positions in the steel sockets and the sockets fixed in the saw blade in a sequence that will give a coverage of diamond cutting points over the width of the blade.

Crushed diamond, in various grades, is sintered into a metal bond and formed into segments. These segments are fixed around the periphery of the saw blade at regular intervals. As the segments are impregnated with crushed diamonds they cut over their full width and do not have to be set in sequence as with the single diamond type of socket. High-pressure water is fed on to the blade to wash away the stone dust and to keep the blade cool.

These large circular sawing machines are capable of very fast cutting on most hard and soft stones, but they are not suitable for sawing granite, the primary sawing of which is usually done on the frame saw or the wire saw.

Wire Saw.—This comprises a long length of stranded steel wire traveling over pulleys so that a length of the wire is free to rub on the top of a block of stone. An abrasive, mixed with water, is fed automatically on to the wire at the point of contact with the stone and the pulleys over which the wire travels are mechanically lowered very slowly, so that a cut is gradually formed.

Secondary Saws.—These are used for cutting the slabs from the primary saws to the required sizes; for cutting the joints of stones which have been worked on the molding machines; for cutting notches and checks and for all other smaller sawing operations.

These machines are all of the circular-saw-blade type and have movable tables, either hand- or power-operated, for traversing the stone against the saw blade, or alternatively they can be smaller versions of the beam or crosscut machines described under primary saws. The cutting agent on the saw blade can be either silicon carbide (carborundum) in a continuous rim or crushed diamond segments.

Molding Machines.—As their name implies these machines are used for forming molded or profiled surfaces such as cornices, string courses, etc. A power-driven table, on slides, moves the slab of stone against cutting tools mounted in a toolbox on a crosshead. The toolbox is adjustable vertically and horizontally. After "roughing out," steel plates shaped to the profile required are mounted in the toolbox to form the correct contour on the stone. The cutting tools are usually tipped with tungsten carbide to give a better and longer-lasting performance. These machines are used on all soft and hard stones, but not on granite. Molded work on granite is invariably done by hand.

Another type of molding machine works on the same principle as the secondary saw, but instead of a saw blade a wide carborundum drum is fitted. This drum can be formed to the required profile and, when rotated at high speed, grinds the stone to shape.

Surfacing Machines.—These are used for producing different surface finishes on plain face stonework. There are three main types: rubbing table; jenny lind; and dunter.

Rubbing Table.—This comprises a large cast-iron circular disk, up to ten feet in diameter, which is power-rotated on a vertical axis. Water and sharp sand are fed on to the table and the stone is placed face downward against a stop so that the action of the rotating disk with the sand and water rubs a smooth face on the stone. It is used on granite and marble as well as hard stone.

Jenny Lind.—This machine is used for rubbing and polishing stone, marble and granite. It consists of a head which is power-rotated on a vertical axis and to which circular disks, fitted with different forms of abrasive, can be attached. The head is mounted on a double hinged arm which allows it to be moved freely over a horizontal surface on the pantograph principle.

Dunter.—A machine used on granite for working large surfaces roughly level and straight. It comprises an arm, capable of moving over the surface of the stone, to which is fixed a percussion tool actuated by compressed air.

Lathes.—These are similar to machinists' and wood-turning lathes, but are more sturdily constructed. Stone columns are turned with the aid of a toolbox mounted on a saddle as in metal turning, but stone balusters are normally turned with hand tools using a tool rest as with wood turning.

Light Hand Tools.—Power-operated hand tools are widely employed in masonry production. Chipping hammers are extensively used by masons on hard stone, marble and granite and speed up their work. High-speed rotating heads are used for rubbing and polishing, and pneumatic and electric percussion and rotary drills are used for forming holes in all types of stone.

PRODUCTION AND FIXING

Before stonework for a building can be produced and fixed, much planning by the masonry contractor is necessary. A time program must be worked out to fit in with all other trades, availability of labour determined, supplies of raw stone from the specified quarry secured, drawings made and approved, and transport and plant for fixing arranged. The usual routine is for the masonry draftsman or setter-out, as he is called, to prepare working drawings, normally to a scale of $\frac{1}{2}$ in. to 1 ft., from details supplied by the architect. Where the building has a steel or reinforced concrete frame, details of this would be required from the consulting engineer so that details can be worked out for attaching the stones to the frame. These working drawings also have to be furnished to other specialist firms such as window-frame suppliers, etc.

It is important to ensure that the design of the stone jointing allows for proper bonding, *i.e.*, that a proportion of the individual stones are of sufficient depth, front to back, to get support from, and be built into, the brick or concrete backing to the stonework. (This condition would not apply to solid masonry walls, but such construction is now rarely used.) Where it is not possible to provide bonding, metal ties and supports must be used. (See *Metal Ties and Supports*, below.)

It is also important with the majority of stones, and particularly with stratified stones, that they are worked and fixed on their natural bed; *i.e.*, with their laminae horizontal. Doing so ensures greatest strength and durability. There are exceptions to this rule: in arch stones the natural bed should be at right angles to the face and parallel to the centre line of the voussoirs; in cornices with large projection, the natural bed should be vertical and at right angles to the face, except for corner stones, which should be fixed on the natural bed.

When all details have been verified, each individual stone in the building is given an identification number on the working drawing, the necessary templates are cut out of sheet zinc and a schedule, giving a full description of each stone, is issued to the foreman, who then marks out the raw stone as economically as possible. The stones are sawn and passed through the various processes, and on completion the identification number is cut into each stone and the stone is stacked in proper sequence ready for delivery to the building.

Fixing.—The mason-fixer is responsible for setting the stones on the building in their correct order and position. He is issued a copy of the working drawings on which all relevant information is given and calls for delivery of stone from the masonry works in the required sequence.

Stones are set into position with the aid of light lifting appliances, usually of the endless-chain tackle variety, and must be perfectly level and upright. For setting arch, lintel and similar stones, wooden supports known as centres have to be provided as a support for the stones until the mortar in the joints has set and the stones are capable of supporting themselves. The centres are then removed.

Stones are never fixed directly in contact with each other; they always have a mortar joint separating them. This joint can vary from $\frac{1}{16}$ to $\frac{1}{4}$ in. wide according to the architect's design and the type of stone. In addition to this mortar joint, the vertical joints of the stones have a V-shaped groove cut into them, called a joggle, so that when two stones are fixed the grooves correspond. Cement grout is poured into the joggle to lock the stones together.

When an area of stonework has been fixed, it is usual to protect the exposed face from damage and dirt until such time as the whole building is completed. This protection is given by brushing on a thick coating of slurry composed of stone dust and lime mixed with water. (This treatment does not apply to granite, marble and certain soft stones.) On completion of the building, this protective coating is washed off and the exposed face of the stonework rubbed down either by hand using abrasive blocks such as sharp grit stone or carborundum, or by mechanical spinners—high-speed rotating heads with flexible abrasive pads.

The scaffolding, from which the mason-fixer works, has to be designed as an independent structure; it must have no fixings into the wall of the building as in the case of scaffolding for brickwork. It is known as a mason's independent scaffold.

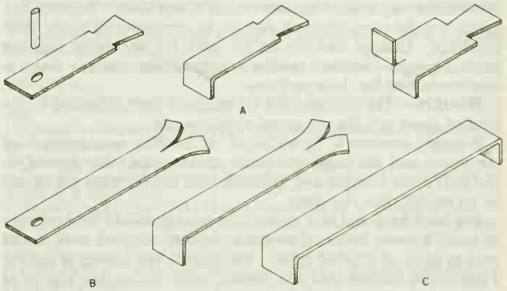

FIG. 3.—METAL TIES AND SUPPORTS USED IN PRODUCTION AND FIXING: (A) CRAMPS FOR FIXING STONE TO CONCRETE; (B) CRAMPS FOR FIXING STONE TO BRICKWORK; AND (C) GENERAL-PURPOSE STANDARD CRAMP

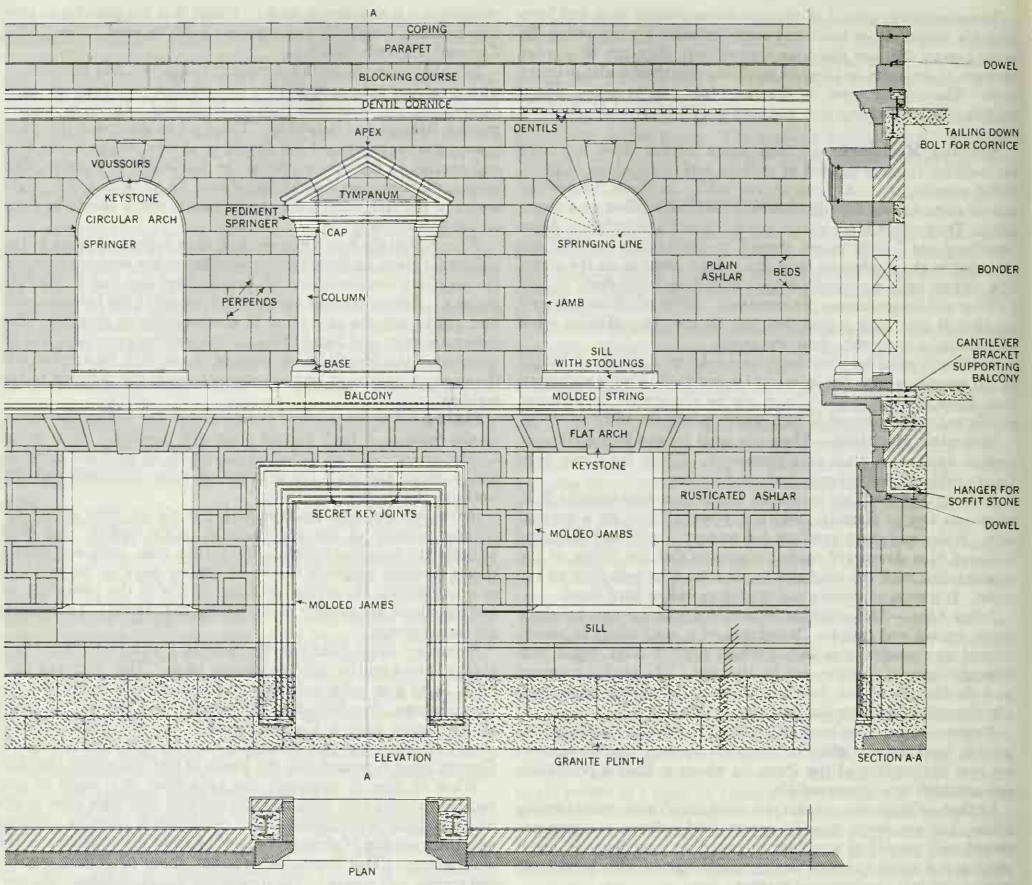

FIG. 4.—ARCHITECTURAL TERMS ILLUSTRATED IN ELEVATION, SECTION AND PLAN

Metal Ties and Supports.—In modern building construction it is very frequently necessary to use metal ties and supports for securing the stonework to the structure. The design of these has to be worked out to suit individual cases, but there are certain stock designs which have wide application (*see* fig. 3).

In all cases, metal fixings should be made of nonferrous metal or, if made of iron or steel, should be galvanized, sheridized or in some other way treated against rust and corrosion. Rusting iron fixings are the cause of much damage to stonework in many older buildings. Cramps and dowels are used for anchoring together stone copings, cornices, mullions and similar items. Slate is sometimes used for these purposes.

Mortars.—The mortars used for masonry vary according to the kind of stone and the structural requirements.

Wrought stonework, by virtue of the bonding arrangements of the stones and the large true joint surfaces, does not depend on the mortar for strength and, generally, the mortar when set should be no harder than the stone.

For most hard and soft stones, the mortar should be a mixture of crushed stone, hydrated lime and cement. Washed sand can be used in place of crushed stone. For granite the mortar is usually a mixture of washed sand and cement, while for marble, plaster of paris is normally used. Pointing in the masonry joints should be done with the same mortar and at the same time as fixing. For filling joggles, neat cement is normally used.

TECHNICAL TERMS, SURFACE FINISHES AND TYPES OF STONE

Technical Terms.—The following are some of the terms used in masonry and not explained in the article (*see* fig. 4).

Apex stone is the top stone of a gable, spire or pediment.

Arch is a method of spanning an opening with masonry consisting of a series of wedge-shaped stones, known as voussoirs or arch stones, which are supported by lateral pressure induced across the radial joints. The three types are: *flat arch*, in which the voussoirs are arranged to provide a horizontal soffit; *joggled arch*, in which adjacent stones are interlocked by means of rebates or tongues and grooves; and *skew arch*, whose face is not at right angles to its supports.

Arris is the line or edge made by the junction of two surfaces, forming an external angle.

Baluster is a short pillar, usually circular on plan, the characteristic feature of which is the bulging-out or swell of the lower part.

Band course is a plain course of stone continued horizontally along the face of a building.

Banker is a mason's workbench, made of heavy timber or blocks of stone.

Barge is a projecting stone drip at the base of a chimney stack to throw off water.

Batter is an inward inclination of the exterior face of a wall.

Bed is the lower or upper surface of a block of stone. The term *natural bed* is used to indicate the way sedimentary rocks were originally laid down or deposited. Also, a bed is the line of cleavage between the laminae of stratified rocks.

Bed mold is the lowest molded member of a cornice.

Birdsmouth is a notch cut on the edge of one piece of stone to receive the square edge of another.

Blocking course is a plain course of masonry over a cornice.

Bonder is a stone whose longer dimension is in the thickness of the wall.

Cladding consists of thin slabs of stone used externally as a nonload-bearing covering to the structure of a building.

Closer is a stone placed in a course of masonry to fill or close a gap.

Column is a free-standing vertical member usually circular on plan.

Coping, or *capping*, is the topmost course of masonry on a wall usually made wider than and arranged to overlap the wall and having a sloping top to throw off rainwater.

Corbel is a stone or series of stones which projects from a wall, often used as a bracket or support.

Cusp is the projection from the inner face of the curves of Gothic arches.

Damp-proof course is a layer of impervious material interposed in the bed joint of a wall to prevent the passage of moisture.

Dentil is a series of small rectangular blocks cut in the bed molding of cornices, giving the appearance of a row of teeth.

Dressing is a general term used for all wrought masonry.

Entasis is the outward curvature of the shaft of a column to counter an illusionary concave appearance.

Finial is a finishing ornament at the top of a gable, a pediment or pinnacle.

Gablet is a small gable-shaped carved panel, frequently used in Gothic stonework for apex stones and in spires, etc.

Galleting, small pebbles or chips of flint pressed into the mortar, while still soft, in the joints of rubble or flint walling.

Gargoyle is a projecting stone formed as a waterspout for throwing rainwater from gutters clear of the walls. In early work it was often carved into grotesque shapes of animals and other forms.

Hoodmold, or *dripstone* or *label*, is a projecting molding or canopy over a door or window opening to throw off rain from the walls of the building.

Impost is the top member of a pier or pillar from which an arch springs.

Jambstone is one of a number of stones forming part of the vertical surface at the sides of a door or window opening.

Joggle consists of adjacent recesses in vertical joints of stones for filling with cement grout, and is also a projection on one stone which fits into a corresponding recess in another stone.

Keystone is the central stone of an arch.

Kneeler is a stone bonded into the wall and forming an intermediate length of the coping to a gable wall.

Linings are thin slabs of stone, marble or granite used internally as a nonload-bearing covering.

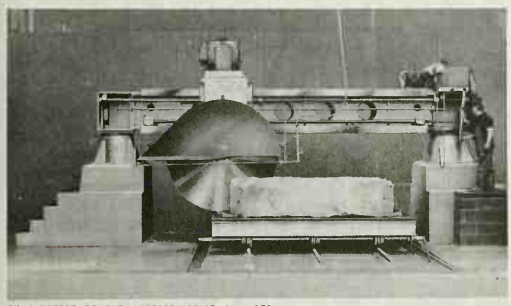

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FIG. S.—CIRCULAR CROSSCUT SAW FOR STONE

Lintel is a stone which spans in one piece the top of an aperture.

Mason's mitre is a mitre worked out of a single piece of stone and not forming a joint at the mitred angle as in a joiner's mitre.

Modillion is an ornament bracket worked out of the solid at regular intervals in the molded member under the corona of a cornice.

Mortice is a sinking in a stone to receive a corresponding projection on another stone, or to receive a dowel, cramp, rail, lug, etc.

Mullion is a vertical member subdividing a window.

Padstone, or *template*, is a stone incorporated in the structure to distribute a concentrated load.

Parpend is a through bondstone faced on both sides.

Perpend is a vertical joint in masonry.

Pier is any load-bearing vertical mass of masonry, either detached from or attached to a wall.

Pilaster is a flat rectangular pillar which slightly projects from a wall.

Plinth is the projecting base of a wall or column.

Quoin is a stone at an external angle of a wall.

Rebate is a continuous rectangular sinking along the edge of a stone to receive window or door frames or other similar members.

Respond is a half pillar or pilaster corresponding to another or to a pillar opposite to it.

Returned end is the termination of a stone worked to match the face with an external mitre.

Reveal is that part of the jamb of a window or door opening which is not covered by a frame.

Sill is the lower horizontal member of a window opening and certain external door openings.

Skewback is an inclined or splayed surface of an abutment from which an arch springs.

Soffit is the undersurface of a lintel or arch, or the lower surface of a vault.

Spandril, or *spandrel*, is a triangular space enclosed, approximately, by the curve of an arch with a horizontal line drawn through its apex and a vertical line drawn through its springing.

Springer is the stone from which an arch springs.

Springing line is the level from which an arch commences.

Stool is a seating such as that on both ends of a sill on which a jambstone is fixed.

Stopped end is the termination of a molding worked in the solid.

String course is a narrow molded or plain projecting course of stone continued horizontally along the face of a building.

Throat is a groove worked in the undersurface of overhanging stonework to prevent rainwater flowing back to the wall.

Transom is a horizontal member subdividing a window or other opening.

Voussoir is a wedge-shaped stone forming a unit of an arch.

Walling: ashlar (*q.v.*) is masonry consisting of plain blocks of stone, finely dressed to given dimensions and laid in courses; *block in course* is roughly squared blocks of stone which may vary in length, having worked beds and hammer-dressed faces and joints and set in courses which may vary in height not exceeding 12 in. (used in heavy engineering masonry); *brought to courses* is walling, similar to uncoursed rubble, which is roughly leveled up to courses at intervals usually to correspond with the heights of the quoin and jambstones; *coursed rubble* is roughly squared stone walling to courses to suit the heights of corner stones; *dry walling* is walling without mortar; *polygonal* (*rag walling*) is walling built of stones of irregular shape which may be roughly worked to fit adjacent stones; *snecked* means a rubble wall in which the stones are squared but of irregular size, with small stones, known as "snecks," introduced to break the line of the courses.

Weathering is working the top face of a stone to an inclined plane for the purpose of throwing off rainwater.

Surface Finishes.—There is a wide range of different finishes used in masonry; the following are the more common.

Axed is used for granite only, having a surface obtained by using an axe or a patent axe. "Fine-axed" is when the surface has been chopped with fine-axe marks. "Once-axed" is the term used when the surface has been roughly chopped with an axe.

Batted means having a surface comprising a series of parallel grooves formed with a wide batting tool regularly spaced across the face of the stone. The number of grooves may vary from five to ten per inch.

Boasted means a stone finished by dressing with a boaster.

Boasted for carving refers to a stone roughly worked to the approximate form required by the carver or sculptor.

Combed means having all irregularities on the exposed surfaces of soft stones worked off by the use of a drag or comb.

Dabbed means fine and close sparrow-pecked with a sharp point.

Dressed means having any kind of worked finish; of slate, having a rough beveled edge as left by a dressing knife or guillotine, as opposed to a sawn edge, which is not beveled.

Eggshell means having a dull polish or a matte surface.

Face-bedded is a stone cut so that the natural bed is vertical to and parallel with the face.

Fluted means having a surface worked into a regular series of concave grooves.

Hammer-dressed (for granite) means having a rough face prepared with a hammer.

Joint-bedded is a stone cut so that the natural bed is vertical to and parallel with the joints.

Pencil-arrissed means having the arris rounded to a radius of approximately $\frac{1}{8}$ in.

Picked, or *pecked*, is a dressing obtained by means of a point tool or pick.

Pitched is a surface produced by a pitching tool so as to resemble the natural rock face.

Polished means having a high-gloss mirrorlike finish.

Punched is a finish obtained by removing the larger irregularities by means of a point tool.

Reeded is a surface worked into a regular series of convex ridges.

Reticulated means an irregular network of bands worked on a true-faced stone, the sinking between the bands being about $\frac{3}{8}$ in. deep, worked true to a gauge and "picked" with a fine point.

Rock-faced is the natural face of the rock or a dressing resembling it (*see* also "Pitched").

Rubbed is a finish obtained by rubbing the surface with abrasives to the degree of smoothness required.

Rusticated refers to a stone which has a sunken, dressed margin.

FIG. 6.—MASONS CARVING GOTHIC TRACERY HEAD

Shotted is the face which results from grinding with steel shot by means of a heavy steel ring used in a polishing machine.

Tooled is a surface showing the mason's tool marks.

Vermiculated is a surface which has a dressing taking the form of irregularly shaped sinkings resulting in winding wormlike ridges.

Types of Stone.—There are five main classifications of natural stone used in masonry. They are: *granite*, a holocrystalline plutonic rock composed of quartz, feldspar, mica, or hornblende and accessories; *marble*, a granular limestone, recrystallized by heat or pressure; *slate*, a rock derived from argillaceous sediments or fine-grained volcanic ashes by metamorphism and characterized by a cleavage along planes independent of the original bedding; *limestone*, a bedded rock consisting essentially of calcium carbonate; *sandstone*, a bedded rock composed of grains of quartz sand naturally cemented together.

The use of the different types of stone depends largely upon the geographical situation of the source of supply, transport facilities, availability of skilled labour and costs. Granite is the hardest and most durable of all the building stones and is widely used for architectural, civil and marine engineering and decorative purposes. It comes in a wide range of colours and textures and is generally capable of being polished. Marble is used mainly for internal wall linings, staircases, floors and decorative work. It is also used externally, mostly in thin cladding to walls and, where supplies are abundant such as in Italy, as solid masonry. There are endless varieties and combinations of colours, which are considerably enhanced when the material is polished. Slate is used extensively as a roofing material and also for floors, stair treads, shelves and decorative work. In the second half of the 20th century, it has found favour as an external cladding material in some modern buildings. This particularly applies to the green variety of slate, which is used as panels in conjunction with other stone dressings. Limestone and sandstone are the most widely used stones for general masonry work. There is a considerable variety of colour, texture and quality, and special care is needed in selecting the type to be used to ensure that it will withstand the climatic conditions prevailing in the locality of the building. *See* BRICKWORK; *see* also references under "Masonry" in the Index.

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MASORETES (MASSORETES) were the keepers of a cumulative body of biblical text tradition (Masorah), which they codified in order to ensure the accurate transmission of a standard Hebrew Bible text. They flourished at the Babylonian and Palestinian academies of Jewish learning between the 7th and the 10th centuries A.D. and are chiefly responsible for the text tradition of the Hebrew Bible, as found in all the manuscripts known before 1947 (when ancient biblical manuscripts were found in the Dead sea region). It appears in all printed editions and has come to be known as the Masoretic text (MT).

Historically, the text of the Hebrew Bible is made up of three distinct components. In order of antiquity and stability they are: the basic consonants; the vowel letters; and the system of Masoretic marks for vowels, accents and cantillation. In the beginning there was a consonantal text in pre-exilic Hebrew script with or without word dividers and with only a sprinkling of *matres lectionis; i.e.*, the letters *waw*, *yod* and *he* indicating long *u*, *i* and *o*. The ancient Greek version of the Pentateuch (3rd century B.C.) was translated from just such a sparsely vocalized Hebrew text.

As the study and recitation of Scripture spread to schools and local synagogues, more vowel letters were introduced as an aid in reading. Some of the biblical manuscripts from the caves of Qumran near the Dead sea, besides displaying differences in wording, also show excessive use of vowel letters. To hold deviations under control, three standard scrolls (according to rabbinic sources) were exhibited in the Temple forecourt in Jerusalem, and "correctors" were maintained out of the public treasury, so that copies could be compared and divergencies in wording and spelling checked. After the fall of Jerusalem (A.D. 70) the "hedge" around the Hebrew Scriptures was complete. Biblical manuscript fragments from the caves of Wadi Murabba'at (south of Qumran) dated between A.D. 70 and 135, in contrast to the earlier Qumran manuscripts, are already in accord with our printed Hebrew Bible.

The transmission of the text continued uninterruptedly, though only fragments have come down from before the 10th century. Origen and Jerome as well as rabbinic literature bear witness to the stability of the text. This does not mean, however, that the Hebrew Scriptures were free from earlier textual corruptions or immune to new scribal errors. Although tradition scrupulously supervised the copyists' work, errors which had earlier been admitted into the text were perpetuated. The Masoretes of the 8th century were probably stimulated by the challenge of Karaism (*q.v.*), which, by contesting the authority of the rabbis, revived intensive Bible study. They devised safeguards to prevent misspellings, recording variant readings meticulously and providing the text with fixed vowel signs and accents.

About the 8th century A.D., coinciding with a similar development in Syriac and Arabic, three systems of Hebrew vocalization emerged out of a few rudimentary diacritical marks. In Babylonia, where the eastern Masoretes were active, six vowel sounds, stressed and unstressed, plus a *shewa mobile* were represented by a combination of tiny letter marks and dots all placed above and between the consonants. Of the two Palestinian systems, the Tiberian has 13 vowel signs made up of dots and dashes beneath the line and denoting largely the quality of each vowel. The Masoretes also constructed a graphic scheme for accents serving both as musical notes for cantillation and as guides for proper sentence division. There are disjunctive accents (or "masters") indicating various degrees of stress and pause, and conjunctive signs ("servants") marking continuity.

A critical index to the biblical text also was compiled. All inconsistent spellings, alternative readings (*qere* and *kethib*) and any other peculiarities in the text were noted, registered and counted. These abbreviated notations were inserted in the upper, lower and side margins of the text (marginal Masorah); at the end of the manuscript (final Masorah) all data, including even the total number of letters in each book, were arranged in alphabetic order of content.

Toward the end of the 9th century, the western or Palestinian school achieved dominance, continuing in two main families of Masoretes, Ben Naphtali and Ben Asher of Tiberias. Their fully vocalized and annotated manuscripts, with accompanying manuals, became models for all copyists. Differences in the work of the two schools, involving minutiae of vocalization, can hardly be gauged by modern scholars, since Aaron ben Asher's manuscript was later accepted by Maimonides and replaced rival copies.

When the text of the Hebrew Bible was prepared for a second printing by D. Bomberg at Venice in 1524–25, the editor, Jacob ben Hayim, found it difficult to secure reliable Masoretic manuals. Older manuscripts prepared by the great masters were not available to him. In the 19th century the basic Masoretic works were again re-examined and critically evaluated. A methodical search for old manuscripts in the Cairo Geniza and elsewhere brought important results. In 1937 the third edition of R. Kittel's *Biblia Hebraica* was based on an original copy belonging to the Ben Asher

tradition and dated A.D. 1008 (Leningrad Public library, catalogued as B 19a). Part of the Aleppo codex, the most authentic Masoretic manuscript, vocalized and annotated in A.D. 930 by Aaron ben Moses of the Ben Asher family and salvaged at mid-20th century, constitutes the basis of the Jerusalem edition under preparation by the Hebrew University Bible project. *See* also BIBLE: *Canon and Text: Text of the Old Testament;* HEBREW LANGUAGE.

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(S. I.)

MASPERO, GASTON CAMILLE CHARLES (1846–1916), French Egyptologist and one of the most brilliant scholars and administrators of his generation, was born in Paris on June 23, 1846, his parents being of Lombard origin. He was educated at the École Normale and in 1869 became teacher (*répétiteur*) of Egyptian language at the École des Hautes Études. In 1874 he was appointed professor at the Collège de France.

In Nov. 1880 Maspero set out for Egypt as head of an official archaeological mission, which developed into the Institut Français de l'Archéologie Orientale. The following year, on the death of A. F. E. Mariette (*q.v.*), he became director-general of excavations and of the antiquities of Egypt, a post that he held until June 1886. During these years he organized the mission which was mainly occupied in recording the scenes and inscriptions in many important tombs, particularly those in the Valley of Kings at Thebes, and continued Mariette's work at the Bulaq museum and the excavations of the pyramids at Saqqarah. Early in 1881 Maspero suspected the clandestine discovery of a royal tomb and instituted the investigations that led to the opening of the tomb at Hawd ad Dayr al Bahri the following July. The results of Maspero's intensive study of the royal mummies and other contents of the tomb were published in 1889. During 1886–89 he resumed his professional duties in Paris, afterward returning to Egypt to take up his former post. One of his principal tasks was the arranging and cataloguing of the now vast collection from Bulaq, which had just been transferred to the Cairo Museum of Antiquities at Qasr an-Nil. Maspero also regulated excavations throughout the country and attempted to prevent illicit trading in antiquities. He was much concerned with the preservation and strengthening of monuments: his repairs and clearance of the temple at Karnak led to remarkable discoveries in later years (*see* THEBES). It was also under Maspero's direction that G. A. Reisner carried out the archaeological survey of Nubia (1907–09).

Maspero was created knight commander of the Order of St. Michael and St. George by Edward VII in 1909. In 1914 ill-health compelled him to return to France, and he died suddenly in Paris on June 30, 1916.

Among his best-known publications are *Histoire ancienne des peuples de l'Orient* (1875), which outlines the history of the near east before Alexander, and an expanded and more detailed study of the same subject, *Histoire ancienne des peuples de l'Orient classique*, three volumes (1895–97); *Études de mythologie et d'archéologie égyptiennes*, eight volumes (1893–1916); *L'Archéologie égyptienne* (1887; several times translated into English); *Les Inscriptions des pyramides de Sakkarah* (1894); *Les Momies royales de Deir el-Bahari* (1889); *Les Contes populaires de l'Égypte ancienne*, 4th ed. (1914; English ed. 1915); *Causeries d'Égypte* (1907; translated by Elizabeth Lee as *New Light on Ancient Egypt*, 1908).

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(W. R. D.)

MASQAT: *see* MUSCAT AND OMAN.

MASQUE, a band of masked persons of the same sex who, accompanied by torchbearers, arrived at a social gathering to dance with the guests. It could either be a procession introduced by a presenter or an elaborately staged show in which a brief lyrical drama heralded the appearance of masquers who, having descended from their pageant to perform figured dances, reveled with the audience until summoned back into their pageant by farewell speech and song. The masque theme was usually mythological and symbolic and complimentary to the noble or royal host. The dramatic business was performed by professionals, the masquers remaining mute until they consorted with the guests. Traditional festivals and social events were celebrated by masques and the Twelfth Night court masque was so diplomatically important that foreign ambassadors intrigued for positions in the auditorium.

Origin and etymology are obscure. The masquerade, a popular carnival amusement akin to mumming (*see* MUMMERS), was transformed by Lorenzo de'Medici into a performance designed to illustrate a theme and accompanied by songs explaining the meaning of costume and pageantry. By the time it reached France it had become very spectacular and toward the end of the 16th century provided material for the French and Italian humanists who, attempting to revive classical drama, invented opera and ballet de cour. The English court masque was continuously influenced by its continental analogues.

In 15th-century Ferrara, young men in masks and dominoes paraded the streets at carnival time and penetrated uninvited into festive gatherings. The fashion reached France in the 16th century. Henry VIII introduced it into England on Twelfth Night 1512, when he and 11 others, disguised in masks and Italian dominoes, entered the banqueting hall and invited ladies to dance and converse. Some refused, scared possibly by the rumoured licentiousness of continental masquers. Dominoes were soon discarded and the masque, combining with other kinds of entertainment, became increasingly dramatic. The earliest extant example of a developed masque, *Proteus and the Adamantine Rock*, presented by gentlemen of Gray's Inn, London, in 1594, complimented Elizabeth as empress of hearts and of the ocean.

The production of *Of Blacknesse* in 1605 marked the beginning of the partnership of Ben Jonson and Inigo Jones and the introduction of Italian methods of staging. Instead of dispersed decorations, a scene in perspective was presented on a raised stage. Later, Jones introduced methods of instantaneous scene-changing. In 1609, the *Masque of Queenes* opened with an antimasque of witches who symbolized evil and vanished at the appearance of the virtuous masquers. Jonson used the antimasque as foil to the main masque; but it gradually ceased to be functional and became a series of entries of grotesque or realistic types with little relevance to the central theme. The sacrifice of poetic unity to variety and spectacle led to a quarrel between Jones and Jonson and after 1631 the libretti were composed by more subservient poets. The term "masque" was sometimes used sufficiently loosely to include entertainments such as Milton's *Comus*.

The performance of *Salmacida Spolia* in 1640 closes the history of the court masque, which was too intimately bound up with social life to survive the fall of the monarchy.

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(E. E. H. W.)

MASS (Lat. *missa*) is the common designation for the service of the Eucharist when it is celebrated with Roman ritual and in the Latin language, as by the vast majority of Roman Catholics. The name, which is comparatively late, derives from the dismissal formula *Ite, missa est* ("Go, it is the dismissal"). The word has been naturalized in most European languages (French *messe*, German *Messe*, Italian *messa*, Spanish *misa*).

This article deals first with the external forms of the Latin

Mass rite, as it is known to the vast majority of Roman Catholics, and briefly with their history; the second part of the article is concerned with the musical settings of the Mass. For the book containing the prayers and instructions for the Mass, *see* MISSAL; for the theology of the Mass, *see* EUCHARIST; for the history of the Mass and other matters related to it, for other Latin rites, and for the eucharistic rite among Eastern Christians and among Protestants, *see* LITURGY.

THE RITE OF THE MASS

The Latin Mass is a union of two services distinct in origin. The first, or Foremass, is an adaptation of the Jewish Sabbath synagogue service (*see* LITURGY, JEWISH) and consists of recitations from both Old and New Testaments interspersed with set invocations and prayers. It is often called the Mass of the Catechumens because at its close (marked on Sundays by the sermon) in early days unbaptized persons under instruction in the Christian mysteries used to be dismissed from the assembly. The second service (which when there is no sermon follows immediately on the first) is the commemoration of the Last Supper by the reenactment of Christ's blessing of bread and wine with thanksgiving and partaking. It is called the Mass of the Faithful, because to it only the baptized were at first admitted. The two services have been united in all localities since the 3rd century. St. Justin Martyr as early as the 2nd century was able to describe the oldest, simplest Mass of the city of Rome as consisting first of readings from an apostolic letter, Gospel and sermon; followed by the kiss of peace, offering of bread and wine, eucharistic prayer and communion.

By the time the two parts had been fused, the Eucharist was already a purely sacramental rite. At first, the sacrament was given during a meal; the Last Supper itself was probably the Passover, and the subsequent meals may have been friendly *haburah* suppers. Paul (I Cor. xi, 20–34) and Luke (xxii, 7–20) set their accounts of the Eucharist in the framework of a meal, although Matthew and Mark mention no meal other than consecrated bread and wine. (A vestige of the meal celebration was the giving of milk and honey with symbolic meaning between the two communions in the baptismal Mass of Hippolytus' *Apostolic Tradition.*)

The Mass of the Catechumens.—This consists of the following parts:

1. An introductory psalm and form of confession, recited at the foot of the altar steps. This, originally the priest's private preparation for Mass, was added on to the beginning of the service in the 16th century.

2. A few verses, usually from a psalm, read at the altar and called the introit (Latin *introire,* "to enter"). It was introduced about the 5th century and was originally a fairly long psalm-chant, marking the formal beginning of the Mass.

3. A ninefold invocation of Christ (in Greek), beginning *Kyrie eleison* ("Lord, have mercy"; *see* KYRIE), which originated in its present form from the east in the 5th century. It is the remnant of a former litany with procession.

4. An eastern hymn, *Gloria in excelsis Deo* ("Glory to God in the highest").

5. A scriptural salutation to the people, *Dominus vobiscum* ("The Lord be with you").

6. One or more prayers (collects) presenting to God the petitions of the assembly.

7. A single lesson from the Old or New Testament. The Jewish synagogue service had several lessons with a prayer after each; certain Masses during penitential seasons perpetuate this arrangement.

8. A few verses, usually from a psalm, with recitation of alleluia (or, on certain occasions, singing of the tract, a penitential chant). This is called the gradual (*q.v.*), from Latin *gradus,* "step," because at an early period it was sung from the steps of the altar (a whole psalm being then customary).

On certain days a sequence (a kind of hymn) is sung between the gradual and the Gospel: the *Victimae paschali* at Easter, the *Veni, sancte Spiritus* at Whitsun, the *Lauda Sion* at Corpus Christi, the *Dies Irae* at All Souls' and certain requiem Masses and the *Stabat Mater* on the Feast of the Seven Sorrows.

9. A portion from one of the Gospels, which marks the culmination of the Mass of the Catechumens. At all Masses the people stand for the reading; at solemn ones the deacon chants it from a place set apart in the sanctuary; acolytes with lighted candles attend the book and the deacon incenses it and kisses it. These and similar rites have developed to mark the honour in which the book of Christ is held. On Sundays a sermon follows, on the theme of the Gospel.

10. On Sundays and great feasts the Nicene Creed (*see* CREED) is then recited, a custom dating from the 5th century in the east but later in the west.

The Mass of the Faithful.—Now begins the eucharistic rite proper. Its four parts are:

1. Offering of materials for sacrifice (offertory).

2. Thanksgiving—commemoration—consecration (eucharistic prayer or canon, called in the east *anaphora*).

3. Breaking of bread.

4. Communion.

Offertory.—This was at first preceded by a series of solemn collective prayers, which survive only in the unique liturgy of Good Friday; the last vestige of them in the normal Mass is the *Dominus vobiscum* and *Oremus* ("Let us pray"). Thereupon a verse is recited, which was once a whole psalm or canticle. During this the people used to carry gifts to the altar, from which the priest would select bread and wine for the sacrifice. But now the bread is prepared in advance in the form (since the early middle ages) of flat, unleavened, circular wafers, a large one for the priest and small ones for the people, in place of the earlier loaf. These wafers are called Hosts (Latin *hostia,* "victim"). All that remains of the gift procession is the presentation of wine and water for the chalice by a server. The mingling of drops of water with the wine is mentioned in the 2nd and 3rd centuries and symbolizes the union of the people with Christ. The priest holds up in a gesture of offering first the Host (on a flat metal plate, the paten) and then the chalice, at the same time reciting silently prayers to implore the salvation of the world through the "spotless victim" and the "chalice of salvation." These prayers are ancient but were not adapted to this context until about the 10th–11th centuries. Then, still silently, the priest recites a psalm while water is poured over his fingers by the server in symbol of the purity needed to offer the sacrifice worthily. In early days the priest had to wash his hands thoroughly after handling the people's gifts. Next he invites the people to pray that their sacrifice and his may be acceptable to the Almighty and recites the secret, a silent prayer asking God to accept the gifts. This is the only primitive offering prayer and varies according to the day. It is followed by the preface, or prayer before the people, introduced by exhortations to them to lift up their hearts and give thanks. Primitively, the preface marked the beginning of the canon, but it is now separated from it by a triple *Sanctus* ("Holy, holy, holy") with the *Benedictus* and hosanna acclamation (Matt. xxi, 9), which came to be interpolated here from another position.

Canon.—The three parts of the primitive canon were: (1) thanksgiving (commemoration of the supper, consecration of the bread and wine, memory of the passion, death, resurrection and ascension of Jesus Christ); (2) oblation of the gifts; (3) calling down of the Holy Spirit or *epiclesis* (only in eastern liturgies). By the 4th century the unity of these parts was broken through the introduction of the several prayers additional to the *Sanctus* which are said today; for many hundreds of years the canon has been recited silently throughout. Before the consecration comes first a prayer presenting the offerings; second, a prayer for the living (which originally involved the reading of the diptychs or lists of people to be prayed for; *see* DIPTYCH), followed by a commemoration of many saints; third, a recalling of the purpose for which the Mass is offered; and fourth, an appeal for the acceptance of the sacrifice. After the consecration is recited the memorial of the saving events at the end of Jesus' life, which is called the *anamnesis* and is fused with the prayer of oblation. Next comes a prayer that God will accept our sacrifice as he accepted those of old, followed by a prayer for those shortly to communicate. After

this comes a prayer for the faithful departed, whose names were formerly read from the diptychs, and a second list of saints. The priest, lifting up the large host and the chalice in a last gesture of offering, ends the canon with a solemn doxology whose last words are uttered aloud and to which the people answer "Amen." This is historically and liturgically important, for by it the people signify the offering of themselves with the gifts.

Breaking of Bread.—This and the communion originally followed straight upon the canon, but the recitation of the Lord's Prayer (*q.v.*) or Our Father (*Pater Noster*) was early transferred from after the communion to before the breaking of bread. The last petition, "Deliver us from evil" (*libera nos a malo*), has from the earliest times been followed by an expansion (embolism) of its theme; at the close of which the breaking of bread (fraction) takes place. This, since the introduction of separate Hosts for the people's communion, has become a purely ritual breaking of the priest's Host, accompanied by a peace greeting. He breaks off a further small piece which he places in the chalice. There follows a brief prayer with the theme of this ritual union of the body and blood of Christ as a sign of resurrection. The commingling also recalls the ancient, long-obsolete custom of the pope sending a piece of consecrated bread from his Mass to all Roman churches as a sign of unity. The kiss of peace, now a preparation for communion, follows, having, in the west, been transferred here from the offertory. It now takes place only at High Mass and is there confined to the clergy. It is preceded by a threefold invocation of the Lamb of God (*Agnus Dei*) and by a medieval prayer for peace and unity; and followed by two medieval antecommunion prayers.

Communion.—Before receiving communion, the priest makes a scriptural invocation and prays that the body and blood of Christ may preserve his soul to life everlasting. After receiving under the forms of both bread and wine, he then distributes to the people under the form of bread alone, saying the words Corpus Christi ("the body of Christ") to each communicant, who answers "amen." Communion of the laity under either form alone has always been an occasional practice (consecrated bread was from the beginning reserved for the sick); but the difficulty of dealing with large quantities of wine led, in the east, to the practice of giving the laity a morsel of bread dipped in wine (intinction) and, in the west, to their being communicated under the form of bread only.

When all who wish have received, the priest collects into the chalice any crumbs and rinses it, first with wine and then with wine and water, letting the water flow over his thumbs and forefingers to wash off any minute particles that may be clinging to them. He drinks these ablutions and wipes out the chalice with a special cloth. (Until about the 13th century, the ablutions were not drunk but were poured away in some suitable place.) Next the priest recites the communion antiphon, which was once a psalm sung during the distribution of communion; and the postcommunion prayer of thanksgiving, variable according to the day. The dismissal *Ite, missa est* follows, but Mass no longer ends at this point; a last blessing and a recital of the prologue of St. John's Gospel were added in medieval times to close the rite.

Solemnizing of Masses.—There are four distinct types of Mass. (1) The most solemn form, which is also the most ancient, is High Mass (*Missa solemnis*). This is now usually celebrated with three priests, a number of servers or acolytes, and a choir. The actual requirements are for a priest, a deacon and a subdeacon, but in modern times—since the orders of deacon and subdeacon are merely the last steps to the priesthood and therefore filled only for a short time by students—it is normal for priests to take their parts. (2) A bishop's High Mass is called pontifical because he is the chief priest or *pontifex* (the papal Mass is a special form of this). Nonsolemn Mass, with one priest and one or more servers, can be either (3) low (*Missa privata* or *plana;* recited) or (4) sung.

The Ordinary and the Proper of the Mass.—Parts of the Mass are unvarying (*Ordinarium Missae*), and into them the variable parts (*Proprium Missae*), which change according to the day or feast, are fitted. The Ordinary of the Mass includes the *Kyrie, Gloria,* Creed, offertory prayers, preface (though there are 15 proper prefaces), *Sanctus,* canon, Lord's Prayer, fraction, *Agnus Dei,* communion prayers, conclusion and last Gospel. The Proper of the Mass comprises the introit, collects, Epistle, gradual, alleluia (or their substitutes), sequence, Gospel, offertory verse, secret, communion verse and postcommunion prayers.

There are Masses with characteristic variations in the ordinary and with special propers for funerals and commemorations of the dead (requiem Masses); for weddings (nuptial Masses); for ordinations; and for other special occasions.

Action of Second Vatican Council.—By mid-20th century it was felt by many that the Latin Mass rite, almost static for 400 years and performed largely by clergy, acolytes and choir, afforded too little participation to the people and was too remote from the mentality of modern man for maximum profit to be drawn from Sunday worship. Pope Paul VI, on Dec. 4, 1963, formally promulgated a constitution on sacred liturgy of the second session of the second Vatican council, laying down that the intelligent participation of the laity in the Mass, characteristic of the earliest centuries, was to be restored. Comprehension was to be aided by simplification of the rite through the removal of duplications and confusing accretions and by bringing into prominence necessary elements that had become obscured. The selection of Scripture readings was also to be widened.

For these readings, as well as for those parts of the Mass intended to be said or sung by the congregation and possibly almost all of the Foremass, vernacular languages might be introduced at the discretion of regional bishops' conferences to be held during 1964, subject to the direction of the holy see.

Non-Latin Forms of Celebration.—Various small groups of Roman Catholics celebrate the Eucharist with almost the same rites as the autocephalous Eastern churches. This is because these usages originated before the breakup of Eastern Christendom; hence those autocephalous Christians who return to the Roman Catholic Church preserve in general eucharistic ritual, language and customs of the body from which they came. *See* ROMAN CATHOLIC CHURCH: *The Catholic Eastern Rites.* (F. Ds.)

THE MUSIC OF THE MASS

The Ordinary of the Mass.—Settings of the *Kyrie, Gloria, Credo, Sanctus* and *Benedictus,* and *Agnus Dei* have been created in the forms of chant, polyphony and concerted music over a period of nearly 1,400 years. The *Ordinarium Missae* contains not only those items mentioned above, which make up the standard polyphonic or concerted Mass familiar to musicians, but also a final section, either *Ite, missa est* or *Benedicamus Domino,* not always included in the usual musical settings. In the middle ages the texts of the Ordinary were not as standardized as they have been since the 16th century, and the texts sometimes varied from day to day: the tropes (or additions of music and text) to the *Kyrie, Gloria, Sanctus* and *Agnus* changed according to the feast or season. Although the trope texts are no longer in use, the numerous settings of the *Kyrie* in plainchant are still distinguished by their old titles.

The modern Roman *Kyriale* is a collection of chants for the Ordinary, the main part being a group of 18 composite Masses. The various chants are in different styles and modes, and they stem from different epochs in the development of Gregorian chant. Tradition and usage account for their manner or grouping, though no hard-and-fast rule need be observed. Chants from one Mass may be interchanged with chants from another, and to give added variety there follow a number of plainsong settings of every section of the Ordinary, including the *Credo.*

Florid settings for one, two or three voices of tropes to the *Kyrie, Gloria, Sanctus, Agnus* and *Benedicamus* were written down as early as the 13th century and formed part of the repertory of the Notre Dame school of Paris which spread rapidly throughout the Christian world. There is even a troped *Sursum corda,* which belongs neither to the sung Ordinary nor Proper but to the preface spoken by the celebrant. At first these different settings were combined with considerable freedom so as to constitute Mass cycles for daily use, and this custom persisted into the 14th and 15th centuries, when manuscript choirbooks often contained hundreds of individual settings grouped together under *Kyrie, Gloria* and so

on. The 14th century saw the beginnings of a tendency to paired movements, usually *Gloria-Credo* or *Sanctus-Agnus*, and about this same time the Masses of Toulouse, Tournai and Besançon give evidence of further progress in the combination of four or more items to make a unified Ordinary. In some cases these experiments were not entirely successful, but when Guillaume de Machaut wrote his Mass it became clear that homogeneous style and liturgical fitness were not incompatible.

Parts of Machaut's Mass were built on a plainsong *cantus firmus*, and this method of construction was followed by J. Dunstable, G. Dufay, J. d'Okeghem, J. Obrecht, Josquin Després, R. Fayrfax and many Renaissance composers up to the time of Palestrina and Victoria. There was, however, a gradual change from Masses containing at least one clearly instrumental part to those whose polyphonic texture was entirely vocal, even though instruments may have been used to double the voices. Early in the 17th century concerted music greatly influenced ecclesiastical music, and many of the Masses by T. Merula, M. A. Grancino, O. Tarditi and Francesco Cavalli prepared the way for the baroque extravagances of the Masses of Orazio Benevoli. In Germany the chief composers of Masses were H. I. F. von Biber, J. H. Schmelzer and J. C. Kerll, while in France the outstanding composer was M. A. Charpentier.

Operatic music inevitably made a profound impression on concerted Masses, with the result that elaborate solos began to be incorporated into the choral and orchestral background. Bach's B minor Mass was probably never used liturgically, although the Masses of J. A. Hasse, F. Durante, J. J. Fux, Haydn and Mozart successfully adorned the services of their time and place. Beethoven's C major Mass was conceived as a liturgical work, but his *Missa Solemnis* is basically a work for concert performance. Large-scale Masses continued to be written in the 19th century by Cherubini, Schubert, Weber, Liszt, Franck, Gounod and Bruckner, and in the 20th century some of them were occasionally heard in the concert hall if not in church. Toward the middle of the 20th century a sharp distinction arose between Masses written in imitation of the Renaissance style, such as those by L. Perosi, and the more original and forward-looking examples by G. F. Ghedini, F. Poulenc, Vaughan Williams, Benjamin Britten, Edmund Rubbra and Stravinsky.

The Ordinary of the Mass was not always assigned to voices, or voices and instruments. Sometimes the organist was allowed to alternate with the plainsong of choir or congregation, and composed settings for organ are generally termed organ Masses. Early 15th-century Italian and German organ Masses set the pattern for most subsequent developments, which gave rise to complete settings of the Ordinary by J. Buchner, P. Attaignant, Philip ap Rhys, G. Cavazzoni, C. Merulo, N. de Grigny, N. A. Le Bègue and F. Couperin, to name only the most important.

The Proper of the Mass.—As the items comprising the *Proprium Missae* vary according to the feast and season they are clearly more bound to the liturgy and its immediate needs than the Ordinary is. A Mass Proper has not made its presence felt in the concert hall, though it is of prime importance in the service of the church. Its principal sections are: introit, gradual, alleluia (or on certain occasions tract), sequence, offertory and communion. Once again the earliest noteworthy polyphonic settings are those of the Notre Dame school of Paris, beginning in the last decade of the 12th century. Leonin, and after him Perotin, set most of the great responsorial chants for two, three or four voices, and their lead was followed by English and Spanish composers. Isolated compositions are found in the 14th century, but no large-scale settings of the Proper preceded those of Dufay, presumably written from 1430 onward.

The seven choirbooks at Trent preserve many settings of the Proper, though these are not invariably grouped as a cycle; it was customary to keep texts of one kind together, as in collections of the *Ordinarium Missae*. Choirbooks similar in type to those of Trent, and again containing a large selection of items from the Proper, are to be found in Jena and Weimar, but the earliest and most ambitious venture of the 16th century was H. Isaac's *Choralis Constantinus*, printed at Nürnberg after the composer's death. Isaac's polyphonic monument provided music for all the principal feasts of the church year as well as for the Common of Saints and Martyrs, and although there were other printed collections of the time (the Lyon *Contrapunctus* of 1528 and G. Rhau's editions of 1539 and 1545) the *Choralis Constantinus* is unrivaled in its scope and excellence.

Both Orlando di Lasso and Palestrina wrote complete cycles of the offertory, and many of their unclassified motets could be assigned to the Proper. But it was not until William Byrd's two books of *Gradualia* appeared in 1605 and 1607 that a truly great scheme made itself felt in the world of church music. Even then, Byrd's work did not receive the recognition it deserved since England was no longer a Catholic country and the number of copies exported must have been small. The baroque era saw only isolated settings of texts for the Proper. The earliest made considerable use of divided choirs (*cori spezzati*) and reached a minor peak of excellence in the work of M. Zieleński, S. Bernardi, G. F. Sances and F. Foggia.

The concertante style was exploited by J. Hofer, S. Mayr, V. Rathgeber, V. Ruffo, N. Jomelli, G. B. Martini and Michael Haydn, to mention only a few of a vast and active group of church composers. Subsequent contributions to the Mass Proper were, on the whole, desultory rather than broadly conceived, though contributions were made by a few composers of good standing. Settings of the Proper for organ, alternating with plainchant, are comparatively rare, but there is one notable and reasonably complete setting of the Proper for Easter day by the Tudor composer Thomas Preston.

The Requiem Mass.—The plainchant of the *Missa pro defunctis* combines parts of the Ordinary and the Proper: introit, *Kyrie*, gradual, tract, sequence, offertory, *Sanctus, Agnus* and communion. Not all of these are set in polyphonic and concerted requiem Masses; on the other hand, additions are sometimes made, as in Verdi's *Requiem* which ends with the responsory *Libera me*, taken from the burial service which follows the Mass. One of the earliest polyphonic settings is that of Okeghem; others followed in the 16th century, by Pierre de la Rue, Johannes Prioris, A. de Fevin, C. de Morales, F. Guerrero, Lasso, Palestrina and Victoria. Later settings by J. C. Kerll and H. I. F. Biber emphasized the dramatic element, especially in the *Dies Irae*, and this is largely true of the requiems by N. Jomelli and Mozart. Outstanding among 19th-century settings are those of Berlioz, Cherubini, Dvorak, Verdi, Bruckner and Fauré. Benjamin Britten's *War Requiem* (1962), based on a text consisting of both the Latin prayers and the war poems of Wilfrid Owen, was the outstanding work of this kind of the mid-20th century. *See* also CHURCH MUSIC; PLAINSONG; and references under "Mass" in the Index.

(D. W. St.)

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MASSA-CARRARA, a province in northwestern Tuscany, Italy, largely mountainous, lies between the Tuscan Apennines and the Tyrrhenian sea. Area 446 sq.mi., pop. (1961) 201,295. In the centre are the Apuan Alps, a small massif, world-famous for their marble quarries. The northwestern corner, the valley of the Magra river, is known as the Lunigiana district. The province was originally created in 1938 and was known as the province of Apuania until 1945 when it received its present name. The Cybo Malaspina family, long the feudal rulers of the area, built the splendid 16th-century fortress of Massa and a handsome palace in the city itself. Massa is now the capital (pop. [1961] 57,308 [comm.]). Carrara (pop. [1961] 63,741 [comm.]), besides being synonymous with the best marble of the world, has a fine Romanesque-Gothic cathedral (12th–14th century), built in the Pisan style. The Rome-Genoa railway passes through the short

coastal section of the province; there are also rail and road connections with Parma and Lucca. (G. Kh.)

MASSACHUSET, an Algonkian-speaking tribe that may once have numbered 3,000 and in the early 17th century were said to live in more than 20 villages distributed along the Massachusetts coast (*see* Algonkian Tribes). Before colonial settlement began, however, they were greatly reduced in number by intertribal warfare and by a pestilence in 1617, followed in 1633 by a smallpox epidemic which wiped out most of the few remaining members of the tribe, including its chief. Toward the end of the first half of the 17th century they became Christians and lost their tribal identity.

See F. W. Hodge (ed.), *Handbook of American Indians North of Mexico* (1959).

MASSACHUSETTS, popularly known as the Bay state or Old Bay state, was the sixth of the 13 original colonies that formed the United States. Its name, meaning "large hill place" or "at or about the Great Hill," came from the Massachuset Indian tribe. The official motto of the state is *Ense petit placidam sub libertate quietem* ("By the sword we seek peace, but peace only under liberty"). The state flower is the trailing arbutus, commonly called the Mayflower. The state tree is the American elm and the bird is the chickadee.

The state of Maine—larger than the other five New England states combined—was part of Massachusetts until 1819. Vermont and New Hampshire now form the northern boundary of Massachusetts. To the east is the Atlantic ocean. On the south is the ocean, Rhode Island and Connecticut. New York forms the western boundary. Because of its peculiar form, these boundaries are only approximate in the east. Its main portion forms a parallelogram about 130 mi. from east to west and 46 mi. from north to south, its straight southern boundary being almost coincident with the parallel of 42° N. In the east, the state spreads out, extending considerably south and somewhat north of the lines of the parallelogram, the counties of Plymouth and Barnstable forming the peculiar southeast "pothook" of Cape Cod. The state extends approximately between the extremes of 41° 14′ and 42° 53′ N. Boston, the capital and principal city, is in about the same latitude as Rome. The total area is 8,257 sq.mi., of which 390 sq.mi. are water. Massachusetts ranks 45th in size among the states.

PHYSICAL GEOGRAPHY

Physical Features.—These can be understood in their full significance only by reference to those of New England as a whole. The Appalachian mountain barrier, which extends from southwest to northeast parallel to most of the eastern coast line of the United States, continues through western New England in the Berkshire hills and the Green and White mountains. From the base of these ranges a gently sloping upland descends south and eastward to Long Island sound and the Atlantic ocean. The only large river navigable for any considerable portion is the Connecticut, which flows southward from the Green mountains of Vermont to the sound. As Massachusetts in form is a long narrow strip extending westward from the ocean, it runs at right angles, so to speak, to these principal New England features of mountains and river. Its eastern two-thirds is mostly made up of the sloping upland. West of that the state is divided by the Connecticut valley, the best portion and maritime outlet of which is in Connecticut, and west of that again lie the mountainous western counties.

There are several small ranges, each with local names, in the Berkshires. The more eastern is that known as the Hoosac hills, which have an elevation of only 2,100 to 3,041 ft. and divide the valley of the Connecticut river from that of the smaller but more picturesque Housatonic. Bordering the lowlands of the Connecticut a few well-known hills rise to a marked height above the general level, such as Mt. Tom (1,202 ft.), Mt. Holyoke (935 ft.) and Mt. Toby (1,269 ft.). West of this, in what is known locally as more particularly the Berkshire region, are found such peaks as Mt. Williams (2,951 ft.) and Greylock (3,491 ft.), the highest point in the state. From the Connecticut valley eastward the elevations steadily decrease to the coast, and the extreme southeastern portion is low lying and sandy. There are a few exceptions, such as Mt. Lincoln (1,238 ft.), Mt. Wachusett (2,006 ft.) and the Blue hills. These, like those mentioned in the western section, appear to be residual peaks of an original mountain range that covered the entire state in the geological era before the whole had been leveled to the plain which was then carved into its present features. The existence of this original mountain range is also indicated by the structure and extremely complicated disorder of the gneiss and crystalline schist of the uplands. On the other hand, the valley of the now much shrunken Connecticut river is composed mainly of shale and soft sandstone. The evidences of the glacial period occur everywhere, the entire state having been covered by the ice sheet, with resultant glaciation of the rocks, as far as the Cape Cod peninsula, where are found traces of the terminal moraine.

The eastern part of the state can be described almost wholly in terms of the junction of sea and land, though there is one small river, the Merrimack, important not because of its very short navigable portion but for the water power it provides by its fall. The coast line extends for about 250 mi., with a number of good harbours. The enormous water area included between the two points of Cape Ann and Cape Cod is known as Massachusetts bay, with the designation Cape Cod bay for its southern portion. Among the harbours, all of which are excellent, and popular yachting resorts, may be mentioned those of Salem, Gloucester, Marblehead, Boston and Provincetown on the east, and Buzzards bay on the south. The northern part of the eastern shore is somewhat rocky and picturesque, whereas the long pothook or encircling arm of Cape Cod peninsula (Barnstable county) is low and sandy. Almost the entire coast is lined with summer resorts. Those within a 30-mi. radius of Boston, however, were rapidly becoming year-round towns in the second half of the 20th century. Modern highways coupled with population growth are the main reasons.

At Woods Hole on Buzzards bay is the U.S. fish and wildlife service station with a marine biological laboratory. Leaving the mainland, there are several islands to the south, two of them, Martha's Vineyard and Nantucket, being of considerable size and importance. Martha's Vineyard, a little the larger (about 9 by 20 mi.), has a good harbour which, aside from summer yachting, is resorted to by stormbound vessels avoiding the dangerous shoals that lie to the southeast of the state.

The physical features thus briefly described have had a marked effect upon the history of Massachusetts at every period. In the colonial days, when waterways provided the only means of travel, the absence of any large river leading to the interior retarded development of the sections lying back of the coast, prevented the development of the fur trade and led the people to look to fisheries and commerce for their livelihood, an influence that was strengthened by the rather poor soil of most of the state. The climate (*see* below) was another factor that prevented the growth of large estates and a slave economy as in the south. The broken character of the eastern upland has had a marked effect also, the richer valleys having afforded moderate ease and comfort, which resulted in conservative politics, whereas the "hill towns" were poorer, radical in politics and largely abandoned when a changed economic situation and western expansion opened new opportunities for their dwellers. The fact that the Connecticut river merely ran through the state, flowing thence into another, led the inhabitants of this richest of all sections to ally themselves rather with their neighbours to the south in Connecticut than with their own fellow citizens to the east. To the west of this, the mountainous and somewhat rugged land gave special character to its inhabitants, who have always shown themselves more democratic and radical than those in the mercantile towns of the seaboard. As a whole, the mountain barrier to the west long tended to isolate New England from the rest of the country, to preserve certain New England characteristics, which included a certain provinciality of outlook in which Massachusetts shared. Although railways overcame this isolation to some extent, the great traffic from the west goes to New York city rather than to Boston, and both commerce and manufactures declined relative to those in competing states. Massachusetts lost much of its textile industry in the 20th century, but it rapidly diversified and attracted new firms in

the electronic and chemical industries. The beautiful scenery and changing seasons attracted more and more people, and the automobile brought unexpected prosperity to villages that shortly after 1900 seemed doomed.

Climate.—Massachusetts has four distinctive seasons. It is a rare winter that does not have at least one severe snowstorm throughout the state. It is not uncommon, however, for the western part of the state to have severe storms while the southern section—Cape Cod and the islands—enjoy moderate weather with little or no snow. Spring often brings the extremes of winter and summer with generous amounts of rain. July and August are the hottest months, with September offering relief with dry, crisp air. Mean averages in the middle of the 20th century at Boston were 30.4° F. (−0.9° C.) in the winter and 70.3° F. (21.1° C.) in the summer. Extremes recorded were 106° F. on July 4, 1911, in Lawrence, and −34° F. on Jan. 18, 1957, at Burch Hill dam. The average annual precipitation for the state is 43.06 in. along the coastal area, 44.64 in. in the central area and 45.14 in. in the western area.

Vegetation and Animal Life.—There is little that is distinctive in either animal or plant life as differentiated from New England as a whole. The state is a meeting place, however, for many southern and northern species of which it forms, respectively, the northern and southern limits. It is, for example, the northern limit of such trees as the holly and tupelo, the latter occasionally found in southern New Hampshire also. There is a small colony of prickly-pear cactus in Nantucket. It is also the northern limit of many insects, notably the 17-year locust. Among the birds likewise limited are the seaside sparrow, blue-winged warbler, prairie warbler and quail. On Martha's Vineyard there was a colony of the heath hen, until 1929 or 1930, but it is now extinct.

Most remarkable from the standpoint of its fauna and flora is the influence of Cape Cod, which stretches out to sea and deflects the current of the Gulf stream. To the south of the cape are found many southern fishes and other marine creatures, including the Portuguese man-of-war. On the north side of the cape the fish and invertebrates are entirely different; it is said that no other barrier makes so sharp a dividing line in ocean animal life.

Parks.—There are more than 100 state parks, forests and other state reservations. October Mountain state forest, with 13,723 ac. in western Massachusetts south of Pittsfield, is the largest in the state. Savoy state forest (10,956 ac.), farther north on the Hoosac range, offers scenic attractions and various camping and recreational facilities; Myles Standish state forest covers about the same area in the eastern part of the state south of Plymouth. State parks include Clarksburg (near Mt. Greylock), Cochituate (includes the lake of the same name west of Boston) and Pilgrim Springs park.

The Cape Cod National Seashore recreational area, comprising 50 mi. of coastal dunes and beaches, was authorized in 1961.

HISTORY

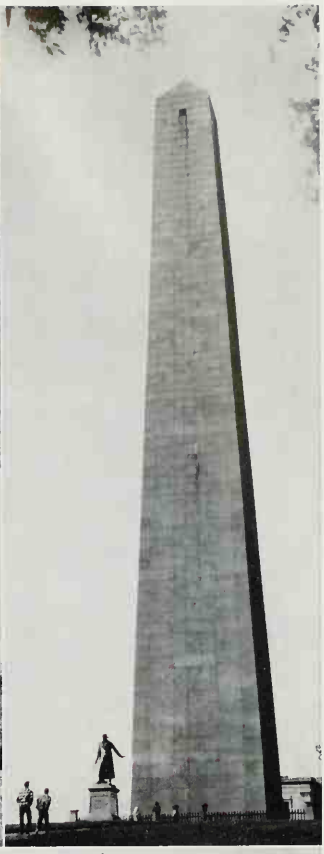
Exploration and Early Colonization.—It is uncertain when Massachusetts was first visited by Europeans. In spite of conjecture of visiting Norsemen around A.D. 1000, there is no proof of anyone's having been there before 1602, when the English navigator Bartholomew Gosnold visited Massachusetts bay and named it Cape Cod. Two years later Samuel de Champlain explored the coast and in 1614 John Smith also did so, naming many of the points along it. After that, visits became more frequent, but it was not until many years after other settlements had been made in America that a permanent colony was planted there at Plymouth, in 1620. Certain separatists from the Church of England had fled from England to the Netherlands several years before and from there decided to migrate to the new world. After considering Guiana and other places, they determined to try the territory owned by the Virginia Company of London, and financial assistance was received from colonizing speculators in London. When the "Mayflower" sailed, of its 102 passengers only 35 came from the Leiden religious group and 67 from London. Before landing, the leaders of the Pilgrims drew up the famous Mayflower Compact to serve as the basis of government. There was no intention of making a new departure in the direction of a democratic constitution, and the short document was merely a modification of the customary form of church covenant to meet the temporary crisis in an unfamiliar situation. (*See* "MAYFLOWER.") Because of stress of weather or some other, unknown cause, the colonists landed in Massachusetts instead of in the Hudson river area, then included in the domain of Virginia. They had no other government than this formed by themselves, and the pure democracy thus inaugurated and later modified was accidental. It became, however, the precursor of innumerable other written covenants in New England, forming the basis of town and church government there. (*See* also NEW ENGLAND.)

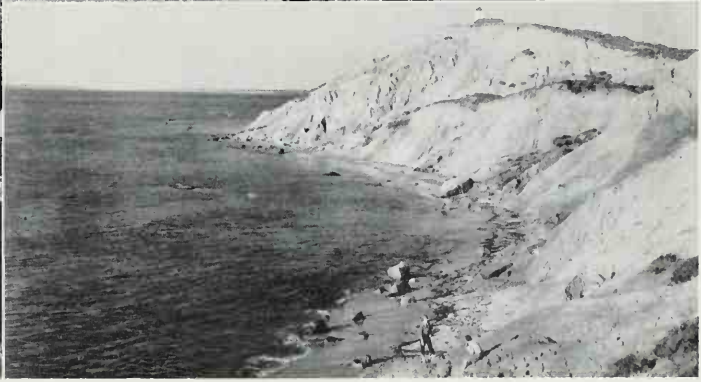
The troubles of the first winter were severe, and half the colony died, including Gov. John Carver, whose place was taken by William Bradford. Indian tribes in the Plymouth area had been decimated by illness a few years earlier and the settlement had little trouble on that score. Fields earlier cultivated by the Indians were of considerable help to the colonists, who were ill fitted to carve farm land from the forests. The contract with the London promoters had called for ownership of property in common, but this was soon modified in favour of individual property. Although the colony managed to survive its initial difficulties and become modestly comfortable, it was never financially successful and eventually all connection with the English company was terminated. After the adjustment of accounts with its financial sponsors, the colony succeeded in getting grants defining its territorial boundaries, and gradually the village of Plymouth threw off other little settlements, such as Scituate (incorporated 1636) and Duxbury (incorporated 1637), but was finally absorbed into the larger and more powerful Colony of Massachusetts Bay in 1691.

Soon after the Plymouth settlement was made others were established along the coast, mostly by individuals, a number of whom from 1625 onward settled around Boston harbour. A small fishing company tried to establish a foothold and business on Cape Ann, which was the forerunner of a much more important colonizing movement than any yet made in North America. In England it was a time of much change and unrest, quite as much political and economic as religious. The Puritans were drawn to a great extent from country gentlemen and middle-class businessmen, all of whom were feeling the stress of the times severely (*see* PURITANISM). There was a great migration of the discontented to the new world, a migration by no means confined to New England. Between 1620 and 1642, for example, 18,600 persons went to Barbados as compared with only 14,000 to Massachusetts, and 18,000 went to other West Indies islands as compared with fewer than 4,000 to the rest of New England. The Massachusetts settlement was thus merely an episode in a much broader movement.

The Massachusetts Bay Colony.—Certain Puritans in England became interested in an attempt to revive the defunct fishing company at Cape Ann, and in 1628 a patent was received from the Council for New England and a number of settlers were sent out under John Endecott as governor. Meanwhile the number in England interested in a Massachusetts venture had increased, and in 1629 a rather strong group, including John Winthrop, obtained a charter as "The Governor and Company of the Massachusetts Bay in New England." The grant was similar to that of the Virginia company in 1609, the patentees being joint proprietors, with rights of ownership and government. The intention of the crown was evidently to create merely a commercial company with what, in modern parlance, would be called stockholders, officers and directors, but by a shrewd and legally questionable move the patentees decided to transfer the entire management and the charter itself to Massachusetts, thus paving the way not only for making the management local but also for the unwarranted assumption, pregnant with most important consequences, that the charter for a commercial company was in reality a political constitution for a new government with only indefinable dependence upon the imperial one at home.

The religious motive was but one among others inducing even the leaders to emigrate to America. It was undoubtedly important, but even it looked merely to the establishment of a community in which the emigrants would be free to worship as they





BY COURTESY OF (TOP RIGHT, CENTRE, BOTTOM LEFT, BOTTOM RIGHT) MASSACHUSETTS DEPARTMENT OF COMMERCE; PHOTOGRAPH, (TOP LEFT) THE DICKSONS FROM AUTHENTICATED NEWS

HISTORIC AND SCENIC VIEWS OF MASSACHUSETTS

Top left: Burial hill, Plymouth, once the site of a fort and a church. Several of the Pilgrims are buried there

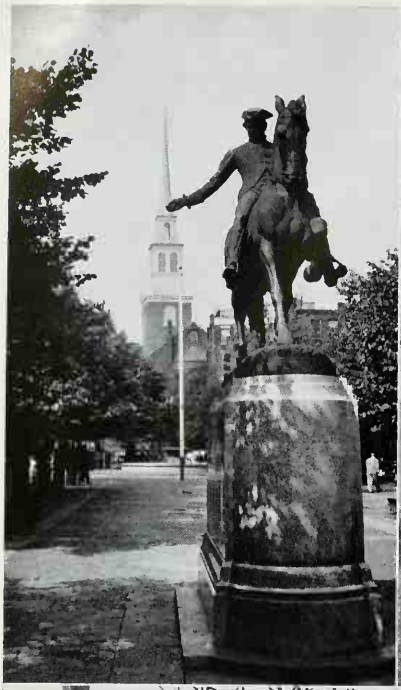
Top right: Bunker Hill monument at Charlestown, Boston, on the approximate site of the battle of Bunker Hill (1775). It is about 220 ft. high and 30 ft. square at the base

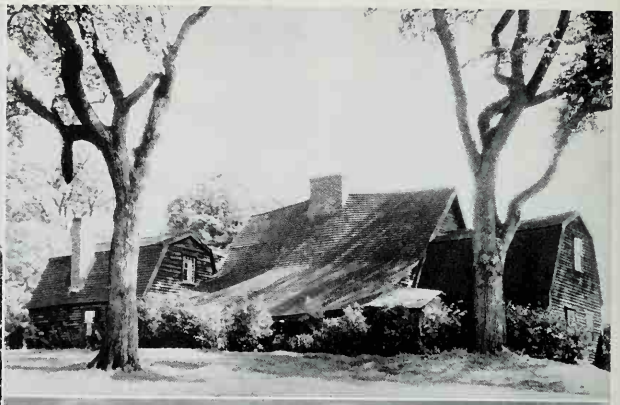
Centre: Artist from Gloucester summer art colony painting the Eastern Point lighthouse

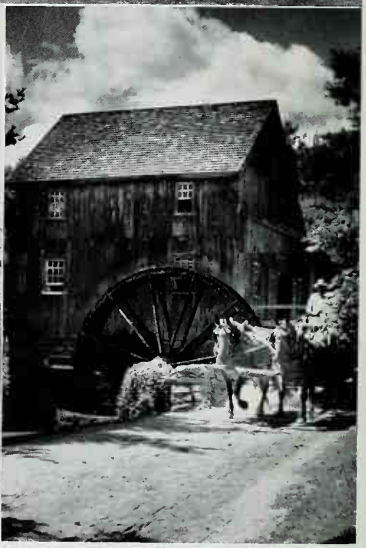
Bottom left: Minute Man statue by H. H. Kitson on Lexington green, a level triangular area where the battle of Lexington was fought in 1775

Bottom right: Gay Head cliffs on Martha's Vineyard

MASSACHUSETTS







BY COURTESY OF (TOP LEFT, TOP RIGHT, BOTTOM RIGHT) MASSACHUSETTS DEPARTMENT OF COMMERCE; PHOTOGRAPHS, (TOP LEFT) ARTHUR GRIFFIN, (BOTTOM RIGHT) CHARLES W. SAXE, (CENTRE RIGHT, BOTTOM LEFT) AUTHENTICATED NEWS

SOME HISTORIC BUILDINGS OF MASSACHUSETTS

Top left: Paul Revere Mall and Hanover street, Boston, with statue of Paul Revere and restored steeple of Old North church in background

Top right: Shaded by giant elms, Fairbanks house at Dedham is one of the oldest wooden houses still standing in the United States. Its central structure was built in 1636

Centre right: Open-air museum at Salem shows pillory and stocks used for public punishment and thatched-roof houses similar to those built by 17th-century settlers

Bottom left: John Howland house, built in 1666, Plymouth

Bottom right: Grist mill at Old Sturbridge village

themselves wished, not to establish in any way a refuge for those who might wish to worship differently. Indeed, throughout the whole colonial period, the leaders of the colony fought religious liberty with every weapon in their power. The economic motives were also strong (as Winthrop clearly indicated in writing in his own case), the sudden increase in the cost of living in England, with consequent unsettlement of established habits and social position, being a leading factor.

In the summer of 1630 a fleet of ships transported nearly 1,000 emigrants, including Winthrop as governor and Thomas Dudley as deputy governor, to Massachusetts bay, where they settled the towns of Boston, Charlestown, Dorchester, Medford, Watertown, Roxbury and Lynn. Such leaders as Winthrop, Dudley, Endecott and the Rev. John Cotton were strongly opposed to democracy, were zealous to prevent any independence in religious views and had no trust in the people at large. Opposition showed itself now and then in the case of individuals, the general court or even a town (as Watertown, which protested a tax levy).

Religious Disputes.—The first of the more noted cases was that of Roger Williams, who was banished from the colony and settled in Rhode Island (1636). Almost simultaneously occurred the so-called Antinomian controversy in which Anne Hutchinson (*q.v.*) and Henry Vane the younger were the protagonists and which ended in the banishment of Mrs. Hutchinson and the return of Vane to England. There was much criticism in England, even among the friends of the colony, of the policy of repression adopted by the leaders, lay and clerical, but they pursued their course until halted by royal authority a generation later.

The harshness of rule, narrow-mindedness and self-satisfaction, which became characteristic of the Massachusetts colony, cannot be ascribed wholly to Puritanism. Much of it was motivated by a desire for profit. As has been said, it was a period of great Puritan emigration and all the colonies both on the American mainland and in the West Indies were strongly Puritan in tone at first. In the south and on the islands, differing climatic and other conditions induced modifications in cultural life and thought, but even in New England both Rhode Island and Connecticut were far more liberal than Massachusetts.

Extension of settlements brought on troubles with the Indians and in 1637 there occurred the war with the Pequots in which that people was practically annihilated. In the same year a synod of the clergy, held at Boston, listed 82 blasphemous, erroneous or unsafe opinions held in the colony. In 1643 a loose confederation of the four colonies of Massachusetts, Connecticut, Plymouth and New Haven was effected under the title of the United Colonies of New England. It performed some useful work but its policies were largely dominated by Massachusetts and it lost influence.

In 1644 laws were passed against the Baptists and several of them were cruelly dealt with. The Quakers also were persecuted, more particularly from 1656 to 1662, four being put to death and many others whipped, imprisoned, branded or banished. Finally, owing partly to a revulsion of public feeling and largely to action by the English crown, a stop was put to the worst forms of persecution. During the English Civil War and the Cromwellian period, the colonies had for the most part been left to go their own way, and Massachusetts had arrogated to itself an almost complete independence of the home government. It was obvious according to the ideas of the time that if the colony were to remain part of the empire a closer dependence would be essential, and after the Restoration it was decided to send out a royal commission to investigate conditions. In 1665 the commission visited New England, and the following year the king sent a circular letter to all the colonies, expressing dissatisfaction with Massachusetts only. There was, indeed, a considerable and respectable party in the colony itself that was opposed to the extreme pretensions of the local government. That government, however, trusting to distance and the preoccupation of England with the European war, pursued its course.

In 1675 there occurred a second and much more serious Indian war, known as King Philip's War, caused by the grasping land policy of the colonies and the desperation of the Indians at seeing themselves more and more hemmed in by the whites. It was an inevitable conflict, and although the whites were victorious they suffered severely. It was said that 1 man in every 16 of military age was killed and it was long before the frontier recovered. Meanwhile the case of Massachusetts was again taken up by the English government. The colony adopted the method of evasion and delay in meeting charges and complying with orders. This policy resulted in the annulment of the charter in 1684, in leaving the colony defenseless against the king and with few or no friends in England to defend the course it had taken. In some respects, such as the end of the exclusion of nonchurch members from the franchise, the cause of liberty gained by the change.

Royal Government.—In 1686 a royal government was inaugurated by the arrival of Joseph Dudley, a native of Massachusetts, as president of a provisional government until a new one could be devised. He was soon supplanted by Sir Edmund Andros, whose government extended over all New England and New York. Although he was by no means the "tyrant" whom the earlier patriotic historians painted, he was lacking in tact and in the qualities of wise statesmanship, and his situation was an extremely difficult one. When word came that the Stuart dynasty had been overthrown in England in favour of William of Orange, a mild revolution occurred in Boston, and Andros and most of his government were imprisoned. Finally, in 1691 a new charter was procured for Massachusetts, to whose territory it added the province of Maine and the former colony of Plymouth.

Although the new charter provided for a royal governor and in other ways greatly diminished the power of the old theocratic party, it was a more reasonable governmental instrument than the anomalous commercial charter which the colony had for so long tried to twist into a political constitution. The first royal governor was a New England man, Sir William Phips, who had led an unsuccessful attack on Quebec in 1690. Massachusetts had carried out an easy raid upon Acadia, which had inspired hopes of a larger conquest of French territory, with the sole result of almost bankrupting the colony by a debt of £200,000.

The last decade of the 17th century was also marked by the witchcraft delusion, mainly in Salem village, during 1691–92. In all about 32 persons were executed, one by the horrible medieval penalty of being pressed to death under heavy weights. After the end of that delusion, the life of Massachusetts took on a more modern tinge. Not until 1957, however, was a resolve passed by the state legislature declaring that the proceedings convicting one Ann Pudeator and certain other persons in 1692 of witchcraft had been shocking and the result of a wave of hysterical fear of the devil, even if lawful under the province charter. Connecticut had shown the way to civil, and Rhode Island to religious, liberty. If the far more powerful colony of Massachusetts cannot lay claim to having been a leader in either of these directions, its founders had established the strongest colony in North America in their search for profits, had made creditable beginnings in public education, had developed the system of town government and had laid the foundation for the Congregational Church. Although the results of the intellectual repression of its first century were long to be felt, with the opening of the new century the colony swung more and more into the growing liberalism of thought of the 18th century.

18th Century.—The colony also shared more in the larger life of the empire. Several times, notably in the unfortunate expeditions against Jamaica (1702), against Canada (1709–11) and Cartagena (1740), Massachusetts troops played an honourable part, and to that colony must be given the main credit for the capture of Louisburg from the French in 1745. In the French and Indian War its soldiers also took part in the expedition against Oswego, took the chief part in the capture of Acadia and also shared in the Crown Point and second Louisburg attacks. Meanwhile, the colony had been making rapid strides in wealth and was becoming markedly self-conscious politically. There had been serious trouble with the currency earlier in the century, due to the colonists' insistence, perhaps necessary, upon the use of large amounts of paper money, in which it was opposed by the English government. This trouble culminated in a crisis, including rioting, under Gov. Jonathan Belcher in 1740, but the repayment to the colony by

England of about £183,000 in sterling to cover its expenses in the capture of Louisburg enabled it to retire about £2,000,000 of its depreciated bills and establish itself on a firm money basis, a fact of great importance in its subsequent commercial development. Fortunes were accumulating, business operations were growing much larger in scale, Harvard had become liberal in thought and Connecticut, not Massachusetts, had become the last stand of the old religious ideas.

During the war there had been much smuggling and trading with the enemy, and the British government became more stringent in trying to enforce trade regulations. In 1756 it introduced a system of general search warrants, such as Massachusetts itself had had in force for eight years. Merchants who saw their profits endangered protested, and in 1761 James Otis made his famous and impassioned attack in court upon these writs of assistance, the strict legality of which was hardly open to question. Following the peace of 1763 and the need for readjusting the cost of maintaining and defending the empire, came the attempts to solve the problem.

Pre-Revolutionary War.—In 1765 Massachusetts was prominent among the colonies which resisted the Stamp act. Samuel Adams of Boston, one of the ablest agitators and propagandists any country has produced, set himself to keep alive the flames of discontent, having made up his mind that the colonies should be wholly independent of England. In his skilful manipulation of public opinion and emotion, and in his organization of the committees of correspondence, he probably did more than any other man to arouse the opposition of certain elements against England and to prevent the possibility of any reconciliation.

In 1768 royal troops were stationed in Boston and on March 5, 1770, a clash occurred between them and some citizens, of whom five were killed. The soldiers had been constantly subjected to taunts and abuse and on the whole had behaved well. In this incident a small mob had been the aggressors. Officers and men at once surrendered to the civil authorities and upon trial by the local court were acquitted, except two who received slight penalties for technical homicide. Samuel Adams and his party made the most possible of the "atrocity" and dubbed it the "Boston massacre."

In 1773 occurred the Boston Tea Party, in which a band of citizens disguised as Indians boarded ships carrying tea and threw it overboard. In retaliation for this wanton destruction of private property parliament passed the Boston Port bill, closing the port to commerce. (*See* also BOSTON.) The increasing agitation and violence of the mobs during this decade presaged more serious armed conflict.

Revolutionary War and After.—Gen. Thomas Gage was made governor and in April 1775 sent an armed force to Lexington and Concord to destroy military stores gathered at those places. The force was attacked and completely routed by the country people, and Gage was practically besieged in Boston. In an effort to release himself the battle of Bunker Hill was fought—actually on Breed's hill—June 17, resulting in a military defeat but a psychological victory for the Americans. The British loss was exceedingly heavy. In July Washington arrived at Cambridge to take command of all the troops, and soon after the scene of war shifted from Massachusetts and no important military action occurred within it for the rest of the struggle. During the whole of it Massachusetts contributed more liberally than any other colony in men and money, though military leadership, except for Gen. Henry Knox and Gen. Benjamin Lincoln, passed to other hands.

Two years of prosperity following the signing of peace in 1783 soon gave place to serious financial difficulty, particularly among the poor and heavily taxed farming class. Violence occurred in most counties and became especially serious in the western ones. Owing largely to the failure of the legislature either to suppress the insurrection or to redress grievances, the revolt gained headway. Many former Revolutionary soldiers and officers took part in it, among others Capt. Daniel Shays, and because of his leadership the movement became known as Shays's rebellion. It was finally put down by aid of heavy forces under General Lincoln.

The incident was important as frightening the moneyed classes into accepting more readily the new federal constitution. This was ratified by only a very small majority in Massachusetts, which was considered a "pivotal state." After its adoption the state became strongly Federalist in politics.

19th Century.—A group of leading politicians, known as the "Essex Junto" and including such men as Fisher Ames, George Cabot, Timothy Pickering, John Lowell and others (all opponents of democracy and strongly reactionary), long dominated the politics of the state. They were utterly out of sympathy with the principles of the party in national power after 1800 and with the policy of war against England in 1812. As a commercial community the state suffered heavily from the embargo measures preceding the war and it was characterized by extreme sectionalism and antinationalism during the war. Although New England held most of the specie of the country, it refused, in the main, to subscribe to the war loans and Boston took only $75,000 of that of 1813 as compared with $7,000,000 subscribed in Pennsylvania. Although great numbers of its citizens supported the government, the policy of the state as a whole was distinctly obstructionist. Rumours of secession, which had been heard at intervals from 1800, seemed to find confirmation with the convening in 1814 of the Hartford convention to consider grievances against the federal government; it was mainly dominated by Massachusetts. The convention adjourned, however, doing little harm except to the reputations of those who had attended. The state also opposed the Mexican War of 1846–48 as it had the policy leading to it.

The period 1830–40 witnessed great social changes, among others the rise of the factory system and the substitution to a great extent of imported foreign for native American labour. It was a period of intellectual ferment and of social experiment. Utopian communities, such as Brook farm, were undertaken, and although they all ended in failure they left their mark on the thought and idealism of the times.

Under the lead of William Lloyd Garrison and Wendell Phillips, Massachusetts was in the van of the abolitionist movement. Such citizens as C. F. Adams and Charles Sumner took leading parts in the formation of the Free-Soil party, and when at last the Civil War came the state rallied to the support of the federal government in a spirit utterly different from that which had marked the two preceding ones. It has been stated that of the 159,165 men (including re-enlistments) whom the state sent to the war fewer than 7,000 were drafted.

Post-Civil War and Later History.—After the war the Republicans maintained a fairly continuous control until 1911. The industrialization of the state and the increasing domination of the cities by immigrant peoples strengthened the Democrats, and, except for the period 1916–28, they dominated the state in national elections. In 1928 Massachusetts was among the few supporters of Alfred E. Smith, and in all presidential elections from 1932 through 1948 continued to vote Democratic. Dwight D. Eisenhower won the state for the Republicans in the presidential elections of 1952 and 1956. As Republican governor in 1919, Calvin Coolidge (elected U.S. vice-president in the following year) came to national prominence when he put down with state troops a strike by the Boston police. Republican governor Christian A. Herter (1953–57) was named U.S. secretary of state by President Eisenhower in 1959. Herter was succeeded as governor by Democrat Foster Furcolo in 1957. In 1960 Sen. John F. Kennedy of Massachusetts, the Democratic presidential candidate, carried the state and the country in the general election.

Massachusetts Men and Women.—The influence of Massachusetts in life of the nation has been out of all proportion to its size and population. The roll of historians has been notable, including John Winthrop and William Bradford in the settlement period, Thomas Hutchinson in the Revolutionary one and culminating with Bancroft, Sparks, Prescott, Motley, Parkman, Thayer, Henry Adams (historian and philosopher) and Rhodes by adoption. In poefry Massachusetts produced R. H. Dana, Bryant, Longfellow, Whittier, Lowell, Holmes and Amy Lowell; in philosophy and theology, Jonathan Edwards, Channing, Emerson, Theodore Parker, William James and Mary Baker Eddy; in fiction, Harriet Beecher Stowe and Hawthorne; in education, Horace Mann, Charles W. Eliot and James Conant; in oratory and states-

manship, James Otis, John Adams, John Quincy Adams, Webster, Rufus Choate, Everett, Sumner and Wendell Phillips; in social reform, S. G. Howe and B. F. Sanborn; and in law, Story, Parsons, Shaw, Holmes, Gray, Brandeis and Frankfurter.

GOVERNMENT

The first government, other than that of the Plymouth settlement, was based upon the charter of 1629, which was intended to be merely the charter for a commercial company but which was twisted by the colonists into a political constitution.

The system of "towns" created became the most characteristic feature of the New England system. The word meant a "township," an area of considerable extent that might include several settlements, villages, etc. Each township had the right of sending deputies to represent it in the general court, as the legislature was styled. The affairs of the towns, including election of officers and representatives, were conducted in town meetings at which all citizens had the right to speak although the franchise was for long limited by religious requirements. The town meeting was a political school of prime importance and although the system has less significance now it has been abandoned slowly and with reluctance even in the larger places; Boston, for example, refused incorporation as a city until 1822, when it had a population of 47,000. There still remained, however, over 300 towns compared with only 39 cities in 1960. Among the larger towns, based on 1960 population figures, were Brookline, Arlington, Weymouth, Watertown and Framingham.

Representative government dates from 1634 and the general court (the legislative body) was divided into two chambers in 1644. The old charter was annulled in 1684 and a royal one, with a governor appointed by the crown, substituted in 1691. The government functioned under this until the Revolutionary period when, first, committees and, next, a provincial congress took over the duties. The constitution, adopted in 1780 and which calls the state a commonwealth, is the oldest of all state constitutions still in force. It has been amended frequently. Townships ceased to be represented as such after 1856. The franchise is enjoyed by citizens over 21 years old.

The last religious test even for officeholders was abandoned in 1821 and the last remnant of a property qualification in 1891 and sex distinction in 1924. A slight educational test can still be enforced. Massachusetts was the first state to adopt the blanket ballot, in which the names of candidates are arranged alphabetically without party columns. A relic of colonial times is the council, a body elected to represent divisions of the state to assist the governor in executive functions. Its major power lies in its veto over gubernatorial appointments and pardons. In 1916 the jurisdiction of district or municipal courts was extended to run throughout the state.

Massachusetts has been a leader in the creation of boards and commissions whose functions extend to almost every department, such as the boards of education (1837), agriculture (1852), railroad commissioners (1869), health (1869), statistics of labour, fisheries and game, charity (1879), insanity (1879) and the dairy bureau (1891). Others have to do with prisons, highways, insurance, banking, ballot laws, voting machines, gas and electric companies, conciliation and arbitration in labour disputes, registration in dentistry, medicine and pharmacy, inspection of food and drugs, etc.

Almost all state employees are under civil service regulations, even in the smaller political subdivisions. There are rigid laws to prevent stock watering in all corporations of a semipublic sort. The Torrens system of land registration was adopted in 1898 and a court created for its administration. Municipal ownership of public utilities, particularly gas and electric light works, is permitted. There were more than 40 publicly owned utilities after mid-20th century. The state did notable work for municipalities in such matters as roads, docks, parks and water supply.

Finance.—In addition to real and personal property taxes, major sources of revenue in the 1960s were the state income taxes, corporation taxes, and motor-vehicle and trailer excise taxes. In 1959 the state began a payroll withholding system for state income taxes similar to that for federal income taxes.

POPULATION

In 1790 the population was 378,787. It grew to 994,514 by the census of 1850, and to 2,805,346 fifty years later. It was 4,316,721 in 1940, 4,690,514 in 1950 and 5,148,578 in 1960. The population in 1960 was nearly twice what it was in 1900.

In 1960 the state had 11 standard metropolitan statistical areas: Boston, Brockton, Fall River, Fitchburg-Leominster, Lawrence-Haverhill, Lowell, New Bedford, Pittsfield, Providence-Pawtucket, Springfield-Chicopee-Holyoke, and Worcester. These areas had a total population of 4,408,687 or 85.6% of the total population of the state. In October of 1963 these areas were redefined, bringing the total population to 4,467,964 or 86.8% of the state total.

The table gives comparative population figures for towns and cities over 5,000.

In 1960 the population per square mile was 623.5 compared with 568.1 in 1950; in 1950 it was 50.7 for the United States as a whole and in 1960 it was 49.6. In 1960 the population breakdown for Massachusetts was 4,302,530 urban, and 846,048 rural. There were 1,534,732 households in 1960. Ten years before there were 1,307,450 households with an average of 3.9 persons per household.

Of the total population there were 2.4% nonwhites in 1960. The six leading countries of origin of the 576,452 foreign born in 1960 were: Canada, Italy, Ireland, the United Kingdom, Poland, and the U.S.S.R. There were 2,662,343 females and 2,486,235 males in 1960. Of the total, 11.1% were over 65 years of age and 77.8% of those over 14 years of age were in the labour force.

EDUCATION

In the colonial period Massachusetts took the lead in popular education and was the first colony to found a college, but at no time in that period could Harvard compare with the new world universities at Mexico City or Lima, Peru. The quality of New England colonial education has been greatly overestimated.

The real beginning of the state's modern system dates from about 1840, when the extremely bad situation everywhere in the schools of the country had aroused great criticism. At that time 29 of the richest towns in the state maintained no schools at all as they should have in accordance with the law. The school board was organized in 1837, and under the leadership of Horace Mann conditions improved rapidly. The system was still conducted in the second half of the 20th century under the general laws relating to education passed in 1920, with amendments.

There is a department of education "under the supervision and control of a commissioner of education, and an advisory board of education of six members, of whom at least two shall be women and one shall be a school teacher." The commissioner and the board members are appointed by the governor and council. The system includes common, high and normal schools, and all have a high reputation. Manual training from 1894 was part of the curriculum in all municipalities of more than 20,000 population. The state agricultural college at Amherst (incorporated 1863) became the University of Massachusetts in 1947. The first normal school (teachers' college) in the country was that founded at Lexington in 1839; a number of others were established later.

There are many private secondary schools of high standing, such as Phillips academy in Andover, and schools in Groton and Mount Hermon. The Roxbury Latin school, founded in 1645, is one of the oldest in the United States. Of the higher institutions of learning, besides Harvard (1636), may be mentioned Williams college (1791) at Williamstown, Amherst (1825) near Northampton, Boston university (Methodist Episcopal) and Boston college (Roman Catholic) at Boston (1839 and 1863), Tufts university (1852) at Medford, Clark university (1887) at Worcester and Brandeis university (1947) at Waltham. For women there are Mount Holyoke (1837) at South Hadley, Smith college (1871) at Northampton, Wellesley college (1870) near Boston, Simmons college (1899) in Boston and Radcliffe college (1879) in connection with Harvard. Technical instruction is at Worcester Polytechnic institute (1865), Worcester; the Massachusetts Institute of Technology (1861), Cambridge; and other schools.

*Massachusetts: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total State	5,148,578	4,690,514	4,316,721	3,852,356	2,805,346
Adams	11,949	11,633	12,608	12,967	11,134
Amesbury	9,625	9,711	10,862†	10,036†	9,473†
Amherst	10,306	17,900	6,410†	5,550†	5,028†
Andover	15,878†	12,437†	11,122†	8,628†	6,813†
Arlington	49,953†	44,353†	40,013†	18,665†	8,603
Athol	10,163	9,708	11,180†	9,792†	7,061†
Attleboro	27,118	23,809	22,071	19,731	11,335†
Belmont	28,715†	27,381†	26,867†	10,749†	3,929†
Beverly	36,108	28,884	25,537	22,561	13,884
Boston	697,197	801,444	770,816	748,060	560,892
Braintree	31,069†	23,161†	16,378†	10,580†	5,981†
Brockton	72,813	62,860	62,343	66,254	40,063
Brookline	54,044†	57,589†	49,786†	37,748†	19,935†
Cambridge	107,716	120,740	110,879	109,694	91,886
Canton	12,771†	4,739	6,381†	5,915†	4,584†
Chelsea	33,749	38,912	41,259	43,184	34,072
Chicopee	61,553	49,211	41,664	36,214	19,167
Clinton	12,848†	12,287	12,440†	12,979†	13,667†
Concord	12,517†	8,623†	7,972†	6,461†	5,652†
Danvers	21,926†	15,720†	14,170†	11,108†	8,542†
Dedham	23,869†	18,487†	15,508†	10,792†	7,457†
Everett	43,544	45,982	46,784	40,120	24,336
Fairhaven	14,339†	12,764†	10,938†	7,291†	3,567†
Fall River	99,942	111,963	115,428	120,485	104,863
Fitchburg	43,021	42,691	41,824	41,029	31,531
Framingham	44,526†	28,086†	23,214†	17,033†	11,302†
Franklin	6,391	5,348	7,303†	6,497†	5,017†
Gardner	19,038	19,581	20,206	16,971†	10,811†
Gloucester	25,789	25,167	24,046	22,947	26,121
Greenfield	14,389	15,075	15,672†	15,462†	7,927†
Haverhill	46,346	47,280	46,752	53,884	37,135
Holyoke	52,689	54,661	53,750	60,203	45,712
Hudson	7,897	8,211†	8,042†	7,607†	5,454†
Hull	7,055†	3,769†	—	—	—
Hyannis	5,139	4,235	—	—	—
Ipswich	8,544†	6,895†	6,348†	6,201†	4,658†
Lawrence	70,933	80,536	84,323	94,270	62,559
Leominster	27,929	24,075	22,226	19,744	12,392†
Lexington	27,691†	17,335†	13,187†	6,350†	3,831†
Lowell	92,107	97,249	101,389	112,759	94,969
Lynn	94,477	99,738	98,123	99,148	68,513
Malden	57,676	59,804	58,010	49,103	33,664
Marblehead	18,521†	13,765†	10,856†	7,324†	7,582†
Marlborough	18,819	15,756	15,154	15,028	13,609
Maynard	7,695†	6,690	6,812†	7,086†	3,142†
Medford	64,971	66,113	63,083	39,038	18,244
Melrose	29,619	26,982	25,333	18,204	12,962
Methuen	28,111‡	24,477†	21,880†	15,189	7,512
Middleborough	6,003	5,889	9,032†	8,453†	6,885†
Milford	13,722	14,396	15,388†	13,471†	11,376†
Milton	26,375†	22,395†	18,708†	9,382†	6,578†
Natick	28,831†	19,838†	13,851†	10,907†	9,488†
Needham	25,793†	16,313†	12,445†	7,012†	4,016†
New Bedford	102,477	109,189	110,341	121,217	62,442
Newburyport	14,004	14,111	13,916	15,618	14,478
Newton	92,384	81,994	69,873	46,054	33,587
North Adams	19,905	21,567	22,213	22,282	24,200
Northampton	30,058	29,063	24,794	21,951	18,643
Norwood	24,898†	16,636†	15,383†	12,627†	5,480†
Oxford	6,985	3,238	—	3,820†	2,677†
Peabody	32,202	22,643	21,711	19,552	11,523†
Pittsfield	57,879	53,348	49,684	41,763	21,766
Plymouth	6,488	10,540	13,100†	13,045†	9,592†
Quincy	87,409	83,835	75,810	47,876	23,899
Randolph	18,900†	9,982†	7,634†	4,756†	3,993†
Reading	19,259†	14,006†	10,866†	7,439†	4,969†
Revere	40,080	36,763	34,405	28,823	10,395†
Salem	39,211	41,880	41,213	42,529	35,956
Saugus	20,666†	17,162†	14,825†	10,874†	5,084†
Sharon	5,888	2,815	—	—	—
Somerset	12,196†	8,566†	5,873†	3,520†	2,241†
Somerville	94,697	102,351	102,177	93,091	61,643
Southbridge	15,889	16,748	16,825†	14,245†	10,025†
Spencer	5,593	5,259	6,641†	5,930†	7,627†
Springfield	174,463	162,399	149,554	129,614	62,059
Stoneham	17,821†	13,299†	10,765†	7,873†	6,197†
Swampscott	13,294†	11,580†	10,761†	8,101†	4,548†
Taunton	41,132	40,109	37,395	37,137	31,036
Wakefield	24,295†	19,633†	16,223†	13,025†	9,290
Waltham	55,413	47,187	40,020	30,915	23,481
Ware	6,650	6,217	7,557†	8,525†	8,263†
Watertown	39,092†	37,329†	35,427†	21,457†	9,706†
Webster	12,072	12,160	13,186†	13,258†	8,804†
Wellesley	26,071†	20,549†	15,127†	6,224†	5,072†
Westfield	26,302	20,962	18,793	18,604	12,310
Weymouth	48,177†	32,690†	23,868†	15,057†	11,324†
Whitinsville	5,102	5,662	10,242‡	10,174‡	7,036‡
Whitman	10,485†	8,413†	7,759†	7,147†	6,155†
Williamstown	5,428	5,815	4,294†	3,707†	5,013†
Winchester	19,376†	15,509†	15,801†	10,485†	7,248†
Winthrop	20,303†	19,496†	16,768†	15,455†	6,058†
Woburn	31,214	20,492	19,751	16,574	14,254
Worcester	186,587	203,486	193,694	179,754	118,421

*Populations are reported as constituted at date of each census. †Township.
‡Northbridge township, which includes the population of Whitinsville.
Note: Dash indicates place did not exist during reported census, or data not available.

Libraries.—The Boston Public library (first city public library to be entirely supported by taxation) is one of the great scholarly libraries of the country open to the public, specializing in Shakespeare, Americana and Spanish literature. Other notable libraries are the Massachusetts Historical society's library, rich in Americana manuscripts; the state library, with one of the finest existing collections of the laws of foreign countries; the Boston Athenaeum, including Washington's library; the New England Historic Genealogical society library, mainly devoted to family history; various libraries connected with Harvard university; Essex institute library, Salem; and the American Antiquarian society library, Worcester, with the finest collection of bound newspapers in the United States. There are other important technical libraries and many general ones of 100,000 or more volumes scattered throughout the state.

Museums and Historic Places.—Massachusetts has a wealth of museums and historic houses and buildings. The Museum of Fine Arts in Boston (1870) has what many consider the most important collection of Asian art in the western world. The Boston Museum of Science (1949) is an outgrowth of the Museum of Natural History (1830). Other museums to be found in Boston include the Isabella Stewart Gardner museum, the Institute of Contemporary Art, the Children's museum and the Children's Art Centre, Inc.

More than 175 museums and houses in the state are of historic interest. They reflect not only early life in New England but the interest created in the rest of the world during the days of the clipper ships that carried Massachusetts commerce to all parts of the globe. At Plymouth is the Plimoth Plantation, which contains the "Mayflower II" and has early Pilgrim dwellings on exhibition. At Sturbridge village in the western part of the state is a reproduction of a New England village of 1790. It contains old homes, shops and mills. There are demonstrations of spinning, weaving, cabinetmaking, furniture finishing, pottery, metalwork, printing, gristmilling and blacksmithing. There also are exhibits of the period. At West Springfield in southwestern Massachusetts there is another New England colonial village. Other historic sites and places of special interest are covered in articles on Cambridge, Concord (the home of Emerson, Thoreau and other literary figures), Deerfield, Gloucester, Lexington, Marblehead, Martha's Vineyard, Nantucket, North Adams (the site of Fort Massachusetts), Provincetown, Quincy, Salem, Saugus (site of the first colonial ironworks; restored in 1954) and Stockbridge.

HEALTH, WELFARE AND CORRECTIONS

Many private charitable corporations report to the state department of public welfare, and a large number of private infirmaries are subject to visitation by an inspector from the department. The Perkins Institution for the Blind is particularly notable for its historical association with Samuel Gridley Howe. Under the department of public welfare is the state infirmary at Tewksbury (1866). Under the department of public health are four tuberculosis sanatoriums at Rutland, Westfield, North Reading and Lakeville. The Pondville hospital is for cancer patients. The Massachusetts Hospital school is for the care and education of crippled and deformed children. The Lemuel Shattuck hospital is a chronic disease institution. Under the department of mental health are state hospitals for the insane at Worcester, Taunton, Northampton, Danvers, Westborough, Boston, Grafton, Medfield, Waltham and Foxborough, and a colony at Gardner; Monson state hospital for epileptics at Palmer; schools for the feeble-minded at Waverly, Wrentham and Belchertown; the Walter E. Fernald State school at Waltham; and the Massachusetts Mental Health centre (Boston Psychopathic hospital).

The department of correction has a reformatory for women at Framingham, a state reformatory at Concord for men, a state prison at Walpole, prison camps at South Carver, Monroe and Warwick, a state farm at Bridgewater and a state prison colony at Norfolk. A modern state prison at Walpole replaced an ancient prison at Charlestown; many other penal plants, however, were in need of repair or replacement in the second half of the 20th century.

THE ECONOMY

Agriculture.—Conditions of soil and climate in Massachusetts are favourable for the raising of apples, small fruits, berries, potatoes, onions, market-garden vegetables and some kinds of tobacco. The average yield per acre for potatoes, oats and tobacco

is higher than the national average. In the 1960s the 11,000 farms in the state were less than half the number at the end of World War II, and the total acreage decreased to about 1,100,000 as compared with 2,100,000 ac. in 1945. The average value per farm more than doubled in that period, however, increasing from about $7,000 to more than $16,000. Dairy products and eggs are the leading farm products in the state.

Industry.—There was little manufacturing in Massachusetts before the American Revolution. The state, however, quickly became the leader in the textile industry as well as other industries of importance. The first cotton mill was established at Beverly in 1788 and the first woolen mill at Byfield in 1794. The first power loom was set up in 1814 at Waltham. With the improvement in machinery and the development of water power, the great centres of Lowell, Lawrence and Fall River arose in the 1830s. In the 20th century vast changes occurred in the industry of the state as a result of the transfer of much of the textile business to the south.

The leading industries in the 1960s were machinery, including electrical machinery manufacture; textile mill products; food and kindred products; and leather and leather goods. The state is noted for its footwear industry. After mid-20th century over one-third of the persons employed worked in manufacturing industries; the next largest field of employment was wholesale and retail trade.

Minerals.—The chief products of quarries in the state are sand and gravel building stone, monumental stone, traprock and limestone. The principal granite quarries are in Quincy, Rockport, Westford and Milford, although granite is a common rock in Massachusetts and is found in every county except Barnstable, Dukes and Nantucket.

Commerce.—The cod fisheries have always been of prime importance in the economics of the state and formed one of the bases of the earliest commerce to Europe. Until 1785 when trade was opened with China and 1788 when trading began with the American northwest coast, trade was mainly with Europe, Africa, and the West Indies and American coast ports. Shipbuilding was always an important industry and with the rise of the clipper ships and the rich trade to the orient, merchants of Salem and Boston grew rapidly in wealth. Owing to great changes in the United States and in transportation facilities to the interior, Massachusetts fell behind many other states in foreign commerce.

Transportation and Communication.—In the 1960s the state was served by over 1,500 mi. of railroad track, 2,350 mi. of paved state highways and 25,000 mi. of all roads within the state. There were more than 100 municipal, commercial and private airports, of which Logan International airport in Boston was the most important.

In addition to separate articles on most places and persons of historical interest mentioned under *History, see* also references under "Massachusetts" in the Index.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year*, American edition. (J. T. A.; L. SL.; R. C. BE.)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, a U.S. institution of higher education and a research centre, was incorporated in 1861. It opened in Boston in 1865 and moved to Cambridge, Mass., in 1916. *See* CAMBRIDGE.

MASSAGE is the rubbing, kneading, stroking or tapping of muscles or joints for therapeutic or related reasons. The manipulating may be performed with the bare hands or with a device such as an electric vibrator. A lubricant may be applied to the skin.

Massage is one of the oldest forms of therapy. It is mentioned in the earliest medical works, such as those of the Chinese, and at different times has enjoyed great vogue. During the T'ang dynasty (A.D. 618–906) in China, for instance, massage was regarded as one of the branches of the healing art.

In modern medicine, massage is employed only occasionally, usually in those conditions in which an increase in the circulation of blood and lymph is thought to be desirable. Beginning in the 1920s massage was used increasingly in physical therapy. *See* PHYSICAL THERAPY: *Types of Treatment: Massage.*

MASSASOIT (*c.* 1580–1661), chief of the Wampanoag Indians, was born in the present limits of Massachusetts about 1580. His tribe of several thousand had been almost destroyed by an epidemic (thought to have been yellow fever) just before the arrival of the Pilgrims on the "Mayflower." In March 1621, an Indian, Samoset, appeared at Plymouth and to the surprise of the Pilgrims spoke to them in English. He arranged for a meeting between his chief, Massasoit, and Gov. William Bradford. Massasoit appeared a week later, and signed a treaty of peace with the white men which remained inviolate for 54 years. In 1623 when the Indian chief was very ill, Edward Winslow visited him at his principal village, in what is now Rhode Island, and effected a cure. In return for this kindness, Massasoit revealed the plot of a neighbouring tribe to destroy the white men. After Massasoit's death in 1661 his son Metacomet succeeded him and became known as King Philip (*see* PHILIP, King).

See A. G. Weeks, *Massasoit of the Wampanoags* (1919); William Bradford, *Of Plymouth Plantation 1620–1647* (1952).

MASSAWA (MASSAWAH), in Eritrea province, the largest port of Ethiopia, lies in the Bay of Massawa, on the Red sea, 40 mi. N.E. of Asmara. Pop. (1956 est.) 26,627. It stands on two connected islands, Taulud and Massawa, and on the mainland. Massawa Island is the port and trading centre, Taulud the residential sector; the mainland, hot and arid, has a smaller population. The harbour is well equipped, with shipyards and berths for seagoing vessels; the naval establishments were enlarged after 1960.

Massawa is connected by narrow-gauge railway with Asmara and Agordat. It is served also by a winding mountain road and has an air connection. Industries include saltworks, fishing and marine undertakings (including pearl fishing), bone meal and glue factories. Dried fish and shells are exported. Ethiopian maritime and naval services are being built up at the port, which is administered by the central government.

Christopher da Gama landed with a small force at Massawa in 1541 to help the Ethiopians repel the conquering Muslim invaders. The Turks occupied the island in 1557, and it remained intermittently in Turkish hands for more than 300 years. In 1865 the Turks transferred the port to Egypt; 20 years later it was occupied by an Italian force and the Egyptians withdrew. Massawa (Italian Massaua) was the capital of the Italian colony of Eritrea until 1900, when the government moved to Asmara. It

was the principal base from which the Italians invaded Ethiopia in 1935. Captured by British forces in 1941, it remained under British administration, with the rest of Eritrea, until the federation of Eritrea with Ethiopia in 1952. Eritrea became a province of Ethiopia in Nov. 1962. (F. E. Sp.)

MASSÉNA, ANDRÉ, Duc de Rivoli and Prince d'Essling (1758–1817), French general of the Revolutionary Wars and one of the first of Napoleon's marshals, was born at Nice on May 6, 1758. After going to sea as a ship's boy in 1771 he enlisted in the Royal Italian regiment in the service of France in 1775. In 1789, at the outbreak of the French Revolution, he was a sergeant, married to a surgeon's daughter and settled in some comfort at Antibes. He was soon picked from the volunteers of Var to be "captain of guides" to the new "army of Italy" at Nice; but as early as Feb. 1793 he was denounced by J. M. Collot d'Herbois, the *représentant en mission*, for looting the villages. Spared because his knowledge of the villages and valleys was useful, he was made a general of division in December. Three months later he commanded 20,000 men, in unexpected charge of the offensive which brought the army to the head of the valleys leading down to the Po.

By 1796 he was an experienced wing commander with a genius for moving his men over difficult country in small-scale actions. By 1797 he was Napoleon Bonaparte's most trusted lieutenant, and the regiments under him were famous. He and his men showed immense energy Jan. 11–16, 1797, in the battle of Rivoli; and his conduct in March, crowned by the capture of Tarvisio on the road to Vienna, showed that he could act without being directed by Bonaparte.

Peace, and the political occupation of dependent republics, did not suit Masséna. His rapacity was notorious, and when he went to Paris for the first time he was found to have no political ability. After marked delay he was sent to Italy as L. A. Berthier's subordinate. A week after his arrival at Rome, in Feb. 1798, his men mutinied and expelled him; they had been left without pay, and he had enriched himself. He went home to Antibes and was not taken by Napoleon to Egypt.

In Nov. 1798, however, he was J. B. Jourdan's subordinate, with a corps in Switzerland; and when Jourdan was defeated in March 1799 the command of the whole army passed inevitably to Masséna. In the stubborn withdrawal he was left with 52,000 men, the larger part of the army, facing Zürich and the more numerous Russians and Austrians. The allies prepared their attack, but Masséna attacked first. His battle of Zürich (Sept. 25) was a victory carefully planned in advance, and he followed it by turning aside from Italy A. V. Suvorov's Russian army as it came down from the Alpine passes. He had saved France from invasion and had ended the crisis of 1799. (*See* French Revolutionary Wars.)

Immediately after the *coup d'état* of Brumaire (Nov. 1799) Bonaparte sent Masséna to command the broken army of Italy. The restoration of its fighting spirit was one of Masséna's great achievements, but his vigorous actions in the hills ended in his being besieged in Genoa. Bonaparte then left him to his fate and used the siege as cover for his own Marengo campaign, which on June 14, 1800, reversed the effect of Masséna's capitulation.

Masséna did not love Napoleon's imperial regime, though he was made a marshal in 1804. In 1805 it was only at the last moment that he was sent to command in Italy, where he conducted a sterile campaign on the Adige; he was not ready to fight hard to settle Joseph Bonaparte on the throne of Naples or to win a kingdom for Eugène de Beauharnais. In 1806, however, in unexpected command of the army of Naples, he once more displayed his energy when he had to reconquer Calabria after the British victory at Maida. This episode ended with a demand from Napoleon for the refund of 3,000,000 francs which Masséna had levied. Summoned to Poland, Masséna had a corps in reserve there for four months in 1807.

Masséna was made duc de Rivoli in 1808. He also lost an eye in a shooting accident. He seemed to take little interest in his corps command in the Austrian war of 1809, but in the battles of Aspern-Essling and Wagram he led his men with a fierce heroism which impressed the whole army: at Wagram he drove round in his carriage, as he had been injured by a fall. Napoleon made him prince d'Essling in Jan. 1810. (*See* Napoleonic Wars.)

Ignoring the visible deterioration of Masséna's health, Napoleon sent him to Spain in April 1810 to command the army of Portugal. This was the end of Masséna's career. He quarreled with his subordinates, could not cope with the difficulties of supply, fought an unnecessary battle at Bussaco and was baffled by Wellington's lines at Torres Vedras. When he had to retreat from Portugal in March 1811 he attempted to disguise the fact by an impossible march to the south; and when at last he counterattacked, at Fuentes d'Oñoro in May, he could not resolve to press the battle to a decision. He was superseded by Marmont in a humiliating manner; yet the campaign had been marked by a certain fierce obstinacy which helped his fame to survive. (*See* Peninsular War.) Masséna was in Paris in 1815 but did not take an active part in the Hundred Days. He died in Paris on April 4, 1817. (I. D. E.)

MASSENET, JULES ÉMILE FRÉDÉRIC (1842–1912), French composer and teacher who helped establish the late 19th-century style of French opera, was born at Montaud, near St. Étienne, on May 12, 1842. He entered the Paris conservatoire in 1853, studying the piano with Adolphe Laurent and composition with Ambroise Thomas. His knowledge of instrumentation was partly acquired from his practical experience as a timpanist in the orchestra of the Théâtre Lyrique. He won the Prix de Rome in 1863, and after traveling to Germany and Hungary he married his piano pupil, Mlle de Sainte Marie, to whom he had been introduced by Liszt.

With the production of *La Grand' Tante* (1867) he embarked on a career as a composer of operas and incidental music. The latter includes the score for Leconte de Lisle's *Les Erinnyes* (1873), containing his song "Élégie." In the same year his "sacred drama" *Marie Magdeleine*, later produced as an opera, established his characteristic style, which made both religious and erotic appeals. *Ève* and *La Vierge* were other choral works of this kind. His opera *Hérodiade* (1881) was followed by his masterpiece *Manon* (Paris, Opéra-Comique, 1884), which displayed his gifts for sensuous melody and characterization. Thereafter he remained the principal composer of French opera of his time, admired for his lyrical though often sentimental qualities. His reputation spread beyond France to the extent that he was sometimes described without malice by his detractors as "Mlle Wagner." Among his later operas, produced between 1889 and 1910, are *Esclarmonde* (in which the principal part was taken by Sibyl Sanderson), *Werther*, *Thaïs*, *Le Jongleur de Notre Dame* and *Don Quichotte*.

He was an influential teacher of composition; his pupils at the Paris conservatoire, where he taught from 1878 to 1896, included Alfred Bruneau, Gabriel Pierné, Florent Schmitt and Charles Koechlin. Though Massenet achieved great popularity in his lifetime and was sufficiently affluent to spend the latter part of his life at his château at Egreville, his reputation declined in the following generation. He died in Paris on Aug. 13, 1912.

See L. Schneider, *Massenet* (1926); J. Massenet, *My Recollections*, Eng. trans. by H. Villiers Barnett (1919). (E. Lr.)

MASSEY, WILLIAM FERGUSON (1856–1925), New Zealand statesman, prime minister from 1912 to 1925, was born on March 26, 1856, at Limavady, Ire. While he was at school his father, a tenant farmer, emigrated to New Zealand, buying land near Auckland, and William arrived there in Dec. 1870. He entered parliament in 1894 as a farmers' man, first for Waitemata, then (1896–1925) for Franklin. He became leader of the opposition in 1903, and led the new Reform party to victory in 1912 (*see* New Zealand: *History*).

Always a firm freeholder, Massey enabled crown tenants to convert to freehold more easily, which increased land speculation. He placed the civil service under a nonpolitical Public Service commission, which improved administration. In labour disputes he was very firm; a miners' strike at Waihi in 1912 was ended with some violence and imprisonings; and in 1913, when a strike at the Wellington wharves spread to other ports, militant farmers loaded

and worked ships and served as mounted police. These measures hardened the core of the emerging Labour party and strengthened its appeal. A devoted imperialist opposed to separate sovereign status for the dominions, Massey supported Britain wholeheartedly in World War I. When the 1914 election gave him an uncertain majority, he formed a National government with Sir Joseph Ward's Liberals. After the war, land purchase with borrowed money by returning soldiers led to inflated land prices and large mortgages, which accentuated the postwar fall in prices. To ease this, the Meat board was set up in 1922 and the Dairy board in 1923, while labour became increasingly restive as prices rose. Massey, though a man of limited range, by courage, industry and political astuteness was prime minister with very small majorities for 13 years. He died in Wellington on May 10, 1925. (N. M. Ta.)

MASSIF CENTRAL, an upland area in the south-central part of France. It is bordered by the lowlands of Aquitaine and the Loire basin on the west and northwest, and by the valley of the Rhône and Saône rivers on the east and its southern edge overlooks the Mediterranean coastlands of Languedoc. It is conventionally demarcated by the 1,000-ft. contour and in area it occupies about one-sixth of France (32,819 sq.mi.). The highest peak is the Puy de Sancy (6,188 ft.), while to the south of this lies the Plomb du Cantal (6,096 ft.). The greater part of the massif, however, consists of plateaus lying between 2,000 and 3,000 ft.

About three-quarters of the region is underlain by crystalline

MAP SHOWING REGIONS OF MASSIF CENTRAL, FRANCE AND ITS ADJACENT AREAS

rocks, mainly granite, gneiss and schist. The structures found in this basement were produced by the Hercynian earth movements, and in this respect the massif may be compared with certain other European regions, *e.g.*, Brittany or the Vosges. Resting on the crystalline basement in some areas are sedimentary deposits of a later age, such as the Jurassic limestones of the Causses or the Tertiary sands and clays of the upper Allier and Loire valleys. One of the most recent episodes of geological history in the massif was characterized by volcanic activity, continuing into the early Quaternary period and giving rise to the great volcanic cones and lava plateaus of Auvergne, Velay, etc. All the volcanoes are now extinct.

For long periods of geological time much of the massif was exposed to denudation; this resulted in the formation of extensive plateaus at various altitudes. The older of these are now deeply dissected by river valleys. The highest parts of the massif have also been glaciated; small cirques and moraines occur in Mt. Dore and in the Cantal.

In the Massif Central are the sources of several of the larger French rivers: the Loire and the Allier rise in Auvergne; the Cher, Creuse and Vienne originate in Limousin; the Dordogne, Lot and Tarn flow westward into Aquitaine; and numerous smaller rivers in the east contribute to the Rhône-Saône drainage.

Physiographic Regions.—The diversity of geological structure is reflected in the variety of regions found within the massif. Four broad divisions can be recognized.

The Eastern Margins overlook the Rhône-Saône trough and Languedoc in a marked fault-line scarp and consist mainly of crystalline uplands. Morvan in the north reaches 2,959 ft.; southward, in order, lie the divisions of Autunois, Charolais (the lowest part of the eastern margins, averaging only 1,500 ft.), Beaujolais (up to 3,320 ft.), Lyonnais and Vivarais (4,705 ft.). The last two are separated by the St. Étienne depression. The Cévennes continue the region southward from Vivarais; their eastern scarp face is intensely dissected and they rise to the granite summits of Mt. Aigoual (5,141 ft.) and Mt. Lozère (5,584 ft.). Heath and moorland occupy the higher parts of the eastern margins and the scenery at such elevations is characterized by bleakness. Snow often lies for several months of the year. At lower levels, especially in Morvan and the Cévennes, considerable areas are forested. The natural forest of beech, oak and chestnut has been greatly depleted by clearing, but more recently there has been extensive development of state forests, mainly of the conifers. On the slopes of the Cévennes below 1,500 ft., Mediterranean scrub forest occurs, with mulberries and olives planted on the lowest parts.

The emphasis in farming throughout the whole region is pastoral; cattle are especially important in Charolais and Lyonnais, reared for both meat and milk. In the Cévennes, sheep are dominant and large numbers move up to the higher pastures from Languedoc in the summer. Vineyards and orchards are found on the lower eastern slopes from Charolais southward; the orchards produce peaches, apricots, plums and cherries, and the vineyards of Beaujolais and Charolais are the source of many of the famous Burgundy wines.

The Western Margins bordering the Aquitaine lowlands include Limousin in the north where a plateau bevels the crystalline rocks at 1,500–2,500 ft., but rises to 3,209 ft. in the Millevaches plateau. Rough grassland and heath are extensive on the exposed plateaus and the relatively high rainfall coupled with the impermeable bedrock is responsible for the frequent occurrence of peat bogs and pools of water. Sheep and hill cattle are kept on the poorer areas, while the more favoured parts support increasing numbers of the famous Limousin cattle which are bred for beef and veal. In the southwest of the massif lies Ségalas, another crystalline plateau similar in elevation to Limousin and named after rye (*seigle*) which was formerly its main crop. The Montagne Noire and the Monts de Lacaune, projecting from the southwest of the massif, are prominent crystalline massifs rising to almost 4,000 ft.

Arable farming in the western margins is limited by low temperatures on the uplands and by poor soils on the crystalline rocks, though liming and fertilizing have in places made great improvements (*e.g.*, in Ségalas). Wheat, potatoes and fodder crops are generally the main products.

The Central Region consists mainly of Auvergne and has a greater diversity of scenery than the other regions. Three basic types of structure can be recognized: first, the crystalline massifs, such as Forez, Livradois and Margeride (up to 5,098 ft.); secondly, the volcanic regions of Les Puys (a chain of recent ash or lava cones, culminating in the Puy-de-Dôme, 4,806 ft.), Mt. Dore and Cantal (large volcanic cones, originally comparable in size

with Vesuvius and Etna respectively, but greatly dissected by subsequent erosion), Cézallier and Aubrac (basaltic plateaus rising to over 4,500 ft.), and Velay (consisting of lava plateaus flanking the basin of Le Puy with its striking volcanic hills); thirdly, the downfaulted Tertiary basins of Limagne, the Forez plain and Roannais.

These variations in relief and geology are among the factors responsible for the different types of land use in Auvergne. Rough pasture and moorland occupy the high ground; forest is not usually found above 4,000 ft., though it is extensive at lower levels in many areas. Considerable numbers of cattle are kept, mainly for dairy produce, and full use is made of the higher mountain pastures in summer. Many distinctive cheeses, such as Cantal and St. Nectaire, are produced in Auvergne. There is also much arable farming in the valleys; wheat, barley, oats, potatoes and sugar beet are important crops and market gardening is practised near the large towns. Vineyards and orchards occupy favoured slopes, particularly around the basins of Forez and Limagne.

The Limestone Regions principally in the south of the massif have distinctive characteristics associated with the permeability of the limestone and the resultant general lack of surface moisture and drainage. The largest of the limestone regions is the Grands Causses, where the Jurassic limestones are beveled by extensive peneplained surfaces at 2,500–3,500 ft. On these uplands, the scenery is unattractive, with scanty vegetation, except for some recent forest plantations. The area is, however, trenched by the imposing gorges of the Tarn, Lot and their tributaries, in some places up to 2,000 ft. in depth. The Tarn and Lot rise outside of the limestone region and maintain a continuous flow of water, though the volume is much reduced in summer.

The main economic importance of the Causses lies in the sweet but scanty pasture on the limestone plateaus, which supports fair numbers of sheep and some cattle. Roquefort cheese, made from ewes' milk, is a well-known product of the region. Arable farming is confined to depressions in the plateau surface where some soil has collected. Small orchards and vineyards are found on south facing slopes within the deep gorges.

Mining and Industry.—Coal is the most important mineral produced in the massif, but the deposits are comparatively small and scattered since only restricted patches of Carboniferous rocks have survived subsequent periods of erosion. The coal fields at St. Étienne, Alès and Blanzy each produce between 2,500,000 and 3,500,000 tons a year. Small-scale mining of metal ores is associated with the crystalline rocks, such as lead and hematite in the Cévennes, zinc (refined at Viviez) in Ségalas and pyrites in Lyonnais. At St. Yrieix, south of Limoges, there are china clay deposits worked since 1755.

The coal fields have given rise to important steelworks, now using pig iron from Lorraine. The development of steelworks in the massif has been helped by strategic considerations, the sites selected being less vulnerable than those near France's north-eastern frontiers. Manufacture of armaments, locomotives, machinery and other metal goods is carried on in the St. Étienne region, at Le Creusot and Montluçon. The second most important industry is that of rubber, established by Michelin at Clermont-Ferrand and employing about 18,000 workers. A smaller Dunlop rubber factory is located at Montluçon. At Limoges, the porcelain industry has long been famous for its fine products. Various textile industries are widespread in the massif: those connected with silk and rayon are of considerable importance in towns within 30 mi. of Lyons (including St. Étienne) and at Roanne. Other industries are concerned with the manufacturing of bricks and tiles, furniture, paper, leather goods, glass, lace, etc., often using local raw materials.

Electricity for industry and other consumers comes both from thermal power stations and from hydroelectric installations. In the 1960s about one-third of France's hydroelectricity was generated in the massif, mainly from large plants on the Dordogne, Cère, Truyère, Lot and Tarn, whose gorgelike valleys provide ideal dam sites. Problems of seasonal variation in river discharge have been partially overcome by the construction of barrages in series.

Population.—The population is unevenly distributed over the massif. The largest conurbation is centred around St. Étienne, this area as a whole containing about 300,000; Clermont-Ferrand and Limoges come next in size. In contrast, there are areas which are virtually uninhabited including some plateaus over 3,000 ft. and parts of the Causses. Lozère has the lowest population of any *département* in France. The more agriculturally productive areas possess a more dispersed population and numerous market towns. There are also tourist centres, such as Vichy, La Bourboule and Royat.

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MASSILLON, JEAN BAPTISTE (1663–1742), bishop of Clermont, one of the great preachers at the court of Versailles, was born at Hyères in Provence on June 24, 1663. Educated by the Oratorians at Hyères and Marseilles, he joined the order in 1681. He was ordained in 1691 and in 1696 made director of the St. Magloire seminary in Paris. But his heart was in preaching, and his sermons at the Paris oratory led to his preaching at court. After hearing him, Louis XIV said that formerly he had been well pleased with preachers, but now he was ill-pleased with himself. "On the fewness of the elect" is considered his best sermon, but the most striking words he ever pronounced were the first of his funeral oration of the Roi Soleil: *Dieu seul est grand.* As a preacher he spoke to the heart, and while severe in teaching was gentle in his treatment of sinners. Appointed bishop of Clermont in 1719, he proved himself a zealous and enlightened prelate who did much for the poor, gaining relief for them from onerous taxes. He died at Beauregard near Clermont on Sept. 18, 1742.

See *Oeuvres complètes*, ed. by E. A. Blampignon, 3 vol. (1865–86); *see* also A. A. L. Pauthe, *Massillon* (1908). (M. DE LA B.)

MASSILLON, a city of Stark county, eastern Ohio, U.S., on the Tuscarawas river, 8 mi. W. of Canton. It is an important manufacturing centre, its principal products being electric furnace alloy steels, stainless steels, cold-drawn steels, evaporators, household wares, surgeons' rubber gloves, lock washers and automobile parts. It is also a major centre for the production of mass advertising materials.

Massillon was founded in 1826 with the advent of the Ohio and Erie canal and became the greatest "wheat city" of the state. It was incorporated as a city of second class in 1853 and as a city of first class in 1868. The public library, housed since 1937 in a structure of modified Georgian design, is connected architecturally and administratively with the Massillon museum, which occupies the oldest building in Massillon, the remodeled residence of James Duncan, founder of the city. The city was named after Bishop Jean Baptiste Massillon of France. A state hospital for the insane is located there.

For comparative population figures *see* table in OHIO: *Population.* (E. T. HE.)

MASSIMO (MASSIMI), a Roman princely family of great antiquity. Though their reputed descent from the Maximi of republican Rome is purely legendary, they may be traced back with some confidence at least to the end of the 10th century A.D. Their name recurs in the annals of medieval Rome, but they did not rise to particular wealth or importance before the 15th–16th centuries. The Palazzo Massimo, one of the finest Renaissance buildings in Rome, was built by Baldassare Peruzzi for Pietro di Domenico Massimo (d. 1544) on the ruins of a far older family palace, in which the first Roman printing press had been established by immigrant Germans in 1467 and which had suffered destruction during the sack of Rome in 1527. The sons of Pietro's brother ANGELO (d. 1550) founded four branches of the family. Two of these became extinct in the 17th century. The Massimi delle Colonne, however, descended from Angelo's son FABRIZIO (d. 1633), became lords of Arsoli in 1574 and princes of Arsoli in 1826, with the rank of Roman prince for all members of the

branch; and the Massimi d'Aracoeli (extinct in 1907), descended from TIBERIO (d. 1588), received the Roman duchy of Rignano in 1828.

MASSINE, LEONIDE (1896–), Russian dancer and choreographer noted for the wit and style of his characterizations, was born in Moscow on Aug. 9, 1896. He developed the symphonic ballet, as in *Les Présages* (Tchaikovsky's Fifth) and *Choreartium* (Brahms's Fourth), and excelled in staging light, sparkling ballets such as *Gaîté Parisienne* and *Le Beau Danube*. Massine graduated from the Imperial Ballet school, but had almost decided to renounce dancing for acting when Sergei Diaghilev, seeking a replacement for Vaslav Nijinsky, whom he had just dismissed, invited him to join his company. After further training under Enrico Cecchetti, Massine made his debut in *La Légende de Joseph* in 1914. Diaghilev supervised Massine's artistic education, taking him to museums and concerts, and encouraged his choreographic talent. His first ballet was *Le Soleil de Nuit* (1915). For the Diaghilev company he created such masterpieces as *Le Tricorne* and *La Boutique Fantasque*.

From 1932 to 1938, Massine was principal dancer and choreographer of the Ballet Russe de Monte Carlo. Disagreements with its director, Col. Wassily de Basil, led Massine to resign and form the new Ballet Russe de Monte Carlo, which he headed until 1942. Later he appeared with the American Ballet Theatre and the Royal Ballet of England. In 1960 he produced *Commedia Umana*, a ballet version of Boccaccio's *Decameron*, for the Nervi festival, in Italy. (LN. ME.)

MASSINGER, PHILIP (1583–1640), English Jacobean and Caroline playwright whose gifts for comedy, plot construction and social realism are seen at their best in his most successful play, *A New Way to Pay Old Debts*. He was baptized at St. Thomas', Salisbury, on Nov. 24, 1583, the son of Arthur Massinger (thrice member of parliament and fellow of Merton college, Oxford), a gentleman in the service of the earls of Pembroke at Wilton house. Massinger matriculated at St. Alban hall, Oxford, in 1602 but there is no evidence that he graduated. Nothing is known for certain about his life from 1602 to 1613, though he may have been an actor. After an indefinite period of apprenticeship, during parts of which he was writing for the theatrical manager Philip Henslowe and collaborating, from *c.* 1613, with John Fletcher and others, he began as an independent dramatist *c.* 1620.

When Fletcher died in 1625, Massinger succeeded him as the regular dramatist of the King's Men. His plays were not so successful as Fletcher's; there is much evidence in his dedications that he was poor and no certainty that he ever had a regular patron. Apart from guesses based on the play texts and their dedications, personal details about him are very scanty: no record of a marriage has been found; the idea (first suggested by W. Gifford [see *Bibliography*] because of certain features of the plays) that he became a Roman Catholic has not won acceptance. Anthony à Wood in *Athenae Oxonienses* (1691–92) says that he died suddenly at his house near the Globe theatre and was buried, according to his friend Sir Aston Cokayne, in Fletcher's grave at St. Saviour's, Southwark, on March 18, 1640.

The Canon.—For Massinger's share in the Beaumont and Fletcher canon, *see* BEAUMONT AND FLETCHER. Two other important plays written in collaboration are *The Fatal Dowry* (1616–19, with Nathan Field, *q.v.*), a domestic tragedy in a French setting which was the basis of Nicholas Rowe's *Fair Penitent* (1703), and *The Virgin Martyr* (1620? with Thomas Dekker, *q.v.*) about the persecution of Christians under Diocletian, with elaborate scenes of torture, conversion and apotheosis. Fifteen of Massinger's unaided plays have survived, many of the dates of which can only be conjectural. There are four tragedies: *The Duke of Milan* (1621–22), *The Unnatural Combat* (1624?), *The Roman Actor* (1626), *Believe as You List* (1631); seven tragicomedies: *The Maid of Honour* (1621?), *The Bondman* (1623), *The Renegado* (1624), *The Parliament of Love* (1624), *The Picture* (1629), *The Emperor of the East* (1631?), *The Bashful Lover* (1636); and four comedies: *A New Way to Pay Old Debts* (1621 or 1622), *The Great Duke of Florence* (1627?), *The City Madam* (1632?), *The Guardian* (1633).

The Plays.—Of the tragedies, *The Duke of Milan* and *The Unnatural Combat* are both skilfully told mystery stories of a horrific and melodramatic sort, Fletcherian in style and not showing much of Massinger's individuality. *The Roman Actor* and *Believe as You List*, historical tragedies in a classical setting, are very different. *The Roman Actor*, "the most perfect birth of my Minerva," is perhaps his best serious play. It is the story of the actor Paris and Domitia, wife of the emperor Domitian, and is skilfully constructed to provide a defense of the stage in the scene depicting Paris before the Roman senate (act i, scene 3). Also, in the character of Paris, Massinger draws a sympathetic and truthful portrait of a great actor. Both this play and *Believe as You List* give scope for Massinger's fondness for long trial scenes, of which the one in *Believe as You List* (Antiochus before the Carthaginian senate, act ii, scene 2) is exceptionally studied: the struggle between the tempted and persecuted pretender Antiochus—beggar, suppliant, galley slave, but marked, it seems, by innate royalty—and his great enemy the Roman general Flaminius, gives unity to the play and is handled freshly, and with genuine historical sense, in a way much surpassing Fletcher's treatment of similar stories.

Four of the tragicomedies may be selected as representative. The chief interest of *The Bondman*, a play about a slave revolt in Syracuse led by a Theban nobleman in disguise, is its reflection of Massinger's independent-minded concern with state affairs, and his ability to relate them to contemporary situations. *The Renegado*, with its heroic Jesuit, religious sentiment and conversion scenes, and its skill in rendering locality (*e.g.*, the Tunis bazaar, act i, scene 3), is one of the plays which gave rise to the theory that its author became a Roman Catholic. *The Maid of Honour*, which M. Chelli in *Le Drame de Massinger* (1924), considered the most complete expression of Massinger's talents, combines some political realism with the high-souled courtly refinement that came to dominate Caroline drama through the influence of such courtly amateur playwrights as William Cartwright and Thomas Killigrew. Of this refinement Massinger's last play, *The Bashful Lover*, is a fairly exact expression. Lastly, *The Picture*, despite its interesting feminine roles and its well-managed but artificial story, may justly be considered a "decadent" play because it treats morality as a branch of etiquette.

The tendency of the serious plays to conform more and more to the high-flown sentiments of Caroline fashion is contradicted by the mordant realism and satirical force of Massinger's two great citizen comedies. *A New Way to Pay Old Debts* is the best thing of its kind outside Ben Jonson, to whose plays it is much indebted. It also draws inspiration from Thomas Middleton's *A Trick to Catch the Old One* (1608). Through the grim and powerful figure of Sir Giles Overreach, the "cormorant" extortioner, and his suborned man of law Mr. Justice Greedy (based on two actual personages, Sir Giles Mompesson and Sir Francis Michell, whose financial swindles had been exposed in 1621) Massinger expresses genuine indignation at economic oppression and social disorder. *The City Madam* deals with similar evils, within a more starkly contrived plot curiously combining naturalistic and symbolic modes in its story and characterization. The gradual revelation of the character of the merciless miser, Luke Frugal, is splendidly handled, and Luke is made the satirical scourge of the superstition, affected gentility and wealthy ostentation of city ladies. These two comedies, with the Roman tragedies, put Massinger in a class above Fletcher, with whom he otherwise has much in common.

Though fond of relying on devices such as the trial scene, sudden changes of character and the concealmept of secrets from the audience, Massinger was an exceedingly competent dramatic craftsman both as a storyteller and as a composer of even-paced and vigorous verse. He originated little and diluted much that he inherited from Shakespeare and his other predecessors, but he often appears much less remote from the real world of his day than the other dramatists of the 1620s and 1630s.

Reputation.—A few of Massinger's plays were revived after the Restoration; Samuel Pepys enjoyed *The Virgin Martyr* and *The Bondman* (with Thomas Betterton), and Betterton revived

The Roman Actor. From David Garrick's revival of 1748 until about 1880 *A New Way to Pay Old Debts* held the stage in Great Britain and the United States, with Charles Kemble, George Cooke, Edmund Kean, the Booths and others creating a remarkable tradition in the character of Sir Giles Overreach. There were collected editions by T. Coxeter (1759 and 1761), Monck Mason (1779, with an essay by T. Davies lamenting the current neglect of Massinger), W. Gifford (1805, 1813, reprinted by F. Cunningham, 1871) and Hartley Coleridge (1839–40). S. T. Coleridge praised Massinger's narration and verse ("the nearest approach to the language of real life at all compatible with a fixed metre") but not his characterization. Charles Lamb, in *Specimens of English Dramatic Poets* (1808), rated him low: "he never shakes . . . the mind with grief." Notable Victorian critiques include S. R. Gardiner's article on the political elements in the *Contemporary Review* (Aug. 1876); L. Stephen's destructive analysis in *Hours in a Library,* vol. ii (1877); and Swinburne's enthusiastic essay in the *Fortnightly Review* (July 1889). The book by A. H. Cruickshank (1920), reviewed by T. S. Eliot in a well-known essay in *The Sacred Wood* (1920), proved a starting-point for modern criticism, which stresses Massinger's realism, satirical power, political and social attitudes and his share of the responsibility for the "decadence" of the drama.

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MASSINGHAM, HENRY WILLIAM (1860–1924), British journalist, known for his advanced and often unpopular liberal opinions, was born at Old Catton, Norfolk, on May 25, 1860. Educated at King Edward VI's school, Norwich, he started as a reporter at the age of 17 and after working on various newspapers, including four years as editor of the London *Daily Chronicle,* was appointed editor of the *Nation* in 1907, a post that he held until his resignation in 1923. One of the best all-round journalists of his day, he was a trenchant writer on politics and did not hesitate to express unpopular views, such as his opposition to the South African War and criticism of the peace treaty of 1919. Although he ultimately joined the Labour party, his sympathies were with the ethics rather than the economics of socialism. He was also a discerning critic of literature and drama. He died at Tintagel, Cornwall, on Aug. 28, 1924.

See *H. W. M.: a Selection from the Writings of H. W. Massingham,* ed. by H. J. Massingham (1925), which contains tributes by Bernard Shaw and other associates.

MASSON, FRÉDÉRIC (1847–1923), French historian and academician, best known for his books on Napoleon, was born in Paris on March 8, 1847. In *Napoléon inconnu* (1895), Masson, with Guido Biagi, brought out the unpublished writings (1786–93) of the future emperor; these were notes, extracts from historical, philosophical and literary books and personal reflections.

His other works include several books on Josephine; *Napoléon et sa famille,* 13 vol. (1897–1919); *Napoléon et son fils* (1904); and *Autour de Sainte-Hélène,* 3 vol. (1908–12). Masson died in Paris on Feb. 19, 1923.

A bibliography of his works, including anonymous ones and those under an assumed name, was published by G. Vicaire, *Manuel de l'amateur des livres du XIXe siècle,* vol. v (1904).

MASS PRODUCTION. The term mass production refers primarily to methods of organizing manufacturing processes to attain high output rates. Both mechanization of production processes—the substitution of machine operations for manual work—and application of appropriate systems of industrial administration are involved. Although some of the more striking examples of mass production are provided by giant enterprises, high output production techniques are not restricted to large industrial organizations. The essential features of mass production are: (1) manufacture of standardized commodities; (2) long production runs; (3) continuous plant operation; (4) use of specialized production and material-handling equipment; (5) plant arrangements minimizing material handling and based on the particular sequence of operations required for the production of the standardized product; (6) division of labour to the point where most production workers perform short and simplified operation sequences repetitively; and (7) systematic planning, direction and control of manufacturing operations. When these characteristics are present, output per time period and per worker are both high, compared with the output rates obtained by small-lot, custom production in plants having nonsequential layouts and little specialization of jobs and equipment.

EVOLUTION OF MASS PRODUCTION

Mass-production methods were not applied on a wide scale in the U.S. until the beginning of the 20th century but their origins are much older. Factory production with considerable division of labour existed in western Europe long before the general employment of powered equipment for manufacturing processes which began with the industrial revolution of the 18th and 19th centuries. There are even accounts of manufacturing methods as early as the 13th century which indicate that arrangements much like the assembly line of the 20th century were then used for outfitting ships and making weapons. (*See* INDUSTRIAL REVOLUTION.)

Several streams of technical, managerial and social development culminated in modern mass production. Expansion of basic scientific knowledge and improvement of technology opened up new possibilities for invention and innovation in production, including new and improved materials, more efficient manufacturing processes, and equipment designed to operate faster and more accurately and last longer. The rise to dominance of the corporate form of enterprise allowed aggregation of large amounts of capital in continuous and stable organizations able to conduct long-term programs of product and process development. Beginning with the scientific management movement of the early 20th century, industrial management increasingly emphasized elimination of waste and promotion of efficiency. Many of the most modern analytical tools available to managers—time and motion study, job analysis, budgeting and cost accounting, equipment selection and replacement study, production planning and scheduling—are basically refinements of those used or suggested by the pioneers of scientific management. (*See* MANAGEMENT SCIENCES.) The philosophy of mass production which emerged as managerial and technical proficiency increased is that output expansion, quality improvement and cost reduction achieved through improvement of methods and investment in plant and equipment should be major goals of industrial enterprise. In mass-production economies which give expression to this philosophy, wage rates and living standards tend to rise in step with productivity increases so that expansion of output tends to be cumulative.

Clearly, mass production is as much a market phenomenon as anything else, for it implies mass consumption. Urbanization, widening of educational opportunity, reduction of inequalities in income distribution, social and geographical mobility of the population and other influences which induce homogeneity in tastes and patterns of consumption both impel mass production for mass markets and are furthered by it. As individual manufacturing firms concentrated on large-scale production, a system of industrial specialization evolved, in which firms may mass produce and sell in industrial markets one or a few items used, in turn, as materials or components by other producers whose products ultimately find their way to consumers.

PLANNING FOR MASS PRODUCTION

In any variety of production a certain amount of planning necessarily precedes conduct of operations. Time and effort must be devoted to determination of product characteristics, quantity of output, production methods, equipment to be employed and other aspects of the manufacturing process before work can begin. Thorough, often elaborate, planning must be completed in advance of mass-production operations and it is the high ratio of long-range

planning to planning for day-to-day operation which sharply differentiates representative mass-production enterprises from other types. Manufacturing establishments which produce mainly to customers' orders often shift much of the burden of product conception and design to the buyer.

Similarly, small-lot producers escape inventory expense at the cost of convenience to purchasers of their products. Mass-production enterprises, in contrast, must anticipate the future flow of orders and often must produce to build up inventories. The flexibility of general-purpose equipment which permits quick production shifts must be sacrificed in large part for the efficiency which comes from use of special-purpose equipment. Because of the large investments which must be made in plant and equipment and because of the often lengthy intervals from the decision to proceed with product development and plant construction to the attainment of expected rates of production and to repayment of plant and equipment costs, a potentially high and stable demand, permitting long production runs without major changes in products, generally is regarded as necessary. Continuous and intensive use of plant for reduction of fixed cost per unit of output requires that pronounced seasonal fluctuations or other variations in demand be at a minimum. The market risks in equipping for mass production of new products obviously are great. Even conversion to high-volume methods for established products is not without risk.

Standardization of products, materials, processes, equipment and other factors of production is as integral a part of mass production as interchangeability of product components is a key requirement for specialization of operations. The degree to which production processes can be broken down to simple operations which workers can perform with increased speed and accuracy is determined by the final effect on total production time. Hand fitting, rework and repair of product components and multiple inspections must be eliminated as far as possible if gains from division of labour and mechanization are not to be offset. Elimination of needless product variety, reduction of the total number of individual parts that must be made in order to turn out a series of product sizes, maximum utilization of specialized and expensive equipment units, minimization of material and parts inventories and avoidance of repetitive design and manufacture of items that differ only slightly are but a few of the advantages which stem from well-conceived company, industry and national programs of industrial standardization.

Proper standards for dimensions and other properties of materials and parts are the basis for sampling inspection and statistical control of quality, measures which can contribute to cost reduction in mass manufacture. Standardization, however, must be planned carefully in co-ordination with every other plan of production to assure that standards for products and processes are neither premature, overly rigid nor excessively narrow.

The visible results of the comprehensive planning for mass-production operations are production and assembly lines, combinations of work stations, machines and material-handling equipment arranged for continuous flow of units from raw material to finished product. In designing a production line, the sequences of operations for manufacture of each product component are determined, man-machine combinations for each manufacturing step are provisionally decided and plans or models of proposed physical arrangements are prepared for study. Each movement of material is scrutinized in detail, simplified or shortened if possible and crossflows and backtracking eliminated. Operations are balanced by so setting work assignments, numbers of machines and operating rates that all stations along the line have the same production rate. Where their use is indicated, mechanical or gravity conveyors are selected to couple the work stations. Auxiliary departments and plant services are planned in conjunction with the production layout to maximize convenience and ease of maintenance. The end in view is a set of production facilities capable of performing as an integrated unit with no bottlenecks and with minimum flow times and distances.

Operation of an automobile assembly line epitomizes mass production. Starting with a bare chassis, components are attached successively as the growing assemblage moves along the conveyor. Feeder lines on which parts are matched into subassemblies intersect the main line to deliver body parts, running gear, engines and other assemblies. Each worker along the line performs his job as the units move past, and each part and tool is delivered to its point of use in exact synchronization with the line. An intricate system of production scheduling and control ensures that the right body type and colour, trim, engine and optional equipment arrive together for assembly, for a number of individual assembly combinations are on the line simultaneously. The automobiles driven off the end of the line under their own power consist of parts which a few weeks before were raw materials, a few days before were unfinished in a distant supplier's plant and only a few minutes before were starting down the line.

In the most modern automobile plants, as has been true in such continuous process industries as petroleum refining and chemical manufacture for some time, many of the production lines are almost completely mechanized and workerless, consisting almost entirely of automatic, self-regulating equipment. A new word, "automation," was coined to describe the process of making machines to run machines, and the growing technology of automatic control is having a dramatic impact throughout the mass-production industries. As the promise of automation for high and sustained rates of output is made a reality, the terms automation and mass production are likely to be virtually synonymous. *See* also AUTOMATION and references under "Mass Production" in the Index.

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(J. D. Rs.)

MASS SPECTROSCOPY is that field of physics in which the motion of charged atoms and molecules in electric and magnetic fields is used to sort those atoms and molecules according to their atomic masses. The instruments used for this purpose are mass spectrometers and mass spectrographs, differing only in their method of making the sorted charged particles (ions) observable. In the mass spectrometer, the sorted ions are detected electrically; in the mass spectrograph, they are detected photographically or by other nonelectrical means. The term mass spectroscope is used in a loose sense to include both types of instrument. A person who specializes in their use is called a mass spectroscopist.

A number of quite different instruments can also sort out atomic masses but do not depend on the motion of ions in electric or magnetic fields. In the 1960s these instruments were also classed as mass spectrometers but with a prefix added; they included the microwave absorption mass spectrometer, the nuclear-induction mass spectrometer, the molecular mass spectrometer and the optical mass spectrometer. They will not be discussed further here, but it should be noted that many of the problems that the mass spectrometer has solved could also be solved through the use of these instruments.

The fundamental problems to which the mass spectroscope has been applied include identification of the isotopes of the elements; determination of the relative abundances and precise masses of isotopes; energy levels of atoms and of molecules; the structure of molecules; equilibrium and kinetics in chemical reactions; surface chemistry; the study of geological samples and hence the history of the earth; the study of meteorites and hence the history of the solar system; and studies in medicine and biology, generally through the use of isotopic-tracer techniques (*see* ISOTOPE).

About 1940 the methods of mass spectroscopy were first applied on a large scale to the separation of isotopes. The initial impetus was the need to isolate U^{235} for use in producing atomic energy (*q.v.*). The techniques were quickly extended to the isotopic separation of other elements.

Mass-spectrometric equipment became available commercially about 1940, and for a number of years was limited to gaseous-state studies, as in the analysis of hydrocarbon mixtures and inorganic gases. The first large-scale use of this equipment was in the on-stream analysis of the gases in isotope separation plants.

In 1943 special purpose mass spectrometers (with helium as a tracer gas) became available for leak detection.

In the early 1960s equipment became commercially available for the analysis of solid materials. It has been applied mainly to the determination of the chemical purity of solid materials, having the advantage (over the usual optical spectroscopic methods) of higher sensitivity to trace impurities.

Historical Mass Spectroscopy.—In 1886 E. Goldstein, experimenting with electrical discharges in gases at low pressures (a neon light is a well-known example), observed that if a hole was placed in the negative electrode, the luminous discharge extended through that hole into the gas behind. He concluded that this luminosity came from some sort of beam that traveled in the opposite direction from that of the then-known cathode rays; by analogy to their method of production, he named them Kanalstrahlen, or canal rays. In 1898 W. Wien showed that these beams could be deflected by magnetic fields. This fundamental property serves as the basis of a large part of mass spectroscopy. An ion beam (homogeneous as to energy or velocity) of small mass is deflected more sharply by the magnetic field than one of larger mass with the same energy of velocity (fig. 1); *i.e.*, the ions are sorted according to mass by deflection in a magnetic field.

A series of investigations was carried out (1907–13) by J. J. Thomson using simultaneous parallel electric and magnetic fields.

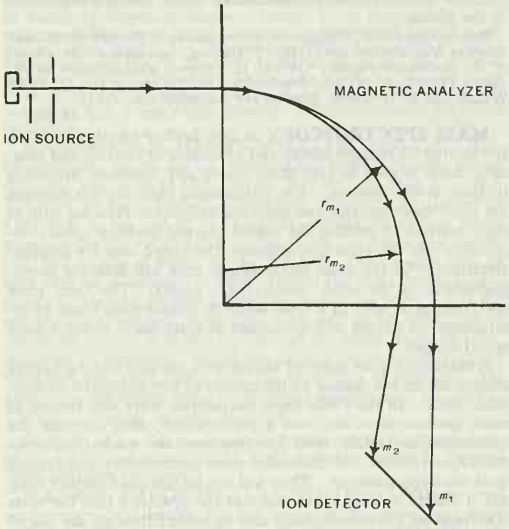

FIG. 1.—TRAJECTORIES IN A MAGNETIC FIELD OF TWO PERFECTLY COLLIMATED ION BEAMS HAVING THE SAME ENERGY BUT DIFFERING IN MASS

With this arrangement of fields an ion beam is resolved into a series of more or less complete parabolas, each characteristic of ions of one mass. The limitation of the simple magnetic deflection (*i.e.*, that the energy or velocity of the ions in the beam be constant) is removed. With this instrument Thomson investigated the ions formed by electrical discharges in a number of gases. He renamed the ion streams positive rays since most of the ions he observed had positive charges. Thomson's apparatus could separate ions differing in mass by 1 part in 15. His investigations in 1913 gave the first indication that ordinary neon was a mixture of two kinds of atoms (isotopes) that differed in mass by two atomic mass units.

All the devices noted above are analogous to the pinhole camera in optics; *i.e.*, no focusing is involved and definition of the ion beams is only as good as the pinhole is small. An advance came with the introduction of focusing types of mass-sensitive instruments. The use of ion lenses so improved the resolving power and sensitivity of the devices that by 1920 they had become practical tools. In 1918 A. J. Dempster introduced the first of these focusing analyzers. In his analyzer an ion beam (homogeneous as to energy or velocity) diverging from a defining slit was refocused after passing through a magnetic field, different masses being brought to focus at different points (fig. 2). Analogous to the function of a cylindrical lens in optics this is called direction focusing. In 1919 F. W. Aston introduced a focusing analyzer (fig. 3) in which successive electric and magnetic fields were oriented to bring to focus all perfectly collimated ions of one mass, independent of their velocity. This is called velocity focusing. Because the different mass ions were recorded as a spectrum of lines on a photographic plate Aston in 1920 introduced the term mass spectrum and termed the instruments mass spectrographs; these, with some expansion, became the standard designations. With these two types of instrument (which in 1920 could resolve masses that differed by 1 part in 100) the isotopic compositions of many elements were investigated and the first precise measurements of atomic mass were made.

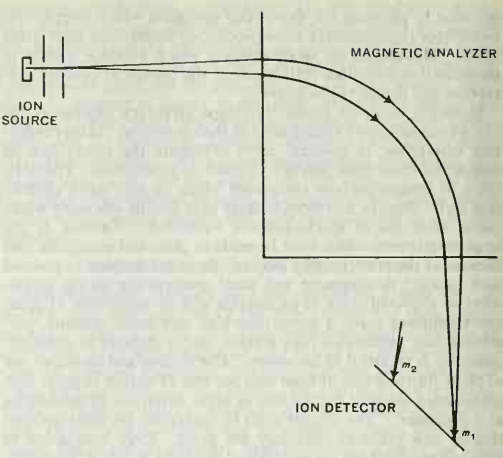

FIG. 2.—DIRECTION-FOCUSING ACTION AND MASS SENSITIVITY OF A MAGNETIC FIELD FOR ION BEAMS HOMOGENEOUS AS TO ENERGY

By the mid-1960s instruments based on direction focusing had become standard tools for isotopic-abundance measurements. When designed for high resolving power they could resolve masses differing by 1 part in 5,000, and when designed for high accuracy in relative isotopic-abundance measurement they yielded accuracies of 1 part in 10,000.

In 1935–36 Dempster, K. T. Bainbridge and J. Mattauch introduced instruments using successive electric and magnetic fields; *i.e.*, a configuration similar to fig. 3, but combined to refocus ion beams that are inhomogeneous both in direction and in velocity. This is called double focusing; instruments based on this principle produce much higher resolution than those based only on direction focusing. However, double-focusing instruments are quite com-

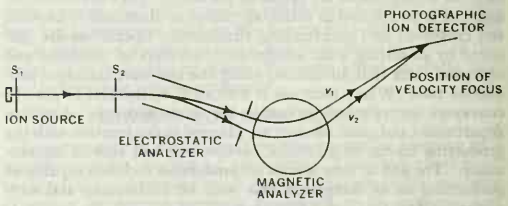

FIG. 3.—MASS SPECTROMETER USED BY F. W. ASTON. SLITS S_1 AND S_2 DEFINE AN ION BEAM. THE ELECTROSTATIC DEFLECTION INTRODUCES A VELOCITY DIVERGENCE IN THE ION BEAM WHICH IS JUST CANCELED BY THE MAGNETIC FIELD SO THAT VELOCITY FOCUS OCCURS AT THE PHOTOGRAPHIC ION DETECTOR

plex and are generally used only when simpler instruments are inadequate; *e.g.*, for measuring precise atomic masses and for the chemical analysis of solids. By the mid-1960s double-focusing instruments could separate ions differing in mass by as little as 1 part in 750,000 and could measure relative atomic masses to an accuracy of 1 part in 100,000,000.

All of the methods that have been described involve electric and magnetic fields that are invariant in time. In 1932 W. R. Smythe introduced alternating electric fields at radio frequencies (RF) to separate ions of different mass. Ions with the same energy but different mass have different velocities, the lighter masses moving faster. If a single short pulse of ions is directed into a tube of fixed length, the lighter (faster moving) ions will separate from the heavier (slower moving) ions. At the end of the free-flight path there will be a temporal resolution of the original pulse into separate mass components. In a practical instrument this separation is repeated over and over. A mass-sensitive instrument based on time-dependent phenomena to obtain mass resolution is generally termed a time-of-flight (or RF) mass spectrometer.

A number of simple useful RF mass spectrometers were developed in the 1950s. These included the pulsed-beam instruments, the RF-accelerator instruments, the omegatron and the quadrupole instruments. By the mid-1960s these were used routinely in chemical applications. Since they could be made small and very light, they were used extensively in space science; for example, in determining the composition of gases through which satellites move.

For precise mass determination RF fields alone are inadequate. However, combination of RF techniques with deflection in magnetic fields permits very high resolution and precise determination. Instruments of this type include the omegatron and the mass synchrometer. By the mid-1960s these had achieved resolutions of 1 part in 100,000 and accuracies in relative isotopic-mass determination of 1 part in 100,000,000.

Experimental Mass Spectroscopy.—An experiment with a mass spectrometer involves: (1) the production with an ion source of an ion beam characteristic of the sample under investigation; (2) separating the beam into various mass components with a mass analyzer; and (3) rendering the resolved beam observable with an ion detector. Any device that combines these parts and functions is classed as a mass spectrometer. A typical combination is shown in fig. 2.

ION SOURCES

The production of an ion means in its simplest case the detachment of one or more electrons from a neutral atom. The production of an ion beam is accomplished by accelerating ions by means of electric fields and directing them through small holes or slits. The beam is thus collimated by the slit and has an energy or velocity that can be computed from the voltage through which the ions were accelerated. There are a number of mechanisms for producing ions.

Gaseous-Discharge Ion Source.—The gaseous-discharge ion source was used almost exclusively until 1920. It was developed by Goldstein in 1886 and was improved by Wien, Thomson, Aston and others. Ions are produced by a gaseous discharge maintained (at low gas pressures) by high voltage between two electrodes. The ions are accelerated by the same field and pass through holes in the electrodes as a beam. Although this source is simple in concept and construction, no complete theoretical explanation has been made despite a great deal of work. By 1940 it had been replaced by other sources that are simpler in theory and is now relegated to occasional special applications.

Solid-Loaded Gas Discharge.—The simple gas-discharge source is limited to the ionization of substances with appreciable vapour pressures at room temperature. This limitation is removed by the solid-loaded gas method introduced in alternate forms by E. Gehrcke and O. Reichenheim in 1906 and by Bainbridge in 1932. The method is based on the introduction of the solid material to be analyzed into small holes drilled in the anode or cathode of a gas-discharge ion source. Operation of the gaseous discharge in the supporting gas evaporates and spatters the solid material into the discharge chamber as ions and as neutral atoms. Further ionization takes place in the discharge itself. Since the source depends on a gaseous discharge the limitations are quite similar to those of the simple gas-discharge source.

Gaseous Discharge in a Magnetic Field.—In 1937 F. M. Penning developed an ion gauge (*i.e.*, a pressure-measuring device) in which a gaseous discharge takes place in a magnetic field. This discharge is much more stable and operates over a much wider pressure range than the simple gaseous discharge described above. Ions can be drawn from such a discharge either axially or at right angles. The ion beams produced are stable and useful for special problems in mass spectroscopy.

Arc Discharge.—The sources noted thus far require only high voltages to maintain the discharge. If a hot filament is used as the negative electrode to supply a continuous stream of electrons, another type of discharge occurs called an arc discharge. This can be operated at much lower voltages than can the simple gaseous discharges, yielding an ion beam more homogeneous as to energy and, hence, more useful in mass spectroscopy. The major advantage of such a source is that it produces an intense ion beam. Since isotopic separators require intense beams, the arc-discharge source is best suited for this application. Its instability is a major factor in making it undesirable for ordinary isotope-abundance work.

Surface Ionization.—The surface-ionization source was discovered by Gehrcke and Reichenheim in 1907. When an atom or molecule is evaporated from a surface it has a probability of being ionized that is given by

$$\frac{n^+}{n^0} = \exp\left[\frac{e(w-\phi)}{kT}\right]$$

where n^+/n^0 is the ratio of the charged to neutral constituents, e is the electronic charge, w is the work function of the surface, ϕ is the ionization potential of the constituent evaporated, k is the gas constant and T is the absolute temperature. The theory behind this source is thus understood and the special requirements of the source are deducible from the equation. They are: (1) the ionization potential of the material to be analyzed must be low; (2) the work function of the surface from which evaporation takes place must be high; and (3) substances for which the ionization potential is higher than the work function of the surface should be in refractory compounds to take advantage of the temperature sensitivity.

Two variations of the surface-ionization source are used. In one the material to be analyzed is deposited directly on the surface to be heated (filament), and ionization occurs when the material is re-evaporated in vacuum. In the second the sample is introduced as a gas and is ionized when it meets the hot surface. A typical ion source of the former type is shown in fig. 4. It can be used with any type of mass analyzer since the ion energies are homogeneous.

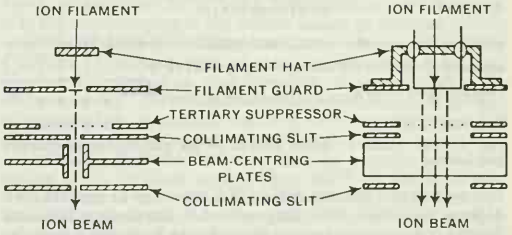

FIG. 4.—TWO VIEWS AT RIGHT ANGLES OF A SURFACE-IONIZATION SOURCE

For many elements surface ionization is the most sensitive of all sources used in mass spectroscopy. It has been used for all isotopic studies of the transuranium elements (*q.v.*) and for most other studies of highly radioactive substances. Its high sensitivity permits work with such small samples that special precautions to protect people from radiation are not required, far outweighing the shortcomings of relatively poor stability.

Vacuum Spark.—The vacuum-spark ion source was developed by Dempster in 1935. In this source a potential of about 50,000 v. is placed between two electrodes. The resulting electrical breakdown produces a hot spot on the electrodes from which solid material is evaporated and spattered into the space between. The electrons present in this space produce ions by bombardment. Further ionization is produced by the impact of ions against the electrodes themselves. A fraction of the ions is then accelerated from the discharge and focused into a beam. To keep the electrode from melting, the voltages are applied as pulses of a few microseconds' duration, repeated at a rate of about 60 per second. The source must be used with a double-focusing analyzer for mass resolution since the ion energies are not homogeneous.

The spark source is erratic since it depends on chance electrical breakdown. It does however have the great advantage of roughly constant sensitivity to all elements. It is thus the standard tool for general chemical analysis of solids.

Electron Bombardment.—The electron-bombardment source was introduced by Dempster in 1921. In the 1960s it was the most universally used ion source. Its modern form was worked out by W. Bleakney and A. O. Nier. When an electron collides with an atom or molecule it may lose a fraction of its energy to that atom or molecule in the form of ionization or excitation or both. The ions, whether they are atomic or molecular, are immediately usable. In the case of an atom, the excitation is lost by radiation to, or collision with, the walls of the ionization chamber or by collisions with other molecules having ionization potentials less than the excitation energy. Only the last of these types of energy loss has any influence on mass spectroscopy since it is the only one that results in charged particles. In the case of a molecule, the excitation is often lost by dissociation of the molecule into ionized fragments. Thus, the important characteristic of an electron-bombardment source is ionization with or without fragmentation.

In one variation of the electron-bombardment source the sample is introduced as a gas from an external system; in the other the sample is evaporated from a crucible placed in juxtaposition to the ion source itself. In either case, the sample enters the ionization chamber as a gas and the source itself is unchanged. The source shown in fig. 5 is typical; electrons are produced at the filament by thermionic emission (*see* THERMIONICS). The electrons are accelerated and projected across the ionization chamber by a constant voltage between the filament and the chamber. Since the amount of ionization produced is a function of the electron current and electron energy, it is necessary to regulate both of these quantities. The ions produced by the electron beam are drawn out of the chamber and focused electrically into a beam by the collimating slits. Since ionization in this source occurs in an approximately field-free region, the beam is homogeneous as to energy and the source will work with any type of mass analyzer.

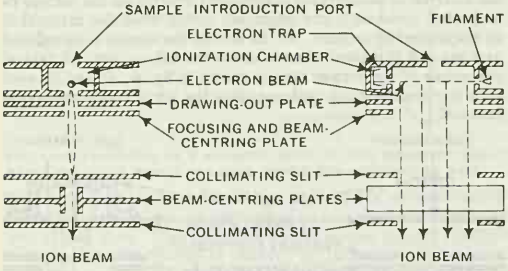

FIG. 5.—TWO VIEWS AT RIGHT ANGLES OF AN ELECTRON-BOMBARDMENT ION SOURCE

Photo-ionization.—In photo-ionization photons (rather than electrons) produce the ions. Thus if the electron beam of fig. 5 is replaced by a photon beam, the device becomes a photo-ionization ion source. Photon energies required are in the range of 10–20 electron volts; *i.e.*, photons of 500–1,000 Å. These wavelengths are in the very far ultraviolet range and require windowless light sources. Light sources most used are the many-lined spectra of hydrogen and the continua from helium or argon (*see* LIGHT).

Electron Affinity.—The electron-affinity ion source is based on the fact that an atom or molecule can be evaporated from a surface as a negative ion with a probability given approximately by

$$\frac{n^-}{n^0} = \exp\left[\frac{e(A-w)}{kT}\right]$$

where the symbols have the same significance as in the equation under surface ionization, and A is the electron affinity (*i.e.*, the energy with which an extra electron can be bound to a molecule) of the evaporating species. This source is quite similar to the surface-ionization source except that it depends on electron affinity rather than ionization potential, and it produces negative rather than positive ions.

Field Emission.—The field-emission ion source first applied by M. G. Inghram and R. Gomer in 1954 is based on the fact that when very intense electrostatic fields are placed at a surface, the absorbed gases on that surface are pulled off as positive ions. Fields of the order of 10^8 v. per centimetre are necessary to draw off such ions. The source is useful mainly in the study of surface chemistry. Since the ions are drawn from an equipotential surface, they are homogeneous as to energy and the source may be used with any of the various mass analyzers.

MASS ANALYZERS

The thousands of mass analyzers that have been constructed can be assigned to a few basic classes depending on their principle of mass separation.

Parabola Mass Analyzer.—If a well-collimated ion beam is projected through parallel homogeneous electrostatic and magnetic fields, it will be resolved into a series of more or less complete parabolas, each characterized by a particular mass-to-charge ratio. The completeness of the parabolas is a measure of the inhomogeneity in energy of the original ion beam; and the structure within a parabola yields information on the ion-molecule reactions occurring in the beam. The parabola mass analyzer is no longer used for analytical purposes because, since it involves no focusing, it is a low-resolving-power, low-sensitivity instrument. The major uses are for studying the characteristics of ion sources and for studying ion-molecule collisions.

First-Order Velocity-Focusing Mass Analyzers.—The first mass analyzer to achieve first-order velocity focusing used successive electric and magnetic fields and was constructed by Aston in 1919 (fig. 3). Though four instruments involving first-order velocity focusing have been constructed, they are no longer in use largely because no direction focusing is involved and the ionic transmission is low. The first-order double-focusing mass analyzer has replaced the velocity-focusing analyzer for most purposes.

Velocity-Selection Mass Analyzers.—The crossed-homogeneous electric- and magnetic-field mass analyzer was developed by Wien (1898). If a beam of ions is projected at right angles into such fields, only ions of velocity

$$v_0 = \frac{cE}{B}$$

will traverse those fields without deflection. In this equation, c is the velocity of light, E is the electrostatic field strength and B is the magnetic field strength. If the source produces a monoenergetic ion beam, the velocity is given by

$$v_0 = \sqrt{\frac{2eV_0}{m}}$$

In this equation e is the charge on the electron, V_0 is the potential through which the ion was accelerated and m is the mass of the ion. On eliminating v_0 between these two equations

$$m = \frac{2eV_0B^2}{c^2E^2}$$

it is seen that, in combination with a source that produces an ion beam homogeneous as to energy, the crossed-field arrangement may be used as a mass spectroscope. In addition to mass sensitivity, the arrangement does have the property of direction focusing. Theoretically, an ion beam diverging from a slit within the crossed field will come to focus at distances that are any integral multiple of πa_m from the entrance slit. The quantity a_m is the radius of curvature of the ion path in the magnetic field alone. This analyzer has been little used by itself because of the bulkiness of the equipment necessary to give the desired resolving power. Its main use is in conjunction with other types of analyzers where the property of velocity measurement is of fundamental importance.

Perfect Double-Focusing Mass Analyzers.—The perfect double-focusing trochoidal mass analyzer was introduced by Bleakney and J. A. Hipple (1938). The fields in this analyzer are again crossed-homogeneous parallel electrostatic and magnetic fields, but the trajectories are not straight lines as in the last case but trochoids as shown in fig. 6. This is one of the few analyzers in which perfect double focus occurs; *i.e.*, the focused image is a perfect image of the source slit rather than an approximation. The image occurs for every multiple of $2\pi a_m$ along the x axis where a_m is the radius of curvature of the ion trajectory in the magnetic field alone. The mass scale is exactly linear.

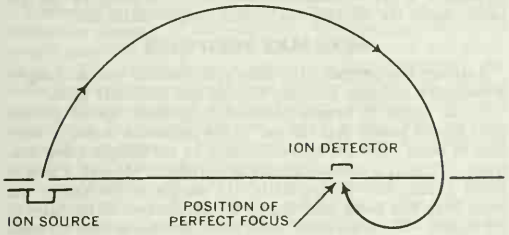

FIG. 6.—TROCHOIDAL TRAJECTORIES OF IONS IN THE PERFECT DOUBLE-FOCUSING CROSSED-FIELD MASS ANALYZER. THE ELECTROSTATIC FIELD IS PLACED IN THE PLANE OF THE PAPER AND IN A VERTICAL DIRECTION. THE MAGNETIC FIELD IS PLACED NORMAL TO PLANE OF THE PAPER

First-Order Direction-Focusing Mass Analyzers.—The first-order direction-focusing mass analyzer was introduced in 1918 by Dempster. The extension of this principle to sector-shaped magnetic analyzers was made by Bainbridge and Nier in 1938. From 1940 until the late 1950s this was the only type of mass-spectrometric equipment available commercially. This type of analyzer can be used only with those ion sources that produce beams homogeneous in energy.

In this analyzer an ion beam homogeneous as to energy is projected at right angles into a homogeneous magnetic field (fig. 7). After deflection, it again comes to focus. The relation between the lengths l'_m, l''_m, ϕ_m and a_m is given by the equation

$$(l'_m - a_m \cot \phi_m)(l''_m - a_m \cot \phi_m) = a_m^2 \csc^2 \phi_m$$

a_m is given by the equation

$$a_m = \frac{m_0 V_0 c}{eB}$$

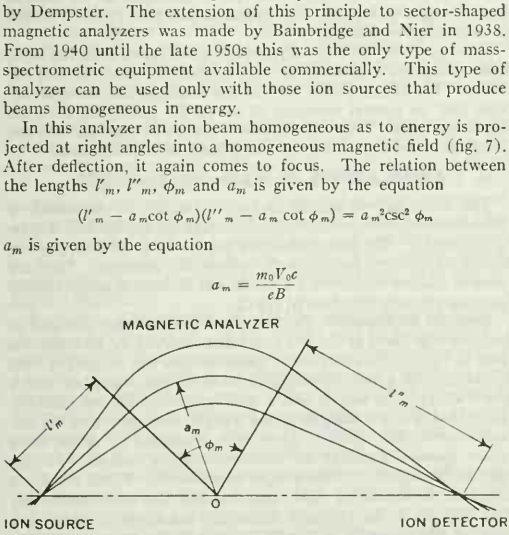

FIG. 7.—FOCUSING ACTION OF A VECTOR TYPE OF DIRECTION-FOCUSING MASS ANALYZER

It is clear from these equations that from the theoretical standpoint all such instruments are the same regardless of the angle of deflection. The problem of the deflection angle is dictated by such auxiliary considerations as construction requirements. There are, of course, more complicated equations governing the focal conditions in the case of ion beams that do not enter or leave the magnetic field at right angles, but these are different only in detail.

First-Order Double-Focusing Mass Analyzers.—The successive-field first-order double-focusing mass analyzer has been

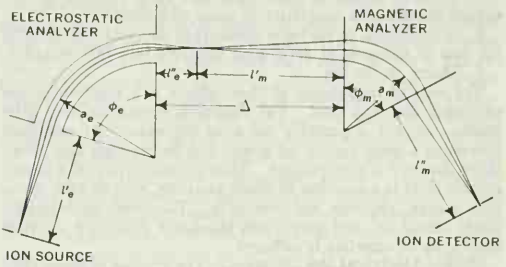

FIG. 8.—FIELD ARRANGEMENT USED WITH FIRST-ORDER DOUBLE-FOCUSING MASS ANALYZERS. THE DEFLECTION ANGLES ARE ARBITRARY, ANY ANGLES BEING USABLE. HOWEVER, CERTAIN RELATIONSHIPS AMONG l'_e, l''_e, Δ, l'_m, l''_m, a_e AND a_m RESULT IN DOUBLE FOCUSING

used extensively for precise mass determinations. After 1945 it was applied to the chemical analysis of solids. Since the device is double focusing (*i.e.*, takes into account spreads in both velocity and direction in the initial ion beam) it will work with any ion source. A typical field arrangement is shown in fig. 8. In this device ions are projected first into a radial electrostatic field that has an energy but no mass sensitivity, and then into a homogeneous magnetic field that has both mass and energy sensitivity. With proper arrangement of the fields, the magnetic field can be made to just cancel the energy sensitivity of the electrostatic field and give an image that is independent of initial ion velocity. At the same time mass resolution does not cancel so that the combination is mass sensitive. Again, any angle of electrostatic and magnetic deflection can be used and the instruments are not different in concept.

Higher-Order-Focusing Mass Analyzers.—By shaping the magnetic field pole faces in first-order-focusing mass analyzers, it is possible to produce higher-order focusing (*i.e.*, more perfect images). Similarly, by using particular combinations of electric and magnetic fields in double-focusing mass analyzers it is possible to produce higher-order focusing in both direction and velocity. The experimental realization of such higher-order focusing is not easy since it is difficult to take accurately into account fringe fields. The most important use of higher-order-focusing mass analyzers is in the determination of the precise masses of isotopes.

Time-of-Flight (RF) Mass Analyzers.—As outlined earlier, a number of different types of mass analyzers have been constructed that depend on time-dependent electrostatic fields for mass sensitivity. By the mid-1960s the pulsed beam, the RF accelerator and the quadrupole analyzers were extensively used for the analysis of the chemical composition of gases.

Composite Mass Analyzers.—There are a number of combinations of the analyzers outlined above which are useful for special purposes. For example, two successive first-order direction-focusing mass analyzers have been used to achieve the advantages of a double achromat in optics. An energy selector followed by a direction-focusing mass analyzer has been used as a tool in molecular energy-level studies.

ION DETECTORS

Photographic-Plate Ion Detectors.—The application of photographic plates to the detection of ion beams was due originally to J. Koenigsberger and J. Kutschewski. Unfortunately the action of fast-moving ions in forming a developable image is poorly

understood. No single law has been found to describe the action satisfactorily. Among the factors involved are:

1. Breaking of chemical bonds of the silver halide molecule by the energetic motion of an atom passing near or through that molecule.
2. Production of light by the atoms excited in the process of stopping the moving atom.
3. Production of secondary electrons.
4. Penetration of the ion through the emulsion.
5. Chemical effects of ionic molecules after stopping as evidenced by excessive sensitivity to some molecules.
6. Gross deposit of ion-beam elements in the emulsion, affecting the rate of diffusion of developing solutions into that emulsion.
7. Charge on the ion.

The relative importance of these effects is a function of the particular emulsion used. For emulsions containing very little gelatin, factor 1 is probably the most important; for emulsions containing a large amount of gelatin and having high light sensitivity, factor 2 is predominant. Thus the sensitivity of a photographic plate is a function of many variables, such as ionic mass, ionic energy, exposure and chemistry. Therefore, photographic plates should be used only when absolutely necessary or when qualitative information is sufficient.

Simple Electrical Ion Detector.—The first use of direct electrical detection of resolved ion beams was due to Dempster (1918). To accomplish this the resolved ions are made to pass through a defining slit and impinge on a collector plate; they are neutralized by electrons flowing to the plate. The flow of this current can be detected with a sensitive amplifier and recorded. The measurement of the relative intensities of the two ion beams is thus simply a matter of reading a meter when first one and then the other ion beam is striking the final collector.

Dual Electrical Ion Detector.—The limitations in the accuracy of a mass spectrometer equipped with a simple electrical ion detector are usually a function of ion-current stability. One method of minimizing the effect of these fluctuations is to collect both beams at once and balance one against the other electrically; *i.e.*, null detection. The use of dual collectors was first reported by H. A. Straus (1941). The arrangement shown in fig. 9 was developed by Nier, Inghram and E. P. Ney in 1947. In this collector one ion beam strikes the defining slit plate and the other passes through to the final collector. The null balance is accomplished with the electronic arrangement shown at the right in this figure.

Suppressive Electrical Ion Detectors.—The suppressive electrical ion detector detects only those ions with full or a known fraction of full energy; *i.e.*, those that have not lost part of their energy by gas collisions or by ion breakup in transit (metastable ions). These collectors are therefore used mainly in applications in which the spectrometer operates at relatively high pressures (leak detection) or where metastable ions are of importance (hydrocarbon analysis). There are three important methods of accomplishing this suppression: (1) by passing the ion beam over a potential barrier; (2) by placing the final collector at such a potential that the beam is decelerated after passing through the image slit and arrives at the final collector with (effectively) zero energy; or (3) by adding an electrostatic analyzer after the image slit to select those resolved ions of the proper energy.

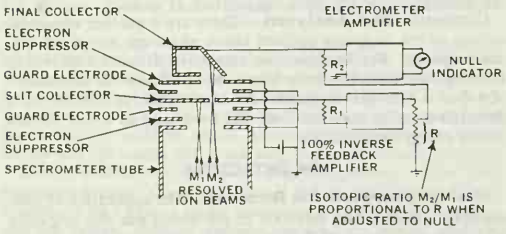

FIG. 9.—ONE ARRANGEMENT OF ION-RECEIVING PLATES FOR DUAL COLLECTION AND NULL MEASUREMENT OF ISOTOPIC COMPOSITION

Electron-Multiplier Ion Detection.—When extreme sensitivity or rapid or panoramic (oscilloscope) recording is of prime importance, the electron-multiplier ion detector is advantageous. The system is avoided whenever possible since it is nonlinear with such factors as ionic mass, ionic energy and stray magnetic field. In addition, with a sensitive spectrometer and most ion sources, background peaks are observed at many masses so that the added sensitivity is often useless. The use of electron multipliers can be illustrated from fig. 9. If the final collector plate is removed and the first stage of a standard electron multiplier is put in its place, the secondary electrons produced when the ion beam strikes that plate will be multiplied and detected as a much larger current, thus increasing the sensitivity of the instrument. Such multipliers were first used in mass spectroscopy by A. Cohn in 1941. In his application they were used to count the individual ions striking the final collector. The scintillation ion-beam detector has been used in two forms. In the first the ion beam impinges directly on a scintillator such as potassium iodide and the light pulse produced is amplified with a standard commercial photomultiplier. In the second the beam strikes a plate that converts the beam into electrons; these are accelerated onto a standard scintillator and the light pulse is amplified by photomultiplier for recording. By the 1960s the latter method was used most since in this form the scintillator is not contaminated and spattered away by the ion beam; hence the detector has a much longer useful life.

AUXILIARY EQUIPMENT

Auxiliary components of a mass spectrometer include sample-introduction systems, pumping systems and electronic units.

In the design of sample-introduction systems, special precautions should ensure that the gas in the ionization region is identical or bears some known relationship to the sample being analyzed. Thus, if a gaseous sample is introduced through a leak in which viscous flow predominates, the sample in the source will differ from that being analyzed by the square root of the ratio of the masses. If, on the other hand, molecular flow is used throughout, there will be no difference. Again, if a sample is evaporated from a hot crucible placed in juxtaposition to an electron-bombardment ion source a correction of the square root of the masses is needed if the evaporation is from a solid surface, but not if it is from a liquid surface. Note that in the latter case, as is also true in molecular-flow gas leaks, the composition of the sample itself changes with time. It is apparent that each problem should be considered separately.

The electronic units usually require more space than the three basic components themselves; *i.e.*, ion source, analyzer and detector. The requirements vary so much among the different devices that no general rules can be set up for specifying them for electronic units. They can, however, always be specified starting from the requirements on the three basic units themselves.

APPLICATIONS OF MASS SPECTROSCOPY

The following will summarize only a fraction of the wealth of information that has been obtained through the application of mass spectroscopy. The instruments are used in such fields as physics, chemistry, geology, meteorology, biology and medicine. They are used to analyze microscopic crystals and to control automatically huge gas streams in industrial plants.

Isotopic Existence.—The first mass-spectrometric evidence of isotopes was found in the two parabolas observed by Thomson for neon in 1913. The existence of these isotopes was verified in 1920 by Aston with a velocity-selection mass analyzer equipped with a gas-discharge ion source and a photographic-plate ion detector. From that time the analysis of the isotopic composition of the elements proceeded rapidly. Most were examined by Aston using either gaseous-discharge or surface-ionization sources. In this way he identified 212 isotopes in 74 elements. Other observers analyzed the remaining stable elements and also discovered many rare isotopes in the elements Aston had examined to make up a total of 283 naturally occurring isotopes in the first 83 elements in the periodic table. By the early 1960s, 19 of these 283 isotopes

were known to be radioactive with half lives exceeding 100,000,000 years. All elements with atomic numbers greater than 83 are radioactive; thus the term "naturally occurring" requires interpretation. Only three isotopes above element 83 have half lives comparable with or greater than the age of the solar system: Th^{232}, U^{235} and U^{238}.

The discovery that the chemical elements consist of isotopes with integral values for their masses led to the revival of William Prout's theory of 1815, according to which the atoms of all the elements are different aggregations of hydrogen atoms. This theory had been abandoned toward the middle of the 19th century when precise measurements of the atomic weights of samples of many elements produced results that are definitely not integers. When the nonintegral values were found to result from the presence of isotopes, it was again possible to think of atomic nuclei as built up of different numbers of fundamental units (*see* NUCLEUS). These units were considered in 1920 to be protons and electrons, but after the discovery of the neutron by Sir James Chadwick and the development of the theory of exchange forces by W. K. Heisenberg in 1932, the building blocks (nucleons) were supposed to be protons and neutrons, the number of protons being equal to the nuclear charge and the total number of nucleons being equal to the isotopic mass. More precise comparisons soon showed, however, that the masses of isotopes depart slightly from exactly integral ratios, as will be discussed below.

Radioactive Isotopes.—Isotopes were found in the naturally radioactive elements as early as 1906. The chemical identity of several pairs and groups of radioactive products was well established by 1913, when the term isotope was first introduced. Between the thallium isotope of mass number 205 and the uranium isotope of mass number 238, 40 different kinds of radioactive atoms were known and classified into 10 groups with different chemical properties. The different groups constitute different elements with two to eight isotopes each.

The confirmation in 1934 by Irène Joliot-Curie and Frédéric Joliot of earlier claims of induced radioactivity, that stable isotopes of boron and aluminum could be transformed into radioactive forms by the impact of alpha-rays, led to an unexpected extension of knowledge of isotopes. Protons, deuterons and especially neutrons also were found to produce radioactive isotopes. By the 1960s more than 1,000 so-called active isotopes had been produced (*see* RADIOACTIVITY.) Their masses not only occupy the gaps between the stable isotopes but extend to lighter and heavier masses.

In many cases a particular isotope, identified by its half life, can be formed in several ways from neighbouring elements and it is possible to deduce its mass from its relation to the stable isotopes. However, the occurrence of isomeric forms often introduces uncertainty.

The masses of many active isotopes have been observed directly by the methods of mass spectroscopy. For this purpose the radioactive sample mixed with stable isotopes is used in the ion source of a mass spectrograph. The isotopes separated by the mass analyzer are allowed to fall on a photographic plate or other collecting plate and the positions of the radioactive isotopes are identified, either by means of a counter tube or by making a transfer in which the radiations from the radioactive isotopes produce images on a second photographic plate placed in contact with the original deposits.

Relative Abundance of Stable Isotopes.—The relative abundance of the isotopes of an element may be found either by comparing the relative ion currents in the resolved ion beams characteristic of each isotope or by photometric measurements of their images on a photographic plate. The latter method was used by Aston with the many elements he analyzed. Current measurements give more accurate values; this method has been used to measure the abundances of all of the isotopes.

In the case of hydrogen, carbon, oxygen, sulfur, rubidium and lead the mass spectrometer has detected slight differences in the relative abundances of the isotopes as they occur in nature. The carbon isotope at mass 13 is more abundant in organic samples (1:88.3) than in limestones (1:92.3). Lead samples from different sources vary markedly because of the admixture of some lead from radioactive decay. Water from various sources varies in density because of variations in the relative abundance of the oxygen isotopes (M. Dole, 1936). The strontium found in certain micas, formed by the radioactive decay of rubidium, consists almost entirely of an isotope at mass 87 (Mattauch, 1937).

Absorption of neutrons produces samples with very abnormal isotopic abundances, especially in the case of elements with large neutron-absorption cross sections; for example, cadmium, samarium, gadolinium or mercury.

Exact Masses of the Isotopes.—All quantities in physics are relative; exact mass actually means the ratio of an unknown mass to an arbitrary unit of mass. For many years there was a great deal of confusion about the atomic mass scale because it was defined in different ways. Physicists defined the atomic mass unit (amu) in terms of the lightest isotope of oxygen, assigned exactly 16 amu. Chemists defined the mass unit in terms of ordinarily occurring oxygen (a mixture of three isotopes: mass numbers 16, 17 and 18). The difference in the two scales was 0.0275%. As a result such quantities as Avogadro's constant (*q.v.*) and the faraday were different on the two scales, leading to much ambiguity. The two scales were replaced by international agreement in 1961 with a single scale based on the lightest isotope of carbon, assigned a mass of exactly 12 units (12 u). The u designation was selected to distinguish it from the old atomic mass unit (amu). The new unit shifts chemical atomic weights by about 0.004%; for all practical chemical purposes the old scale can be used without correction (*see* ATOMIC WEIGHT). However, appropriate corrections must be made in using the physicists' older atomic mass tables. The correction reduces masses based on the oxygen isotope by 0.0318%.

The determination of precise masses of isotopes with the mass spectroscope is fundamental for understanding the structure of atomic nuclei. Such measurements led to the discovery of basic relations governing energy release in nuclear transformations, a most important chapter in the subject of mass spectroscopy.

The discovery by Aston (1920) that the mass of hydrogen was 1.008 when compared with oxygen defined as mass 16.0000 was of great importance; for the empirically measured masses of all the nuclei above hydrogen are slightly less than would be expected if these nuclei were simply multiples of the hydrogen mass. One feature of the relativity theory formalized by Albert Einstein in 1905, that the relationship between mass change and energy change is $\Delta E = \Delta mc^2$, entered in a very general way.

The mass of any physical thing could be regarded inherently as an aspect of a hypothetical energy content; thus any change of the energy involved a corresponding change of mass. From the mass-spectroscopic results of 1920 it could be assumed that isotopes are built of hydrogen and that the loss of approximately 0.008 atomic mass units for each hydrogen atom was accounted for by the energy lost when the elements were formed. Conversely this is the energy that would have to be put into the nucleus to remove a proton (hydrogen nucleus) from that heavier nucleus.

Mass measurements made by Aston (1920–27) of the most abundant isotopes of 20 elements were enough to show the general nature of the nuclear binding energies; for example, he found the atomic mass for hydrogen was 1.008, helium 4.004, sulfur 31.982, argon 39.975, mercury 200.61. All these numbers are very nearly integers. Because the difference between the exact mass and the nearest integer was always small Aston introduced the term packing fraction (*P.F.*), which is a measure of the deviation from integral masses. It is defined as

$$P.F. = \frac{M-I}{I}$$

where M is the precise mass and I is the nearest integer to that mass. Although *P.F.* data were commonly given up to the mid-1950s, the term has little physical significance. By the 1960s almost all data on precise masses were given in terms of the average binding energy per nucleon.

The discovery by J. D. Cockcroft and E. T. S. Walton in 1932 of the artificial disintegration of lithium by rapidly moving protons

to form isotopes of helium offered hope of verifying Einstein's mass-energy equation. It was immediately apparent, however, that the then available figures for mass were of such poor precision that the accuracy in the quantitative relation would be no better than 50%. It was evidently necessary to improve mass measurement to yield results accurate to five or six significant figures. This led Dempster, Bainbridge and Mattauch to develop double-focusing mass analyzers. With the first of these Dempster (using the vacuum-spark ion source) investigated the four remaining elements that had been too difficult to study with the older analyzers. In these and 13 other elements he found 33 isotopes that had been missed on the earlier equipment, including the rare isotope of uranium U^{235}. The spark source formed a great number of multiple-charged ions and made possible 60 accurate mass determinations among the heavier elements. Bainbridge and E. B. Jordan with their double-focusing device measured the mass of 14 of the light elements with great accuracy. Mattauch with his equipment made 12 comparisons and deduced seven precise masses. Other devices were completed by T. Okuda (1939) and Jordan (1940), the latter having a resolving power of 30,000. Thus in eight years the resolving power of mass spectrometers had improved from 130 to 30,000; by the mid-1960s Nier, Mattauch, H. E. Duckworth and others had further improved the instruments. Resolutions achieved were 1 part in 750,000 and accuracies in isotopic-mass determination were 1 part in 100,000,000. A graph showing average binding energy per nucleon is shown in fig. 10. Note that the vertical scale covers a variation in binding energy of less than 5%. The information exhibited by fig. 10

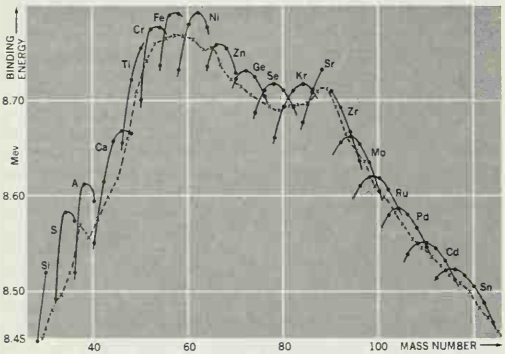

FIG. 10.—THE AVERAGE BINDING ENERGY OF ISOTOPES AS A FUNCTION OF ISOTOPE MASS NUMBER. THE DASHED CURVE CONNECTS ISOTOPES OF ODD MASS. THE PARABOLIC LOOPS REPRESENT ISOTOPES OF EVEN MASS FOR EACH ELEMENT. THE LIGHT-MASS ELEMENTS ARE FAR OFF SCALE IN THE DOWNWARD DIRECTION

is remarkable; it represents detailed experimental verification of the mass-energy relation of relativity theory and constitutes a major scientific achievement. What had been a grandiose theoretical formulation of 19th-century physics is shown to apply in one of its fundamental features to the partially explored field of nuclear phenomena.

Ionization Phenomena and Chemical Physics.—Mass spectroscopy grew out of and includes the study of ionization and its resulting reactions. Wien showed in 1900 that ions formed in a gas discharge are characteristic of that gas. Thomson from 1910 to 1913 found with his parabola analyzer that molecular gases may be ionized with or without dissociation, that ions with multiple charges or single negative charges occur and that a variety of reactions take place as an ion moves through a gas.

An important step in the study of ionization phenomena was Dempster's introduction (1916) of electron beams of known energy as ionizing agents. In 1922–30 H. D. Smyth and others gradually reduced the energy of the electrons and improved techniques to the point where thresholds for ionization could be determined. This appearance potential is related to the ionization potentials of elements or molecules and its measurement has proved important in the quantum theory of atomic and molecular structure (*see* QUANTUM MECHANICS). In 1930 J. T. Tate and Bleakney determined the kinetic energy with which excited ions dissociate and gave strong impetus to the study of quantum-mechanical energy levels in molecules. Another important step was the introduction (1957) of photon beams of known energy as ionizing agents.

These techniques have now been applied to a wide variety of problems in chemical and molecular physics. These include the determination of bond strengths in molecules; the structure of molecules; the composition of the gases in equilibrium with condensed phases at high temperatures; the kinetics of unimolecular dissociation; the kinetics of evaporation and condensation; cross sections for many kinds of molecular reactions.

Hydrocarbon Analysis.—The study of Smyth, Tate and Bleakney concerning ionization phenomena in gases led by 1940 to the use of the mass spectrometer on an industrial scale for the analysis of hydrocarbons and other gaseous mixtures. In such applications the mass spectrum recorded by a hydrocarbon mixture can be represented as the sum of the intensities of the pure components. Thus by measuring two peaks the relative concentration of a two-component system may be determined. By measuring ten peaks a ten-component system may be analyzed, and so on. Such analyses require the solution of simultaneous equations since most peaks are an admixture of several components. In conjunction with these devices it is therefore important to have a special calculator for solving simultaneous equations. Such calculators became commercially available in 1945. Using this mass-spectrometric method, the analysis of a ten-component hydrocarbon gas mixture takes, on the average, about half an hour; a similar analysis using the older distillation methods would require many hours of work. In addition these instruments have been used directly on gas streams for continuous analysis of industrial plant operation. Instruments used for continuous monitoring are more rugged and correspondingly somewhat less accurate than their laboratory counterparts. In some cases the instruments are connected directly to the plant controls to attain automatic plant operation (*see* AUTOMATION).

Leak Detection.—Mass spectrometers can be used to detect extremely small amounts of gas mixed with large quantities of other gases. Nier and A. Hustrulid in 1943 constructed a simple direction-focusing instrument for detecting leaks in systems that must be airtight. The system is evacuated and the leak detector is connected to sample the gas remaining. If there is a leak that gas will be air. If a small jet of helium is then allowed to flow over any suspected point in the system the mass spectrometer gives an immediate signal if the helium leaks in. Since the helium content of air is 1 part in 500,000, such a detector can locate 1 leak in the presence of 500,000 other equal leaks. In the mid-1960s there was no other leak detector known with higher sensitivity. Leak-detecting mass spectrometers became available commercially in 1945.

Age of the Earth and Nucleogenesis.—The discovery by Aston that the isotopic composition of lead (Pb) from various sources differed markedly and that the variation arose from the accumulation of radioactive decay products from uranium and thorium, was an impetus to geochronology (*q.v.*), the dating of geological materials. Since radioactive decay products accumulate with time in a predictable way the excess isotopic abundance is a measure of time elapsed since a geologic sample was last altered.

Following Aston's findings and later work by Nier on the Pb technique of age determination, a number of other naturally occurring radioactive isotopes have been found useful for age determination. These include $K^{40} \rightarrow Ar^{40}$, $Rb^{87} \rightarrow Sr^{87}$ and $Re^{187} \rightarrow Os^{187}$ decays. Their application to geologic samples has been a major tool in tracing the history of the surface of the earth. In 1955 methods were first applied to meteorites. The isotopic composition of lead and argon from meteorites indicates the age of meteorites and of the earth to be about 4,500,000,000 years.

How long it took from the time of the formation (nucleogenesis) of the elements that make up our solar system, and the time when the system took on the basic structure it had 4,500,000,000

years ago is of basic importance in cosmogony. This time can be measured, or at least something related to it can be measured, if a decay product can be found from a radioactive substance that has a half life comparable to the time between nucleogenesis and the formation of the earth. J. H. Reynolds detected an effect arising from such an activity in the study of xenon from meteorites. The material responsible for the decay was an isotope of iodine, I^{129}. In the mid-1960s the interpretation of the data was still uncertain. However there was general agreement that nucleogenesis took about 500,000,000 years, beginning about 5,000,000,000 years ago. *See* also COSMOGONY; RADIOCARBON DATING; and references under "Mass Spectroscopy" in the Index.

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(A. J. D.; M. G. I.)

MASSYS (MATSYS, METSYS, MESSYS), **QUENTIN** (QUINTEN) (1466?–1530), Flemish artist and the first important painter of the Antwerp school, was born at Louvain, where he learned the trade of blacksmith. During the greater part of the 15th century the centres in which the painters of the Low Countries most congregated were Bruges, Ghent and Brussels. Toward the close of the same period Louvain took a prominent part in giving employment to workmen of every craft. It was not until the opening of the 16th century that Antwerp usurped the lead which it afterward maintained against Bruges and Ghent, Brussels, Mechlin and Louvain. Quentin Massys was one of the first men of any note who gave repute to the guild of Antwerp. A legend relates how the smith of Louvain was induced by affection for the daughter of an artist to change his trade and acquire proficiency in painting. Van Mander does not give us the name of Massys' master. Massys was ten years old when Dierik Bouts died at Louvain, and his style was probably formed by the Bouts tradition, which survived in the workshop of Dierik's son Albert. In 1491 Massys went to Antwerp, and was there admitted into the guild of St. Luke. He was one of the first men of any note in the guild of that city, which was then rapidly becoming the most important commercial centre in the Netherlands.

Early works by Massys are two pictures of the Virgin and Child in the Brussels gallery. His most celebrated pictures are two large documented altarpieces, the triptych of the "Marys of Scripture Round the Virgin and Child," which was ordered for St. Peter's church in Louvain (1507–09), now in the Brussels gallery, and the triptych of the "Pieta" (*c.* 1508–11), which he executed for the joiners' company in the cathedral of Antwerp, now in the Antwerp gallery. These pictures display great earnestness in expression, strong religious feeling, great minuteness of finish and a general absence of light or shade. As in early Flemish pictures, so in those of Massys, excessive care is lavished on jewelry, edgings and ornament. There is a tendency to accentuate individual expression. This is illustrated in such pictures as "The Old Man and the Courtesan" in the Pourtales collection, Paris, and "The Banker and His Wife" in the Louvre, where an attempt is made to display cupidity and avarice. The "Ecce Homo" and "Mater Dolorosa," at Antwerp, display serenity and dignity. Very attractive are his pictures with figures on a smaller scale, such as the polyptych in Munich, the scattered parts of which have been fitted together, and "The Virgin and Child" in the Aynard collection in Paris. His landscape backgrounds are often in the style of Patinir, who came to Antwerp in 1515 and is said to have painted backgrounds for some of Massys' pictures. "The Crucifixion," in the Liechtenstein collection, is believed to be the joint work of the two masters.

In 1517 Massys painted many great portraits, including those of Erasmus and Peter Gillis, to be sent to Sir Thomas More. The original of the Erasmus may be the portrait in the Corsini palace in Rome; the Gillis, in Lord Radnor's collection, drew from Sir Thomas More a eulogy in Latin verse. Other portraits are in the museums of Chicago and Oldenburg (Ger.) and in the collection

ALINARI—ART REFERENCE BUREAU

"THE BANKER AND HIS WIFE," SIGNED AND DATED "QUENTIN MATSYS SCHILDER 1514," OIL ON WOOD PANEL, LOUVRE MUSEUM

of the prince of Liechtenstein. The man with a pair of eyeglasses in the Städel gallery at Frankfurt, Ger., is full of vitality; he seems to be speaking. The Musée André, Paris, has an expressive profile of a man, signed and dated 1513. The artist obviously aimed at depicting the desires and emotions of the men of his day.

When compared with portraits by Dürer or Holbein, Massys' art appears subjective and personal. He came into contact with both German masters, for both in turn visited him in his house at Antwerp. Dürer's first call was made in Aug. 1520. The two men must have had much in common, for they were both humanists. The lost original of Massys' "St. Jerome in His Study," of which there is a copy in Vienna, owed something to Dürer's "St. Jerome," now at Lisbon. Holbein, as a young man, passed through Antwerp in 1526 on his way to England, and he carried an introduction from Erasmus to Gillis, who was to send him to Massys' house. The question as to how much Massys was indebted to the Italian art of his time is difficult to determine. There is a picture by him from the Raczinski collection, in the museum at Poznan (Pol.), representing the Virgin and Child playing with the lamb. These figures are obviously copied from Leonardo's famous "St. Anne, the Virgin and Child," now in the Louvre, except that the St. Anne is left out, and the group is placed on a landscape background in the style of Patinir.

Quentin Massys died at Antwerp in 1530. He had two sons who were artists.

JAN MASSYS (1509–1575) was at first a weak imitator of his father. He became master in the guild of Antwerp in 1531, was banished for his heretical opinions in 1543 and stayed away until 1558. During these years he is supposed to have visited Italy or France. An early picture by him is the "Virgin Kissing the Child" in the church of St. James at Antwerp, which imitates the "Madonna Enthroned" by his father, now at Berlin. A half-length "Judith," now in the museum at Boston, is of a later date and seems to recall Italian or French influences. To the same class belongs the "Lot and His Daughters," at Vienna, dated 1563.

CORNELYS MASSYS (1513–1579) became a master painter in 1531. There is a signed picture of him at Amsterdam, dated 1538, representing the prodigal son; also a genre picture, signed and dated 1543, at Berlin. He painted landscapes in the style of his father, and he was also an engraver.

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MASTABA, in Egyptian architecture, a rectangular cut stone tomb, with sloping sides and a flat roof, usually containing three chambers. In the first chamber the walls were sometimes richly decorated with paintings, and there was a low bench of stone on which incense was burned. The second (*serdab*), containing the image of the deceased, was either closed, with holes pierced in the wall separating it from the first chamber, or entered through a narrow passage, through which the fumes of the incense passed. A vertical wellhole descended to the third, in which the mummy was laid. *See* Egyptian Architecture.

MASTER, a man having a position of authority. The word is derived from the Latin *magister,* the original meaning being perhaps best seen in compounds such as master mason and master cook. But, even in classical times, *magister* had acquired the special connotation of schoolmaster; its principal English usage is still perhaps in this sense. (In this sense it is often adjectivally qualified, and many Englishmen are unaware of the subtle distinctions among master, schoolmaster, high master, head master and headmaster.) The word has other uses, as for an employer; for the captain of a British merchant navy ship; for some heads of university colleges and of other institutions; for the head of the household; and in such compounds as master-craftsman.

In the universities the main usage is related to that in the schools: the master of arts (*magister artium* or M.A.; in the U.S., often *artium magister* or A.M.) is in theory the holder of a licence to teach. The term "master" was originally equivalent to that of doctor; in the faculty of arts the approved scholar was styled master, while in faculties of divinity, medicine and law he was termed doctor. Perhaps because of the need to become a master of arts before proceeding to other studies, the doctorate came to be esteemed as a higher title. In modern usage in most universities, except in Scotland, the gradation in the faculty of arts is B.A., M.A., Ph.D., D.Litt. The automatic conferring of an M.A. degree upon the holder of B.A. seven years, or nearly seven years, after matriculation is practised at Oxford and Cambridge, but elsewhere in England, and in the U.S., the M.A. must be achieved through examination or by the completion of a piece of research. *See* also Degree, Academic.

MASTER AND SERVANT. This is the traditional name for the legal relationship between the parties to a contract by which one agrees to work for another who, for wages or other consideration, acquires the right to control the work in performance as well as in the result. With its connotation of menial duty, the name is an anachronism and gradually is giving way to expressions such as "employer and employee." However, the phrase "master and servant" is too deeply embedded in Anglo-American jurisprudence for early extinction.

The concept is important in defining common-law rights and obligations attending contracts for personal service, and especially in applying the doctrine of *respondeat superior* by which the master, though faultless, is liable for damages to third persons caused by the tort of his servant in the scope of employment. Occasionally, for reasons of social policy, vicarious liability has been imposed on the master under the law of crimes. The master-servant concept is also significant because it often determines the ambit of social legislation such as minimum wage laws and unemployment insurance acts.

While the master's right of control has been regarded as the essential distinction between servant and independent contractor, other criteria are relevant and sometimes decisive. These include the duration, continuity and exclusiveness of the relationship; the integration of the worker's duties as part of an enterprise; and, conversely, the extent to which he invests capital (as by furnishing equipment or place of work) and shares in profit and loss.

The relationship is contractual, and therefore requires mutual manifestations of assent. However, the contract need not be evidenced in writing and need not even be express, provided that a contract can be inferred from the parties' conduct. Once a contract is found, its terms may be supplemented (and sometimes superseded) by implication or operation of law, or by collective bargaining.

If the contract fails to specify length of employment, the English courts have tended to infer some definite duration, based upon custom, agreed pay period or the like. U.S. courts have tended to find in such a contract mere employment at will. There is no conflict between these views, however, for both purport to derive the intent of the parties from context. While U.S. industry has been characterized by employment at will, the employee is often protected by a collective bargaining agreement requiring "just and proper cause" for discharge.

A servant is normally under obligation, express or implied, to perform his duties diligently, with appropriate care and skill, obeying all reasonable orders of his master and avoiding use of his position for a purpose detrimental to the master's interests. In turn, the master must exercise due care, as specified by statute, to protect the servant from physical hazards of the work. During the 19th century, English and U.S. courts developed the defenses of contributory negligence, assumption of risk, and common employment (the last was a rule, since abrogated, denying the master's liability for injury by a fellow servant), so that employers were virtually insulated from tort liability to their employees. This result was consistent with the prevailing policy of encouraging capital investment, but a spreading belief that it was unjust led to adoption of employers' liability and workmen's compensation acts.

See Agency; Labour Law; Workmen's Compensation.
(C. H. Li.)

MASTER OF THE ROLLS, in England, originally chief of the 12 clerks or masters in chancery and, as such, keeper of the rolls, or records of the chancery, especially the register of original writs, and all patents and grants under the great seal. He was first called master of the rolls in the statute 2 Hen. VIII, c. 18. Before and after this date he is sometimes called vice-chancellor, since with the development of the chancery as a court, he was called upon to sit at first with the justices or with two or more masters; later, in the absence of the chancellor, by himself for judicial business. In fact he became the deputy of the chancellor. Meanwhile he had long ceased to be keeper of the records, but by the Public Record Office act of 1838 their custody was restored to him. He is now also chairman of the State Papers and Historical Manuscripts commissions. Since the Judicature act of 1875 and the Appellate Jurisdiction act of 1876 he is in effect the president of the court of appeal, whose decisions can be questioned only in the house of lords.
(W. T. Ws.)

MASTERS, EDGAR LEE (1869–1950), U.S. poet and novelist, author of *Spoon River Anthology,* the first of the many works representing the "revolt from the village" in American literature, was born at Garnett, Kan., Aug. 23, 1869. He attended Knox college, Galesburg, Ill., for one year, was admitted to the bar in 1891 and developed a good law practice in Chicago. A volume of his verses appeared in 1898, followed by *Maximilian,* a drama in blank verse (1902); *The New Star Chamber and Other Essays* (1904); *Blood of the Prophets* (1905); and a series of plays issued between 1907 (*Althea*) and 1911 (*The Bread of Idleness*).

If Masters had continued to write along these lines, he would not be remembered; but forces were at work on him that would soon induce him to write a work that stands as one of the most significant American books of the early 20th century. In 1909 his friend William Marion Reedy of St. Louis, Mo., editor of *Reedy's Mirror,* introduced him to *Epigrams From the Greek Anthology* (*see* Anthology). Masters was seized by the idea of composing a similar series of free-verse epitaphs in the form of monologues spoken from the grave by former inhabitants of Spoon River, a fictitious village compounded of Petersburg and Lewistown, Ill., as he had known them as a boy. The result was *Spoon River Anthology* (1915).

Though Masters continued to publish almost yearly during the rest of his life, the quality of his work never again rose to the level of the *Spoon River Anthology.* Other volumes of verse are

Songs and Satires (1916); *The Great Valley* (1916); *Toward the Gulf* (1918); *Starved Rock* (1919); *Domesday Book* (1920); *The New Spoon River* (1924); *The Fate of the Jury* (1929); *Godbey* (1931); *Richmond* (1934); *Invisible Landscapes* (1935); *Poems of People* (1936); and *Illinois Poems* (1941).

Among his novels are *Mitch Miller* (1920) and *The Nuptial Flight* (1923). Masters wrote biographies of Lincoln (1931), Whitman (1937) and Mark Twain (1938); his best effort in this form is *Vachel Lindsay, A Poet in America* (1935), a study of his friend and fellow poet. Also notable are his autobiography, *Across Spoon River* (1936), and *The Sangamon* (1942), a volume in the "Rivers of America" series.

Masters died at Philadelphia, Pa., on March 5, 1950.

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MASTIC (MASTICH), a resinous exudation obtained from the lentiscus (*Pistacia lentiscus*), an evergreen shrub of the cashew family (*Anacardiaceae; q.v.*). The lentisk or mastic plant, in the same genus as the pistachio tree, is indigenous to the Mediterranean coast region from Syria to Spain but grows also in Portugal, Morocco and the Canary Islands. The production of the substance has been, since the time of Dioscorides, almost exclusively confined to the Greek island of Chios in the Aegean sea. The shrubs are about six feet high.

The resin is contained in the bark and not in the wood, and in order to collect it numerous vertical incisions are made, during June, July and August, in the stem and chief branches. The resin speedily exudes and hardens into oval tears, which are collected every 15 days. The collection is repeated several times between June and September, a fine tree being found to yield about eight or ten pounds of mastic during the season. Mastic occurs in commerce in the form of roundish tears about the size of peas. They are transparent, with a glassy fracture, of a pale yellow or faint greenish tinge, which darkens slowly. It is used in making a pale varnish for coating metals and paintings and as an adhesive and cement in dental work.

Other *Pistacia* trees, growing from India to the Mediterranean, yield a kind of mastic. In Algeria, *Pistacia atlantica* yields a solid resin. Cape mastic is the produce of *Euryops multifidus*, the resin bush, or *harpuis bosch* of the Boers—a plant of the family Compositae. Dammar resin is sometimes sold under the name of mastic. The West Indian mastic tree is *Bursera gummifera*, and the Peruvian mastic, or California pepper tree, is *Schinus molle*. The name is also applied to a timber tree, *Sideroxylon mastichodendron*, family Sapotaceae, which grows in the West Indies and on the coast of Florida.

MASTIGOPHORA, alternative name for the Flagellata, a group of protozoans characterized by having one or more threadlike processes called flagella. *See* PROTOZOA.

MASTODON, the common and generic name (synonymous with *Mammut*) of extinct elephantlike proboscideans; the term, sometimes as "mastodont," is applied generally to various other related forms. As a group, mastodons were numerous, widely distributed and extremely diversified during much of the Tertiary period. These mammals were probably haired. They invaded all of the northern continents, and even reached South America, apparently living in herds that rivaled the American bison of the 19th century. Only a few, including *Mastodon*, persisted into the Pleistocene epoch or Ice Age (about 1,000,000 years ago).

The earliest and most primitive mastodon was *Palaeomastodon* from the Lower Oligocene epoch of Egypt (about 40,000,000 years ago). It was the size of a large pig, with massive skull, heavy limbs and an elongated proboscis or trunk. As in all mastodons, certain incisor teeth were greatly enlarged to form tusks, usually two above and two below. The cheek teeth or molars, six above and five below on each side, were large and equipped with many cusps on the grinding surfaces. In the course of their evolution,

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PAINTING OF A MASTODON BY CHARLES R. KNIGHT IN THE CHICAGO NATURAL HISTORY MUSEUM

mastodons increased in size and in elaboration of their tusks. In height they seldom exceeded nine feet. Tusks of some mastodons were as long as ten feet, but a length of seven to eight feet was usual. In some forms the lower tusks were short or absent, in others they were long and spirally twisted or broad and touching, forming a scoop; some tusks curved up and out, others down.

The mastodons represent the main line of development of the proboscideans, with many side branches. One of the early side branches developed in somewhat parallel fashion, culminating in the mammoths (*q.v.*). From this latter branch, in relatively recent times, our modern elephants (*q.v.*) originated. Compared to the mammoth, the mastodon had a low forehead, massive limbs and an enormously broad pelvis; compared to modern elephants, it had a shorter and higher brain case, longer limbs and low-crowned molars, with fewer ridges, all in place simultaneously.

The best-known example from North America is *Mastodon americanus*, a large, two-tusked mastodon of the Pleistocene epoch. Numerous skeletal remains have been found in postglacial swamps and peat bogs, over most of the United States and northward to Lake Winnipeg and British Columbia, with other records from Nova Scotia and Alaska. Carbon-14 dating methods indicate that this mastodon survived until 8,000 or 10,000 years ago. It was probably contemporaneous with early man, who may have hunted it and contributed to its extinction, as attested to by pieces of charcoal and broken pottery found associated with mastodon bones.

See PROBOSCIDEA; *see* also PALEONTOLOGY. (R. H. MA.)

MASTOIDITIS is almost invariably secondary to acute or chronic disease in the middle ear. In some instances inflammation may spread into the mastoid antrum and the mastoid cells following otitis media, but when the infection is very severe the whole middle ear cleft, which includes the mastoid region, is infected simultaneously. The narrow drainage channels from the antrum and cells are obstructed readily and the degree to which the products of inflammation are penned within the mastoid antrum and cells determines the severity of the mastoid symptoms. The chief symptom is pain behind the ear and over the side of the head, and there may be evidence of increasing toxemia characterized by rise of temperature and pulse rate. Tenderness over the mastoid bone may be marked and, as the condition develops, there is increased swelling of the tissues overlying the mastoid bone. The swelling may increase until a fluctuant abscess develops; this indicates that the infection has eroded the bone and destroyed the cortex (outer layer) of the bone. Different forms of abscess are described according to the structures involved; *e.g.*, zygomatic abscess, or Bezold abscess spreading down the neck. In some circumstances the mastoiditis, instead of coming to the surface, may involve structures within the cranium and so give rise to complications. The most important of these are abscess without or within the dura mater covering the brain, infec-

tion and thrombosis of the lateral sinus (the large blood channel flowing into the internal jugular vein) and infection of the labyrinth containing the balance and hearing apparatus. In addition, meningitis is an outstanding danger.

Mastoiditis is treated by the early administration of antibiotics. At one time a frequent and dangerous disease, it is now rare, owing to the effective treatment by modern drugs of the preceding otitis media. In the few cases that do not respond to these remedies, surgical drainage with wide removal of diseased bone is demanded.

Chronic mastoiditis is a part of the disease of chronic otitis media and results from unresolved attacks of acute mastoiditis. Acute exacerbations of chronic mastoiditis may produce any of the symptoms and signs already described. Its treatment is surgical and is undertaken when operation is carried out for the cure of chronic otitis media. The conditions most frequently confused with mastoiditis are furunculosis of the external auditory meatus, erysipelas and inflammation of glands overlying the mastoid bone.

See also EAR, DISEASES OF. (I. S. H.)

MASUDI, AL- (ABU-AL-HASAN 'ALI AL-MAS'UDI) (d. *c.* 956), Arab traveler and historian, known as "the Herodotus of the Arabs," was born at Baghdad toward the end of the 9th century. His travels extended to Palestine, Persia, Armenia, the shores of the Caucasus, India, Ceylon, the China seas, Madagascar, Zanzibar and Oman. He was in Antioch in 943 and in Damascus two years later. The last ten years of his life he spent in Syria and Egypt, dying at Al Fustat (Old Cairo) in 956 or 957. Himself a rationalist (Mu'tazilite) he took his information, when necessary, from Persians, Jews, Indians and even the chronicle of a Christian bishop. His historical works included *Kitab akhbar al-Zaman,* in 30 volumes, and a supplement *Kitab al-Awsat,* a chronological sketch of general history. Only one volume of the former has survived but the two parts were epitomized in *Muraj al-Dhanab wa Ma'adin al-Jawahir* (French translation by C. Barbier de Meynard and P. de Courteille, *Maçoudi: les prairies d'or,* 9 vol., 1861–77). In the last year of his life he wrote *Kitab al-Tanbih wa-al-Ishraf* (French translation by B. Carra de Vaux, *Maçoudi, le livre de l'avertissement et de la revision,* 1897) in which he summarized, corrected and completed his former writings. Masudi's historical works are somewhat superficial as he accepted many unauthenticated stories and seldom went to original sources, but they are enlivened by his boundless curiosity and interest in the world and marked by many anecdotes drawn from his travels and his observation of strange places, peoples and animals.

See C. Field, *Tales of the Caliphs* (1909), based on Masudi's history; R. A. Nicholson, *Literary History of the Arabs,* 2nd ed., pp. 352–354 (1930).

MASULIPATNAM (formerly MASULIPATAM; also BANDAR), a seaport and the administrative headquarters of Krishna (Kistna) district, Andhra Pradesh, India, lies between a distributary of the Krishna river and a canal of its delta system, 215 mi. N.N.E. of Madras. Pop. (1961) 101,417. The town was made a municipality in 1866. Robertson square, in the middle of the town, is the main traffic centre. The fort, now in ruins, with the Tomb of the Dead erected in memory of the 30,000 who died in the great storm of 1864, Volandalapalem and Frenchpet (where formerly the Dutch and French resided) are places of interest. There are three colleges, including a Sanskrit college, all affiliated with Andhra university, and an engineering institute.

The port is only a roadstead, vessels having to anchor 5 mi. out. It is connected by a branch line from Vijayavada (Bezwada) with the main Madras-Calcutta railway, and by the Bandar canal with the canal system from the anicut on the Krishna river at Vijayavada. The town is noted for its manufacture of scientific instruments, and the traditional (but declining) industry of weaving chintzes and carpets.

Masulipatnam was the earliest English settlement on the Coromandel coast (*q.v.*), and important as the *bandar* or port of Golconda. An agency was established there in 1611. In 1686–90 it was held by the Dutch. During the wars of the Carnatic, the English were temporarily expelled from the town, which was held by the French from 1750. In 1759 the town and fort were stormed and taken by a small force led by Francis Forde, a soldier in the service of the East India company. (B. S. R.)

MASURIUM: *see* TECHNETIUM.

MATACO, the largest and most important Indian tribe of the Gran Chaco, living between the Bermejo and Pilcomayo rivers in northeastern Argentina. Latest available data in the 1960s indicated they numbered about 20,000 of the 68,000 total aboriginal population of the Chaco. Formerly known as Mataguayo, they were until relatively recently considered to form an independent linguistic family, Matacoan or Matacan. The relationship to Macá (Enimagá-Cochaboth) is generally accepted, however, and more distant relationship to the Guaycurú seems so probable that all have been suggested as forming a Macro-Guaycurú linguistic phylum (*see* table in INDIAN, LATIN-AMERICAN). The Mataco practise considerable agriculture, growing principally maize, pumpkins, sweet manioc and beans, but they still rely on fishing, hunting and wild-food gathering, formerly of far greater importance. Classed as foot Indians, they make slight use of boats or horses.

See W. Revill, *Chaco Chapters* (1947). (J. A. MN.; X.)

MATADOR: *see* BULLFIGHTING.

MATAGALPA, a large department in the central highlands of Nicaragua, and its capital city. The population of the department (1950) was 135,401; (1959 est.) 161,191. Matagalpa is important in agriculture, mining and manufacturing, producing especially coffee (about 20% of the national output), corn, tobacco, potatoes and other vegetables, fruits, brown sugar (*panela*), cattle, swine, gold and silver, processed foodstuffs, furniture, leather goods and clay products.

The city of Matagalpa, pop. (1950) 10,323, (1959 est.) 14,494, is located in the north central part of the department in a highland valley at 2,131 ft. above sea level. It is one of the older picturesque cities of the country. Until well into the 20th century it could be reached only by horseback. A highway 20 mi. long connects Matagalpa with the Inter-American highway at Sébaco, giving it direct connections with Managua 103 mi. distant. The city is the leading trading and manufacturing centre of the department. (C. F. J.)

MATA HARI (1876–1917), Dutch dancer, courtesan and spy, known also by her real name MARGARET GERTRUDE ZELLE, was born on Aug. 7, 1876, at Leeuwarden in the Netherlands. Married to Capt. Campbell MacLeod, an officer of Scottish origin of the Dutch colonial army, she accompanied him to Java and there learned to practise ritual oriental dances. After divorcing her husband she sailed back to Europe, assumed the stage name of Mata Hari and danced with great success in several European capitals. In 1908 she settled in Paris, where she made full use of her beauty as well as her personal charms and had lovers in French political circles. It was then that she began to act as a secret agent in Germany's pay. She went to Berlin a few days before the beginning of World War I but came back to Paris through the Netherlands in 1915. As she was suspected by both British and French intelligence services, traps were set for her and she was eventually caught. Tried in July 1917 by a French court-martial, she was convicted of being a spy (her number in the German intelligence files was H. 21) and sentenced to death. She was shot at Vincennes on Oct. 15, 1917, having gallantly faced the firing squad.

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MATAMOROS, a town and border port in the Mexican state of Tamaulipas, 28 mi. from the mouth of the Río Grande, on its south bank opposite Brownsville, Tex. Pop. (1960) 92,327. It is a commercial centre for the Mexican portion of the lower Río Grande valley. Trade via the Gulf of Mexico is impeded by sand bars at the river's mouth. By international treaty effective Nov. 8, 1945, Mexico and the United States undertook to provide a series of dams and allied works across the river, chief of which are the international Falcón dam, 75 mi. down river from Laredo, Tex.; and, on the Mexican side, Anzalduas dam and canal, whose irrigation district of 540,000 ac. (a thriving cotton area) depends on Matamoros.

The city has rail outlets to Monterrey and Mexico City, and also has highway and air connections. It was the scene of bitter fighting in the U.S.-Mexican War, and was captured by U.S. troops (May 1846). Matamoros is one of Mexico's chief ports of entry for tourists and for the import and export of goods. (J. A. Cw.)

MATANZAS, a province and its capital city, in west-central Cuba. The province was established in 1879 between Havana province on the west and Santa Clara (now Las Villas) on the east and south. It is the smallest province in population (1953 census, 395,780 [1961 est.] 427,088), and next to smallest in area (3,260 sq.mi.). Its fertile plains have supported a prosperous sugar industry since colonial days. Various industries have been developed at Matanzas and Cárdenas, the port cities, and at Colón on the Central highway. The province's tourist attractions include Yumurí valley, Bellamar caves and Varadero beach.

The city of Matanzas was founded in 1693 on an excellent open bay, which had been known to the Spanish since 1508 and had been used by pirates. By 1860 it was the second city of Cuba, having 30,000 inhabitants, but its growth thereafter was slow as the sugar industry expanded into the eastern part of the island. Pop. (1953) 63,916. In the mid-19th century Matanzas exported more than one-third of Cuban sugar. It has been called the Athens of Cuba because of its active cultural institutions, public library, and famous poets, sculptors and artists. The city has beautiful drives, plazas and monuments, as well as historic buildings, such as Castillo de San Severino and San Carlos, the oldest church, founded in 1730 and raised to the rank of cathedral in 1915. Monserrate shrine, located on La Cumbre hill, overlooks the Yumurí valley back of Matanzas.

Matanzas, about 50 mi. E. of Havana, is one of the chief ports of Cuba, exporting sugar and henequen fibre. The establishment of a free zone in its spacious harbour has resulted in the expansion of industry, chief of which is a large rayon fibre factory. Other plants manufacture ropes, shoes, fertilizers and matches. Matanzas is linked to Havana by two railways, one of which is the electrified Hershey railroad, and by the Central highway. (D. R. D.)

MATARA, a town and coastal district in Southern province, Ceylon. The town, capital of the district, lies at the mouth of the Nilwala Ganga about 100 mi. S.E. of Colombo by road. Pop. (1953) 27,641. In Portuguese and Dutch days Matara was an important trading centre; the Dutch built fortifications (Star fort) which can still be seen. It is a commercial centre and a railhead, being the terminus of the coastal railway.

MATARA DISTRICT is densely peopled (pop. [1953] 413,431) and has paddy fields and plantations of coconut, with some tea, rubber, cinnamon and citronella grass. It covers an area of 481 sq.mi. and stretches inland into hilly country. (B. H. F.)

MATARÓ (anc. ILURO), a seaport of Barcelona province in Catalonia region, northeast Spain, is on the coast 29 km. (18 mi.) N.E. of Barcelona by road. Pop. (1960) 41,128 (mun.). The church of Sta. Maria has a baroque altar and fine paintings. There is a museum and a public library. The first railway in Spain was built between Barcelona and Mataró (1848). The line now continues to Gerona, Port-Bou and France. Wine, carnations and potatoes are produced and exported. There are manufactures of hosiery and underwear, knitting machinery, soap, paper, chemicals and bus and truck bodies. Nearby is the carbonated mineral spring of Argentona. (R. H. CA.)

MATCH, a splinter of wood, strip of cardboard or a length of waxed thread provided with a combustible tip that ignites by friction.

A match consists of three basic parts: a head, which initiates combustion; a tinder substance to pick up and transmit the flame; and a handle. There are two main types of modern friction matches: (1) strike-anywhere matches and (2) safety matches. The head of the strike-anywhere match contains all the chemicals necessary to obtain ignition from frictional heat while the safety match has a head that ignites at a much higher temperature and must be struck on a specially prepared surface containing ingredients that pass ignition across to the head. The substance commonly used for obtaining combustion at the temperature of frictional heat is a compound of phosphorus or one of its allotropic forms. This substance is found in the head of strike-anywhere matches and in the striking surface of safety matches.

In addition to the phosphoric igniting agent, three other main groups of chemicals are found in the match: (1) oxidizing agents, such as potassium chlorate, which supply oxygen to the igniting agent and the other combustible materials; (2) binders, such as animal glue, starches and gums, which bind the ingredients and are oxidized during combustion; an increasing interest was being shown early in the second half of the 20th century in the use of synthetics for this purpose, particularly in countries such as Brazil where climatic conditions make the drying of natural adhesives difficult; post-combustion binders, such as ground glass, which fuse and hold the ash together, must also be used; (3) inert materials, such as diatomaceous earth, which provide bulk and regulate the speed of reaction.

HISTORY

The development of matches was preceded by centuries of experiment with many methods of fire making (*see* FIRE) but the production of fire by spontaneous chemical reaction was unknown until the 17th century. A variety of experiments continued until the friction match, introduced in the 19th century, provided a means of making fire that was pocketable, reliable, safe and speedy.

Early Beginnings.—In 1669 a Hamburg alchemist, Hennig Brand, discovered phosphorus (*q.v.*) and thus placed a highly combustible material at the disposal of other experimenters. Apart from the discovery by Robert Boyle in England in 1680 that fire was produced when sulfur-tipped splints were drawn through a pleat of coarse paper coated with phosphorus, no other major development took place for over a century, probably because of the difficulties in preparing phosphorus.

With early methods of fire production it was common to use specially made splinters tipped with some combustible substance, such as sulfur, to transfer the flame. An increased interest in chemistry led to experiments to produce fire by direct means on this splinter. Jean Chancel discovered in Paris in 1805 that splints tipped with potassium chlorate, sugar and gum could be ignited by dipping them into sulfuric acid. Later workers refined this method, which culminated in the "promethean match" patented in 1828 by Samuel Jones of London. This consisted of a glass bead containing acid, the outside of which was coated with igniting composition. When the glass was broken by means of a small pair of pliers, or even with the user's teeth, the paper in which it was wrapped was set on fire.

In the meantime, interest in phosphorus had reawakened. The "ethereal match," or "phosphoric taper," appeared in France about 1780. This consisted of phosphorus and a piece of waxed paper or thread sealed in a glass tube in which the oxygen had been used up. When the glass was broken and the contents withdrawn, fire was started. By 1786 an Italian living in Paris had brought out the "phosphorus box," a pack of sulfur-tipped wooden splints with a small bottle of phosphorus. A splint was dipped into the bottle and ignited by the decomposition of adhering phosphorus upon withdrawal into the air. These methods were popular with those who could afford them and they continued in use until the friction match established its supremacy.

It is possible that phosphorus matches ignitible by friction were made in Paris as early as 1805; certainly a proposal by Derepas in 1809 to regulate the reaction of phosphorus by mixing it with magnesia lends credence to this. But the honour of making the first phosphorus friction match is usually granted to François Derosne of Paris (1816).

The Start of Industrialization.—Economic conditions between 1825 and 1835 appear to have favoured the manufacture of matches as an industrial proposition, although the first suppliers fell back on nonphosphoric formulas, *i.e.*, those based mostly on potassium chlorate mixtures. John Walker of England made a match of this type in 1827, although more serious production was undertaken in 1829 by Samuel Jones, who in the preceding year

had patented the "promethean match." Nonphosphoric friction matches were being made by G. E. Merkel of Paris and J. Siegal of Austria, among others, by 1832, by which time the manufacture of friction matches was well established in Europe.

These first matches were extremely difficult to ignite, and they frequently erupted in a shower of sparks. In addition, the smell was particularly offensive and the warning printed on Jones' box ("Persons whose lungs are delicate should by no means use Lucifers") seems well founded.

The first step in making matches that were both stable and easy to ignite was taken in 1831 by Charles Sauria of France, who evolved a satisfactory method of incorporating white (yellow) phosphorus into the formula to replace other oxidizable ingredients. As his principle was not patented, the next few years saw the introduction of white phosphorus matches throughout Europe. In the U.S. a patent was granted to A. D. Phillips as early as 1836, though Ezekiel Byam is usually acclaimed as the industrial pioneer. However, interest in nonphosphoric formulas continued until phosphorus established a clear lead.

Safety Matches.—An important milestone was the discovery of red phosphorus by Anton von Schrötter in 1845. Since red phosphorus is nontoxic and not subject to spontaneous combustion in air, it was of immediate interest to matchmakers. The idea of making matches intrinsically safe by placing some of the combustion ingredients on the striking surface of the box was first put forward by Gustaf Pasch of Sweden in 1844, although it is sometimes credited to B. Bottger of Frankfurt, who appears to have thought of the principle a year later. A manufacturing method making use of red phosphorus and the principle of separating the combustible ingredients was patented by J. E. Lundström of Sweden in 1852. Licences were taken out and other formulations prepared so that by 1856 matches of this type were being manufactured in several European countries.

Strike-Anywhere Matches.—Although the new safety match was widely accepted, white phosphorus matches continued to be used for many years since they had good keeping qualities and were relatively unaffected by climatic conditions.

The poisonous nature of white phosphorus was found to have serious effects on the health of workers in match factories. Phosphonecrosis, or phossy jaw (*see* MOUTH: *Diseases*), resulted when fumes entered the body through decayed teeth. Because white phosphorus was a danger to health and also was a fire threat since it burns spontaneously at 30° C. (86° F.) in moist air, many countries, starting with Denmark in 1875 and Sweden in 1879, introduced legislation to ban white phosphorus matches. As a result of a convention held at Bern, Switz., in 1905–06, white phosphorus matches were prohibited in the major countries of western Europe after 1912; in the U.S., they fell into disuse about the same time because of taxes levied against them when suitable alternatives became available.

Phosphorus sesquisulfide, which is much less toxic than white phosphorus, was first prepared by G. Lemoine in 1864 but the substance was not investigated by the match industry until E. D. Cahen and H. Savène, both employed in the French government match monopoly, filed a patent in 1898 for its use in strike-anywhere matches. Leaders of the industry in countries that still permitted the manufacture of strike-anywhere matches immediately obtained licences, which were subsequently made available to their competitors without charge; Bryant and May introduced the technique into Britain and the Diamond Match company pioneered its use in the United States. Even so, considerable difficulties were encountered and it was some years before a reliable product was evolved.

Range of Products.—With the general acceptance of the friction match, many types of heads were investigated and the experience of the long-established candle trade was drawn on to provide tinder substance. However, economic considerations forced the matchmakers to use disagreeable materials, such as sulfur and resin, in their more competitive lines until the U.S. oil industry made mineral waxes available at prices everyone could afford. A wide variety of contrivances were made: *e.g.*, sealing wax and candles were crowned with match heads, and matches were made with heads at both ends and even in the middle. Because of fiscal requirements, market conditions and the availability of labour and raw material, only one or two types of matches are available in most countries.

20th Century.—Most of the changes made in matches in the first six decades of the 20th century were refinements of early details. One of the few innovations was the everlasting match of F. Ringer of Austria, Z. Földi and R. König of Hungary, and the Swedish Match company during the 1930s; its promise, however, was never realized.

MODERN TYPES OF MATCH

Household, Kitchen or Standard Matches.—These consist of the ignition head, tinder (made by soaking the splint nearest the head in paraffin wax) and the handle (the unsoaked portion of the splint). The splints are usually treated with some retardant, such as ammonium phosphate, to prevent afterglow when the match is extinguished. This type of match occurs in a wide range of box and splint sizes.

Vesta Matches.—These have short sticks in relation to their cross-section. They were originally made from wax and are generally regarded as smokers' matches.

Double-dip or "Bird's Eye" Matches.—These are commonplace on the North American continent as a form of strike-anywhere match, although in Europe they are restricted to the quality markets. A bulb of combustible material is interposed between a fast-ignition head and the tinder of the stick; they combine high sensitivity with safety in transport. The construction enables a smaller quantity of igniter to be used and the safety factor is increased since the igniter is kept from contacting the adjoining tips by the insensitive bulb below it.

Wax Matches.—These matches, which are popular in Latin countries, have their ignition head on the end of a short length of wax taper formed from paper or cotton filaments. The whole stick is therefore tinder. As they are difficult to extinguish, they are not permitted in certain countries because of the danger of starting fires.

Book Matches.—Matches of this type are made by stapling a comb of wood or cardboard matches inside a cardboard cover. Their method of burning is the same as a standard match. Wooden combs are more popular in continental Europe, while cardboard combs are used in the English-speaking countries. Book matches are used as an advertising medium, especially in the U.S., and the popularity of the book match stems entirely from its suitability for this purpose, which is much influenced by fiscal considerations from country to country.

Pyrotechnic Matches.—Commonly called "Bengals," these have a tinder substance below the head that is designed to burn with a bright flame tinted with one of the characteristic colours of metallic salts. The splint serves as a handle only.

"Lifeboat" and "Windproof" Matches.—Matches of this type share a common design and are similar to "Bengals." The tinder substance, which is spread along the splint below the head, produces a more positive reaction than the combustion of wood and paraffin wax, with the result that it cannot be extinguished by wind or water spray. Such matches may be subdivided into "fusees," in which the tinder substance burns strongly without flame (although ignition may be passed on), and "flamers."

Waterproof Matches.—As both the common match and the striking material on the side of the box are hygroscopic, many attempts have been made to make them waterproof. However, the more successful the proofing, the higher the cost and the more difficult the ignition. Use of waterproof matches is therefore restricted mainly to the armed forces.

MANUFACTURE

Splint Manufacture.—This procedure involves three main techniques. Square or oblong splints are made by peeling wood veneer (usually poplar or pine) in a lathe to the thickness of one dimension and chopping it on a separate machine to the other two dimensions. Splints that are round or crescent-shaped in cross-section are limited to the American market and are made

by forcing circular dies through soft pine blocks of thickness equal to the length of match to be produced. Wax splints are made by drawing paper or cotton filaments through a succession of wax baths and die plates until the requisite thickness is built up. The search for a suitable synthetic material for splints had not met any commercial success by the mid-1960s.

Box Manufacture.—In most areas of the world, the standard match box consists of separate inner and outer cases. An exception is the so-called "flap" box common to many Latin countries. In Europe, South America and the east, boxes are usually manufactured from wood and cardboard components held together by paste and paper. This type of box has not been widely used in the U.S., where the availability of suitable cardboard, coupled with high labour costs, encouraged the use of a one-piece component generated at high speed from a reel. Paul Dietmann in Sweden contributed much to the design of the European type of box, while the Diamond Match company developed the American style box. After World War II Bryant and May in England, and Arenco in Sweden, developed an American style of box adapted to European conditions.

Match Machines.—In the early days of the industry, match splints were dipped in the head composition by holding them in rows between slats in a hand frame. William Gates, Jr., of the U.S. patented a machine in 1854 that mechanized the handling of these frames and also made circular splints.

An outstanding early worker was A. Lagerman of Sweden, who in 1864 was operating a continuous match machine that embodied the principles used today. Also notable were R. Czerweny of Austria and G. Sebold of Germany. But it was the Diamond Match company of the U.S. that, early in the 20th century, first mass-produced a continuous match machine; it was based on the earlier designs of McClintock Young and was suitable for any climatic conditions. However, the machine did not keep pace with market conditions and went out of production, although in many parts of the world models of the machine were still in use in the 1960s.

Modern machines include an endless belt made up of metal bars suspended by chains in which the match splints or combs are carried from the feeding station to a hot plate to dry the tips. After this they are successively dipped in molten paraffin wax and ignition composition. If "bird's eye" matches are to be made, a second dipping station is provided, after a gap to ensure partial hardening of the first dip. The matches are then dried and dropped in controlled numbers into boxes, which are subsequently closed and packed. The trend after World War II was to integrate all manufacturing operations, including boxmaking and packing, into one unit capable of producing 40,000 boxes an hour.

Book matches are made in a very similar manner. When these are made from cardboard, the comb is cut from a reel at the feeding station of the match machine; when the matches are dry they are carried to a separate booking machine where the cardboard cover is folded round and the whole stapled. These machines can produce 600 books per minute. A separate process enables the cover design to be changed without stopping the match machine.

The bulk of the world's machinery for producing household matches is manufactured in Sweden, but book-match machinery is made in many countries.

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(Jo. M. M.)

MATE (PARAGUAY TEA), the dried leaves of *Ilex paraguariensis* (and some other species), an evergreen shrub or small tree belonging to the same genus as the common holly. Native names include hierba (yerba) mate and *hierba del Paraguay*. The leaves are from 6 to 8 in. long, shortly stalked with a somewhat acute tip and finely toothed at the margin. The small white flowers grow in forked clusters in the axils of the leaves; the sepals, petals and stamens are four in number, or occasionally five; and the berry is 4-seeded. The plant grows abundantly in Paraguay, and the south of Brazil, forming woods called *hierbales*.

Although mate appears to have been used from time immemorial by the Indians, the Jesuits were the first to attempt its cultivation. This was begun at their branch missions in Paraguay and the province of Rio Grande de San Pedro, where some plantations still exist, and yield the best tea that is made. From this circumstance the names Jesuits' tea, tea of the Missions, St. Bartholomew's tea, etc., are sometimes applied to mate. Under cultivation the quality of the tea improves, but the plant remains a small shrub with numerous stems, instead of forming, as in the wild state, a tree with a rounded head. From cultivated plants the leaves are gathered every two or three years, that interval being necessary for restoration to vigorous growth.

An open space, called a *tatacua*, about six feet square, is prepared in which the surface of the soil is beaten hard and smooth with mallets. The leafy branches of the mate are then cut down and placed on the *tatacua*, where they undergo a preliminary roasting from a fire kindled around it. An arch of poles, or of hurdles, is then erected above it, on which the mate is placed, a fire being lighted underneath. After drying, the leaves are reduced to coarse powder in mortars formed of pits in the earth well rammed. Mate so prepared is called *caa gazu* or *yerva do polos*, and is chiefly used in Brazil. In Paraguay and the vicinity of Paraná in Argentina, the leaves are deprived of the midrib before roasting; this is called *caa-míri*. A very superior quality, or *caacuys*, is also prepared in Paraguay from the scarcely expanded buds. Another method of drying mate has been adopted, the leaves being heated in large cast-iron pans set in brickwork, in the same way that tea is dried in China.

The tea is prepared in a small silver-mounted calabash, the tapering end of which serves for a handle. In the top, there is a hole and the tea is sucked by means of a *bombilla*. This instrument consists of a small tube six or seven inches long, formed either of metal or a reed, which has at one end a bulb made either of extremely fine basketwork or of metal perforated with minute holes, so as to prevent the particles of the tea leaves from being drawn up into the mouth. Some sugar and a little hot water are first placed in the gourd, the tea is then added, and finally the vessel is filled to the brim with boiling water, or milk previously heated by a spirit lamp. A little burnt sugar or lemon juice is sometimes added instead of milk.

Mate, like tea and coffee, contains caffeine, but in less quantity. It is also less astringent. Mate retains its flavour against exposure to air and dampness.

See R. H. Porter, "Mate—South American or Paraguay Tea," *Econ. Bot.*, 4:37–51 (1950).

MATERA, a city of the Basilicata region in southern Italy, chief town of the province of Matera, 27 km. (17 mi.) S. of Altamura by rail. Pop. (1961) 37,550 (comm.). The old part of the town is built on the slope of a deep ravine; the houses are cut in the rock in terraces, with only the façade built of stone. The modern part consists of normal dwellings. Important monuments are the Romanesque cathedral (13th century; rebuilt in the 19th century); and the churches of S. Domenico and S. Giovanni Battista (13th century); S. Agostino (16th century); and S. Pietro Barisano, carved out of the rock. The population is engaged in agriculture, tufa quarrying and the manufacture of terra cotta and artistic ceramics.

The origin of the town is obscure (it does not appear to be the Roman Matteola). It formed part of the duchy of Benevento and of the principality of Salerno and was occupied consecutively by

the Normans, the Aragonese and the Orsini. (M. T. A. N.)

MATERIAL CULTURE consists of tools, weapons, utensils, machines, ornaments, art, buildings, monuments, written records, religious images, clothing and any other ponderable object produced or used by humans. If all the humans in the world were to die simultaneously, nonmaterial aspects of culture would cease to exist; but the material culture would still be present until it disintegrated. It is in what L. A. White has termed the technological system that most of material culture is manifested. White's concepts of the sociological and ideological systems correspond in the main to what is meant by the term nonmaterial culture. The ideological (or philosophical) systems both affect and express technology and reflect the social systems which in themselves are functions of the technological systems. Authorities continue to debate whether material culture is dominant in molding nonmaterial aspects (*see* SOCIAL ANTHROPOLOGY); however it seems clear that its impact has varied from society to society.

Even under civilized conditions a great part of man's material culture is directly associated with the primary needs for food, shelter, clothing and protection. The classification of peoples or communities as hunters, pastoralists or farmers is therefore not without value.

It is probable that the first men to begin the cultivation of plants were neither hunters nor herders in a specialized sense, but food gatherers who, from depending upon such plant and animal produce as they could collect, were led to discover that roots and shoots and seeds could be made productive under control. Apart from such existing marginal peoples as pygmies (*see* PYGMY) who live by collecting, hunting and fishing alone, hunting may be a more or less essential activity in higher grades of culture, its importance decreasing with the extension of plant cultivation and animal husbandry, until in the higher civilizations it degenerates into a sport. The domestication of animals except as pets is in one way or another associated with agriculture. (*See* ANIMALS, DOMESTICATION OF; AGRICULTURE; HUNTING AND FISHING, PRIMITIVE.)

Hunting, fishing and agriculture may be regarded as specializations which arose out of the food gathering that was in the beginning the compulsory occupation of the human stock, as it is of the existing apes. Specialization in and dependence upon hunting involved a mode of life less likely to lead to and foster plant growing than would a more settled existence in an area where botanical food was plentiful, and where the phenomena of growth could be observed under similar conditions year after year. As is generally recognized, a settled life based on an abundance of food allows elaborations of culture that are impossible for nomadic hunters and fishermen. However, it was only when plant cultivation established itself as cereal culture—the growing of grain such as barley and wheat and maize, which could be stored for winter consumption—that the first civilizations became possible (*see* AGRICULTURE, PRIMITIVE).

Other primary needs such as clothing and shelter result in the invention of artificial environments without which man could not survive in nontropical habitats. The fur clothing of the Eskimo, for example, provides a warm bodily climate without which human life in cold regions is impossible. Without their bark-covered houses and an adequate supply of firewood the Huron Indians of Canada could not have survived northern winters. Ancient man could not have spread beyond the confines of warm climates without clothing and shelter (*see* DWELLINGS, PRIMITIVE).

Means of travel and transportation, especially over water and deep snow, were also very important since they played a necessary part in opening up new food areas and regions of possible settlement (*see* TRANSPORT).

A close study of the means of procuring food, obtaining clothing and shelter, and providing defense against enemies reveals innumerable weapons and devices for fighting, hunting and fishing; methods and appliances used in clothing and vehicle manufacture, plant cultivation and animal husbandry; and methods, implements and utensils for carrying, storing and preparing food. To these must be added, with considerable overlap, the tools and mechanisms used in the treatment of materials, and in the construction of artifacts of all kinds. (*See* such articles as WEAPONS, PRIMITIVE; HAND TOOLS, HISTORY OF; FLINT AND OTHER STONE TOOLS; TEXTILES; BARK CLOTH; WEAVING; SPINNING; BASKET; BOW AND ARROW.)

To this core of material culture associated with primary needs must be added other items of material culture such as personal ornaments, objects of art, religious buildings, images of gods, religious and burial paraphernalia, instruments for measuring space, time and weight, games and musical instruments. Their nature is, indeed, determined by the state of culture with which they are associated and in their development they may react conspicuously upon the technique or construction principles, materials and habitat upon which they depend. (*See* such articles as ARCHAEOLOGY; ART; ARCHITECTURE; POTTERY AND PORCELAIN; FUNERARY RITES AND CUSTOMS; SCULPTURE; MUSICAL INSTRUMENTS; GAMES [ARTICLES ON]; METROLOGY.)

Culture Types and Culture Areas.—Particular cultures may be compared and contrasted with one another; those which are quite similar to each other may be grouped together to form a culture type. The cultures belonging to a culture type occupy and use a given territorial unit called a culture area. Usually in a culture area the technological aspect of culture interacting with the habitat is responsible for many of the similarities among the related cultures. For instance, one may speak of Plains Indians culture type or culture area (*see* PLAINS INDIANS). The chief natural resource of the North American plains region was the countless herds of buffalo grazing in the open grasslands. The buffalo was the staff of life for the typical Plains tribes and their cultures were a reflection of this fact. The people depended upon the buffalo for food, clothing, shelter and warmth. Their nomadic mode of life, concepts of warfare, social organization and religious ideas were elaborated in ways that were related to their primary dependence on the buffalo.

Ethnologists have described most, if not all of the culture types and culture areas of Africa, Europe, Asia, North America, South America, Australia and Oceania (*qq.v.*). Some culture types were of relatively brief duration whereas others persisted for a millennium or more.

Culture Change.—Culture is superorganic and superindividual; it is produced, participated in and carried by organic individuals, but it is transmitted from one individual, generation, age or group of people by social mechanisms without becoming a part of any individual's genetic endowment.

All cultures change by the addition and subtraction of trait elements, traits, types, complexes or configurations. All additive changes are innovations originating in a given culture by independent invention or by diffusion from one culture to another. In the realm of material culture such additions can be described in terms of form, material, use and technical principles. All subtractive changes are losses of what once were innovations. Any subtractive change can originate within a given culture or can be the product of diffusion.

Any cultural addition may or may not produce a corresponding subtraction. And if a subtraction does occur, it may be delayed for a considerable time. In North America, for instance, some Indian tribes in the Great Lakes region used bows and arrows for a hundred years after they had flintlock guns; there was a long period of innovation without corresponding loss. Among the same tribes, however, earthenware vessels of native manufacture disappeared from the cultural inventory at about the same time that brass kettles were supplied to them by French fur traders, a form of innovation by diffusion, with corresponding loss.

Culture change is required for culture growth or evolution; but there can be culture change without evolution.

Cultural Evolution.—Since evolution became a dominant motive in scientific studies, anthropologists have been guided by discoveries in archaeology as clues to the evolution of material culture. In modern civilizations there is a constant striving after discovery and invention. However, among early men, such developments were probably not so premeditated. It is reasonable to ascribe many of them to chance; for example, it seems unlikely that primitive man experimented with stones to produce fire

before he had observed sparks arising from chance percussion. But he must have soon lost this dependence on environmental suggestion. Thus, when he found he could make a new tool by thrusting a stone blade in the cleft of a stick, man opened a new field of invention. By variation, the bronze dagger emerged, later lengthened to become a sword. But important changes occurred as single steps of a more decisive character; *e.g.*, the abrupt change from the worked stone held in the hand to one fixed in a wooden haft. Such steps of truly inventive nature have sometimes been called (as in biology) mutations. Most modern inventions are mutations that involve the adaptation of principles discovered in scientific research, or the adaptational transfer of a device or feature from one appliance to another.

In cultural evolution material culture plays an important role because so much of it is a manifestation of the technological system, the evolution of which is primary in the rise of civilization. The evolution of culture depends upon energy and the tools or machines which harness the energies. Primitive or unelaborated cultures depend upon human energy; the degree to which they can develop depends upon the type and efficiency of their tools and implements as well as their environments.

All civilization is based on the harnessing of plant energy in the form of cereals; thus civilization could only develop in environments suitable for agriculture and the growing of grains. With such energy at the disposal of man, subsistence was controlled. The more abundant supply of food increased the limits of population, allowed for the development of special skills and great specialization of labour, and permitted more people to live in one place, giving rise to cities and urban life. The society of precivilized cultures was based on ties of kinship and tribe (*qq.v.*). Populations were relatively small and the groups were unspecialized and not elaborated.

The society of civilized peoples was based on state and organized religion involving rulers, priesthoods, class systems, specialized labourers and artisans, and many other social and ideological forms that could only arise in relation to a well-developed agricultural technology. Western civilization had its first great revolution or radical change more than 8,000 years ago when the shift from food collecting to food producing (the agricultural revolution) was well under way. About A.D. 1800 the second great change in technology (the industrial revolution) took place; it was based on the harnessing of energy in the form of coal, oil, gas and heat as used in production of energy for engines. The harnessing of atomic energy has marked the beginning of the third great revolution in material culture and culture as a whole system.

See INDUSTRIAL REVOLUTION; ATOMIC ENERGY.

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(H. S. H.; G. I. Qv.)

MATERIAL HANDLING. Since the beginnings of civilization, man has sought ways of moving objects which were too heavy or too bulky to be easily moved by himself. The use of mechanical devices to eliminate or simplify elements of human work has been termed mechanization, and material handling is that part of mechanization which is concerned with the transporting, positioning and storage of materials in industry.

The science of industrial material handling dates back to the late 18th and early 19th centuries. The use of an integrated system of belt conveyers for handling materials in a flour-processing mill was discussed by Oliver Evans in *The Young Mill-Wright and Miller's Guide* (1795). Bucket conveyers were employed in grain elevators as early as 1843, and overhead cranes were in limited use by 1850. By 1900, two-wheel and four-wheel industrial trucks were employed in industry for handling bags, drums and pans, and in 1913 the Ford Motor company established the first progressive assembly line for automobiles.

During World Wars I and II and in the intermediate period, the development of material-handling equipment progressed at a rapid pace. More and more, industrial plants adopted line-manufacturing methods in which whole processes were designed around the material-handling system. Although U.S. firms adopted mechanized production systems more rapidly than those in other countries, considerable progress was made in all industrial areas of the world in replacing manual handling with mechanical-handling devices. In some cases, integrated systems of automatic processing equipment and material-handling equipment have produced completely automated processes which have eliminated the need for direct manual labour. Of course, skilled technicians are required to set up and maintain such complex manufacturing systems.

Since the handling of material does not usually contribute to its value, the moving, positioning and storing of product is always expensive, and one of the prime objectives of material handling is to lower handling costs. Various studies have shown that from 20% to 60% of total manufacturing cost may be attributed to handling materials. In addition, there are many indirect costs which may be affected by the procedures used for material handling, such as scrap material losses and machine delay losses. Other important objectives of good material handling are to (1) reduce production time; (2) aid in the control of the flow of materials; (3) reduce inventory quantities; (4) conserve plant floor space; (5) limit worker fatigue and prevent injuries; and (6) integrate handling and processing operations.

Selection of the proper handling equipment for a particular installation involves considerations of cost, reliability and suitability. For handling that involves area coverage, long hauls or changing flow patterns, industrial trucks or overhead cranes may provide the best solution; for fixed-path coverage, medium hauls or relatively stable flow patterns, conveyers may prove more satisfactory. The selection of a specific type of equipment requires detailed study of the product, the nature of the handling operation and the design of the manufacturing process in general. In selecting positioning or storage devices, product orientation or alignment may be another important consideration. Material-handling equipment may be classified as (1) conveyers, (2) hoists and cranes, (3) industrial trucks, and (4) unit-load accessories. Each type has certain defined areas of usage, although in many situations an integrated system of several different types of material-handling equipment is needed.

Conveyers.—The conveyer provides continuous, mechanized handling of material at any desired rate of movement. Conveyers may be operated intermittently or continuously, as desired, depending upon the type of drive mechanism provided. Conveyers will move anything from the lightest to the heaviest material, in almost any size, shape or condition and with a speed, accuracy and ease seldom achieved manually. The conveyer may serve solely as a movement device between points in the plant, or it may be an integral part of the manufacturing operation. It usually permits a reduction in work-in-process inventory, provides an excellent mechanism for controlling production and may serve as a ready-access, moving storage system. In addition to industrial applications, conveyers find many uses on farms and in other types of enterprise. Conveyers range in length from a few inches to an integrated system of conveyers several miles long. The major types of conveyers are gravity roller, gravity wheel, live roller, belt, floor, slat, flight, apron, vibrating, trolley, en masse, bucket, screw, pneumatic, tow, portable and transfer—each of which is briefly described below.

Gravity-Roller Conveyer.—Roller conveyers employ a series of parallel rollers of various diameters and materials which are supported at specified spacings in a metal frame and are used to convey objects and packages by gravity or manually (fig. 1). The conveyer frame sections may be placed directly on the floor, supported on fixed or adjustable-height legs, or supported on hangers from overhead structures. The frame sections may be straight or curved, and spirals, switches and crossovers are also available. Usually, several conveyer sections are joined together to form a system, and the system is inclined slightly if gravity flow of material is desired.

BY COURTESY OF CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION

FIG. 1.—ROLLER CONVEYER

Gravity-Wheel Conveyer.—Wheel conveyers consist of a series of "skate" wheels mounted on parallel axles and supported at selected spacings between frame sections. They are used to convey packages and other flat-bottomed objects by gravity or applied manual force. They are similar to gravity-roller conveyers except that wheel conveyers are generally used for lighter loads and are comparatively less expensive. The use of wheels also limits the usefulness of the conveyer to specific handling jobs. The conveyer sections are available in both straight sections and curves and are supported like the gravity-roller conveyer.

Live-Roller Conveyer.—This type of conveyer is similar to the gravity-roller conveyer except that the rolls are power driven by means of a belt snubbed against the underpart of the rolls or by a chain driving sprockets attached to the rolls. Power may be applied to all or only a part of the rolls, and the driving medium may be of constant or variable speed. Live-roller conveyers are used to move materials in containers without the need for manual pushing or pulling and where the use of gravity is impractical.

Belt Conveyer.—Where it is desired to move packaged or bulk material, or even individual objects, on a continuously moving conveying medium, the belt conveyer is often selected. The belt may be of fabric, rubber, plastic, leather or metal, and is driven by a power-operated roll mounted underneath or at one end of the conveyer. The belt forms a continuous loop and is supported either on a metal slider pan or on rollers. In addition, suitable take-ups provide enough tension to keep the belt taut. The slider-pan support is used with flat belts when the load is sufficiently light to prevent a heavy frictional drag on the belt. For heavier loads, roller supports are always used. In some cases, the supporting rolls are mounted to form an angular trough in the belt, so that bulk materials can be carried in the cavity (fig. 2). Belt conveyers are generally laid out horizontally, but they can be operated at an incline if the material being carried is of such form that it will not slide back on the belt. For steeper angles of inclination, cleats may be mounted across the belt to prevent slippage of the material during rise or descent. Belt conveyers can be operated close to the floor on low supports, at table height with fixed or adjustable legs or at higher elevations when supported from the overhead structure. Power is generally provided by electric motors operating through a constant or variable-speed reduction gear.

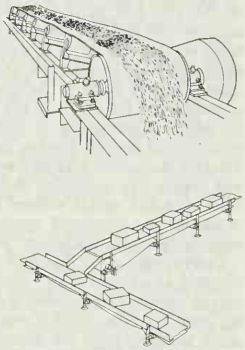

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FIG. 2.—TWO TYPES OF BELT CONVEYERS

Floor Conveyer.—This may be any of several types of conveyers using chain, cable or other linkage mounted in or close to the floor. Such conveyers are often designed to drag a series of four-wheel carts around in a horizontal loop, to carry large products or to permit assembly of products while on the conveying system. Power is supplied to the chain or cable, which operates within an endless track by means of guiding rollers. The material carriers are then attached with permanent or removable clamps to the conveying chain or cable.

Slat Conveyer.—Slat conveyers consist of one or more power-driven endless chains or other linkage, to which are attached spaced slats of various materials, to carry objects which would damage a belt because of weight or sharp edges and for which a live-roller conveyer would not be suitable. The parallel slats do not overlap and are not interlocking; they are attached to provide a continuous moving bed or platform. The chains or other linkage are driven by electric motors operating through suitable reduction gears and sprockets.

Flight Conveyer.—In this type of conveyer, scrapers or flights of various materials are mounted at spaced intervals perpendicular to the direction of travel on one or more endless, power-driven chains operating within a trough. The flights are attached to the power-driven chain and serve to push bulk materials along the trough. These conveyers are designed in many different styles for handling sawdust, sand, gravel, stone, coal, chemicals and many other bulk materials.

Apron Conveyer.—When a continuous moving bed for bulk materials, packages or objects is desired, the apron conveyer may be the best solution. Overlapping and interlocking plates of various materials are joined to one or more endless chains to provide a continuous carrying surface which can be run either horizontally or up and down, as determined by the chain guides or supporting rollers. One of the main advantages of the apron conveyer is the "leakproof" bed which makes it suitable for bulk materials without containers (fig. 3).

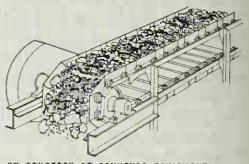

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FIG. 3.—APRON CONVEYER

Vibrating Conveyer.—The vibrating conveyer consists of a trough or tube which is flexibly supported and vibrated by mechanical or electrical means to convey objects or bulk materials. Vibration is in an inclined, elliptical pattern to cause directional as well as upward movement of the material. Since the conveyer has no moving parts other than the drive mechanism, it is particularly suitable for abrasive bulk material.

Trolley Conveyer.—Designed to carry objects and materials in containers from overhead supports, the trolley conveyer utilizes an overhead rail carrying a series of load-bearing carriers or trolleys which are coupled together on an endless propelling medium such as chain, cable or other linkage (fig. 4). Trolley conveyers provide an extremely flexible handling system, in that the rail may be installed to provide both straight and curved horizontal travel as well as inclines and twists. This type of conveyer is used with hooks, magnets or various carriers designed for the particular load to be handled. The trolley conveyer is particularly suitable for long moves between fixed locations, for in-process storage of material between operations, for special processes such as painting, baking and degreasing and for assembly work during movement. The rails are usually supported by the overhead structure of the plant building.

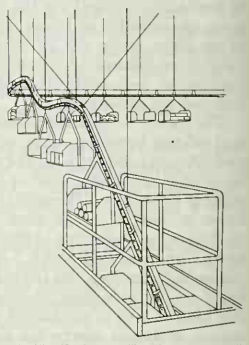

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FIG. 4.—TROLLEY CONVEYER

En Masse Conveyer.—This type of conveyer employs a series of skeletal or solid flights mounted at spaced intervals on a chain or cable which is power driven within a closely fitting casing. It is primarily designed for bulk materials which must be enclosed during transfer to prevent leakage or explosion. The conveyer can operate in horizontal, vertical or inclined positions, and it moves the bulk material in a continuous stream within the casing.

Bucket Conveyer.—The bucket conveyer consists of one or more strands of endless chain, belt or other linkage to which are attached buckets of various shapes and sizes, spaced at regular intervals, to convey bulk material in horizontal, inclined and vertical paths (fig. 5). The buckets remain in the carrying position until they are tipped to discharge the material. The

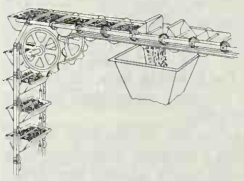

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FIG. 5—PIVOTED BUCKET CONVEYER

bucket conveyer can be used with or without a casing and can be designed with several different types of discharging mechanisms.

Screw Conveyer.—Screw conveyers are essentially a revolving shaft with continuous or broken spiral flighting which operates within a casing to convey materials along a prescribed path. The screw is usually designed to operate in only one direction and is powered by an electric motor and suitable gearing. Screw conveyers are particularly suited to fine bulk material such as meal, seeds and coal.

Pneumatic Conveyer.—Pneumatic conveyers move bulk material in tubes or ducts by means of air pressure or vacuum. Objects can also be handled by enclosing them in a cylindrical sleeve which closely fits the internal diameter of the pipe and is conveyed by the air pressure. Vacuum systems are used for drawing light bulk material from railway cars or bins, and the system works very much like a household vacuum cleaner.

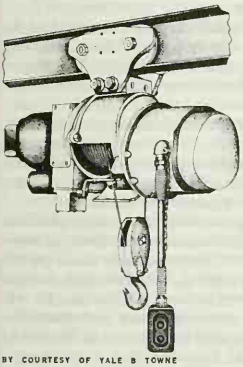
Tow Conveyer.—Either the overhead trolley conveyer or the floor conveyer can be adapted for use as a tow conveyer. The cars or four-wheel carts are locked in to the towing chain or cable to move them from any one point in the system to any other point. Tow conveyers are used for handling many different types of dollies, trucks and cars. When the cars are disconnected from the towing conveyer, they may be used as storage devices or moved manually to any location in the plant. The towing system is usually provided with a variable-speed drive to permit flexibility in its use.

Portable Conveyer.—Any type of conveyer which is mounted on mobile supports, usually wheels, may be considered portable. Gravity-roller and wheel conveyers and short belt conveyers are particularly adaptable to portable use.

Transfer Conveyer.—This term has been applied to the intermittent transfer equipment which is utilized in the automatic transfer machine. It may consist of either a rotary indexing table or a straight-line indexing device which moves work-holding fixtures from one work station to another within one basic machine. The transfer device is a form of conveyer which is incorporated within the machine itself, and the machining heads are mounted onto or around the conveyer. (*See* also ELEVATOR.)

Hoists and Cranes.—These devices are used for lifting and lowering material and for limited area movement. The hoist is primarily a lifting device, the common types being chain, air and electric.

The chain hoist is manually operated. The air or pneumatic hoist employs compressed air to operate a cylinder or air motor and provide the lifting force. The electric hoist, which utilizes an electric motor for power, is the most economical unit for rapid lifting and lowering. In addition, the range of lifting capacities is greater for electric hoists than for air hoists and electrical outlets may be more readily available. However, air hoists are generally considered to require less maintenance. Fig. 6 illustrates a typical electric hoist.



BY COURTESY OF YALE & TOWNE

FIG. 6.—ELECTRIC HOIST

A special type of hoist is known as the skip hoist. It is a motorized hoist having bucket cars which operate on steeply inclined rails. The skip bucket moves up and down the rails by means of a wire rope or chain, driven by a sprocket or drum at the head end. Skip hoists are used for elevating bulk material or parts for delivery into bins, mixers, grinders, etc., and may be either fixed or portable.

Cranes permit both vertical and horizontal movement of material within the limitations of their travel area. The more common industrial types are the portable, jib, gantry and bridge cranes, all of which are discussed in more detail in a separate article (*see* CRANE).

Industrial Trucks.—The industrial truck provides intermittent movement of unit loads of material from any point in the plant area to any other point. A unit load is that amount of material which is grouped together for handling as one load. Industrial trucks provide maximum flexibility in making moves within the plant area, and they permit rapid, mechanized handling of all material which can be handled as a "load." Most of the many types of industrial trucks also permit mechanized pickup and deposit of these loads, thus eliminating manual work in lifting as well as in carrying.

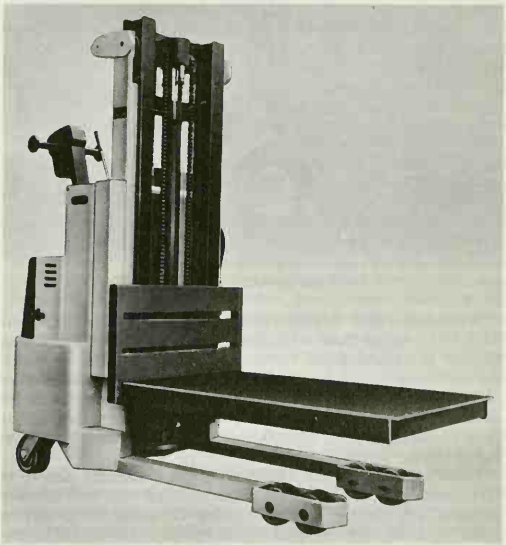
Industrial trucks may be classified as hand trucks or power trucks depending upon the means of locomotion.

Hand trucks may, in turn, be classified by the number of wheels and by usage and general design. In general, two-wheel hand trucks permit most of the load to be carried on the wheels, but a portion of the load must be supported in the hands of the operator in order to balance the truck during movement. Some of the more common two-wheel hand trucks are the barrel, box, drum, hopper, refrigerator, paper-roll and tote-box trucks. Four-wheel hand trucks are found in many more varieties, including dollies, high- and low-bed flat trucks, carts, rack carries, wagons and a number of different types of hand-lift trucks. The latter have mechanical or hydraulic lifting mechanisms for raising and lowering a load preceding and following transport.

Power trucks, as the name implies, have a power drive for locomotion. The use of such trucks in industry dates back to 1906, when electric drives were applied to ordinary baggage trucks at a Philadelphia railroad station. Power is supplied by (1) a gasoline engine and mechanical drive; (2) a gasoline engine, generator and electric-motor drive; or (3) batteries and an electric-motor drive.

Propane and diesel engines are also used in place of gasoline engines on some types of trucks. The common types of powered industrial trucks are the nonlift platform, low-lift platform, high-lift platform, fork, motorized pallet, side-clamp lift, ram, crane, tractor, straddle and side-loading trucks.

Nonlift Platform Truck.—One group of industrial power trucks is designed purely for hauling. A platform is provided on the truck for the load, which may consist of pans, packages or other



BY COURTESY OF BIG JOE MANUFACTURING CO., INC.

FIG. 7.—LOW-LIFT PLATFORM TRUCK

objects. The nonlift platform truck is used to haul heavy loads over longer distances than would be desirable for a hand truck. In most cases, the operator rides on the truck with the load.

Low-Lift Platform Truck.—This type of power-operated truck is self-loading and provides a low platform for use with skids and certain types of metal boxes. These boxes provide a space for entrance of the platform and the front wheels of the truck. Since the front wheels ride under the load, the truck does not require counterbalancing and therefore heavier loads can be handled for a given size truck than with a fork truck. Capacities of these trucks vary from 2,000 to 10,000 lb. and more (fig. 7).

High-Lift Platform Truck.—Similar to low-lift platform trucks, the high-lift trucks are able to stack material. Both low-lift and high-lift platform trucks are available in "walkie" units, in which the operator walks and guides the truck, and in "rider" units, in which the operator rides on the truck. Walkie trucks have capacities up to 4,000 lb.; rider trucks range up to capacities of 60,000 lb. The maximum stacking height for high-lift platform trucks is approximately 130 in. High-lift platform trucks are also self-loading and are used with skids and boxes which permit the platform and front wheels to run under the load. This type of truck is sometimes employed to handle heavy press dies and large tooling. Some types of walkie platform trucks provide outrigger arms which contain the front wheels and go around the load rather than under it. In most cases, a hydraulic cylinder is used as the lifting mechanism.

Fork Truck.—The fork truck, which first appeared around 1927, is either a low-lift or high-lift, self-loading truck equipped with forks to handle loads on pallets, the elevating mechanism permitting multiple-tiering in the case of the high-lift models. The pallet is a load carrier of wood, metal or both, specifically designed to be picked up by and carried on the forks. The load is supported on a cantilever principle, with the rear of the truck being heavily weighted to balance the overhanging load. The fork carriage is supported on two upright masts which may be either rigid or permit tilting backward and forward for easy handling of the load. The masts on some models telescope to permit stacking up to 16 ft. Capacities of these trucks range from 1,000 to 60,000 lb. (fig. 8).

BY COURTESY OF ALLIS-CHALMERS MANUFACTURING CO.

FIG. 8.—FORK TRUCK

Motorized Pallet Truck.—This is another walkie truck, but with forks rather than a platform. It is particularly designed for use in narrow aisles, for moving and stacking loads which are too heavy for a hand truck. Motorized pallet trucks may be counterbalanced, like a fork truck, or they may have outrigger arms with front wheels like the platform truck. Capacities of these trucks range up to 4,000 lb. and may provide telescopic stacking to 130 in.

Side-Clamp Lift Truck.—Side-clamp lift trucks are similar to fork trucks except that the forks are replaced with hydraulically actuated side clamps, thus eliminating the need for a skid or pallet for many types of loads. Side clamps are available in several different designs for handling paper rolls, drums, stacked crates and boxes, bales, etc. In some cases a revolving head is

BY COURTESY OF CLARK EQUIPMENT CO.

FIG. 9.—STRADDLE TRUCK

provided so that the load may be turned over while supported in the clamps. One type of side-clamp truck employs hydraulically expanded rubber cushions to lift tile or brick stacked in unit loads.

Ram Truck.—Similar to the fork truck, the ram truck has a single protruding ram or fork for handling coils of sheet, wire or other coiled material. These trucks are constructed for heavy loads and may have several front wheels back of the ram to support weights of up to 100,000 lb. For lighter loads, a standard fork truck can be used by removing one of the two forks. Both ram and fork trucks are often driven backward, particularly when empty, to avoid serious injuries to workers in the area.

Crane Truck.—This truck consists of a portable boom crane mounted on an industrial truck, and it is used with hooks, grabs and slings for handling bundled or coiled material.

Tractor.—The tractor is essentially a mobile towing vehicle, used with four-wheel carts to make up a trackless train. It is usually co-ordinated with other facilities for loading and unloading.

Straddle Truck.—The straddle carrier closely resembles a gantry crane mounted on four pneumatic-tired wheels. The operator rides above the inverted U frame, within which the load is carried on elevating shoes. These trucks are used to handle lumber, bar steel and pipe. The size of the load can be as large as 108 in. high by 100 in. wide and as heavy as 30,000 lb. (fig. 9).

Side-Loading Truck.—This is a special design which combines features of the platform and fork-lift trucks. The platform portion of the truck has a centrally located well or bay in which is mounted the fork-lifting mechanism. These trucks are useful for picking up and carrying long, bulky loads.

Unit-Load Accessories.—Unit loads may be composed of individual items, grouped together and handled without breaking bulk, or of items which are held together by strapping, gluing or other physical means. The two most important unit-load accessories are skids and pallets.

There are three types of skids used in industry: live skids, which are dollylike carriers with wheels or casters; semilive skids, which have two wheels and two rigid supports; and dead skids, with runners or four rigid supports. Skids are handled by either two-wheel jack trucks or manual- or power-lift trucks.

Pallets usually have three stringers which, with single-platform pallets, act as supports and with double-platform pallets, as separators between the two platforms. Compared with skids, pallets are lower—usually about six inches over-all, with four-inch vertical openings to admit the forks. Double-faced pallets can be obtained for two-way, four-way or even eight-way fork entrance. Pallets are handled by fork trucks, pallet hand trucks or lift trucks adapted with forks. *See* also MASS PRODUCTION.

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3rd ed. (1954); Modern Materials Handling, *Materials Handling Manuals* no. 1 and 2 (1955, 1957). (H. H. Yc.)

MATERIALISM, in philosophy, the view that all facts (including facts about men's minds and wills and the course of human history) are causally dependent upon physical processes, or even reducible to them. The many materialistic philosophies that have arisen from time to time may be said to maintain one or more of the following theses: (1) that what are called mental events are really certain complicated physical events; (2) that mental processes are entirely determined by physical processes (*e.g.*, that "making up one's mind," while it is a real process that can be introspected, is caused by bodily processes, its apparent consequences also really following from the bodily causes); (3) that mental and physical processes are two aspects of what goes on in a substance at once mental and bodily (this thesis, whether called "materialistic" or not, is commonly opposed by those who oppose materialism); and (4) that men's thoughts and wishes influence their individual lives, but that the course of history is determined by the interaction of masses of men and masses of material things, in such a way as to be predictable without reference to the "higher" processes of thought and will.

Materialism is thus opposed to philosophical dualism or idealism and, in general, to belief in God, in disembodied spirits, in free will or in certain kinds of introspective psychology. Materialistic views insist upon settling questions by reference to public observation and not to private intuitions. Since this is a maxim which scientists must profess within the limits of their special inquiries, it is natural that philosophies which attach the highest importance to science should lean toward materialism. But none of the great empiricists have been satisfied (at least for long) with systematic materialism.

Materialistic Schools.—The Greek atomists of the 5th century B.C. (Leucippus and Democritus) offered simple mechanical explanations of perception and thought—a view which was condemned by the Socrates of the *Phaedo;* in the 17th century Thomas Hobbes and Pierre Gassendi, inspired by the Greek atomists, used materialistic arguments in defense of science against Aristotle and the orthodox tradition; and in the next century the materialists of the Enlightenment (Julien de Lamettrie, Paul d'Holbach, etc.) attempted to provide a detailed account of psychology.

In the 19th century the battle moved to new grounds. In the first place, some thinkers were encouraged by the theory of evolution to hope that, just as human life had grown out of animal and plant life, so these in turn might be explained as products of the simplest forms of matter; others, however, for instance C. Lloyd Morgan, later came to hold that new properties "emerged" in evolution—properties not fully explicable in terms of their antecedents (*see* EMERGENCE).

The question of materialism was thus merged into problems of method and interpretation in science (Henri Bergson, Samuel Alexander, A. N. Whitehead). Secondly, Georg Hegel, Auguste Comte, Karl Marx and others raised the question of the explanation of human history. Here Marx offered a new kind of materialism, dialectic and not mechanistic, and embracing all sciences—a materialism which alone retains its full vitality and coherence (*see* MARXISM).

In the 20th century other systems had to face novel developments in the sciences and in philosophy. In physics, relativity and quantum theory modified, though they did not abandon, the notions of cause and of universal determinism. In psychology, J. B. Watson's behaviourism, an extreme form of materialism, did not find general acceptance; and researches both in psychology and in psychoanalysis made it impossible to hold any simple direct view of the mind's dependence on the brain and the nervous system. At the same time experiments in psychical research showed (it was claimed) that mental events might have almost any kind of independence of bodily events. In philosophy, further reflection on the concepts of science and of common sense (especially those of cause and of explanation) suggested to many that it is futile to try to erect a system of belief whether materialistic or otherwise, on such a basis. *See* BODY AND MIND; IDEALISM; *see* also references under "Materialism" in the Index.

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MATERIALS, STRENGTH OF, is that part of engineering science which deals with the behaviour of solids under the influence of forces which are in equilibrium. The forces may be of mechanical origin such as gravity, inertia or fluid pressure or they may be electrical or magnetic. In statics and dynamics it is assumed that solids are rigid and do not suffer any changes under the influence of forces other than those of equilibrium or position. Strength of materials is concerned with the deformation and disruption of solids when forces are acting upon them without consideration of changes in equilibrium or position.

Most engineering products are subjected to forces under whose influence they must neither break down nor deform beyond certain relatively small permissible limits. Strength of materials enables the engineer to estimate the forces which can be safely imposed on a given structure or engineering component, or to choose the appropriate material for and determine the necessary dimensions of structures and components which have to withstand given loads without suffering effects deleterious to their proper functioning.

Strength of materials is involved also in engineering problems of a different kind. The design of machinery such as rock crushers and coal cutters for the breaking up of materials involves consideration of the mechanical strength of these materials. Machining processes such as turning, drilling and planing pose other problems falling within the province of strength of materials. Cold- or hot-forming processes for the production of metal parts such as pressing, extruding or forging involve the problem of determining the forces necessary to produce certain permanent changes in form, and this is yet another group of problems in strength of materials.

This article is divided into the following sections:

I. Elasticity
II. Experimental Stress Analysis
III. Testing of Materials
IV. The Problem of Failure
V. Metal Physics
VI. Survey and Outlook

I. ELASTICITY

The fundamental concepts used in strength of materials are those of the theory of elasticity. This is a branch of applied mathematics, and for a full account reference should be made to the special article ELASTICITY. For the purpose of this article only certain fundamental concepts of this theory will be considered.

Concept of Stress.—Consider a solid of any arbitrary shape upon which several forces, P_1, P_2, P_3, are acting as shown in fig. 1, where these forces are in equilibrium so that the solid is at rest. If a cut such as A–A is now made, destroying the cohesion of the solid, the two parts would move away from one another because the forces acting on each of the two parts are now no longer in equilibrium. Since, prior to the making of the cut, the two parts did not move apart it must of necessity be assumed that forces are acting within the solid on the cut face which prevent this movement. The forces must, therefore, be of such a character that their resultant balances the forces applied to each of the two parts. These internal forces called into play by external forces acting on a solid will be distributed in some manner over the surface of the imaginary cut, and each unit of area of the internal surface will carry an appropriate proportion of the force. This proportion of internal force carried by unit area is termed the stress.

If the force which has to be balanced is P and the area over which the stress can be assumed to be distributed is A then the average magnitude of the stress at every point of the surface A–A will be equal to P/A. In general, the distribution of stress over the area of an imaginary cut will not be uniform, and it is one of the general problems of the theory of elasticity to determine the exact distribution of stress in the interior of a solid subject to external forces.

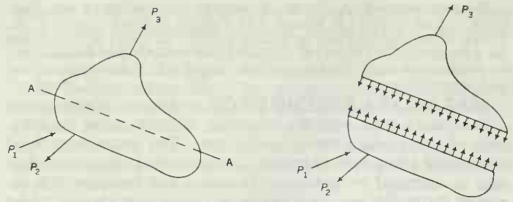


FIG. 1.—STRESSES DUE TO LOADS P_1, P_2 AND P_3 ACTING ALONG LINE A–A OF SOLID BODY

If a solid instead of being divided by one cut into two parts is divided by a large number of cuts into many small cubes of unit volume, each of these cubes by the same reasoning will transmit a force on each of its six cube faces. These forces will not be acting at right angles to the cube faces but each of them can be resolved into three components of which one, the normal stress, is acting at right angles to the cube face, and two components, called shear stresses, are acting in the cube face. Since there are six cube faces there will be 18 such components. Those, designated X_x, X_y, X_z, Y_x, Y_y, Y_z, Z_x, Z_y, Z_z, are shown in fig. 2.

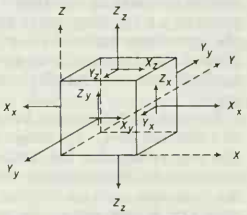


FIG. 2.—CUBICAL ELEMENT OF SOLID WITH STRESS COMPONENTS OF A GENERAL TRIAXIAL STATE OF STRESS ACTING IN THE CUBE FACES

Equilibrium Conditions.—Considerations of equilibrium lead to certain relations between these 18 stress components which reduce their number to 6, of which 3 are normal stresses and 3 are shear stresses. Moreover, certain first-order partial differential equations containing the derivatives of the stress components with regard to a system of rectangular co-ordinates can be deduced from considerations of equilibrium and continuity, and these equilibrium conditions form one set of fundamental equations which must be satisfied by the solutions obtained for any stress problem.

These three equilibrium conditions in the absence of body forces —that is forces proportional to mass and acting on each cubical element—are obtained in the following form where X_x, Y_y, Z_z are the three normal components, and $X_y = Y_x$, $X_z = Z_x$, $Y_z = Z_y$ are the three shear stress components:

$$\frac{\partial X_x}{\partial x} + \frac{\partial X_y}{\partial y} + \frac{\partial X_z}{\partial z} = 0$$

$$\frac{\partial Y_x}{\partial x} + \frac{\partial Y_y}{\partial y} + \frac{\partial Y_z}{\partial z} = 0 \qquad (1)$$

$$\frac{\partial Z_x}{\partial x} + \frac{\partial Z_y}{\partial y} + \frac{\partial Z_z}{\partial z} = 0$$

Tensile and Compressive Stress; Triaxial and Plane Stress.—Consider a solid in the form of a fine wire AB (fig. 3) at the ends of which two forces P of equal magnitude but opposite direction are acting, trying to tear the wire apart. Such forces produce stresses over any cross section of the wire directed away from the area of the cross section, and such stresses are called tensile stresses.

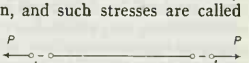


FIG. 3.—WIRE AB EXTENDS TO A′B′ UNDER THE INFLUENCE OF FORCES P, PRODUCING TENSILE STRESSES

Consider a short pillar or block (fig. 4) carrying at the top a load P; an equal and opposite reaction will be produced in the base of the pillar resting on the foundations. The pillar is under the influence of two forces trying to shorten it, and in every cross section of the pillar at right angles to the forces, stresses will be produced directed toward the surface of the cross section. Such stresses are termed compressive stresses. The wire under tension and the pillar under compression illustrate two of the simplest types of stress distributions in solids. The stress at every point of the solid will be the same, and will be in the same direction. If a small cubical element is considered with its edges parallel to the applied forces, only one of the six stress components is acting; all the others will be zero. Such a state of stress is called a uniaxial state of stress. The more general case when stresses are acting on all six cube faces is a general triaxial state of stress.

If stresses are acting only on four of the six cube faces as in fig. 5, the number of stress components will be reduced from six to three and the problem is one of biaxial stress or plane stress.

In the wire under tension or the pillar under compression the state of stress is the same at every point. Such states of stress, and they need not necessarily be uniaxial, are termed homogeneous states of stress. In general, the state of stress in a solid will be nonhomogeneous; this means it will be different at every point, or mathematically speaking: the state of stress is a function of the co-ordinates.

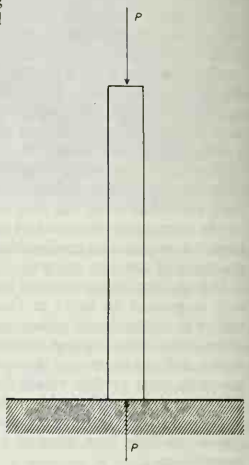


FIG. 4.—COLUMN UNDER COMPRESSION STRESSES PRODUCED BY FORCES P

Concept of Strain; Poisson's Ratio.—Under the influence of the forces P acting on the wire in fig. 3, the ends will be displaced to points A′ and B′ respectively. If the original length of the wire AB was l and the stretched length A′B′ is l' the extension of the wire by the force P is $\Delta l = l' - l$. If the material of the wire is perfectly homogeneous each unit length of wire will make an equal contribution to the total extension and the extension per unit length is $\Delta l/l$. This is called the longitudinal strain.

Exact measurements of the diameter of the wire before and after application of the load would reveal that as the wire lengthens the diameter diminishes. The longitudinal dilatation of the wire under the influence of the tensile forces P is accompanied by a lateral contraction. This lateral contraction per unit length of diameter will be only a fraction of the longitudinal strain, so that the volume of the wire will slightly increase. The ratio of lateral contraction to longitudinal extension is a constant for a given material and is termed Poisson's ratio, μ. Its value varies between 0.2 and 0.5 for different materials. If the value of Poisson's ratio approaches 0.5, as it does for cork, there will be no change in volume in consequence of stress.

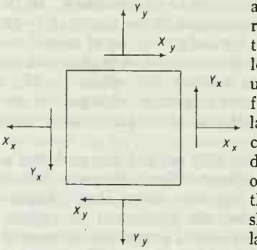


FIG. 5.—CUBICAL ELEMENT WITH STRESS COMPONENTS OF A PLANE STATE OF STRESS

Shear Strain; General Deformation; Compatibility.—The deformation produced by a general state of stress cannot be described in terms of dilatations and contractions alone. A square ABCD under the influence of shear stresses will deform into the rhombus ABC′D′ (fig. 6) much in the manner of cards sliding over each other in a pack. The deformation is described by the angle DBD′, and this is called a shear strain. If, as before, a solid of arbitrary shape is divided into a large number of small cubes each of the cubes can in the most general case suffer dilatations or contractions in the directions of the three cube edges, and in addition each of the squares bounding the cube can suffer a shear strain so that the cube is deformed into a parallelepiped. The three dilatations in the directions of the co-ordinate axes and

the three shear strains in the co-ordinate planes describe the deformation of the elementary cube completely, and if these six strain components are known as functions of the co-ordinates they are known at every point of the solid and the deformation of the solid is then fully described.

There is one important condition which must be satisfied by the strain components. If they were entirely independent from each other, each elementary cube might be deformed in such a manner that after deformation the cubes would no longer fit together without gaps and the continuity of the solid would be destroyed. In order to ensure the continuity of the solid after deformation the functions representing the strain components must satisfy a set of six second-order partial differential equations which are known as the compatibility conditions.

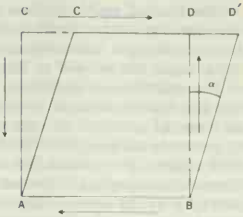


FIG. 6.—CUBICAL ELEMENT ABCD SUBJECTED TO PURE SHEAR STRESS

These six compatibility conditions are obtained in the following form where e_{xx}, e_{yy}, e_{zz} are the three normal strains and $e_{xy} = e_{yx}$, $e_{xz} = e_{zx}$, $e_{yz} = e_{zy}$ are the three shear strains:

$$\frac{\partial^2 e_{xx}}{\partial y^2} + \frac{\partial^2 e_{yy}}{\partial x^2} - \frac{\partial^2 e_{xy}}{\partial x \partial y} = 0$$

$$\frac{\partial^2 e_{yy}}{\partial z^2} + \frac{\partial^2 e_{zz}}{\partial y^2} - \frac{\partial^2 e_{yz}}{\partial y \partial z} = 0$$

$$\frac{\partial^2 e_{zz}}{\partial x^2} + \frac{\partial^2 e_{xx}}{\partial z^2} - \frac{\partial^2 e_{xz}}{\partial x \partial z} = 0 \qquad (2)$$

$$\frac{\partial}{\partial x}\left(\frac{\partial e_{xy}}{\partial z} + \frac{\partial e_{xz}}{\partial y} - \frac{\partial e_{yz}}{\partial x}\right) - 2\frac{\partial^2 e_{xx}}{\partial y \partial z} = 0$$

$$\frac{\partial}{\partial y}\left(\frac{\partial e_{yz}}{\partial x} + \frac{\partial e_{xy}}{\partial z} - \frac{\partial e_{zz}}{\partial y}\right) - 2\frac{\partial^2 e_{yy}}{\partial x \partial z} = 0$$

$$\frac{\partial}{\partial z}\left(\frac{\partial e_{zz}}{\partial y} + \frac{\partial e_{yz}}{\partial x} - \frac{\partial e_{xy}}{\partial z}\right) - 2\frac{\partial^2 e_{zz}}{\partial x \partial y} = 0$$

The compatibility conditions can be derived from the fact that the components of strain are derivatives of the components of the displacement vector. The displacement vector is a measure of the displacement of each cubical element in space with regard to a fixed system of co-ordinate axes. If the components of the displacement vector in the three directions x, y, z of the co-ordinate system are designated by u, v, w respectively, the components of strain are derived as follows:

$$e_{xx} = \frac{\partial u}{\partial x} \qquad e_{xy} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}$$

$$e_{yy} = \frac{\partial v}{\partial y} \qquad e_{yz} = \frac{\partial v}{\partial z} + \frac{\partial w}{\partial y} \qquad (3)$$

$$e_{zz} = \frac{\partial w}{\partial z} \qquad e_{zx} = \frac{\partial u}{\partial z} + \frac{\partial w}{\partial x}$$

The compatibility conditions can be derived from these six equations by eliminating the three components of the displacement vector. These six equations are therefore equivalent to the compatibility equations and are frequently used in their place.

Relation Between Stress and Strain; Proportionality; Elasticity.—It is a fact of experience that a wire subjected to equal and opposite forces P at its ends (fig. 3) extends. The extension is considered a consequence of the stresses produced in the wire by the forces. There exists, therefore, a relation of cause and effect between stress and strain, or strain can be considered a function of stress. This functional relationship must be expressible by some mathematical law, and two distinct possibilities for postulating such a law present themselves.

The one possibility would be to determine the relationship experimentally and then find a mathematical expression representing this relationship. This meets with formidable difficulties because such measurements are possible only for relatively simple states of stress and deformation and cannot be carried out for general states of deformation resulting from triaxial states of stress. Measurements on metal wires and metal pillars, however, show that for certain simple types of stress, when the stresses do not exceed certain limits, the strain is proportional to stress so that a linear relationship holds.

For other metals and materials such as concrete, stone or timber, the relation even for simple states of stress is not linear. Such empirical stress-strain relations could of course only be applied with confidence within the region for which they have been experimentally confirmed.

The second possibility, and this is the one adopted in the theory of elasticity, is to postulate a relationship which will result in a mathematical theory aesthetically satisfying and at the same time simple. Only the assumption of a linear law permits this.

Robert Hooke published an anagram in 1678 embodying a discovery of his made in 1676. The solution of the anagram, "cciiinosssttuu," when published two years later (*De potentia restitutiva*), expressed proportionality between stress and strain *ut tensio sic uis* (vis), "the power of any spring is in the same proportion with the tension thereof" where, as Hooke explains, spring means any "springy body" and tension is used for what is now called strain.

This law of proportionality has to be generalized for triaxial states of stress, and six equations can be written expressing the six strain components as linear functions of stress. This would involve 36 constants of proportionality.

The proportionality between stress and strain does not involve elasticity, this being the property of the solid to recover its original shape completely after the forces producing the deformation are removed. Elasticity on the other hand does not necessarily require proportionality between stress and strain. Modern spring steels, the most perfectly elastic materials known, recover their shape completely after deformation but stress and strain do not obey even approximately a linear law. Despite these fundamental conceptual differences between stress-strain proportionality and elasticity, the two concepts are used indiscriminately in such a way that elasticity implies proportionality and vice versa. The theory of elasticity paradoxically is in fact not primarily concerned with elasticity, that is, with the behaviour of solids after removal of the load, but is essentially employed as a linear theory with proportionality when the load is applied.

The assumption of elasticity, however, permits the application of certain thermodynamic principles which enable the reduction of the 36 independent elastic constants to 21. This number can be further reduced to 15 and if it is assumed that the material is isotropic with regard to its elastic properties, the number of elastic constants can be reduced to 2. These are the modulus of elasticity, generally denoted by the symbol E, and Poisson's ratio, μ, which has already been mentioned. The modulus of elasticity E is also called Young's modulus after Thomas Young who first defined it. It is for a given material the ratio between stress and strain for a simple uniaxial state of stress. Isotropy with regard to elastic properties means that the properties of the material are independent of direction. This is far from being true for most engineering materials. It is obviously not so for wood, which will exhibit different properties along the grain and across the grain. Metals produced by casting, rolling, forging or extrusion, however, will also exhibit some directionality with regard to elastic properties.

The six equations of proportionality or Hooke's law for a general triaxial state of stress are obtained in the following form:

Strains expressed in terms of stresses

$$e_{xx} = \frac{1}{E}[X_x - \mu(Y_y + Z_z)] \qquad e_{xy} = \frac{1}{G}X_y$$

$$e_{yy} = \frac{1}{E}[\ Y_y - \mu(X_x + Z_z)] \qquad e_{xz} = \frac{1}{G}X_z \tag{4a}$$

$$e_{zz} = \frac{1}{E}[\ Z_z - \mu(X_x + Y_y)] \qquad e_{yz} = \frac{1}{G}Y_z$$

In these equations G is introduced as a further elastic constant, the modulus of rigidity. This, however, is not a third independent constant but is a function of Young's modulus and Poisson's ratio; *i.e.*,

$$G = \frac{E}{2(1+\mu)}$$

Stresses in terms of strain

$$X_x = 2G\left(e_{xx} + \mu\frac{e}{1-2\mu}\right) \qquad X_y = Ge_{xy} \tag{4b}$$

$$Y_y = 2G\left(e_{yy} + \mu\frac{e}{1-2\mu}\right) \qquad X_z = Ge_{xz}$$

$$Z_z = 2G\left(e_{zz} + \mu\frac{e}{1-2\mu}\right) \qquad Y_z = Ge_{yz}$$

In these equations

$$e = e_{xx} + e_{yy} + e_{zz} \tag{5}$$

is the change in volume of the unit cube of the material under the given state of stress, the cubical dilatation.

For a hydrostatic state of stress for which the three normal stress components $X_x = Y_y = X_z$ are equal to a uniform pressure p and the three shear stress components $X_y = X_z = Y_z = 0$ the cubical dilatation from summation of equations (4a) is obtained as

$$e = \frac{1-2\mu}{E}p = kp \qquad \text{where } k = \frac{1-2\mu}{E}$$

and k is called the modulus of compression or bulk modulus of the material. It follows from this relation that the value for μ cannot exceed 0.5 since for values of μ greater than 0.5 the bulk modulus becomes negative, which would require the solid to increase its volume under hydrostatic pressure.

Principal Stresses and Strains; Invariants and Strain Energy.—The six stress components describing the state of stress and the six strain components describing the state of strain at every point are of course functions of the co-ordinate axes and will change if a different co-ordinate system of co-ordinate axes is used. They form what are called tensors in mathematics, and from this fact one can make two important deductions with regard to the effect of transformations of co-ordinate axes.

The first is that there are always three orthogonal directions for which, when they are chosen as the co-ordinate axes, the expressions for the shear stresses and shear strains become zero and for which the values of the normal stresses are extreme values. These directions are the directions of principal stress or strain and the largest of the three principal stresses or strains will be the absolute maximum value of the stress or strain at the given point and the smallest of the three will be the absolute minimum value. If the state of stress or strain is written in the form of a matrix; *i.e.*,

$$\begin{pmatrix} X_x & Y_x & X_z \\ Y_x & Y_y & Y_z \\ Z_x & Z_y & Z_z \end{pmatrix} \qquad \begin{pmatrix} e_{xx} & e_{xy} & e_{xz} \\ e_{yx} & e_{yy} & e_{yz} \\ e_{zx} & e_{zy} & e_{zz} \end{pmatrix}$$

then for the three principal directions $x \rightarrow 1$ $y \rightarrow 2$ $z \rightarrow 3$ the state of stress will be fully characterized by three principal stress components

$$\begin{pmatrix} X_1 & 0 & 0 \\ 0 & Y_2 & 0 \\ 0 & 0 & Z_3 \end{pmatrix}$$

and the state of strain by three strain components

$$\begin{pmatrix} e_{11} & 0 & 0 \\ 0 & e_{22} & 0 \\ 0 & 0 & e_{33} \end{pmatrix}$$

In the case of simple tension or compression already discussed the direction of the tensile or compressive stress will be a direction of principal stress because the shear stresses in planes at right angles and parallel to this direction must be zero.

The equations of equilibrium (1), the compatibility conditions (2) and the equations of proportionality (4a, 4b) can be written in terms of principal stresses without losing generality.

In tensor analysis, which is that branch of mathematics dealing with tensors, it is shown that certain expressions can be formed from the components of tensors of the type used for the description of states of stress or strain which are invariants with regard to transformations of co-ordinate axes. These invariants must clearly be representative of some intrinsic properties of the stressed solid since only such properties can be entirely independent of the system of co-ordinate axes and this is the second important deduction to be considered. The first of these invariants for stress and strain are

$$I_1^x = X_x + Y_y + Z_z$$
$$I_1^e = e_{xx} + e_{yy} + e_{zz} \tag{5a}$$

The first of these expressions indicates that the sum of the three principal stresses is a constant. The second of these two expressions is the cubical dilatation and this, as expressing the change in volume, must clearly be independent of the co-ordinate axes.

The following two expressions are further invariants for the two tensors:

$$I_2^x = X_xY_y + X_xZ_z + Y_yZ_z - X_x^2 - Y_z^2 - X_z^2$$
$$I_2^e = e_{xx}e_{yy} + e_{xx}e_{zz} + e_{yy}e_{zz} - e_{xy}^2 - e_{zz}^2 - e_{yz}^2 \tag{5b}$$

They have no physical meaning in themselves but an expression obtained by combining the two invariants (5a) and (5b) either for stress or strain has a physical meaning and must, of course, itself be again invariant. Thus the expression

$$U = \frac{E(1-\mu)}{2(1+\mu)(1-2\mu)}(I_1^e)^2 - \frac{E}{1+\mu}I_2^e \tag{6}$$

is invariant and must represent a physical property U, the strain energy per unit volume of the strained solid. Work is required to be done against the resistance of the body by the external forces in deforming it. This is stored in the form of the elastic energy which is released when the loads producing the deformation are removed. The unwinding of a clock spring is perhaps the best example illustrating stored strain energy.

A similar expression for U can, of course, be derived in terms of stress components by combining I_1^x and I_2^x. This is in fact the form in which strain energy is mostly used. Evaluated in a convenient form the expression (6) becomes

$$U = U_1 + U_2 \tag{7a}$$

$$U_1 = \frac{1-2\mu}{6E}(X_x + Y_y + Z_z)^2 \tag{7b}$$

$$U_2 = \frac{1+\mu}{6E}[(X_x - Y_y)^2 + (Y_y - Z_z)^2 + (Z_z - X_x)^2] + \frac{1}{2G}(X_y^2 + X_z^2 + Y_z^2) \tag{7c}$$

The first part U_1 of this expression is that part of the strain energy which is absorbed by changing the volume of the solid. The second part U_2 is called the shear strain energy or energy of distortion. It is that part of the total strain energy which is absorbed by a pure change in form without any change in volume. Considerations of strain energy play an important part in the solution of many problems in the theory.

Application of Elastic Theory.—The equilibrium conditions, the compatibility conditions and Hooke's law form the fundamental system of equations which must be solved for given boundary conditions in order to determine stresses and strains at every point of a solid subject to given external forces. This undertaking is, even in relatively simple cases, a formidable mathematical one and is possible only by the use of fairly extensive mathematical apparatus and manipulation. Even then solutions are generally obtainable only if certain a priori assumptions are made with regard to the stress distribution or the deformation to be expected which simplify the problem.

Since two dimensions are more easily handled than three, most problems of a practical nature are reduced to problems of either plane strain or plane stress. In the first case it is assumed that the deformation is entirely confined to two directions so that no change in dimensions of the solid takes place in a direction at right angles to the plane of the co-ordinate axes, or at any rate that this change in dimension is a constant. In the case of plane stress problems it is assumed that the object is flat and that stresses can only act on it within its own plane and not at right angles to it. It is certainly no exaggeration to say that hardly ever is a general solution found of a strength of materials problem by producing general solutions without a priori assumptions. In this fact alone lies a severe limitation of the scope of the theory of elasticity. Most solutions involve certain a priori assumptions and are therefore at best approximations. Most of the approximate solutions that have to be used by the engineer are crude in the extreme, though little benefit can be derived by more accurate solutions obtainable only by prodigious labour, because the scope of the theory of elasticity is far too restricted to give in any case more than approximate solutions. This is true because the actual behaviour of materials deviates widely from that assumed in the theory of elasticity. For the exact numerical solution of two-dimensional problems step-by-step methods have been developed, primarily by R. V. Southwell; these are known as relaxation methods.

In order to illustrate the character of approximation made where exact methods are too complex, a simple case will be considered, that of the bending of a beam, which is in itself important.

Bending of Beams.—If a load P (fig. 7[A]) is acting on a beam resting on two supports A and B, reaction forces R_A and R_B will be produced at these two supports which can be determined from the conditions of equilibrium of the beam considered as a rigid body. Equilibrium in the direction of the load P requires that

$$R_A + R_B = P \tag{8}$$

and if the beam under the influence of the three forces P, R_A and R_B is not to rotate, the moments of the forces about any point must be zero. Take for instance moments about point B.

$$R_A \times l + P \times b + R_B \times 0 = 0 \tag{9}$$

From this $R_A = -\frac{Pb}{l}$ and R_B from equation (8) gives $R_B = -\frac{Pa}{l}$.

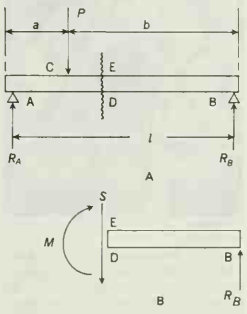


FIG. 7.—(A) BENDING OF A BEAM DUE TO APPLIED FORCE P; (B) SHEAR FORCE S AND BENDING MOMENT M ACTING IN CROSS SECTION ED

If an imaginary cut is now made at say ED and the equilibrium of the length of beam DB is considered (fig. 7[B]), a force S equal and opposite to R_B ($S = -R_B$) must act in the cross section in order to prevent translatory movement. This, however, would cause the beam DB to rotate, and in order to prevent the rotation a couple or moment $M = R_B \times \overline{DB}$ must be assumed to be acting in the cross section as well. This moment is called the bending moment acting in the cross section, and the force S is called the shear force.

Bending moment M and shear force S must be produced by internal stresses in the cross section and the problem is to find the distribution of these stresses. This problem can be solved laboriously by solving the general equations (1), (2), (4) considered previously for the particular boundary conditions of the problem. If, however, one makes the a priori assumption that each of the cross sections of the beam including DE deforms in such a way under the influence of the stresses resulting in the bending moment M that it remains a plane cross section, the problem is greatly simplified.

The cross section DE will turn through a small angle $d\phi$ relative to another cross section FG a small distance dx away from it

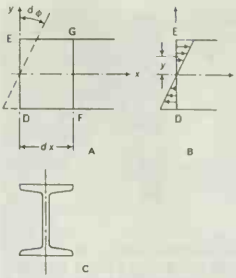


FIG. 8.—BENDING OF BEAM. (A) ROTATION OF CROSS SECTION DE BY ANGLE $d\phi$ RELATIVE TO CROSS SECTION FG; (B) LINEAR DISTRIBUTION OF BENDING STRESSES OVER CROSS SECTION DE; (C) ROLLED STEEL JOIST IN CROSS SECTION

(fig. 8[A]). This requires that the material near point D becomes longer and the material near point E shortens. These changes in length, equal to the strain in the x-direction e_{xx}—if we assume the direction of the x-co-ordinate axis coinciding with the axis of the beam—multiplied by the original length dx of each element are proportional to the distance y of the element from the axis of the beam, and since the stresses are proportional to strain, these too will be distributed linearly over the cross section as shown in fig. 8(B).

The resultant of this stress distribution which is antisymmetrical with respect to the x-axis is a moment, the bending moment M.

A simple calculation gives the stress

$$X_x = \frac{Mxy}{I_z} \tag{10}$$

where I_z is the second moment of area or moment of inertia of the cross section with regard to the axis z at right angles to x and y. The moment of inertia is a simple geometric property of the cross section. It is easily calculated as the integral $I_z = \int y^2 dydz$ and its value will depend on the size and shape of the cross section. The bending stress X_x is a maximum at the extreme fibres and zero at the centre. This region of zero stress coinciding in the present example with the axis of the beam is called the neutral axis.

The maximum value for the bending stress is obtained by substituting the boundary value $\frac{d}{2}$ for y in equation (10) where d is the total depth of cross section. Hence

$$Max\, X_x = \frac{M\frac{d}{2}}{I} = \frac{M}{Z} \tag{11}$$

where

$$Z = \frac{2I}{d} \tag{12}$$

The value Z is called the modulus of the section and this, like the moment of inertia, is a geometrical property of the section.

It is obvious from equation (11) that the maximum stress X_x decreases as the value of Z increases. For a given weight, sections of the form shown in fig. 8 (C) where the material is concentrated as far away as possible from the neutral axis have larger Z values than other possible shapes, and it is for this reason that rolled I sections are generally used as metal beams. They are fabricated in standard sizes and their values of I and Z are tabulated.

The distribution of the shear force S has to be considered next. If a narrow slice of the beam at the section DE is produced by making a second cut FG at a small distance away from DE (fig. 9), the shear forces S will be acting on the two sections in opposite directions (fig. 9[B]). If the cross section of the beam is assumed rectangular of depth d and width b (fig. 9[A]), one can consider the slice DE divided into a number of small cubes as shown in fig. 9(C) and if as a first step one considers the shear force uniformly distributed over the cross section, each cube would carry a fraction of the shear force equal to $\frac{S}{db}$ and the shear deformation of each cube would be the same as shown in fig. 9(D). It will be noted that this deformation still leaves the plane cross sections DE and FG plane. This uniform distribution of shear stress, however, is impossible because it would require shear stresses, which can only occur in pairs for reasons of equilibrium, to act in the surface elements EG and DF. These elements, however, since no force is acting in the surface, must be free from

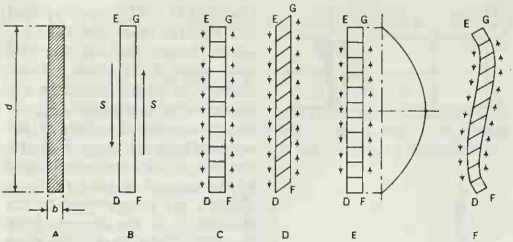


FIG. 9.—RECTANGULAR BEAM: (A) CROSS SECTION; (B) SHEAR FORCES S ACTING IN ADJACENT CROSS SECTIONS DE AND FG; (C) LINEAR DISTRIBUTION OF SHEAR STRESSES; (D) DEFORMATION DUE TO LINEAR DISTRIBUTION OF SHEAR STRESSES; (E) PARABOLIC DISTRIBUTION OF SHEAR STRESSES; (F) DEFORMATION DUE TO PARABOLIC DISTRIBUTION OF SHEAR STRESSES. CROSS SECTIONS DE AND FG WARPED

stress. The uniform shear distribution is, therefore, impossible and the next simple assumption that can be made is a distribution obeying not a linear law but a square law (*see* fig. 9[E]). The shear stresses are distributed in accordance with a parabolic law, so that the shear stress at the neutral axis is a maximum and that at EG and DF is zero. If the deformation resulting from this shear distribution is now considered (fig. 9[F]), it will be seen that the elementary cubes at EG and DF remain entirely undeformed, whereas the elementary cube situated at the neutral axis is deformed most. The cross sections ED and FG, however, are now no longer plane but warped, and this is directly in contradiction with the assumption used in calculating the bending stresses, that plane cross sections remain plane.

This solution for the distribution of bending stresses and shear stresses obtained on the basis of simple a priori assumptions with regard to the deformation leads, therefore, to a contradiction of the original assumption of plane sections and can only be considered as an approximation to the true distribution of stresses over the cross section. It is, nevertheless, found to give reasonably good agreement with experience and observation and the linear distribution for bending stresses and the parabolic distribution for shear stresses are universally used in the design of beams subjected to bending loads.

Calculation of Deformations.—The same assumptions enable the deformations, in particular the curved form of the initially straight beam when it is deflected, to be determined simply. In this instance also the results of calculations are in good agreement with the results of measurements.

The calculation of elastic deformations is in fact one of the most important applications of the theory of elasticity. Whereas the usefulness of the theory is gradually diminishing in other fields, yet to be discussed, it is still of great importance to the engineer when the criterion for the proper functioning of the part is not primarily strength, but deformation.

Limits of deformation have to be imposed, for instance, on the deflections of beams in buildings, since if deflections were not limited, ceilings might sag, walls and glass might crack. To prevent this, it has been found from experience that beams should not be allowed to deflect by more than about $\frac{1}{300}$ part of the distance between supports.

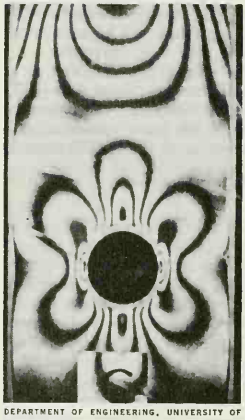
II. EXPERIMENTAL STRESS ANALYSIS

There are many stress problems for which it is impossible to find mathematical solutions. Solutions for the simpler problems such as the one just discussed were worked out 100 years ago. More complex problems require formidable mathematical skill and labour and in many cases mathematical solutions cannot be found at all. Very often the form of the solid is such that the boundary conditions cannot be expressed in mathematical form; often simplifying assumptions that would permit solution are unjustifiable.

Numerous experimental methods have been developed, particularly after the first quarter of the 20th century, which permit the determination of stresses and deformations by measurement. Of these the most important are: photoelasticity, analogy methods, strain measurements and brittle coatings.

Photoelasticity.—Transparent materials when under stress exhibit coloured patterns. This photoelastic effect, discovered by Sir David Brewster in 1816, can be used for the experimental determination of the stresses in transparent objects. Methods for this purpose, developed by E. G. Coker and L. N. G. Filon, have reached a high state of perfection and refinement.

A scale model of the object to be studied is made from a transparent synthetic resin such as Bakelite, Catalin, Lucite or Columbia resin; glass, Celluloid and gelatin which were used by the pioneers of this method are now rarely used. This model is mounted in the loading frame of the photoelastic bench and strained in such a way that the conditions of loading correspond to those expected in practice. Certain optical effects occur which are related to the direction and magnitude of the principal stresses in the model, and which are seen as coloured bands or alternatively bright and dark bands in the model when it is viewed through an analyzer. The analyzer is generally a disk of Polaroid, a plastic material having the property of polarizing light. The coloured bands or light and dark fringes, shown in fig. 10 for a plate with a circular hole, can be readily interpreted to give the directions of the principal stresses and their magnitude at every point of the model.



DEPARTMENT OF ENGINEERING, UNIVERSITY OF CAMBRIDGE

FIG. 10.—PHOTOELASTICITY. TRANSPARENT MATERIAL UNDER STRESS VIEWED IN POLARIZED LIGHT TO SHOW "INTERFERENCE FRINGES" FROM WHICH MAGNITUDE OF STRESS AT EACH POINT CAN BE DEDUCED. BLACK CIRCULAR AREA IS HOLE

The great value of the method lies in giving a visual image of the regions where the stresses are particularly high, that is, where so-called stress concentrations occur. Such stress concentrations are generally associated with abrupt changes in section and contour. Photoelasticity is a magnificent tool for evaluating such stress concentrations quickly and for obtaining exact information on the influence of alterations in form and contour on the magnitude of such stress concentrations. This evaluation is often quite impossible by mathematical analysis and even if it is possible, the amount of mathematical labour involved is prodigious.

Photoelasticity is primarily useful for plane stress problems, but recent developments permit the method to be used in the form of the "frozen stress technique" also for three-dimensional problems.

Analogy Methods.—These are generally based on the fact that some problems in stress analysis lead to differential equations identical to those pertaining to some other physical problem which can be readily solved experimentally.

For instance, the stresses produced by twisting a bar are obtainable mathematically only if the cross section of the bar is circular or of some other simple geometric shape. There is, however, an analogy between this problem and certain geometric properties of a soap film stretched over the contour of the cross section of the bar and maintained under slight air pressure. The geometric properties of the soap film, such as the volume enclosed, the form of the contour lines and the gradients, can be determined relatively easily by measurement, and from such measurement the stresses in, and rigidity of, a noncircular component of a similar cross section subjected to twisting can be readily determined.

Strain Measurements.—A large number of special instruments have been developed which permit the strains experienced by a loaded solid to be measured directly on the surface. Since in most cases the maximum values for the stresses and hence the strains

occur in the surface of the loaded solid, this method permits the direct determination of the maximum value of stress from the measured strains by multiplication with the appropriate elastic constant.

Strains are, of course, extremely small quantities of the order of microinches per inch (10^{-6} in. per inch). The change in length of 1 in. of a steel bar subjected to the maximum value of stress that might normally be permitted to occur in an engineering component would be $\frac{1}{1,000}$ of an inch.

In regions of stress concentration, which are always the most important, the strains alter abruptly within short distances so that the gauge length of the instrument over which the total change in length is measured must be small. Instruments with gauge lengths of $\frac{1}{20}$ in. and less have been constructed. With a gauge length of $\frac{1}{20}$ in. a large strain of 10^{-3} would only be a change in length of $\frac{1}{2}$ of $\frac{1}{10,000}$ in. The measurement of such minute quantities requires that some principle of magnification is made use of in the construction of the instrument. Mechanical, optical, pneumatic, electrical and magnetic principles have been used for magnification in the design of such instruments.

The most ingenious and perhaps most widely used is the electric resistance strain gauge. This is essentially a small piece of thin paper to which a short length of fine wire is cemented. This piece of paper with the wire is glued to the object prior to the application of the load at the point where it is desired to know the stress. When the load is applied and the object deforms, the paper and the wire will suffer a strain equal to that of the object at the particular point. Now, if a fine wire is stretched, its electrical resistance will change because of its change in length and its change in cross section. This resistance change is proportional to the strain experienced by the object and can be accurately measured. An installation of electric resistance strain gauges in the interior of a pressure vessel to determine the stresses in the vicinity of a nozzle can be seen in fig. 11. Strain gauges also can be seen attached to the buckled cylindrical shell shown in fig. 22.

Methods of strain measurement, particularly by electric resistance strain gauges, have been found of particular value in the solution of dynamic stress problems. Where the conditions of loading change rapidly with time as would be the case in all parts of moving machinery or in the members of a bridge when a train passes over it, or in the wings of an airplane passing through a gust, the state of stress will change equally rapidly. In all such cases strain gauges have proved a valuable research tool and have permitted the solution of problems which, had they been left to mathematical analysis on the basis of theory of elasticity, would have remained unsolved.

Brittle Coatings.—If an object is coated with a lacquer or other substance which cannot suffer strains equal in magnitude to those suffered by the object, the lacquer will crack along lines at right angles to the direction of principal stresses, and a pattern of cracks in the lacquer will be obtained which can give a valuable indication of the direction of principal stresses, and from the density of the cracks conclusions with regard to the magnitude of the stresses can be drawn.

III. TESTING OF MATERIALS

The theory of elasticity permits the determination of the deformation of an object under load as long as these loads do not exceed certain limits. The deformation problem, however, is only one aspect of the engineer's strength problem. Far more difficult and far more important is the problem of failure. It might appear at first sight that the theory of elasticity aided by the powerful methods of experimental stress analysis would be equally effective in solving the failure problem.

Until comparatively recently the problem appeared simple enough. Since the stresses are calculated on the basis of the theory of elasticity, it was argued, the stresses must be limited to the maximum value of stress for which proportionality between stress and strain is maintained and for which the material behaves, in accordance with the theory, as an elastic body. In order to determine these limits it became necessary to test materials and to determine their mechanical properties such as the elastic constants,

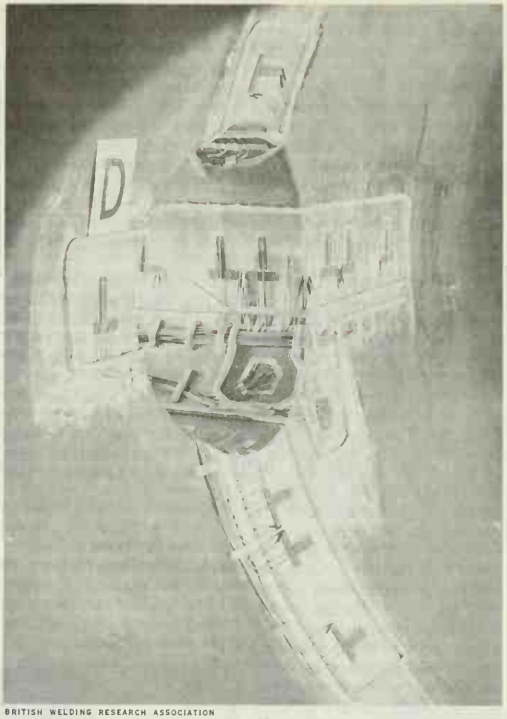


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FIG. 11.—INSTALLATION OF ELECTRIC RESISTANCE WIRE STRAIN GAUGES INSIDE A PRESSURE VESSEL TO DETERMINE STRESS DISTRIBUTION IN THE VICINITY OF A NOZZLE

Young's modulus and Poisson's ratio, the limit of proportionality, that is the maximum stress up to which proportionality between stress and strain is maintained, and the elastic limit, which is the maximum stress up to which elasticity is maintained. It was also interesting to determine to what extent the stress could be increased beyond the elastic limit before rupture occurred under different forms of loading. From such modest beginnings grew a whole separate branch of the science of strength of materials concerned with materials testing.

Originally, materials testing or mechanical testing was confined to the determination of mechanical properties under simple tensile or compressive loading. By the late 1950s the number of different mechanical tests was large. Whereas in the beginning mechanical testing was concerned with the determination of the limits within which elastic theory could be safely applied to engineering materials, it changed its character completely and largely became a method of quality control. In fact, many mechanical tests were no longer concerned with mechanical strength properties in the sense in which this concept logically arises in strength of materials, but with properties required in the fabrication of materials such as the property of a steel sheet to be deformed by deep drawing and pressing, or of a steel plate to be joined by welding.

Tensile Test.—The tensile test occupies a unique position among mechanical tests. This is an extremely curious phenomenon because the true significance of the so-called tensile properties is not easily interpreted. Nevertheless, engineers often judge a material primarily by its properties exhibited in the tensile test. It is simple and economical, it takes little time, it does not require much material or elaborate apparatus other than a tensile testing machine of which one can now be found in almost every metal-producing or metal-using factory. No elaborate or precision measuring equip-

ment is required and the test can be carried out by semiskilled or unskilled labour because the results can be autographically recorded. Tensile testing, like almost all material testing, is governed far more by simplicity, convenience, cheapness and expediency than by scientific requirements.

The tensile test is carried out with a prismatic or cylindrical piece of material of standardized dimensions. Its ends are clamped in the testing machine which applies a tensile load whose magnitude is increased from zero to its maximum value either slowly or sometimes, particularly in routine tests, fairly rapidly. By plotting the load against the extension of the test piece measured over a gauge length of several inches marked out along the test piece prior to the test, the load extension diagram of the material may be obtained.

The salient features of the diagram as shown in fig. 12 are these: from zero load to point A the diagram may closely approximate to a straight line. In this case the material has a proportional limit, the stress corresponding to point A. If the test were interrupted at or below this point and the load released, the specimen would be likely to resume its original length; that is, it would appear to behave with perfect elasticity, and the elastic limit would be found to coincide reasonably well with the limit of proportionality. In actual fact if sensitive methods of measurement were used it would be found on unloading that the specimen did not resume its original length but was left with a "permanent set," because no material exists which on first straining exhibits perfect elasticity. If, however, the test were continued to a point such as C it would be found that the rate of deformation now increased more rapidly than the rate of loading, and if the specimen were unloaded from a point such as C the unloading curve would not follow the original loading curve but would run parallel to the straight (elastic) part of the loading curve to D. The specimen would be found to have suffered a permanent elongation OD. This is called plastic deformation.

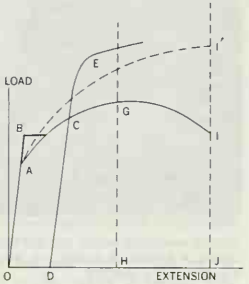

FIG. 12.—SCHEMATIC LOAD EXTENSION DIAGRAM OF A METAL

If the specimen were immediately reloaded the loading curve would follow the almost perfectly straight line from D to C and would then follow the curve CG as if no previous unloading had taken place. Unloading from point C, however, has raised the limit of proportionality of the material which had previously been at point A to a level corresponding to point C. The previous deformation increases, as it were, the resistance of the material to plastic deformation. This increase in resistance against plastic deformation by previous plastic deformation is known as work hardening.

If the test piece instead of being reloaded immediately were allowed to rest for perhaps several months and was then loaded again it would be observed that it had hardened even more. The resistance to plastic deformation might have been increased to a value corresponding to point E. This phenomenon is known as strain age hardening or strain aging. At the same time as the resistance to plastic deformation is raised the capacity of the material for plastic deformation is greatly reduced. Many of the modern aluminum alloys owe their high strength properties to this process of work hardening, which takes place during one stage of the manufacture when the material is shaped by processes, such as cold-rolling or extruding, which impose a large degree of plastic deformation.

If no unloading at any point takes place and the tensile test is completed without interruption the load will reach a maximum value at the point G (fig. 12). Up to this point the specimen will have extended fairly uniformly and the diameter will uniformly diminish because during plastic deformation virtually no change in volume takes place.

After reaching the maximum load, however, the cross section of the specimen at one point diminishes rapidly and a kind of local narrowing down or necking takes place. Further plastic deformation is now confined to a relatively narrow zone in the neck and then fracture occurs suddenly.

The stress obtained by dividing the maximum load by the original cross section of the material is called the ultimate tensile strength of the material. If, however, the actual load at fracture (corresponding to point I, fig. 12) is determined, which is not easy because necking down and fracture may occur in fairly rapid succession, and if this load at fracture is divided by the greatly diminished cross section in the neck, a stress value is obtained appreciably larger than the ultimate tensile strength. This stress value is called the true fracture strength of the material. The method of plotting load against extension hides this fact. If, instead of load, true stress, obtained by dividing the load at any point during the test by the actual cross section corresponding to the load, is plotted against extension the true stress extension diagram is obtained and this is represented by the dotted line going to I' (fig. 12). The point I' represents the true fracture strength and it can be seen that this is larger than the stress corresponding to point H, the ultimate tensile strength. Nevertheless, it is not true fracture strength but the ultimate tensile strength of the material which has been considered by engineers as the most important mechanical strength property characterizing a material.

The total extension of the specimen consists of two distinct parts, 0 to H, the uniform extension, and the part from H to J, the necking extension. It is expressed as a percentage of the original standard gauge length and is known as the percentage elongation. For ductile materials such as some steels and some of the lower strength aluminum alloys, the percentage elongation may be 20% and more. For relatively brittle materials such as white cast iron or severely work-hardened materials the percentage elongation may be only 1%. Percentage elongation is considered as the most important property characterizing the ability of a material to be severely deformed although there are strong indications that the percentage reduction of area, $\frac{A_o - A}{A_o} \times 100\%$ (A_o original area, A minimum area at fracture in the neck), is more valuable for this purpose.

Yield Point.—This brief outline of the tensile test could apply to every metal used in engineering except the most commonly used, mild steel or steel of medium carbon content. The load extension diagram of this material exhibits a curious but important anomaly. Soon after the limit of proportionality is exceeded and slight plastic deformation has set in, the material "yields," that is, it deforms rapidly at constant load; sometimes there is even a small drop in load before the rapid deformation. This drop is indicated by the horizontal step shown as a thicker line in the load extension diagram at point B in fig. 12. The load B at which yielding takes place is called the yield point of the steel. After yielding is completed, which is accompanied by an extension of between 0.5% and 1%, the material begins to harden and the remainder of the tensile test proceeds as described earlier.

The yield point is an important property of the material because it clearly defines a stress level at which the amount of plastic deformation begins to grow large. So useful has this been found that an artificial yield point has been defined for materials such as certain alloyed steels and light alloys which do not exhibit, as it were, a natural yield point. This artificial yield point is termed the proof stress and is defined as the stress for which there is a definite amount of permanent plastic strain after removal of the load. This is generally 0.1% or 0.2%, and one then speaks of the 0.1% or 0.2% proof stress.

The yield point of steel is of great importance because it has long been considered that the permissible or working stresses in structures and components, that is to say the stresses developed when the working loads are applied, should be kept well below the yield point.

The yield phenomenon is the basis of an extensive and relatively new subject of strength of materials: the theory of plasticity. This subject is concerned with the study of the behaviour of metals and

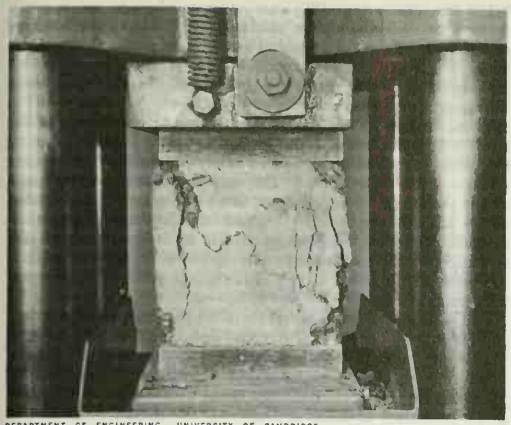

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FIG. 13.—FRACTURE OF CONCRETE IN A COMPRESSION TEST

to some extent other substances such as concrete. For metals the theory of plasticity is of particular value. On the one hand a much more realistic approach than is possible by the theory of elasticity can be made to the problem of failure. On the other many problems arising in the plastic working of metals, such as forging, rolling and extruding, can be solved only by the new theory.

Compression Test.—This is one of many other mechanical tests. A test piece, generally in the form of a cube, a prism or cylinder, is compressed between the platens of a compression testing machine. Ductile metals such as mild steel will deform elastically up to a certain limit; then plastic deformations will occur, and the test piece, if the metal is ductile, can be completely flattened under increasing loads.

Brittle materials such as rock, brick, cast iron and concrete will fracture as shown in fig. 13 though they may exhibit great compressive strengths. Thus, the crushing strength of concrete determined by breaking a cube, and often called the cube strength, may reach values of three tons per square inch and more. Granite may reach 10 tons per square inch and cast iron from 25 to 60 tons per square inch.

Notch Impact Test.—There are various forms of this test. In one of them, the so-called Charpy V-notch impact test—and all notch impact tests are similar in character—a specimen in the form of a simply supported beam approximately 50 mm. long and 10 mm. by 10 mm. cross section, with a sharp notch of 2 mm. depth in the form of a 45° "V" machined in the middle of the underside, is broken by a sharp blow from a weight falling on the specimen. The energy absorbed by the specimen in fracturing is measured.

There is no way of relating results obtained in this test to any strength of materials concept based on the theory of elasticity. Nevertheless the test is most valuable and gives an indication of the toughness of the material under conditions of impact or shock loading. Under such impact conditions and in the presence of a notch producing stress concentrations, ductile and deformable materials may break in a brittle manner without absorbing much energy. A lowering of testing temperature has the same effect and the notch impact test is considered a valuable test for steels used in welded structures and exposed to low temperatures in service (*see* the section *Brittle Fracture*, below).

Hardness Test.—This is carried out by pressing with a given load a hard steel ball (Brinell hardness test), of standardized dimension, or a diamond ground in the form of a square pyramid with an angle of 136° between faces (Vickers' pyramid hardness), into the surface of the material, and then measuring the dimensions of the impression. The harder the material the smaller will be the impression. There are several other forms of hardness test, all based on the same principle.

Fatigue Tests.—It is found that a metal and in fact most other materials can be broken by applying a smaller stress than that corresponding to its static tensile strength if this is applied not once, but many times. This phenomenon is called fatigue. The smaller the applied stress the larger is the number of cycles required to produce fracture, and if the stress is small enough fracture may not occur until the stress has been applied perhaps hundreds of millions of times.

The character and appearance of the fracture is different from that produced in a static test, at least for ductile metals. In the static test appreciable plastic deformation takes place before fracture supervenes; fracture as it were is preceded by a visible warning. No such warning precedes fatigue fracture. A microscopic, sharp crack is formed at some stage during the test which continues to grow until fracture occurs suddenly. There is no sign of deformation visible to the naked eye, the fracture surfaces exhibit a smooth appearance and are often characterized by prominent sea shell-like markings as can be seen in fig. 14 showing a fracture in a crankshaft due to fatigue. The two parts into which the fracture divides the object can be fitted together and match perfectly whereas the plastic deformation during a static test of the same object would so deform the fracture surfaces that the fractured parts would not fit together. This absence of visible deformation makes it appear as if the material was made brittle by the fatigue test. This is not the case. Brittle fracture, although somewhat similar to a fatigue fracture, is due to an entirely different mechanism.

Attempts have been made to deduce the strength of metals under the repeated application of loading, which is called the fatigue strength, from static strength properties and even in the late 1950s some engineers still believed that the fatigue strength of a metal could be assumed to be a definite fraction of the static strength. This, unfortunately, is not the case and the fatigue strength must

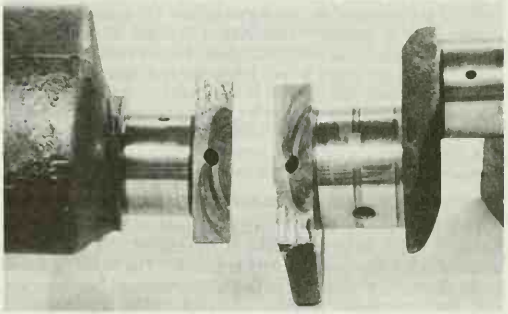

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FIG. 14.—CRANKSHAFT FRACTURED BY FATIGUE

be determined by separate tests.

Special testing machines are necessary for the carrying out of fatigue tests. The machines must be capable of applying many loading and unloading cycles rapidly if fatigue tests are to be completed within a reasonable time, because unlike the static strength which can be determined with one test piece, the determination of the fatigue strength of a given metal requires several. There are many different types of fatigue testing machines, some of which can apply up to 10,000 stress cycles per minute.

The fatigue strength of a material is generally determined in the following way. The first specimen is subjected to cyclic variation of stress of constant amplitude until it breaks. Generally a fairly high value of stress will be selected for the first specimen so that fracture is obtained fairly rapidly. The number of cycles endured to fracture is plotted, say point 1 in fig. 15, against the value of the applied stress. Further specimens are tested in the same way but at smaller and smaller stresses and the results are plotted. In this way a diagram of stress versus number of cycles is obtained which is called the S–N diagram (fig. 15). This diagram tends for certain materials—particularly steels—to run more

and more parallel to the N-axis as the stress is reduced. It is concluded from this that there will be a maximum value of stress which could be applied infinitely often without producing failure, and this is termed the endurance limit or sometimes the fatigue limit of the material.

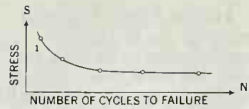

FIG. 15.—S–N (STRESS v. NUMBER OF CYCLES TO FRACTURE) DIAGRAM USED FOR PLOTTING RESULTS OF FATIGUE TESTS

If such an endurance limit exists it will not be much smaller than say the stress which gives failure at 2,000,000 or 10,000,000 cycles, and in general fatigue tests are not carried to greater lengths. The stress for which failure occurs at 2,000,000 cycles or 10,000,000 cycles is determined and used as the mechanical property characteristic of the fatigue strength of the material.

For some other metals, particularly aluminum alloys, the S–N diagram does not become parallel to the N-axis so that one must assume the fracture in consequence of fatigue will supervene eventually however small the stress is. Fatigue tests ending in fracture have in fact been carried out up to 1,000,000,000 cycles.

Fatigue testing by the late 1950s had largely moved out of the field of material testing and was being established as a separate branch of strength of materials. The idea that fatigue strength is a mechanical property of the material, which can be determined basically in the same way as the yield point or ultimate tensile strength, has been abandoned because fatigue strength is influenced by far too many variables. Different values for fatigue strength of the same material will be obtained when it is tested in tension varying between zero and a maximum and when it is tested under some other form of cyclic loading such as equal limits of tension and compression or a cycle varying between two constant tensile limits.

The fatigue strength is also found to be strongly influenced by a whole host of other variables such as the form and surface condition of the specimen, the testing frequency, the type of stressing, either tensile or bending. Moreover, it is found that engineering components may quite readily fail from fatigue even if the maximum value of the stress is well below the endurance limit of the material as determined by tests on specimens of the metal. There is a size effect and numerous other circumstances have compelled engineers to look upon fatigue resistance as something more complex than a simple mechanical property which can be determined unequivocally by testing a few small specimens of the material.

IV. THE PROBLEM OF FAILURE

This brief survey of the testing of materials shows that the region in which materials behave in accordance with the pattern assumed in the theory of elasticity is narrow. The "solid" assumed in the theory of elasticity is in fact a structureless, homogeneous, stiff, but nevertheless jellylike substance, unlike any real solid, conforming to a certain behaviour pattern chosen for mathematical convenience and not for its correspondence to reality. The theory of elasticity in fact does not deal with solids but with regions of space of certain simple properties within closed boundaries. It is only natural that fracture or failure is quite outside its province. There is nothing in the theory of elasticity which would permit the introduction of the concept of fracture.

A solid could, of course, be conceived of perfectly proportional and elastic behaviour up to a maximum value of the stress when it would suddenly break; this maximum value of stress would then be the breaking strength of the material, but no such ideal material exists and the behaviour pattern of most materials used by the engineer is markedly different from this ideal pattern. Moreover, even if such materials existed an important problem would still arise.

In the elastic analysis of the state of stress produced for instance in a thin tube by twisting, it is found that on each element of the tube two stresses are acting: one a tensile stress and at right angles to this a compression stress of equal magnitude. If it is now assumed that the "fracture strength" of the ideal elastic solid had been determined for a simple state of uniaxial tensile stress, the problem arises how large the stresses in the tube may become before fracture occurs. Will fracture occur when the tensile stress reaches the same value as in uniaxial tension, the tensile fracture strength, or will the compression stress at right angles influence the magnitude of the fracture strength? The theory of elasticity by its very nature cannot answer a problem such as this because it is not concerned with fracture.

If the theory of elasticity does not permit the prediction of the stresses at which solids fail, in what way is it then possible to determine the loads which can be safely imposed on engineering structures and components? The answer to this important question is that, except in a few cases, these loads cannot be predicted on the basis of any theory; they can only be determined experimentally. It is obviously impracticable to design all engineering structures on the basis of tests to destruction though this method has been used for such large and important products as automobiles and airplanes.

The difficulty has been overcome in the past by a most plausible and ingenious piece of sophistry and self-deception, the "permissible stress." Since most engineering materials have a range in which they are almost elastic and in which strain is proportional to stress, the theory of elasticity could be assumed to represent actual conditions of stress accurately if the stresses were limited to permissible values not exceeding the proportional limit. If this is possible, fracture and failure need obviously not be considered. In fact, permissible stress methods of design were used by the majority of engineering designers not because the inherent flaws in the method remained unrecognized but because, with one or two exceptions, there was nothing more satisfactory to take their place.

There are four flaws in the permissible stress concept of which two are fundamental, the third is practical and the fourth economic.

The first flaw is similar in character to the difficulty of predicting the fracture strength of a solid under conditions of triaxial stress. The proportional limit stress of the material which the permissible stress is supposed not to exceed can be determined by experiment only for relatively few and very simple types of stress such as tension (tensile test), compression (compression test) and pure shear (twisting of thin tubes). A crankshaft, for instance, would be subjected in service to bending stresses, to shear stresses from the bending loads and to additional shear stress from the torque transmitted by the shaft. Each small element of the crankshaft would be subjected to a combination of stresses, what in fact has been previously referred to as a general triaxial state of stress. The problem is to define the proportional limit for triaxial states of stress from the experimentally determined proportional limits of uniaxial stress. This problem has been quite successfully solved by certain hypotheses which are discussed below, but a second problem remained.

The state of stress in the crankshaft is not uniform. The three stress components describing the state of stress vary from point to point, the question—impossible to decide—is which of these innumerable combinations of stress actually occurring at different points is the most dangerous. Will the proportional limit be exceeded first at the point where the bending stress is a maximum irrespective of the magnitude of shear stress, or where the shear stress reaches a maximum value, or where both bending and shear stress reach modest values? This aspect of the problem can still be overcome in some sort of fashion by introducing a "reference stress" which is calculated for any point by taking account of both shear and bending, though there are formidable practical difficulties in doing this.

There is, however, a third difficulty and this cannot be overcome because it is fundamental. The proportional limit is determined experimentally for states of stress which do not vary from point to point. In applying such data to states of stress which vary from point to point, the assumption is implicitly made that what happens at one point is determined only by the state of stress at that point irrespective of the state of stress at neighbouring points, which means that provided the state of stress at the point considered is not varied its proportional limit will also not be varied however drastically the state of stress is varied in neighbouring material. This assumption is known to be false—the behaviour of the metal at one point is dependent not only on the state of

stress at that point but is strongly influenced by the state of stress in the neighbouring material because certain deformation processes will only take place if an appreciable volume of the material is, as it were, ready to take part in this deformation. It follows that under most practical conditions the stress which can be permitted without exceeding the proportional limit is unknown.

The second flaw in the permissible stress concept is also fundamental. It is in fact virtually impossible to limit the stresses in an engineering component or structure to the proportional limit even if the value of this for complex stress conditions were accurately known. A simple example will make this clear.

Steel structures have for many years been assembled by riveting, which entails the drilling of holes in the members of the structure through which the rivets pass. It was known that the stresses in the immediate vicinity of a hole in a member under load may, by virtue of the sudden geometric discontinuity, reach three times the value which would have been found in the absence of the hole. Similarly the oil holes necessary in the crankshaft referred to earlier and the junctions between crank webs and pins represent geometric discontinuities which give rise to great, though purely local, increases in stress or stress concentrations. Few structures or engineering components have ever gone into service so devoid of geometric stress raisers that the stresses under working conditions were below the proportional limit. From this one can conclude that it is not really sound to base design on the limitation of the permissible stress to the proportional limit.

On the whole, with such exceptions as the all-welded ships which failed at low stresses during World War II, structures so designed have nevertheless given satisfactory service and it was realized that this is due to the ductility of most engineering materials. Once, however, it is conceded that limiting the permissible stress to the proportional limit does not necessarily result in safety, it follows that failure and fracture cannot be neglected, and this hard fact of experience is the third flaw in the permissible stress argument.

The fourth, economic, flaw in the argument immediately follows from the third. If in most cases the plasticity of the material is sufficient to protect a structure against failure despite the fact that stresses occur in excess of the proportional limit, the design based on such low stress values cannot be in fact as economical as it might be. If higher stresses than the proportional limit can obviously be sustained without harm under certain circumstances at points of stress concentrations, it might be possible to permit stresses in excess of the proportional limit far more generally by invoking deliberately the mechanism of plasticity for the whole of the structure or component. Such deliberate recourse to plasticity should afford much greater economy in design.

Consideration of failure could no longer be side-stepped by the artful dodge of limiting permissible stresses to the proportional limit. Adherence to these concepts not only leads to extravagance, it has other far more pernicious effects. On the one hand it stultified the development of structural design, and on the other it has forced the development of metal manufacture into directions which have not altogether proved fruitful and beneficial. In the manufacture of aluminum alloys in particular these outmoded and rigid concepts have led to the development of alloys of ever higher tensile strength which have proved disappointing under actual service conditions.

Modern endeavours are devoted to the development of methods which permit design to be based on actual conditions of failure. There are six primary conditions of structural or material failure which must be considered entirely separate. Which of these six has to be envisaged in design depends of course on the service conditions of the structure.

Structures and engineering components fail by (1) plastic failure; (2) instability; (3) fatigue; (4) creep; (5) corrosion; and (6) brittle fracture.

There may be other circumstances such as excessive wear but these six are responsible for almost all failures in industry and transport, and it is believed that fatigue alone accounts for 90% of service failures.

Plastic Failure.—*Stress Concentration.*—This type of failure is extremely rare because plasticity is by its nature a protective mechanism. This can best be appreciated from a single example. Consider a bar of uniform rectangular cross section (fig. 16[A]) with two tensile loads P acting at the ends as in the tensile test. The stress distribution over any cross section such as A–A will be uniform, the stress being everywhere of magnitude S. If now a circular hole is made in the bar (fig. 16[B]) at the section A–A the stress distribution will be greatly changed. At the ends of the diameter B–B the stress will be increased to a value $S_k = Sk_t$ where k_t is a factor of 3 and is called the stress concentration factor for the circular hole. Other forms of geometric discontinuities will have a similar effect except that the numerical value of the stress concentration factor can be much larger or much smaller than that for a circular hole.

As the load is increased from P to P_1 the stress at points B will reach the proportional limit of the material, and soon after the yield point, if the material is mild steel. The stress distribution will then be that shown in fig. 16(C). Further increase in the load to P_2 (fig. 16[D]) cannot produce any further increase in stress at points B because the material there yields at constant stress and the increase in load must be absorbed by increased stresses on both sides of points B.

In this way increases in load will produce two zones of yielding starting from points B and moving outward toward the parallel edges of the bar. Eventually (fig. 16[E]) load P_3 will be reached for which the zones of yielding have reached the edges and every point of the cross section A–A carries a stress equal to the yield point of the material. The total load carried is, therefore, $A \times fy$ where fy is the yield point stress: this is the same load as would be carried by a bar with the same cross section A but no hole.

The mechanism of plastic deformation has protected the bar from the effect of stress concentration, so that in fact the load carried by the bar when it is loaded up to the yield point is only influenced by the presence of the hole insofar as the cross section is reduced. If it is assumed that a bar without a hole is perfectly safe as long as the stress does not exceed the limit of proportionality, one would obtain the cross section of the bar required to carry a load P as $A = \frac{P}{f_p}$ where f_p is the limit of proportionality. If it is further assumed that the proportional limit is 90% of the yield so that $f_p = 0.9$, fy $A = \frac{P}{0.9_{fy}}$. If it is in order for the bar without the hole of fig. 16(A) to carry this load it must necessarily be so for the bar of fig. 16(E) with the hole also, because at yielding there is no difference in the stress distribution of the bar of fig. 16(A) and that of fig. 16(E), so that for the perforated bar the required cross section is also $A = \frac{P}{0.9_{fy}}$. On the basis of elastic theory and permissible stress the required cross section would be three times as great. This is because the maximum stress in

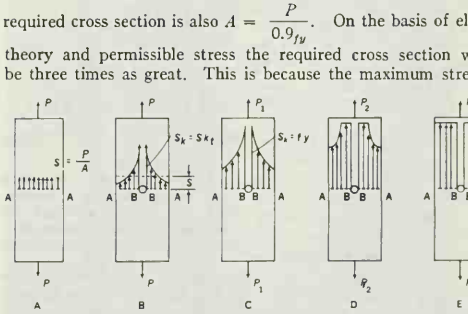

FIG. 16.—EFFECTIVE ELIMINATION OF STRESS CONCENTRATIONS BY PLASTICITY: (A) UNIFORM STRESS DISTRIBUTION IN A BAR OF UNIFORM CROSS SECTION UNDER THE INFLUENCE OF TENSILE LOADS; (B) STRESS CONCENTRATIONS AT THE EDGE OF A CIRCULAR HOLE; (C) MAXIMUM STRESS AT EDGE OF HOLE REACHES YIELD POINT OF MATERIAL WHEN LOAD REACHES VALUE P_1; (D) FOR LOADS BETWEEN P_1 AND P_2 STRESSES AT EDGE OF HOLE CANNOT INCREASE BEYOND YIELD POINT. ZONES OF YIELDING SPREAD OUTWARD; (E) THE ENTIRE CROSS SECTION AT YIELD POINT STRESS FOR LOAD P_3

the perforated bar, occurring at the surface of the hole and of magnitude three times that of the average stress P/A, would have to be restricted to the value of the limit of proportionality; *i.e.*,

$$\frac{3P}{A} = f_p \quad \text{or} \quad A = \frac{3P}{0.9 f_y}$$

This illustrates the point made earlier that the same mechanism of plasticity which, more by accident than by design, protects structures against the effects of stress concentrations ignored in calculations, can be deliberately used in design to effect appreciable economies. The perforated bar in fig. 16(E) would be considered to have reached its maximum carrying capacity when the collapse load $A \times fy$ was reached because large deformations would then be produced. It is important to realize that such a collapse load can be defined only for conditions of static loading, that is, loading which is applied relatively slowly and then remains constant. Applications of the theory of plasticity are, therefore, necessarily limited to cases of statically loaded structures. Unfortunately the theory had not been developed far enough, by the late 1950s, to be used in the design of all such statically loaded structures, but there was one group of structures for which the plastic method of design had reached a high degree of efficiency and perfection: the steel frame for buildings, which is essentially composed of mild steel beams and columns.

Plastic Theory of Beams and Frame Structures.—It was pointed out in considering the bending of a beam that every cross section is subjected to bending stresses which are linearly distributed over the cross section. Consider now what happens in that cross section of a simply supported beam (fig. 17[A]) where the bending stresses are largest, when the load and hence the bending moment is increased.

The bending stresses at the extreme fibre will reach the limit of proportionality and soon after that the yield point of the material *fy* (fig. 18[A]). Further increase in load and bending moment can no longer produce any increase in the maximum bending stresses in the extreme fibres. These will yield at constant stress so that the increase in bending moment has to be absorbed by material closer to the neutral axis which in turn will reach the yield point stress of the material as is shown in fig. 18(B). Two zones of yielding will develop which will spread toward the neutral axis and along the beam as the load is increased. Eventually the state of fig. 18(C) will be attained when the material has reached yield point stress throughout the cross section. No further increase in stress in this cross section is possible until the material begins to work harden. Before this work hardening can set in, the deformations would, however, have grown so large that the beam would have become useless. Thus, the condition shown in fig. 18(C) must be assumed to characterize the maximum load carrying capacity of the beam.

The distribution of bending stress of fig. 18(C) in fact represents a limiting condition and the bending moment represented by this stress distribution is called the full plastic moment of the cross section. When this full plastic moment is reached the two parts of the beam on either side of this fully plastic cross section will continue to rotate at constant load. This condition means, however, that the beam is no longer a structure but a mechanism as shown in fig. 17(B). The cross section which has become fully plastic has the same effect as the insertion of a friction hinge in the beam. The full plastic moment for a rectangular cross section of depth d and width b is given by $M_p = \frac{bd^2}{4} fy$, where fy is the yield point stress of the material.

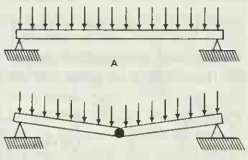

FIG. 17.—(A) SIMPLY SUPPORTED BEAM WITH UNIFORMLY DISTRIBUTED LOAD; (B) DEVELOPMENT OF ONE HINGE AT CENTRE CROSS SECTION. BEAM BECOMES MECHANISM

If, instead of a freely supported beam as in fig. 17(A) a beam is considered whose ends are encastered (fig. 19[A]), that is, prevented from rotation, plastic hinges will form not only at a section within the span but at the encastered ends. It is only when three hinges form that the beam becomes a mechanism (fig. 19[B]), and its full carrying capacity is attained.

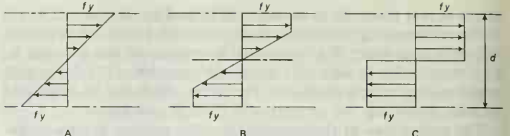

FIG. 18.—BENDING STRESS DISTRIBUTION IN CROSS SECTION OF BEAM SHOWN IN FIG. 17. (A) EXTREME FIBRE STRESS AT YIELD POINT; (B) YIELD POINT STRESS REACHED IN MOST OF CROSS SECTION; (C) YIELDING HAS TAKEN PLACE THROUGHOUT. THE BENDING MOMENT HAS REACHED THE FULL PLASTIC MOMENT

Such a structure in which more than one hinge must be formed before it is converted into a mechanism, is called a redundant structure. The portal frame in fig. 20 under vertical and horizontal load will not, in general, become a mechanism until four such plastic hinges are formed.

The carrying capacity of the encastered beam of fig. 19 is twice as large as that of the simply supported beam of fig. 17(A) although the two beams are otherwise identical. This condition is due to the two extra hinges which can be formed in the encastered beam before collapse takes place. On the basis of elastic theory and permissible stresses the encastered beam would only be considered 1.5 times as strong. This example shows that plastic theory permits the more effective exploitation of the reserves of carrying capacity which ductile redundant structures are shown to possess in comparison with statically determinate structures.

The preceding considerations have left out of account the fact that a beam subjected to bending is generally subjected to shear stresses at the same time. These do not, however, exercise a pronounced influence on carrying capacity in the case considered and can usually be neglected. The presence of other stresses in addition to one normal stress cannot, however, always be neglected and a general problem arises to which reference has already been made in a different context. This is the problem: Supposing that yielding occurs in uniaxial tension at a stress *fy*, what is the individual value of the stresses $X_1 Y_2 Z_3$, the three principal stresses characterizing a general triaxial state of stress, when yielding is due not to simple tension but to this triaxial state of stress?

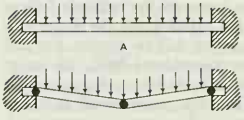

FIG. 19.—(A) BEAM WITH ENCASTERED ENDS WITH UNIFORMLY DISTRIBUTED LOAD; (B) FORMATION OF THREE PLASTIC HINGES CONVERTS BEAM INTO A MECHANISM

Hypotheses of Yielding or Elastic Breakdown.—*Principal Stress Hypothesis.*—The simplest hypothesis would be to postulate that if X_1 is the largest of the three principal stresses so that $X_1 > Y_2 > Z_3$ the stresses Y_2 and Z_3 have no influence on yielding. This hypothesis is not borne out by experiment. While it is impossible in the laboratory to realize and measure uniform triaxial states of stress, biaxial states of stress can be realized either by the twisting of thin tubes in which the two principal stresses are equal but of opposite sign, X_1 tension, $Y_2 = -X_1$ compression and $Z_3 = 0$, or by subjecting thin tubes to internal pressure in which case X_1, the largest stress, is the circumferential or hoop stress, and Y_2, the longitudinal stress, occurs in the direction of the axis and is equal to half the circumferential stress $Y_2 = \frac{1}{2} X_1$.

It was found experimentally by W. Lode that thin tubes subjected to twisting yield when $X_1 = -Y_2 = 0.6\, fy$. Thus yielding takes place under these conditions when the stresses are equal to only 60% of the yield point stress in simple tension, from which it must be concluded that the principal stress hypothesis is untenable.

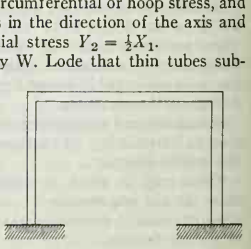

FIG. 20.—RIGID PORTAL FRAME

Principal Strain Hypothesis.—This hypothesis postulates that

the maximum principal strain is constant at the onset of yield irrespective of the state of stress. If we postulate a somewhat simplified stress-strain diagram for the material which is generally used in plasticity and in which the region of proportionality (straight line relation) OA (fig. 21) is assumed to be valid up to the yield point of the material, followed by an unlimited yield range AB with no work hardening, we obtain the maximum strain at yield $e_y = fy$. For the tube subjected to twisting we obtain

$$e_1 = \frac{1}{E}[X_1 - \mu(Y_2 + Z_3)] = \frac{1}{E}[X_1 - \mu(-X_1 + 0)]$$

$$e_1 = \frac{X_1}{E}(1 + \mu)$$

and since μ for steel is approximately 0.28 we obtain

$$e_1 = e_y = \frac{X_1}{E} \times 1.28 = \frac{fy}{E}$$

and hence $$X_1 = \frac{fy}{1.28} = 0.78\, fy$$

Experiment, however, demands $X_1 = 0.6\, fy$ so that this hypothesis cannot be maintained.

Maximum Shear Stress Hypothesis.—According to this hypothesis yielding depends on half the difference between the largest and the smallest of the two principal stresses which equals the largest value of shear stress. Yielding is, therefore, assumed to take place when the largest shear stress assumes the value of the shear in uniaxial tension at yield. In uniaxial tension the largest shear stress is one-half the applied tensile stress, hence at yield when $X_1 = fy$ the largest shear stress is 0.5 fy. For the tube subjected to twisting, the largest shear stress $= \frac{X_1 - Y_2}{2} = \frac{X_1 + X_1}{2}$

and this must be equal to 0.5 fy hence $X_1 = 0.5\, fy$. Experiment demands $X_1 = 0.6\, fy$ and this is therefore a good approximation.

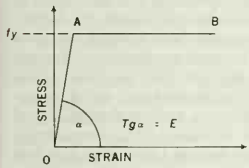

FIG. 21.—SCHEMATIC STRESS-STRAIN DIAGRAM. AB YIELD RANGE

Shear Strain Energy Hypothesis.—This, also known as the Mises, Huber, Hencky hypothesis, postulates that the capacity of the material to absorb shear strain energy without yielding is limited to a constant value and that this value is independent of the state of stress.

Earlier we found the shear strain energy U_2 to be

$$\frac{1+\mu}{6E}[(X_x - Y_y)^2 + (Y_y - Z_z)^2 + (Z_z - X_x)^2] + \frac{1}{2G}(X_y^2 + X_z^2 + Y_z^2)$$

and written in principal stresses this expression becomes

$$U_2 = \frac{1+\mu}{6E}[(X_1 - Y_2)^2 + (Y_2 - Z_3)^2 + (Z_3 - X_1)^2]$$

For uniaxial tension at yield $X_1 = fy$ $Y_2 = Z_3 = 0$ and

$$U_2 = \frac{1+\mu}{6E}(X_1^2 + X_1^2) = \frac{2(1+\mu)}{6E} fy^2$$

For the tube under torsion $X_1 = -Y_2$, $Z_3 = 0$ and

$$U_2 = \frac{1+\mu}{6E}[(X_1 + X_1)^2 + X_1^2 + X_1^2)] = \frac{6(1+\mu)}{6E} X_1^2$$

hence $X_1^2 = \frac{1}{3} fy^2$ and $X_1 = \frac{1}{\sqrt{3}} fy = 0.58\, fy$

Experiment demands $X_1 = 0.6\, fy$ and it is seen that this hypothesis represents experimental results more accurately than any of the other hypotheses. It is now generally accepted as the hypothesis for elastic breakdown or yielding.

Since for hydrostatic states of stress for which $X_1 = Y_2 = Z_3$ the value of U_2 vanishes, yielding cannot occur, however large the magnitude of the principal stresses. This is borne out by experience since metals will tolerate enormous hydrostatic pressures without yielding.

Triaxial isotropic tension with all three principal stresses equal would also make yielding and plastic deformation impossible however large the principal stresses are. It would then have to be assumed that fracture supervenes even in ductile materials without being preceded by plastic deformation. Some authorities in the past have attributed the occurrence of brittle fracture in normally ductile materials to the existence of such states of isotropic triaxial tension. There are, however, objections to this interpretation.

Instability and Buckling.—If a ball is considered resting within a hemispherical shell it is in stable equilibrium because after any small displacement from its position it will return to its original equilibrium position. The potential energy of the ball is a minimum and this is characteristic for stable equilibrium. The potential energy of a ball resting on the outside of a hemispherical shell is a maximum and hence after a small displacement it cannot return to its equilibrium position which is unstable. The ball will roll off altogether after a small displacement from this equilibrium position and may assume another stable equilibrium position by the side of the hemispherical shell.

A somewhat similar situation arises in many cases of stressed solids. The internal stresses with the associated deformation must be in equilibrium with the external forces in the same way as the weight of the ball, when at rest, is in equilibrium with the pressure exerted on it by the supporting shell. But in the same way as the equilibrium of the ball can be either stable or unstable, that of the stressed solid can be stable or unstable. If the equilibrium is unstable a small deformation may cause the pattern of equilibrium to change radically to a stable form, but this change may be associated with such large deformations that it must be considered as failure. Because these deformations frequently appear as buckles this phenomenon of instability is known to the engineer as "buckling." A thin cylindrical shell after buckling under compression is shown in fig. 22.

The commonest form of buckling is that of a column or pillar supporting a load. For loads not exceeding a certain value the axis of the column remains straight, but as the load increases the stored

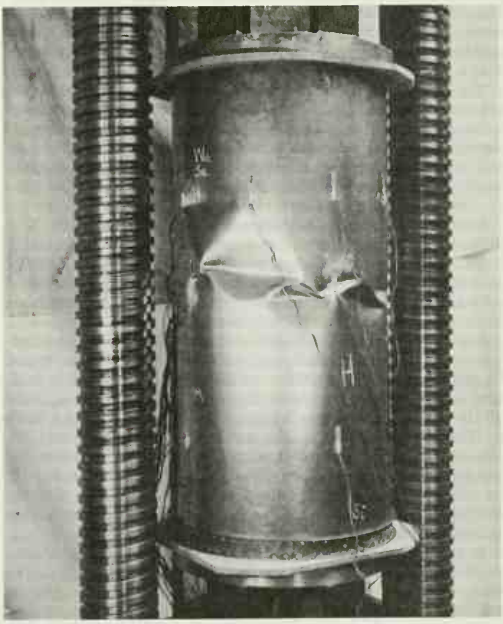

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FIG. 22.—THIN CYLINDRICAL SHELL BUCKLED BY AXIAL COMPRESSION

strain energy increases and may become a maximum. This means that when the load reaches a certain limiting value, the buckling load, another equilibrium position of smaller potential energy becomes possible but no longer with the column axis straight, but curved. At the moment of buckling, each point along the axis will move laterally—as if to shed and evade the load—and the column will no longer be straight but curved and may collapse altogether if another equilibrium position cannot be found for only small displacements.

Every structure or part of a structure in which there are compressive stresses is potentially liable to buckle, although the danger is real only for relatively slender or thin-walled structural members. Buckling is not necessarily always destructive as every airplane passenger is able to observe by looking out at the somewhat crinkly skin of the wing when the plane is air-borne, whereas this skin before buckling, while the airplane was on the ground, was perfectly smooth.

Buckling as an equilibrium problem is not associated with the compressive strength of the material as discussed in the section on compression tests although certain mechanical properties such as Young's modulus and the yield point of the material may enter into the problem. Largely, however, buckling is a function of form —a long straight column will collapse under a much smaller load than a short column of the same material and cross section, though the stresses in the two members would be the same under the same load. Buckling may take place entirely within the elastic region of the material and for such cases solutions may be found by applying the theory of elasticity. It will always be advisable, though, to check such solutions by experiment. Whereas the theory of elasticity gives results in the case of columns in good agreement with experiment, at least for columns of such slender proportions that they will buckle within the elastic region of the material, in other cases this is not so. In the case of the axially compressed thin-walled metal cylinder with a large ratio of diameter to wall thickness, such as that illustrated in fig. 22, the theory of elasticity gives solutions for the buckling load which may be three to four times as large as those found by experiment.

The mathematical solution of all but the simplest buckling problems poses formidable difficulties even if it is fully within the elastic region. These difficulties are enormously increased for buckling problems involving partly plastic deformation, and progress in this field is as yet extremely limited.

Thus, theoretically complete solutions, confirmed by experiment, are not available for many cases of engineering application. Even relatively ancient and common problems, such as the buckling of webs in plate girders and the necessary stiffening, are still the subject of controversy and research, so that the engineer frequently has to rely on the results of past experience and on *ad hoc* tests to prevent failure of his structures from instability.

Fatigue.—Reference to failure by fatigue has already been made under *Fatigue Tests*. The problem must now be considered in its broader aspects. Only a few engineering structures or components are loaded in such a way that the load once applied remains constant for the whole of the life of the structure. In most cases there will be variation of stress, and since fatigue failure is a phenomenon resulting from such variation, almost every engineering component is exposed to the risk of failure from fatigue. Variation of stress may result even if there is no variation in load. The axle of a railway car, even if the axle load remains constant all the time, is nevertheless subject to fatigue. It acts as a beam so that there are always tension stresses on the underside of the axle and compression stresses on top. Since the axle is not stationary but revolves, the material in tension at one moment will be subjected to compression the next moment when the axle has completed half a revolution, and after a further half revolution will be subjected to tension again.

In this case the alternations of stress are sinusoidal and of constant amplitude. This is by no means the case generally. The wings of an aircraft during flight are subjected to many, though quite irregular, alterations of loading depending on the velocity of gusts so that the stress cycles in the wing will be distributed at random between a maximum and a minimum stress. Such random loading complicates the fatigue problem enormously since fatigue data, insofar as they are available, have been obtained for cyclic loading of constant amplitude.

The number of loading cycles endured during the lifetime of a structure may also vary enormously from one type of structure to another. One hundred million loading and unloading cycles may have to be endured in the lifetime of a bridge outside the main line station of a capital city, whereas a similar bridge in some remote part of the country may only be loaded a few times every day. It is estimated that a railway bridge may have to endure between 1,000,000 and 100,000,000 cycles of loading, the axle of a railway car 400,000,000 cycles, and the shaft of a steam turbine 15,000,000,000 cycles of loading. Each blade of a modern aircraft gas turbine may have to endure 60,000,000,000 stress cycles in 500 flying hours. Even if testing machines were available for applying 200,000 cycles of loading per minute, a test on such a turbine blade would still take about a month. At the other extreme, even a few thousand cycles may be sufficient to produce fatigue as the investigations into the failure of the pressure cabin of a famous airliner have shown.

The frequent occurrence of service failure from fatigue is entirely due to the completely inadequate design procedures. In them the stresses in the structure are calculated by some approximate method based on the theory of elasticity and are then limited to some value near the proportional limit of the material or, which comes much to the same thing, to some fraction of the material's fatigue strength determined in tests with small metal specimens. Such procedures leave out of account many effects of which only a few important ones can be considered here.

Notch Sensitivity and Size Effect.—Under conditions of fatigue, as has been explained, the material does not deform plastically in bulk as under static loading. Plastic deformation is definitely associated with fatigue but it occurs on a microscopic scale so that it may be highly localized, concentrated as it were at certain points, where a fatigue crack will then start. A microsection through a piece of mild steel containing a fatigue crack is shown in fig. 23. These points where the microscopic plastic deformation is concentrated will naturally be those where the stresses are highest, that is, at points of stress concentration. Fatigue failures almost without exception will start from points of stress concentration produced by discontinuities in form, either necessarily introduced in design or manufacture such as riveted, bolted or welded joints, shoulders in shafts, oil holes and keyways, or accidentally introduced in manufacture such as tool marks, grinding scratches, accidental indentations, electric arcing marks, small defects such as blowholes in castings and similar minor damage.

Since the fatigue crack starts at a point, it will be the magnitude of stress at this single point which decides whether in fact the part survives in service or fails.

This might appear, at first sight, to simplify the problem, since all the designer has to do is to ensure that the stress at this critical point does not exceed the endurance limit of the material. One of the difficulties is to find the "point," although experience frequently helps greatly in pinpointing the discontinuity most likely to produce the critical stress concentration.

The second difficulty arises in determining the exact value of the stress before the part is made. Mathematical analysis will give solutions in some cases but fails in others. There was, for instance, in the early 1960s, no method of evaluating accurately the stress cycle experienced by the material at the root of gear teeth when the gears are running, particularly if the gears are of more complex form than straight spur gears. In many other common engineering components the situation was similar, though in some cases the value of the peak stress could be determined by one or other of the methods of experimental stress analysis.

Finally, even if the stress value is accurately known, it is not sufficient for this value to be simply limited to the fatigue strength of the material. For one thing, as has already been pointed out, fatigue strength is not a mechanical property depending only on the material. Fatigue tests carried out with identical specimens of rectangular cross section, for instance, will give different values for the "fatigue strength of the material" depending on whether

the specimens are tested by applying axial tension, bending about the minor axis of inertia (specimen bent on the flat) or about the major axis (specimen bent on edge). A different result will be obtained for specimens with sharp edges. The surface finish of the specimen whether as rolled, machined, ground or polished will also profoundly influence the result, so that it is really impossible to define the fatigue strength of the material.

Secondly, the reduction in fatigue strength is not necessarily proportional to the value of the stress concentration factor as defined earlier. If, for instance, the fatigue strength of two components is determined experimentally, the two being identical with the exception of some minor detail which produces the stress concentration—such as a variation in the radius of the transition between pin and web of otherwise identical crankshafts—it is found that the reduction in fatigue strength is not proportional to the values of these stress concentrations. Moreover, if the fatigue strength of two crankshafts entirely similar in form but of different size is compared, the fatigue strength of the larger shaft will be smaller than that of the smaller shaft despite the fact that the stress concentrations for both shafts are the same.

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FIG. 23.—MICROSECTION THROUGH STEEL CONTAINING FATIGUE CRACK

This phenomenon of increasing effectiveness of stress concentration with size is known as the size effect in fatigue.

More "highly cultivated" materials, where high values of tensile strength are produced by careful alloying and heat treatment, suffer relatively greater losses in fatigue strength through the presence of a stress concentration than some more ordinary materials such as gray cast iron. This difference between different materials to suffer relatively greater or smaller reductions in fatigue strength in consequence of stress concentrations produced by notches or other geometric discontinuities is spoken of as the differing "notch sensitivity" of different materials.

There is, however, one important overriding consideration which to some extent at least simplifies matters. Provided the magnitude of the worst stress concentration can be accurately evaluated, the reduction in fatigue strength will never be greater than that which could be expected by dividing the fatigue strength of the material, obtained of course in an appropriate test with a test piece of similar characteristics and subjected to types of stressing similar to that of the component, by the full value of the elastic stress concentration factor. That the value of fatigue strength used must be chosen with great care is perhaps evident when it is considered that a steel rail of 50 tons per square inch tensile strength when tested in the form of machined specimens in bending will give a fatigue strength of perhaps 30 tons per square inch, whereas the actual rail even without stress concentrations will give scarcely more than 24 tons per square inch in bending; when stress concentrations are introduced by the circular holes of the fishplated joint, no more than 8 tons per square inch can be expected.

Cumulative Damage.—Many engineering structures and components are not subjected to stress variations of constant amplitude. The stresses experienced in a ship during a voyage will largely depend on the weather experienced, and similar considerations will apply to aircraft. Experimental means were at the disposal of the engineer in the late 1950s to obtain extensive records of the stress variations for such cases. In the 1950s testing machines were developed capable of applying "program loading"; that is, loading of an amplitude which can be varied in a regular manner during the fatigue test to approximate more closely to conditions in service where a few cycles of high stress amplitude may be followed by thousands or millions of cycles of low amplitude, in contrast to the constant amplitude of stress applied in the conventional fatigue test. The problem of predicting the life of a part subjected in service to stress cycles of variable amplitude, from experimental data obtained with the aid of constant amplitude machines, is known as the cumulative damage problem.

Various methods for assessing cumulative damage have been proposed, based on statistical reasoning, but the problem is still unsolved and will only be solved when the fundamental mechanism of fatigue is better understood. The many theories proposed explained fatigue with the aid of some conceptual model behaving in accordance with the known laws governing the deformation of metal crystals, but none of them had found general acceptance.

Statistical Aspects.—Until the late 1950s it was assumed that ferrous metals have a limiting stress—the endurance limit below which fatigue failure cannot occur—and that this stress can only differ by an insignificant amount from that which still produces failure at 10,000,000 cycles. This would mean that if a part does not fail in 10,000,000 cycles it will not fail at all. Service failures after much longer endurances, thousands of millions of cycles, are, however, not unknown and perhaps it would be more correct to say that if a part does not fail after 10,000,000 cycles it is unlikely to fail at all. This expression "unlikely" introduces a probability aspect into the fatigue phenomenon for which there is increasing experimental support.

For one thing, the S–N diagram discussed earlier is never obtained as a smooth curve passing exactly through the experimental points. In fact, if instead of testing only one specimen at a given stress level, several are tested, each of them will give a different endurance, that is, a different value for N, so that the test results will exhibit more or less scatter. The different values will be distributed in accordance with some frequency distribution. It would appear to follow from this that the life of a specimen subjected to a certain amplitude of cyclic stress cannot be predicted accurately. All that can be said—and even this only if there are sufficient experimental data—is that any given specimen may have a certain definite chance to survive a given number of cycles at a certain stress value. Instead of plotting S–N diagrams one would plot S–N–P diagrams consisting of several lines similar to the conventional S–N diagram, but each of them associated with a certain probability of survival "P." If the S–N diagram were drawn in such a way that, if for a given value S, n specimens have been tested, and the S–N diagram would be made to pass through a point corresponding to N cycles, so that $n/2$ results lie to the right of it and $n/2$ to the left, it could be concluded that the chance of a specimen surviving to the endurance of N cycles at the given stress is $\frac{1}{2}$. The S–N diagram drawn through these points for different values of S would be the S–N diagram for 50% probability, and other S–N diagrams for different probabilities of survival could be obtained in a similar manner.

The lives or endurances of fatigue specimens could be considered to be distributed in accordance with some mathematical frequency distribution in much the same way as the ages of man at death.

The determination of this frequency distribution is one of the cardinal problems for research workers in this field. That fatigue is in fact a statistical phenomenon is becoming widely realized, but engineers are reluctant to accept the inescapable consequence, that however "safe" an engineering part is designed it may nevertheless fail from fatigue. Where millions of identical parts are used in mass-produced machinery such as automobiles, a few of this large number will inevitably fail.

If the frequency distribution for fatigue failure were known, the engineer might on this basis deliberately select a priori the number of failures he is willing to tolerate as a percentage of total production, instead of hoping that it will be tolerably small.

Full-Scale Tests.—It will be clear that no fatigue problem can be solved satisfactorily without fairly extensive experimental data. In the complete absence of fundamental principles upon which to build a reliable theory, engineers are driven increasingly to the full-scale prototype fatigue test of which perhaps the most notable development has been the testing to destruction of complete pressure cabins of large airliners under repeated internal pressurization. Full-scale tests of this and similar types, of course,

can no longer be carried out in testing machines. They require an extensive, complex and costly plant, but at the state of knowledge in the mid-1960s they cannot, unfortunately, be dispensed with.

Creep.—This subject until the early 1950s was of almost purely academic interest. With the rapid increase in the working temperatures of steam-power stations, however, and in particular with the development of the gas turbine and the modern jet engine, the subject has assumed tremendous importance.

If a tensile test, as discussed earlier, is interrupted at a point C (fig. 12), say, on the load extension diagram and the load is maintained at the value represented by C, the specimen will continue to deform at constant load for a long time. This type of plastic deformation which may eventually end in fracture is called creep. On the application of the load the time rate of deformation will at first decrease (primary creep), then remain fairly constant (secondary creep) and then increase just prior to fracture (tertiary creep). The whole process may take place within a few hours or within hundreds of thousands of hours depending on the applied stress, the material and the temperature.

The fabrication of metals by forging, rolling or extrusion is generally carried out at higher temperatures because the resistance of the material against deformation decreases with increasing temperature, but this also means that for a given applied stress the total creep in a given time will increase with increasing temperature and at a given temperature with increasing stress.

Quite apart from the need to avoid failures in steam plant and gas turbines, the deformations which can be permitted to take place within the required service life are necessarily limited to small amounts. If the blades of a gas turbine were permitted to elongate appreciably by creep under the influence of the centrifugal forces, they would soon begin to rub on the casing. The temperatures at which ordinary engineering steels can be used without excessive creep are modest and special steels alloyed with molybdenum, nickel, chromium and vanadium must be used for the high temperatures of a modern steam plant. For the temperatures produced in gas turbines even these steels are not satisfactory, and alloys primarily consisting of nickel and chromium, the "Nimonic" alloys, were developed for jet engines.

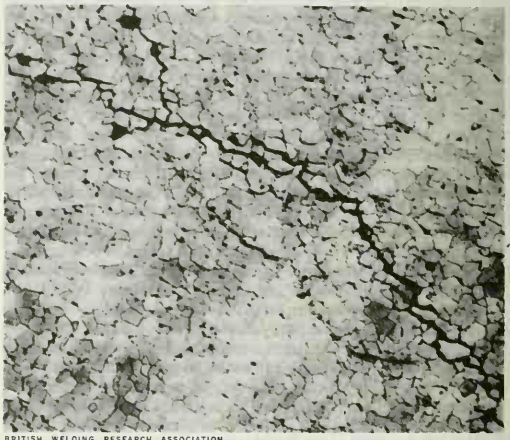
Further increases in jet engine efficiency could be obtained if higher engine compression could be used at present operating temperatures or higher operating temperatures for present engine compressions. In both cases higher creep resistance than that offered by present materials is required. One of the materials used was "Nimonic 80." It would suffer an extension of 0.5% in 10,000 hours at a temperature of 750° C. under an applied stress of four tons per square inch. This type of information essential to the designer is obtained in creep tests. Specimens are tested in tension in specially designed machines which permit the application of loads of varying magnitude within a furnace kept at constant temperature. Apparatus for measuring the creep under load with time must also be provided.

One difficulty in creep testing arises from the fact that the cross-sectional area of the specimen diminishes as creep proceeds and if the load is kept constant the stress applied to the specimen will gradually increase during the test. Most creep tests are nevertheless carried out at constant load and the error is not large if the diminution of cross section remains small. Some ingenious devices, however, have been developed for keeping the stress constant rather than the load. Creep tests are carried out in several different ways and according to the method adopted different types of information will be obtained.

In the "creep rupture test," also known as "time to rupture test," the specimen is loaded at constant load and the time to rupture at constant temperature is observed. By testing a number of specimens at the same temperature but at different stresses and plotting stress against time to rupture, curves are obtained which in appearance are not unlike the S–N diagrams obtained in fatigue tests but with time taking the place of numbers of cycles. While such tests will give no information on the amount of deformation, they will give a good indication of the stress values which might be used at different temperatures without causing rupture within a given period of time. In another type of test, the Rohn test, the temperature is determined at which creep will cease under given stress.

Since the amount of deformation suffered by the material at a given stress and temperature within a given time is of great importance in many practical cases, it has been found necessary to perform creep tests of 10,000 hours' duration at different stresses and temperatures. To obtain complete information of this type within a reasonable time requires batteries of creep-testing machines. Even then it is necessary for the engineer to extrapolate from say 10,000 hours to 100,000 hours which might represent the required service life of a steam pipe. In this light it is perhaps understandable that such problems as the effect of triaxial states of stress, or the effect of nonuniform stress distribution, or the effect of stress concentrations on creep behaviour, has not as yet been investigated to any appreciable extent. It is clear, however, that failure by creep need be considered only for those engineering components which must operate at high temperatures and where, as in steam plants, cooling is impossible. In gas turbines internally cooled blades have been adopted. These enable greater operating temperatures to be used than would otherwise be possible with existing materials. Creep and fatigue frequently arise together and present a problem which is not yet resolved.

Corrosion.—Corrosion is certainly one of the agents responsible for many failures though its connection with strength of materials may seem remote. There is the obvious weakening in consequence of the profound change in the strength properties of metals when they are converted into chemical compounds by corrosion, but there are at least two other phenomena in which corrosion plays a more immediate part in the destruction of the strength of a metal.



BRITISH WELDING RESEARCH ASSOCIATION

FIG. 24.—MICROSECTION THROUGH STEEL CONTAINING INTERGRANULAR STRESS CORROSION CRACK

Corrosion fatigue is one of them. The fatigue strength of all but passivated metals, that is to say, those not liable to corrode in certain mediums, will be greatly reduced by the presence of a corrosive medium. Even that of passivated metals may be reduced if the passivity depends on a surface film which cracks under the influence of fatigue loading conditions and cannot be repaired rapidly enough.

Thus stainless steel, which does not corrode in water, has its endurance limit reduced from 23 tons per square inch to 16 tons per square inch when tested in water. It is clear from this that the most elaborate design procedures may be useless if the designer leaves out of account the possible presence of a corrosive medium, and there is no evidence that paints, which may prevent general corrosion, would effectively prevent this reduction in fatigue strength.

Stress corrosion is another way in which a corrosive agent can

rapidly destroy the resistance of a material to stress. Whereas, in the absence of stress, a corrosive medium may produce only slow general surface corrosion, in the presence of stress the attack may become highly localized and accelerated. In this case deep cracks will develop rapidly, such as that shown in fig. 24, generally along the grain boundaries of the metal, where, in the absence of the corrosive medium, stress by itself would not produce such cracking. Stress corrosion cracking may occur in riveted boilers in consequence of alkali concentrations building up in riveted seams from alkali dissolved in boiler-water treatment. This phenomenon is also known as caustic cracking. An atmosphere containing traces of ammonia may produce cracking in brass articles especially when these have been produced by cold-working processes. This is known as season cracking. Stainless steel and aluminum alloys also are liable to suffer such destruction in the presence of certain chemicals.

Brittle Fracture.—This term in its original meaning denoted fracture of a brittle material such as glass which occurs suddenly at a certain stress without being preceded by any plastic deformation. However, the term was used increasingly to denote not the fracture of a brittle material but that of a ductile material, in particular carbon steel, in an unusual and to all appearances perfectly brittle manner. There is in fact a small amount of plastic deformation present, though this is only revealed by accurate measurement.

Such brittle fractures have occurred in large structures such as bridges, ships and oil storage tanks. All these failures have certain common features: (1) they have occurred mainly in welded structures though a few riveted structures have been affected; (2) in only a few cases was the steel found to be below accepted high standards of quality; (3) the fracture generally occurred suddenly without warning and progressed along its path with great speed; (4) in most cases the ambient temperature was relatively low; (5) the fracture generally originated from one or several geometric discontinuities which produced stress concentration; (6) all the fractures were produced at ordinary working stresses below the proportional limit of the material; (7) the static tensile strength and ductility of the material when tested at the casualty temperature were satisfactory; in particular the material exhibited large ductility.

Although isotropic triaxial states of tensile stress might permit a ductile material to fail in a brittle manner in accordance with the shear strain energy hypothesis for plastic deformation discussed earlier, this simple explanation is not satisfactory for several reasons. For one thing, it is difficult to see why such triaxial states of stress, even if there were grounds to suspect that they might exist in such extensive areas of structures, should be tolerated by the structure at one temperature and not at a somewhat lower temperature.

Although the problem of brittle fracture of ductile steel was far from being solved in the mid-1960s, it began to be better understood when it was shown by C. F. Tipper that a tensile test piece with a notch could break either in a perfectly ductile or in a brittle manner depending entirely on the testing temperature. The fractures experienced were then seen to be due primarily to a change in a property of steel termed notch toughness in consequence of decreasing temperature.

Why exactly this change in property takes place was not clear to researchers, but it was known that the relation between the notch toughness of a steel and the temperature is strongly influenced by the steelmaking process, the chemical composition of the steel, the temperature at which the steel is rolled and the thickness in which it is produced. In general, the notch toughness decreases with increasing thickness of material, and plates one inch thick of material produced to current specifications would generally show signs of becoming notch brittle at ordinary room temperature. This change in notch toughness would not become evident from test results obtained with the standard tensile test commonly used for the acceptance and quality control of ordinary structural steel such as is used for ships, bridges, buildings, storage and pressure vessels.

Since the standard tensile test gives no indication that the material may be notch brittle at the temperature at which it is to be used, it is important that a test be devised which would permit the selection of materials suitable for service at different ranges of low temperature. For economic reasons the test should be not too severe, but for reasons of safety it must be sufficiently discriminating to exclude material which might become dangerous, since if fracture occurs it does so at quite modest stress levels, not due to overload. Such a test must fix for each steel a narrow temperature range above which a structure made from the steel could not fail by brittle fracture, and below which it would be likely to fail. A large number of different tests have been proposed but none has so far been generally accepted as giving the perfect correlation with expected service behaviour. Some tests, such as the notch tensile test proposed by Tipper, are certainly safe but are claimed to be too severe. Other tests such as the Charpy V-notch impact test are considered not to be severe enough.

There are certain indications that it is in fact inherent in the nature of the problem that such an ideal test cannot be devised. For one thing, there is a fundamental difference in the failure of the structure and that of a test piece. Structures have definitely been known to fail at stresses well below the yield point stress of the material, whereas none of the many test pieces proposed can be broken at stresses below the yield.

It appears as if in the structure not only the notch ductility of the material is reduced by the decrease in temperature, but its brittle strength as well, and this is never found in the test piece.

This apparent drop in strength, however, is better understood since A. A. Wells succeeded in reproducing at low stresses in the laboratory such fast brittle through fractures in large welded test pieces.

Two stages in the fracture have to be distinguished: initiation and propagation. Initiation requires the stress at the bottom of the notch to be raised to yield point magnitude. The plastic deformation produced in welding by the severely localized heating will, however, do this, so that an external load producing yield point stress is not required. The second stage of fracture, propagation, is an instability effect.

A. A. Griffith proposed a criterion for the propagation of a fast fracture starting from an internal notch in a brittle solid such as glass. As the internal notch or crack extends, new surfaces are created for which surface energy is required. This cannot be supplied by the external loads since the fracture propagates so rapidly that the external loads cannot move and cannot, therefore, do any work. The energy can, however, be derived from the interior of the solid, since, as the fracture propagates, increasingly large portions of the material become stress free and strain energy is released. If the strain energy release rate exceeds the rate at which energy is absorbed in the form of surface energy in the newly created surfaces, the process is clearly unstable and must proceed at an accelerated rate.

G. Irwin, by interpreting "surface energy" in such a way as to include the energy absorbed in the plastic deformation of two narrow zones at each side of the crack in a steel plate, showed that the same instability effect could explain the rapid propagation of fractures in large structures. The level of the energy to be liberated in crack propagation depends, of course, on the material and the general stress level. High stresses are necessary to propagate small cracks, but the general stress level necessary for propagation rapidly decreases as the length of the fracture increases. High stresses are always present in the form of residual stresses in the immediate vicinity of welds in welded structures, and Wells's experiments have shown that the strain energy from the relief of these residual stresses is sufficient to supply the high strain energy release rate required in the early stages of the extension of a small crack from a weld at low average applied stresses.

V. METAL PHYSICS

The vast number of questions arising in the problem of the failure of metals by plastic deformation, creep, fatigue and brittle fracture which cannot be satisfactorily explained with the aid of the fundamental concepts of the theory of elasticity have given rise to innumerable and diverse investigations, both theoretical and

experimental, which have only one feature in common: that they endeavour to take account of the structure of metals instead of operating with the abstract structureless elastic space of the theory of elasticity. By the 1960s investigations of this type were generally considered to fall within the province of metal physics, though metal physics is concerned with many problems other than strength.

Structure of Metals.—Metals are composed of aggregates of small crystals as can be seen from the microsections in fig. 23 and 24. Whereas crystals grown in a solution have regular plane boundaries, the crystals in metals are of quite irregular shape because on solidification of a metal from the liquid state, many crystals grow simultaneously and then meet along irregular grain boundaries. This original cast structure generally is profoundly modified by later working and heat-treatment processes.

A solid is a crystal when the atoms are arranged in a regular pattern which is repeated throughout the solid. The atoms of iron, for instance, arrange themselves in such a manner that eight of them occupy positions at the corners of a cube and the ninth places itself in the centre of the cube. This arrangement of the crystal is called a body-centred cubic lattice. The existence of such structures can be verified experimentally by the methods of X-ray crystallography which are based on the diffraction phenomenon. These methods also permit the determination of the distance between the atoms, the so-called lattice constant, which for the body-centred cubic lattice of iron is 2.8 Å or 2.8×10^{-8} cm.

Elastic Deformation.—This can be shown to produce changes in the distance between atoms, and this fact has been used for purposes of experimental stress analysis. The change in the lattice constant as measured by X-ray diffraction can be related to the applied stress so that X-ray diffraction can be used for stress analysis though the method has severe limitations.

Plastic Deformation; Slip.—This has been studied extensively with the aid of single metal crystals which can be produced by straining and heat treatment up to several inches in length. Such single metal crystals do not, of course, exhibit the regular arrangement of plane boundaries one generally associates with a single crystal, but unlike polycrystalline materials the orientation of the atomic lattice planes is the same throughout the crystal, the essential criterion for the crystal being "single."

It is found that plastic deformation proceeds by individual layers of atoms in lattice planes of definite orientation with regard to the faces of the cube sliding over each other like a pack of cards. This can be seen under the microscope in the form of so-called slip lines which are edges of blocks of lattice planes breaking the surface after slip.

Resistance to Slip.—From the forces of attraction between the atoms the resistance against this deformation can be calculated, and is found to be about 1,000 times as large as that actually measured in experiments. Actually, single crystals generally are relatively soft, their resistance against plastic deformation is much less than that of the same material composed of many tiny crystals. This lessened resistance is understandable since the irregularly arranged atoms in the grain boundaries may, to some extent, delay the movement of the glide planes.

Dislocations.—The insertion of a few foreign atoms into the lattice, such as carbon in iron, will increase the resistance against deformation. Steels are made creep resistant by the addition of quite small quantities of foreign atoms. On the other hand, the postulation of irregularities in the lattice which can be produced by the insertion of additional atoms into one plane, or by assuming vacant lattice sites, can be used to explain the small deformation resistance of actual metal crystals. These irregularities have been termed dislocations and a whole theory of strength, the dislocation theory, has developed which endeavours to explain many of the phenomena revealed by observation and experiment and which in fact is successful in explaining the small strength of simple crystals in relation to the theoretical strength and many diverse effects observed in plastic deformation.

Cleavage.—Crystals can, however, not only be plastically deformed, but they can be split by cleavage along certain crystallographic planes, the so-called cleavage planes well known from the observation of the exfoliation of mica. Crystals cleave frequently during plastic deformation. A fracture which consists primarily of cleavages of undeformed crystals would be a brittle fracture, and whether brittle or ductile fracture occurs in a piece of metal may depend on the stress components acting in the glide planes and in the cleavage planes, and the relative resistance against slip and cleavage. The resistance against slip is certainly known to increase with decreasing temperature, and if the cleavage strength remained constant it would be natural to expect an increasing number of crystals in a polycrystalline material to fail from cleavage as the temperature decreases. Thus, with decreasing temperature fracture would tend to become increasingly brittle.

Metal Physics and Engineering.—Despite the great contribution these physical considerations have made to our understanding of deformation and fracture phenomena, we are as yet far from having established a unique set of simple fundamental principles which would permit satisfactory explanation for the observed phenomena. The situation in the mid-1960s was this: that principles which permit one group of phenomena to be explained satisfactorily are in direct contradiction with other phenomena. The whole subject was still so much in a state of flux that it would be unwise in this article to do more than indicate some elementary facts which are firmly established.

While metal physical theories of strength have made notable contributions to our understanding of many of our strength problems, they have not developed in a direction in which the engineer can make use of them directly in his problem of design for strength. This situation is, to some extent, a consequence of the fact that physical theories are postulated for pure metals whereas engineers use metals which are anything but pure. Steel contains, as well as iron, carbon in solid solution and iron carbides in the form of a second phase. Brass consists of a mixture of copper and zinc crystals, stainless steel contains impurities to the extent of 18% chromium and 8% nickel, and all engineering metals contain gases such as hydrogen, oxygen and nitrogen together with other metallic and nonmetallic impurities. These trace elements in metals are nevertheless known to have such a profound influence on mechanical behaviour that their presence or absence is often the only criterion determining whether or not a metal can be safely used for a given purpose. In view of these and other facts one is reluctant to advise engineers to look to metal physics for the ultimate solution of their engineering failure problems.

VI. SURVEY AND OUTLOOK

Strength of materials, while firmly rooted in mathematics and physics, did not, at the stage of its development in the mid-1960s, offer so aesthetically satisfying an appearance as either of these two sciences. It was composed of many heterogeneous elements. There was no unique set of fundamental principles and assumptions from which satisfactory solutions to all problems can be derived. The link between the fundamental theoretical concepts derived from the theory of elasticity and the observations made in the testing of materials, and particularly in service, was missing.

As is perhaps to be expected in a science of such utilitarian character, it abounds in contradictions. In some respects it is highly theoretical, in many others purely empirical, and the link between theory and empiricism has become increasingly tenuous. The development of the science in the 20th century had become extremely centrifugal and there was little doubt that for some time, at any rate, its many diverse branches such as the theory of plasticity, fatigue, brittle fracture, metal physics and so forth would have to develop along more or less independent lines. It can only be hoped that at the end of such developments some new concepts may emerge which can serve as fundamental principles on which to build a unified science of deformation and fracture in which theory and experiment would no longer be in conflict.

In the 1960s the old concepts rooted in the theory of elasticity were being increasingly abandoned, and even such basic ideas as stress and strain were becoming inadequate for the description of observed phenomena.

Since the cardinal questions of fracture and deformation are so closely dependent on the methods of manufacture of materials, it

is inconceivable that progress can be made on a purely physical basis. Already strength of materials is closely linked with the science of metallurgy and the technologies of extracting, refining and fabrication of metals. This association must become closer. A science of the strength of materials, unable to account for the profound influence on strength properties of what may be termed manufacturing variables such as chemical composition, heat treatment and fabrication, will not serve the engineer. Metallurgy in turn must take note of the fact that the old mechanical properties which are still used for purposes of development, testing and acceptance of metallic materials have lost much of their previous importance, and that the significance of some of these properties in relation to the service conditions imposed on the material has become questionable.

Strength of materials is undergoing a profound though slow revolution. As in every revolution the first result is confusion. Since past theories no longer serve their purpose and new ones are only slowly emerging, the engineer, for a time at least, will be driven to solve his "strength of materials" problems on the basis of results obtained from *ad hoc* tests. In this way we have turned full circle because it was from such *ad hoc* tests, carried out by the early engineers, that the whole body of our knowledge has developed. *See* ARCHITECTURAL ENGINEERING; *see* also references under "Materials, Strength of" in the Index.

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(J. F. BR.; R. WK.)

MATER MATUTA, goddess of Italian cult, probably most accurately described as a deity of the ripening of grain (Varro, in Augustine, *City of God*, iv, 8), although Lucretius (v, 656) makes her a goddess of dawn. Indeed the root *ma-* is found in both *mane* ("dawn") and *matutus* ("ripe"), but the agricultural explanation is perhaps more in keeping with a deity of Italian cult.

Her worship in Italy was both widespread and of ancient origin. Her temple at Rome, located in the Forum Boarium, was dedicated in 395 B.C. with antecedents going back traditionally to the time of Servius Tullius. The temple, long associated with Fortuna Virilis, an Ionic tetrastyle prostyle temple from the middle of the 1st century B.C., may represent a rebuilding. It is one of the best-preserved temples in Rome thanks to its conversion into the church of Sta. Maria Egiziaca in A.D. 872. That this temple is properly assigned to Mater Matuta, however, has been seriously questioned.

The festival of the Mater Matuta was held on June 11 and was marked by several unusual customs, among them that only free women of a first marriage might take part and that the women allegedly prayed not for their own children but for those of their sisters (but *cf.* H. J. Rose in *Classical Quarterly*, vol. xxviii, pp. 156 ff., 1934).

The goddess was later identified with the Greek Leucothea (Ovid, *Fasti*, vi, 473 ff.), who in turn was identified with Ino, wife of Athamas (*q.v.*). Thus she derives an association with the sea which did not originally belong to her.

See G. Wissowa, *Religion und Kultus*, 2nd ed., pp. 110–112 (1912); *Roman Questions of Plutarch*, trans. by H. J. Rose, pp. 175 ff. (1924).

(R. B. LD.)

MATERNAL AND CHILD HEALTH is defined in preventive medicine as the field of work related to the physical, mental and emotional health of women immediately before, during and after childbirth, and of infants and young children. Emphasis is placed on the prevention of illness and its early correction when it occurs. The development of maternal and child health services has taken place slowly as knowledge has grown and needs have changed; the term has had different meanings in different countries at different times, including the present. These services are now provided mainly by government and voluntary agencies, although they also can be obtained privately. The services vary in many ways but their objectives are always the same.

As maternal and child health services have evolved, their emphasis has shifted to meet new needs. For example, the infant death rate (*i.e.*, in the first year of life) has been reduced greatly since 1900 but most of the reduction has taken place in the latter part of the first year and very little reduction has occurred during the first month, and especially in the first week. Consequently, maternal and child health programs now emphasize (1) prematurity; (2) childbirth accidents; and (3) continuous care of the mother during pregnancy, delivery and the days immediately following delivery. The concept and scope of maternal and child health (abbreviated MCH) have been widened as a result of an increased awareness of the effect of environment on the physical and mental health of infants and also because of recognition of the fact that the social and emotional atmosphere can be as disease-producing as unhealthy or dangerous physical surroundings. The group of health workers who provide MCH services has grown as the services have expanded and may include the family or public health physician, the family or public health dentist, the public health nurse (or health visitor), nutritionist, midwife, social worker, sanitarian, child psychologist, physiotherapist and health educator.

The leading cause of infant deaths throughout the world is diarrhea, especially when related to malnutrition. Progress in the control of diseases such as malaria, smallpox and cholera has revealed the vast reservoir of illness caused by underfeeding or bad feeding among children, especially those recently weaned and fed almost entirely on some locally popular cereal food, which often is coarse, bulky and unsuitable for the growing child.

All countries are concerned with the improvement of obstetrical practices. In many countries, midwives are widely employed and usually are licensed by the government.

National and international agencies have co-operated with local health agencies in the development of MCH services. The higher-level agencies have been most active in staffing and running training projects and seminars, in pediatric education in universities, in research into nutritional and other problems, in the provision of supplies and equipment and in arranging fellowships for the training of MCH workers.

This article first discusses maternal and child health from an international viewpoint and then examines the MCH services in the United States and in Great Britain. *See* also CHILD LABOUR; CHILDREN, DISEASES OF; CHILDREN, LAWS CONCERNING; CHILD WELFARE; DIET AND DIETETICS; INFANTS, CARE OF; NUTRITION; OBSTETRICS; PREGNANCY; PREVENTIVE MEDICINE; PUBLIC HEALTH; SOCIAL WELFARE.

INTERNATIONAL

Maternal and child health throughout the world is promoted and protected by various agencies through the application of current knowledge to the study and satisfaction of health needs of women and children.

In primitive societies the practice of curative and preventive medicine was and still is closely linked with religious beliefs and rites. Traditional knowledge expressed in the form of various rules and tabus frequently has a direct influence on the health of mothers and the survival and health of the child. In these societies the original aim was probably concerned more directly with the maintenance of the equilibrium and survival of the particular group than with the protection of the health of the particular individual. Some beliefs, *e.g.*, those regarding foods that can or cannot be eaten during pregnancy or immediately after delivery, are definitely harmful to the mother and child. Others, such as the custom of separation of husband and wife for some time after delivery, or the regulation of sexual relations between the young couple by the elders of the family, ensure the spacing

of pregnancies and therefore a better start in life for the infant and better health for the mother.

Many of these ancient safeguards have broken down under the impact of western ideas, or as a result of the urbanization and industrialization of communities that were once rural. Where no adequate substitute has been found, such as safe and adequate artificial feeding to replace the traditional prolonged breast feeding, or feasible methods of family planning to replace the traditional methods of control, the health of the mother and child has suffered. The resulting conditions of malnutrition and deprivation have become, in many parts of the world, the chief child health problem.

The Industrial Revolution in western Europe, though it brought the beginnings of public health, was accompanied by a high death rate and much ill health and suffering among the children. It was by no means unusual to find a child five years old employed for a working day of 17 hours under miserable conditions.

The extent of the wastage of child life (ascertained through the collection and study of statistical information about births and deaths) was so shocking—for example, 200 infant deaths per 1,000 live births as compared with about 25 in the mid-1960s in Great Britain—that in several countries centres were set up to teach mothers the elements of child care and child feeding. From these centres (the *gouttes de lait* of Pierre Budin in France) and the "home health bringers" envisaged by Florence Nightingale, the maternal and child health services have developed in different ways in different countries, until they have spread out into all aspects of the lives of mothers and children both within and outside the family.

Death rates for children and for women in childbirth are very sensitive indexes of the health of a population. When a large number of children die before reaching school age, there is good reason to believe that this fact reflects generally insanitary conditions, lack of food, poor weaning and feeding practices and a high prevalence of infectious diseases. The object of maternal and child health programs is to bring these factors to light and to effectively control them. Conditions differ from country to country, but certain elements are common enough to allow distinction of three different situations, namely: (1) countries with well-developed public health services; (2) countries in the process of extending their services; and (3) countries where public health services were established relatively recently.

Countries With Well-Developed Public Health Services

The original "infant welfare services" grew out of circumstances that made the supervision of the infant in the first year of life the most urgent need. These circumstances provided the possibility, at least theoretically, of the mother and child seeking and receiving the needed curative services from other sources. The first infant welfare services were therefore restricted mainly to education and preventive and noncurative activities, and there was often little co-operation between the persons who supplied these services and those responsible for looking after the mother during delivery and for mother and child in future illnesses.

Regular visits to mothers in their homes to advise on child feeding and care and general hygiene were, and still are, considered the basis of all maternal and child health work. The reporting of births enables the public health nurse to make her first contact with the mother soon after the birth of the child and to establish the relationship that continues through subsequent home visits and through the mother's attendance at the infant welfare centre. From these beginnings more comprehensive maternal and child health services have developed.

The Mother.—Prenatal services now ensure that the health, and especially the nutritional state, of the expectant mother is checked periodically; the avoidable complications of pregnancy are prevented or treated; preparations for painless childbirth are carried out; and through discussion groups or individual talks the mother is educated in the necessary skills and knowledge so that she can feed and care for her baby to the best of her ability. In some countries special foods are provided free or at minimum cost to pregnant women.

Most countries have also been concerned with ensuring skilled care and attention during childbirth through the provision of services by midwives trained to certain legally accepted standards or by the family doctor or obstetric specialist. In some countries, special medical attention for the newborn is also available. A domestic service has been organized in some countries to look after the family during the mother's confinement; in others the children are taken care of in holiday homes provided for this purpose.

Postnatal clinics provide a valuable opportunity for a check on the mother's health after delivery and for the early diagnosis and prevention of some chronic disabling conditions common in women. Family planning advice, given either by the MCH service staff or in special centres, is available to the woman as a form of health protection in many countries, especially in Europe and Asia.

A recent development is the marriage guidance service. Problems affecting the family and particularly the relationship between husband and wife are discussed and advice is given by trained counselors. The object is to avert dissolution of the family.

Infant and Child.—Well-developed services for the infant and child carried out in the health centre or during home visits include: (1) the regular checking of its growth and development; (2) informing the mother regarding the nutritional, physical and psychological needs of the child at various stages; (3) immunization against some of the infectious diseases; (4) the treatment of minor ailments; and (5) referral to the proper source for any special preventive or curative action. Dental care is also available at MCH centres in some countries. Home visits provide the best opportunity for education about the nutrition and general care of the growing child in its family, and the prevention of accidents in and around the home. A growing interest in the emotional development of the child has increased both the scope of the educational function of MCH services and the importance of visiting and studying the child in its familiar setting. MCH services are available to sick and well children alike, though with the general improvement in child health and in curative facilities for children in recent years, well-baby clinics have tended to increase. The sick child can receive treatment at the clinic, at home from the family doctor or pediatrician or at special children's departments in general or children's hospitals. It has been realized that the child is not just a small adult but instead is a growing individual with characteristics, needs and weaknesses peculiar to its stage of development. Pediatrics—the science of the diseases of children—has therefore been growing in importance during the 20th century as a specialization with its own knowledge and skills. Simultaneously, closer co-operation has developed between the clinician and the traditional MCH workers, whose knowledge of the child's background, gained through repeated home visits, and whose capacity for continuing surveillance of the child have proved indispensable.

In some countries milk and special health foods are available to the child through the MCH centre. In industrial areas of most countries, and during special times such as harvest in the rural areas of some countries, day care of the children of working mothers is provided by government or voluntary agencies in day nurseries under trained staff.

Children who for one reason or another have been deprived of an adequate home life are looked after in residential homes by trained house mothers and fathers. There is a general trend away from caring for these children in large institutions and toward placing them in small homes where they will regain their sense of belonging to a stable family group. Responsibility for their health supervision is usually undertaken by the MCH service personnel, as is also the health supervision of children in kindergarten or nursery schools.

Less direct but nonetheless important in their effect on the health of women and children are the various national measures for the protection of the woman who is having a child. These may take the form of maternity leave with full pay for employed women; assignment to lighter work during pregnancy; protection from loss of employment because of absence from work because of pregnancy and childbirth; and the provision of maternity allow-

ances or benefits in cash or goods. Family allowances, either as direct grants or as tax relief based on the number of children, are designed to contribute to the social and economic health of the family as a whole.

The School Child.—The health of the school child, when it is the responsibility of health or educational authorities, is supervised and protected by means of the school health service, school dental service and the control of the site and construction and sanitary condition of school buildings. Medical inspection on admission to school and regular inspections throughout the child's school life are compulsory in some countries and are carried out by qualified medical officers. Vaccination and immunization against various infectious diseases as well as treatment and the correction of defects may be provided free at special school clinics or sought by the parent elsewhere on the advice of the school medical officer or nurse. In some countries, dental clinics are a normal part of the school building. In others, children are referred to special clinics or to their own dentists. In rural areas mobile units carry the doctor or dentist and his equipment to the schools. Education of children regarding health matters, the development of good health habits during school life and the provision of adequate time and space for physical recreation are given varying emphasis in different countries. The mental and emotional health and development of school children have received increasing attention in recent years through the services of the educational psychologist and child guidance clinics.

School meals, which were supplied at the beginning of the 20th century to children in need or to those who for one reason or another could not obtain a midday meal, so proved their value in the improvement of the physical and mental health of the school child that they now form a regular feature of school life in countries such as Great Britain, the United States and Sweden.

Special services are provided by government or voluntary agencies for the care of the physically or mentally handicapped child in most countries—as well as convalescent or holiday facilities for the child in need of such short-term care.

Countries in the Process of Extending Their Services

In these countries, MCH services have already proved their worth in cities and urban areas, and in those areas the maternal and infant deaths have fallen considerably. Extension into the rural areas depends on an adequate supply of trained staff; this training generally emphasizes the inseparability of curative and preventive conditions and measures. Some change of emphasis is being given to the services provided. Present-day rural services demand a wider approach than was customarily taken in the past, when attention was concentrated on the infant's first year of life. The hitherto neglected preschool child is also in need of supervision and protection from accidents, infections and nutritional problems; these, it is now realized, cause high rates of sickness and death in this age group. Itinerant clinics have been found useful in the provision of MCH services to scattered rural communities, and the residents of these communities are being encouraged to build and develop their own health centres wherever possible. More use is being made of the auxiliary worker with a shorter training to complement the work of the fully trained doctor or nurse, especially in the field of home visiting and simple educational work with rural families.

Countries in the Process of Developing Basic Health Services

Most of these countries are in the tropical or subtropical areas of the world where the hazards to maternal and child health include poverty, malnutrition, the diarrheal infections and numerous other infectious diseases such as malaria. Sanitary water supplies and sewage disposal are being developed, food production increased and the communicable diseases eradicated or brought under control by various means. In the field of child health, fragmentation of services is avoided by the establishment of an administrative division for maternal and child health in the national health organization. This unit is responsible for the supervision of the health of the mother from the antenatal period and of the child until school-leaving age in a continuing and co-ordinated fashion. Urgently needed personnel such as doctors, public health nurses, midwives and their auxiliaries are being trained as rapidly as possible, often with the help of international organizations such as the World Health organization (WHO) and the United Nations Children's fund (UNICEF).

The assistance provided by WHO in the training of staff has taken various forms. One method has been to assign teaching staffs to medical nursing and midwifery schools for basic and postgraduate education. Sometimes it has been necessary to organize in-service training in demonstration and training centres; and many fellowships have been awarded for academic studies or study tours. The encouragement of the creation of chairs of pediatrics in medical schools—and their staffing by visiting professors for the initial years—is considered one of the most important ways in which WHO can assist countries to develop their services for children.

UNICEF has assisted in much of this work by providing equipment for training centres, schools of nursing and midwifery, teaching wards in hospitals, courses for traditional birth attendants and training stipends. The experience gained in field work is from time to time reviewed so that conclusions may be drawn to guide future plans.

Reliable statistics are available only from those countries where literacy and the general level of education have ensured that the basic information is given willingly and accurately. Until these standards become more general, information regarding the births, deaths and illnesses occurring in the population has to be sought by special surveys and investigations. The work of MCH services in the countries now developing their resources is largely educational—helping the mother to make the best use of the local amenities, soil, water, utensils and food in the care, nourishment and protection of her child. The separation of preventive and curative activities is impossible practically, as well as unacceptable to the people concerned. Indeed, a successful cure or curative campaign has proved one of the best means of encouraging the acceptance of the advice that so often conflicts with long-held beliefs about child rearing. In several countries, the help of anthropologists has been sought by public health and MCH workers to facilitate the development of services and methods acceptable to the indigenous culture. The traditional midwives have been encouraged to attend courses in which elementary concepts of hygienic midwifery practice are taught. Each country has developed its own particular form of rural MCH services, usually around the nucleus of a health centre staffed by at least one public health administrator, the midwife, the home-visiting public health nurse, a sanitarian officer and a village educator. The international agencies co-operate with national governments in the development of these services, in the staffing and running of training projects and seminars, in pediatric education in the universities, in research into nutritional and other problems, and in the provision of supplies and equipment and fellowships for the training of future national MCH workers. (V. W. W.)

THE UNITED STATES

Development.—Late in the 19th century, private agencies in several large U.S. cities opened stations to distribute pasteurized milk for babies in an effort to reduce infant mortality. This was the beginning of the infant welfare movement in the United States. As clean milk became generally available, the purpose of these stations changed. They became centres for continuous health supervision and the prevention of disease in infancy and early childhood; there, mothers could receive health guidance, advice on infant feeding and nutrition, and demonstrations from nurses in the care of the baby.

As the child health programs grew, recognition of the great value of prenatal care in the prevention of maternal and infant deaths became widespread. During the first decade of the 20th century organized prenatal nursing services and prenatal medical clinics began to be included in public health programs. In 1908 the New York city department of health established a division of child hygiene. This action by the largest city in the United States

accorded recognition to the importance of child hygiene and helped give impetus to a new era in maternal and child health.

The United States government in 1912 created the U.S. children's bureau, the first agency of its kind in any national government. According to the creating legislation, the bureau shall ". . . investigate and report . . . upon all matters pertaining to the welfare of children and child life among all classes of people, and shall especially investigate the question of infant mortality, the birth rate . . . and diseases of children. . . ." The bureau, initially a part of the department of commerce and labour, was placed in 1946 in the Social Security administration of the department of health, education and welfare.

An epoch in child health legislation was marked in 1921 with the passage of the Sheppard-Towner bill for the protection of mothers and infants. Administered by the children's bureau, this act provided for grants-in-aid to the states and thereby assisted in the creation of maternal and child health bureaus in many states. It lapsed in 1929 but laid the groundwork for the maternal and child health provisions of the Social Security act.

The Social Security act of 1935 authorized grants to the states for maternal and child health services and for services to crippled children. These grants are administered by the children's bureau. The purposes of the grants are to enable the states to extend and improve, especially in rural areas, (1) services for promoting the health of mothers and children and (2) services for locating crippled children and for providing them with medical and hospital care. Maternal and child health programs are administered by state health departments; services for crippled children are offered by the state agency designated by the state, usually the state health department.

Scope.—The maternal and child health program is primarily one of preventive health services, but a few states also provide some medical and hospital care for women with complications of pregnancy and for premature infants. The state programs include: maternity clinics that provide health supervision of expectant mothers by physicians, with advice by public health nurses and nutritionists as to hygiene and diet during pregnancy and lactation; well-child clinics that provide health supervision of children, vaccinations and advice to parents to help promote optimal growth and development; health services for school children; dental hygiene and prophylaxis; licensing and inspection of maternity homes; consultation to hospitals on maternity and newborn services; provision of incubators and hospital care for premature infants in special centres. There was much variation among the states in their programs.

During the mid-1960s medical prenatal care was provided in the state maternal and child health programs to about 280,000 expectant mothers annually. Medical and hospital care was provided annually to about 42,000 women with complications of pregnancy. Health supervision was provided yearly for 1,500,000 infants and preschool children at well-child conferences. School children examined annually by physicians numbered 2,440,000. Each year, about 3,000,000 children were immunized against smallpox, 4,225,000 against diphtheria, 2,700,000 against pertussis, 4,600,000 against tetanus, and 12,000,000 against poliomyelitis.

Increasing attention has been given to special programs for the care of premature infants, to the mental health aspects of pregnancy and child growth and development, to immunization, to provisions for postgraduate training of personnel, and to perinatal mortality (*i.e.*, fetal and neonatal deaths). Since 1915, when the federal government began recording birth figures, the maternal mortality rate has declined 94% and the infant mortality rate has declined 75%. Much of the decline in death rates is due to improvements in education, hygiene and general living conditions; the greater availability of health and medical services; discoveries such as antibiotics; and hospital insurance. In the mid-1960s, 95% of all births in the U.S. took place in hospitals, and 97% of all births were attended by physicians.

The leading cause of infant deaths in the U.S. in the mid-1960s was prematurity; about 7.5% of all live births were premature. (In the United States a premature infant is defined as a live-born infant weighing 2,500 g. [5½ lb.] or less.)

In 1956 congress earmarked $1,000,000 of the annual maternal and child health appropriation for use in assisting state health departments in developing demonstration programs to serve mentally retarded children. The interest in this work was so marked that other maternal and child health funds were added and by the mid-1960s all 50 states had developed programs. Most of these were organized around a mental retardation clinic staffed by a pediatrician, a medical social worker and a psychologist, with other specialists available. The programs provided diagnosis and evaluation of the child's expected achievement level, with particular attention to the young, more severely retarded children whose parents wished help in caring for them at home.

Much progress has been made in graduate training in public health for physicians, nurses, nutritionists, medical social workers and others. Financial support from the children's bureau was provided for maternal and child health teaching at certain schools of public health (*e.g.*, Harvard, California, North Carolina, Pittsburgh, Johns Hopkins, Michigan, Minnesota), nursing and social work. Opportunities were made available for training in specialized clinical and public health fields such as prematurity, audiology, epilepsy, cerebral palsy, heart disease and childhood amputations of the limbs.

The crippled children's program was originally predominantly orthopedic. As the programs developed, they were extended to include children with other kinds of crippling conditions. The definition of crippling is determined by each state, so that there is some variation among the programs. In the mid-1960s more than 385,000 children received medical services each year in crippled children's clinics, hospitals and convalescent homes. About half of these children had an orthopedic handicap. The distribution of other major conditions included: cerebral palsy 9%; late effects of poliomyelitis 8%; hearing impairment 6%; burns and accidents 5%; cleft palate and harelip 5%; congenital heart disease 5%; rheumatic fever and heart disease 3%; and epilepsy 2%. About 30% of the total had congenital malformations. The number of children with congenital heart disease who received care showed marked increases; *i.e.*, from 2,000 in 1950 to 8,000 in 1956 and 23,000 annually in the mid-1960s. This resulted from the considerable progress that has been made in developing new, highly successful surgical operations for treating these children. It was estimated that about 40,000 infants are born each year with some form of congenital heart disease.

The crippled children's program was expanded to include children with a wide variety of crippling conditions primarily because new methods of diagnosis and treatment became available. The number of epileptic children receiving medical services, though small, increased rapidly because new drugs became available for use in treatment. After ingenious new artificial hands and legs became available, a marked increase occurred in the number of children seeking care for the congenital absence of one or more limbs. The development of antibiotics and of the electronic hearing aid revolutionized the theory and practice of the diagnosis, prevention and treatment of hearing impairment. Programs for the conservation of hearing became widespread, with millions of children receiving audiometer tests each year. Hearing tests were developed for testing the hearing of infants. Because of the importance of helping the hard-of-hearing youngster to hear and speak early, many such children have been fitted with hearing aids at one year of age. This enabled them to learn normal communication instead of sign language and reduced the need for residential care. Increasing attention was being given to the effects of handicaps on emotional as well as on physical growth and development and to the use of measures that would reduce to a minimum the time young children are separated from their parents for surgery or other hospitalization.

Certain crippling conditions declined; *e.g.*, osteomyelitis, mastoiditis, bone and joint tuberculosis and poliomyelitis. As a result, the proportion of children with congenital malformations increased. The trend among all programs was to broaden the scope of services to include more diagnostic services. There was also an increase in the number of diagnostic, treatment and rehabilitation centres for children where all pediatric and specialized

outpatient services could be provided. This had special significance for children with multiple handicaps. (AR. J. L.)

GREAT BRITAIN

During the last half of the 19th century there was a great improvement in the living conditions of the British people and some attention was being paid to the welfare of mothers and young children. Yet it was found at the end of the century that, in spite of a fall in the general death rate, the infant death rate had not fallen. In consequence, the years immediately preceding World War I saw great improvements in the care of infants and young children. Antenatal clinics were begun in London by Herbert R. Spencer in 1891 and in Edinburgh by John W. Ballantyne in 1901, while Frank Drew Harris set up a milk distribution centre in 1899. The Midwives act of 1902 inaugurated the state registration of midwives; the Notification of Births act of 1907 introduced the system of notification of births within 36 hours of their occurrence; and school health service came into being in 1907. Also in 1907, John F. J. Sykes, medical officer of health for St. Pancras, London, established a "school for mothers," consisting of a milk distribution centre and clinics for babies and older children. Local authorities and voluntary agencies, assisted by government grants, established further infant welfare clinics, where infants and young children were examined and mothers instructed in their upbringing; later these agencies founded many antenatal clinics, where expectant mothers were examined physically and were given instruction on how to maintain good health during pregnancy.

World War I delayed progress but the years between World Wars I and II saw the rapid development of all these services, so that by 1938 a comprehensive service was available for all expectant and nursing mothers and for children up to school-leaving age. During World War II, when food supplies were limited, special arrangements were made so that pregnant and nursing mothers and their young children were given priority in the distribution of milk and vitamin supplements. The wisdom of this policy was amply demonstrated by the obvious well-being of the mothers and children in this period and by the fact that the death rate among infants continued to fall through the war years. After the war the National Health Service act of 1946 established a general medical service that gave comprehensive cover for the whole population.

Maternity Services.—Under the National Health Service act, an expectant mother planning a domiciliary confinement can engage the services of a doctor, without fee, to look after her during pregnancy, confinement and puerperium; the services include a postnatal examination about the sixth week. The services of a domiciliary midwife are provided free for the same period by the local health authority. If the mother unexpectedly develops an abnormality during pregnancy or childbirth, the services of a consultant obstetrician are available to her free in her own home; if necessary, the obstetrician can be assisted by a medical and nursing team equipped to undertake emergency operative procedures.

When the mother has her baby in a hospital, all medical and nursing services and accommodation are provided free. In Great Britain approximately 35% of the babies are born at home and 65% in the hospitals. An ambulance service is provided free to transfer a mother to a hospital should an emergency arise or if she goes unexpectedly into labour. Following a normal confinement in the hospital the mother usually remains there for 10 to 14 days before returning home.

Unqualified women are not permitted to nurse women in pregnancy or childbirth. The length of training for a woman wishing to become a midwife is one year for state-registered nurses and 18 months for women who are not state-registered (*see* NURSING).

Whether the mother is confined at home or in a hospital, local authorities are empowered to provide the service of a domestic (who does not undertake nursing duties) in the home during pregnancy and the confinement or if there is illness in the home during that period or at any other time. The service may be provided free or at reduced cost.

Provided she satisfies certain insurance conditions, a mother is eligible for a maternity grant and, if she has been employed or self-employed until 13 weeks before the confinement, for a weekly maternity allowance for 18 weeks. If she has her baby at home she also receives a home confinement grant. (*See* SOCIAL SECURITY: *Social Insurance in Great Britain and the Commonwealth.*)

All expectant and nursing mothers, infants and young children are eligible for a supply of milk free or at reduced cost, as well as free orange juice, cod-liver oil and vitamin A and D tablets.

Postnatal Care.—On the 15th day after delivery, or as soon as possible thereafter, the mother is visited in her home by the district health visitor, a state-registered nurse who received six months' experience in midwifery and nine months' whole-time training in social medicine before taking the examination for the health visitor's certificate. She visits the mother at regular intervals thereafter and gives her advice and help on the upbringing of her child. She invites her to visit the local child welfare clinic, where her child may be examined by the clinic medical officer and where she can listen to health talks, join discussion groups or see health education demonstrations. The function of these maternal and child health clinics is primarily educational. If mother or child is found to be suffering from any disease or disability they are referred to their own family doctor or, if need be, and if the family doctor agrees, direct to a hospital.

Facilities for vaccination against smallpox and immunization against diphtheria, whooping cough, tetanus and poliomyelitis are also provided. Children attend these clinics and are medically examined at lengthening intervals until they are five years old unless they enter a nursery school at an earlier age, in which case they become the responsibility of the school health service. Any child between two and five years of age found to be suffering from a physical or mental handicap is referred to the school health service so that adequate arrangements can be made for his education before he reaches the age of five.

During his first year at school the child is examined by the school medical officer, assisted by the school nurse. Both are often the same persons who saw him in the child welfare clinic. This routine medical inspection is repeated when the child is eight or nine years old and again just before he leaves school. In the intervening period, if he is failing to make satisfactory progress either physically or mentally, he is referred to special clinics for the physically and mentally handicapped and for children who are mentally disturbed; there appropriate arrangements are made, with the approval of his family doctor, for him to receive the special care and treatment he requires.

Local authorities are required to make arrangements for the dental care of expectant and nursing mothers and of children up to school-leaving age but, owing to a shortage of dentists, this service was not fully developed by the mid-1960s.

A cooked meal is available free, or at reduced cost, for all school children. A family allowance is paid for each child in a family except the first child. The allowance in 1964 was 8*s.* for the second child and 10*s.* for each subsequent child. In the case of a widow eligible for widow's allowance, the allowance including the family allowance was 37*s.* 6*d.* a week for each child including the first. Children are eligible for these allowances until their 19th birthday, provided they are receiving full-time education.

The employment of a child under the age of 13 is prohibited. Over that age he may not be employed in such a manner as to be prejudicial to his health or otherwise render him unfit to obtain the full benefit of the education provided for him.

Finally, the youth employment service, which is part of the educational system, collaborates closely with the school medical officer to try to ensure that the young adolescent is placed in employment suitable to his mental and physical capacity.

The services that have been described are financed from central government funds and local taxes and are staffed by whole- or part-time employees of the local health authorities. General practitioners provide similar clinic facilities as part of their services to their patients and seek the assistance of the district health visitors in the social problems arising in their practice.

See also references under "Maternal and Child Health" in the Index. (J. M. MACK.)

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MATHEMATICAL INDUCTION, one of various methods of proof of mathematical propositions, based on the following principle.

The Principle of Mathematical Induction.—A class of integers is called hereditary if, whenever any integer x belongs to the class, the successor of x (*i.e.*, the integer $x + 1$) also belongs to the class. The principle of mathematical induction is then: If the integer 0 belongs to the class F and F is hereditary, every non-negative integer belongs to F. Alternatively, if the integer 1 belongs to the class F and F is hereditary, then every positive integer belongs to F. The principle is stated, sometimes in one form, sometimes in the other; and as either form of the principle is easily proved as a consequence of the other, it is not necessary here to distinguish between the two. (*See* also NUMBER.)

The principle is also often stated in intensional form: A property of integers is called hereditary if, whenever any integer x has the property, its successor has the property. If the integer 1 has a certain property, and this property is hereditary, every positive integer has the property.

Proof by Mathematical Induction.—An example of the application of mathematical induction in the simplest case is the proof that the sum of the first n odd positive integers is n^2; that is, that

$$1 + 3 + 5 + \ldots + (2n - 1) = n^2 \qquad (1)$$

for every positive integer n. Let F be the class of integers for which equation (1) holds; then the integer 1 belongs to F, since $1 = 1^2$. If any integer x belongs to F, then

$$1 + 3 + 5 + \ldots + (2x - 1) = x^2 \qquad (2)$$

The next odd integer after $2x - 1$ is $2x + 1$, and when this is added to both sides of equation (2), the result is

$$1 + 3 + 5 + \ldots + (2x + 1) = x^2 + 2x + 1 = (x + 1)^2 \qquad (3)$$

Equation (2) is called the hypothesis of induction and states that equation (1) holds when n is x, while equation (3) states that equation (1) holds when n is $x + 1$. Since equation (3) has been proved as a consequence of equation (2), it has been proved that whenever x belongs to F the successor of x belongs to F. Hence by the principle of mathematical induction all positive integers belong to F.

The foregoing is an example of simple induction; an illustration of the many more complex kinds of mathematical induction is the following method of proof by double induction. To prove that a particular binary relation F holds among all positive integers it is sufficient to show, first that the relation F holds between 1 and 1; secondly that whenever F holds between x and y, it holds between x and $y + 1$; and thirdly that whenever F holds between x and a certain positive integer z (which may be made to depend on x), it holds between $x + 1$ and 1.

The logical status of the method of proof by mathematical induction is still a matter of disagreement among mathematicians.

Giuseppe Peano (*q.v.*) included the principle of mathematical induction as one of his five postulates for arithmetic (*see* POSTULATE). Many mathematicians agree with Peano in regarding this principle just as one of the postulates characterizing a particular mathematical discipline (arithmetic) and as being in no fundamental way different from other postulates of arithmetic or of other branches of mathematics.

Henri Poincaré (*q.v.*) maintained that mathematical induction is synthetic and a priori; that is, it is not reducible to a principle of logic or demonstrable on logical grounds alone, and yet is known independently of experience or observation. Thus mathematical induction has a special place as constituting mathematical reasoning par excellence, and permits mathematics to proceed from its premisses to genuinely new results, something that supposedly is not possible by logic alone. In this doctrine Poincaré has been followed by the school of mathematical intuitionism (*see* MATHEMATICS, FOUNDATIONS OF) which treats mathematical induction as an ultimate foundation of mathematical thought, irreducible to anything prior to it, and synthetic a priori in the sense of Immanuel Kant (*q.v.*).

Directly opposed to this is the undertaking of Gottlob Frege (*q.v.*), later followed by Alfred North Whitehead and Bertrand Russell (*qq.v.*) in *Principia Mathematica*, to show that the principle of mathematical induction is analytic, in the sense that it is reduced to a principle of pure logic by suitable definitions of the terms involved. A sketch of the method, especially the definitions, by which this is to be accomplished is given under Frege's name in the article LOGIC, HISTORY OF.

Transfinite Induction.—A generalization of mathematical induction applicable to any well-ordered class or domain D, in place of the domain of positive integers, is the method of proof by transfinite induction.

The domain D is said to be well-ordered if the elements (numbers or entities of any other kind) belonging to it are in, or have been put into, an order in such a way that: 1. no element precedes itself in order; 2. if x precedes y in order, and y precedes z, then x precedes z; 3. in every non-empty subclass of D there is a first element (one that precedes all other elements in the subclass). From 3. it follows in particular that the domain D itself, if it is not empty, has a first element.

When an element x precedes an element y in the order just described, it may also be said that y follows x. The successor of an element x of a well-ordered domain D is defined as the first element that follows x (since by 3., if there are any elements that follow x, there must be a first among them). Similarly, the successor of a class E of elements of D is the first element that follows all members of E. A class F of elements of D is called hereditary if, whenever all the members of a class E of elements of D belong to F, the successor of E, if any, also belongs to F (and hence in particular, whenever an element x of D belongs to F, the successor of x, if any, also belongs to F).

Proof by transfinite induction then depends on the principle that if the first element of a well-ordered domain D belongs to a hereditary class F, all elements of D belong to F.

One way of treating mathematical induction is to take it as a special case of transfinite induction. For example, there is a sense in which simple induction may be regarded as transfinite induction applied to the domain D of positive integers. But the actual reduction of simple induction to this special case of transfinite induction requires the use of principles which themselves are ordinarily proved by mathematical induction, especially the ordering of the positive integers, and the principle that the successor of a class of positive integers, if there is one, must be the successor of a particular integer (the last or greatest integer) in the class. And there is therefore also a sense in which mathematical induction is not reducible to transfinite induction.

The point of view of transfinite induction is, however, useful in classifying the more complex kinds of mathematical induction. In particular, double induction may be thought of as transfinite induction applied to the domain D of ordered pairs (x, y) of positive integers, where D is well-ordered by the rule that the pair

(x_1, y_1) precedes the pair (x_2, y_2) if $x_1 < x_2$ or if $x_1 = x_2$ and $y_1 < y_2$.

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(Ao. C.)

MATHEMATICAL INSTRUMENTS. The increasing use of mathematics, both as a language for expressing the problems of science and industry, and as a tool for dealing with those problems, has spurred the development of rapid and economical means for obtaining answers to the mathematical problems posed. In a broad sense, any device capable of supplying such answers is a mathematical instrument, which may be defined as a device in which measurable physical quantities such as distances between marks on a rule, electric currents in wires, etc., are used to represent mathematical quantities, and the physical laws governing the device correspond to a set of mathematical relations for which a solution is sought.

The following discussion deals with forms of mathematical instruments (many of which continue to be used in the 1960s) that preceded the development of more recent devices described under COMPUTING MACHINES, ELECTRONIC.

Classification of Instruments.—Mathematical instruments have been constructed of a great variety of elements, but despite the diversity of the mechanisms employed most of the instruments in common use fall into the three main categories discussed below, which are defined by the characteristic mathematical operations they perform. One group solves finite equations, either algebraic or transcendental and in typical instances makes use of cams, linkages, gears or variable electrical elements to establish the required connections among the given variables. A second group evaluates integrals and derivatives by means such as wheels rolling on surfaces of various shapes, or charges and currents in electrical circuits or the quantity of light transmitted thru specially prepared optical media. The third group solves partial differential equations and may employ elastic membranes, electric currents in conducting sheets or polarized light.

Further information will be found under ABACUS; AUTOMATION; CONTROL SYSTEMS; CYBERNETICS; HARMONIC ANALYSIS; INFORMATION THEORY; SERVOMECHANISM; OFFICE MACHINES AND APPLIANCES; and SLIDE RULE.

INSTRUMENTS FOR THE SOLUTION OF FINITE EQUATIONS

Tide Predictor.—The behaviour of the tides at any given port is characteristic of the behaviour of many physical variables. It is found that the height of the tides is a function of time which can be formed by adding together a number of sinusoidal or simple harmonic functions of time, the periods of the latter agreeing with those of the apparent rotation of the sun and moon. Thus the height of the tide is representable by a trigonometric sum, the value of which can be calculated once the amplitudes of the various sinusoidal components have been determined for the port in question. To avoid the labour of computation, Lord Kelvin, in 1872, built his tide predictor, which is preserved in the Science museum in the Kensington borough of London. In Kelvin's model, eight trigonometric components are generated by eight pulleys carried on axes at the ends of eight cranks of adjustable lengths. Four pulleys are carried on the upper and four on the lower side of a rectangular wooden frame. A cord, fixed at one end, passes alternately under the lower and over the upper pulleys, and at the other end carries a weight and marker. The centre of each pulley can describe a circular motion of adjustable amplitude, which circular motion is equivalent to the sum of two simple harmonic or sinusoidal motions, one vertical and the other horizontal. The horizontal component of the circular motion moves the cord out of its vertical position, but if the radius of the circle described by the centre of each pulley is a small fraction of the distance between the lower and upper pulleys, the effect of the horizontal component is small, and the principal effect on the cord is that of the sinusoidal vertical component. The hanging weight will therefore perform a motion which is the sum of the constituent vertical motions of the pulleys.

In the first complete working machine made on the lines of Kelvin's original model, ten components are added, and the curve representing a year's tide for any port can be drawn in about four hours. In later machines of larger capacity, the horizontal motion of the pulleys was eliminated by the use of scotch crossheads, the portion of the wire between upper and lower pulleys remaining always vertical. In a machine made in 1924 and located at Liverpool, there are 26 components; in an American machine completed in 1910 there are 37 components, and the tidal curves for seven years can be run off in 12 hours.

Harmonic Synthesizer.—While height of the tide is representable by a trigonometric sum having periods that agree with those of the sun and moon, certain other physical functions such as the voltage produced by an alternating-current generator, are representable by sums of components with periods which are all submultiples of a single fundamental period. Several harmonic synthesizers have been built along the lines of the Kelvin tide predictor described in the preceding paragraph but modified so that the rotational speeds of the cranks carrying the pulleys are in the ratios 1:2:3 etc. and hence the periods of the component motions are submultiples of a fundamental period.

A harmonic synthesizer was designed by Albert A. Michelson and Samuel W. Stratton which differs in principle from the Kelvin machine in that components are added by the summation of forces due to a set of springs, instead of the summation of the displacements of pulleys. In 1897 a machine with 20 components was made, and in the following year one with 80 components. Each component is generated by an element containing an eccentric (near the base of the machine) which communicates a sinusoidal motion to the end of a horizontal lever. The foot of a long rod may be clamped in any position along the lever, the amplitude of the motion which the lever communicates to the rod being therefore proportional to the distance from the fulcrum of the lever to the foot of the rod. The upper end of the rod actuates a lever which in turn extends a small spring. The springs of all the elements are attached to one edge of a wide balance lever and the sum of their forces is balanced by the action of a single very stiff counterspring.

The motion of the balance lever is accordingly nearly proportional to the sum of the motions of the rods, and this resultant motion is conveyed to a pen which draws a graph on a paper carried by a traveling plate.

Polynomial Solvers.—In the design of communication circuits, and in the determination of the stability of dynamical systems, it is important to know the values of the roots of polynomials such as

$$P(z) = A_0 + A_1 z = A_2 z^2 + \cdots + A_n z^n$$

that is, it is required to find the values of z which make $P(z) = 0$. The theory of functions of a complex variable shows that if one draws the curve whose rectangular co-ordinates are derived from the coefficients of the polynomial by the relations

$$x = pA_1 \sin\theta + p^2 A_2 \sin 2\theta + \cdots + p^n A_n \sin n\theta$$
$$y = A_0 + pA_1 \cos\theta + p^2 A_2 \cos 2\theta + \cdots + p^n A_n \cos n\theta$$

and if this curve wraps itself k times around the point $x=0$, $y=0$, then there are k roots with absolute values less than p.

The graph defined by x and y is drawn by an instrument devised in 1937 by Thornton C. Fry and R. L. Dietzold and named by them the isograph. Mechanically, this machine is a ten-component harmonic synthesizer of the Kelvin type, in which the sine components are added and applied to move a pencil, while the cosine components are added separately from the sine components and caused to move the table on which the pencil traces the curve (x, y), these two motions taking place at right angles to each other.

In operation, a value of p is chosen; the coefficients are multiplied by the appropriate powers of p, and the products are set on the synthesizer. A curve (x, y) is drawn by the machine, and

the number of roots with absolute values less than p is determined by inspection of the curve. A new value of p is taken, and the process repeated. If the number of roots counted has changed, then at least one root lies between the two values of p. By successive trials, the region containing a root is thus narrowed down as far as may be desired, within the limits of error of the machine. While the isograph is applicable only to polynomials with real coefficients, S. Leroy Brown has employed his harmonic synthesizer-analyzer in a similar way to the search for roots of polynomials with complex coefficients.

A polynomial solver in which the synthesis is performed electrically was designed by H. C. Hart and Irven Travis in 1937. In this machine, the components are represented by electrical voltages generated by a set of adjustable transformers. The transformers are built in a form similar to that of a motor, and are so designed that the amplitude of the voltage supplied by them is proportional to the sine of θ, the angular position of the rotor shaft, and to the voltage applied to the primary windings. The shafts of the set of transformers are so geared that their rotations are proportional to the integers, 1:2:3, etc. The primary voltages are made proportional to the coefficients $p^n A_n$, and the secondary voltages are added together by connecting the transformer secondaries in series. A set of potential dividers, properly interconnected, supplies voltages proportional to the appropriate powers of p multiplied into the coefficients A. In operation, both p and θ are adjusted by hand until the values of the voltages representing the sine sum and the cosine sum are simultaneously zero. The values of p and θ at which this null point is found define a root which is, in complex exponential form,

$$z = pe^{i\theta}$$

Still another form of polynomial solver was proposed and built by Felix Lucas, in 1887. The operation of this device depended upon certain theorems in the theory of functions of a complex variable and in the theory of the flow of electric currents in sheets of conducting material. In Lucas' device, electric currents whose values are calculated from the values of the coefficients of the polynomial, are applied to certain points in a large (theoretically unbounded) sheet of material. The complex plane for z is plotted on the sheet and the required roots of the polynomial are read off this plot at the points where the current vanishes. Lucas found that the errors introduced by neglecting the finite size of his sheets are appreciable but this difficulty can be avoided by throwing one-half the infinite z-plane into a finite region before mapping.

Linear Algebraic Equation Solvers.—A great variety of engineering problems, such, for example, as those of computing stresses in structures, electric currents in distribution networks, and correlations among statistical data, reduce to the solution of a system of linear algebraic equations, in the form

$$\begin{aligned} &C_{00} + C_{01}x_1 + C_{02}x_2 + \cdots + C_{0n}x_n = 0 \\ &C_{10} + C_{11}x_1 + C_{12}x_2 + \cdots + C_{1n}x_n = 0 \\ &\cdots \\ &C_{n0} + C_{n1}x_1 + \cdots + C_{nn}x_n = 0 \end{aligned}$$

where the C's are given numerical values, and it is required to find the values of the x's which satisfy the equations.

Much ingenuity and effort has gone into the problem of designing mechanisms to solve this problem, and many theoretically correct designs have been produced. In general, however, it may be said that the low accuracy obtainable together with the time required to set up the data of problems have prevented these mechanisms from finding extensive application. Many of them depended upon balances among the forces due to springs or weights, or upon the level sought by a fluid in interconnecting vessels.

A linear equation solver which depends upon the addition of mechanical displacements was reported by John B. Wilbur in 1936. With this solver ten unknowns can be found, usually to within 1% of the value of the largest unknown.

In 1933, R. R. M. Mallock described an electrical machine for solving linear systems. An improved version of Mallock's instrument made by the Cambridge Instrument Co., will solve for ten unknowns to 0.1% of the largest, and will also give a least-squares solution of a set of inconsistent equations. The Mallock machine consists of sets of electrical transformers, one for each unknown, and a set of closed electrical circuits, one for each equation. The coefficients are introduced by adjusting the number of turns each circuit makes about each transformer core.

INSTRUMENTS WHICH INTEGRATE AND DIFFERENTIATE

Planimeter.—One of the simplest applications of integration, and one of the earliest historically, is the determination of the area under a curve. If x and y are the rectangular co-ordinates of a curve defined by $y = f(x)$, then the area A bounded by the curve, the two abscissas x_1 and x_2, and the axis $y = 0$, is the integral of $f(x)$ taken from x_1 to x_2:

$$A = \int_{x_1}^{x_2} y \, dx$$

Frequently, the area under a curve represents some quantity of engineering interest and it becomes worth while to make use of an instrument for the rapid determination of that area. To quote only one instance out of many, the area of the curve drawn by a steam-engine indicator is used as the basis for determining the efficiency of the engine.

The invention in 1814 of the first instrument for the direct measurement of the area bounded by an irregular curve is attributed to the Bavarian engineer, J. H. Hermann, and was followed by the invention of similar instruments by numerous men, notably by Tito Gonella of Florence (1824), the Swiss engineer Johannes Oppikofer (1826), and Wetli of Zürich (1849). An example engraved, "Patent von Wetli a Starke, no. 103," which was constructed in 1860, consists of a rotatable horizontal circular disk on which the registering roller rests. The disk is mounted on a frame supported by three grooved wheels, which can roll on three parallel rails. Beneath the disk and mounted on the frame is a horizontal rod held between two pairs of guide rollers, so that it can move in a direction at right angles to the rails. By means of a thin wire wound round the axle of the disk and attached to the ends of the rod the disk is given an angular movement proportional to the longitudinal displacement of the rod. As the tracing point attached to one end of the rod is guided along the curve whose area is to be measured, the distance between the centre of the disk and the plane of the registering wheel is always proportional to the ordinate of the curve. The number of revolutions of the registering wheel is therefore a measure of the area.

J. Clerk Maxwell in 1855 designed a planimeter in which pure rolling was substituted for the undesirable partial sliding of the register wheel, but the instrument was never constructed. James Thomson in 1876 investigated the same problem, and in attempting to simplify Maxwell's mechanism evolved his disk, sphere and cylinder combination which has since been widely used in other mechanisms.

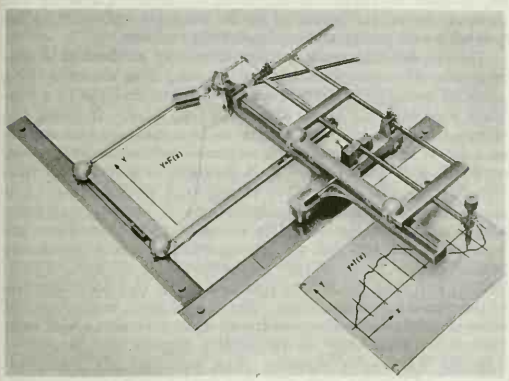
Jacob Amsler, about 1854, invented his polar planimeter which because of its simple construction and low price very soon came into extensive use. In using a polar planimeter manufactured about 1875, a weighted point is fixed and a tracing pointer is guided around the figure whose area is to be measured. The difference of the readings on a graduated roller before and after this operation gives the area of the figure in units depending on the radius of the tracing arm.

Integrators.—A generalized form of planimeter called an integrator was invented by Amsler in 1856. In addition to the area of a figure, this device also measures the moment, $\frac{1}{2}y^2 dx$ and the moment of inertia $\frac{1}{3}y^3 dx$ of the figure about the axis, $y = 0$. The instrument is carried by a pair of wheels moving in a straight groove in a long steel bar, and a counterweight is provided. If the tracing point is guided so as to describe the outline of a plane figure, the graduated roller attached to the swinging arm will register the area of the figure, as in the Amsler planimeter. An outer roller will register the moment of the areas about the

axis of rotation of the instrument. The moment of inertia about the same axis is deduced from the readings on the first roller and the inner one.

In 1887, Capt. Andreas Prytz invented the simple knife-edge or hatchet planimeter. In its original form it consisted of a metal bar, bent at right angles at both ends, one end of which (the tracer) was pointed, and the other was in the form of a curved knife-edge. In using the instrument, a point is chosen near the centre of the area to be measured, and a radial line is drawn from that point to the boundary. The tracer of the instrument is placed at the chosen point, and the hatchet pressed into the paper to form a dent. The tracer of the instrument is then made to follow the radial line and the boundary curve, ultimately returning to the centre point of the area along the same radial line. The hatchet is again pressed into the paper to form a dent. If AB, AB′ be the initial and final positions of the arm, the area described is equal to the length of the arm multiplied by the length of the arc BB′.

Integraphs.—In mathematical language, the planimeter measures the value of a definite integral; for certain applications it is necessary to know the indefinite integral of a function defined by a graph; that is, an instrument is required which will



BY COURTESY OF KEUFFEL AND ESSER COMPANY

INTEGRAPH THAT WORKS ON THE PRINCIPLE OF THE ABDANK-ABAKANOWICZ DEVICE. AS IT TRACES THE OUTLINE OF A GIVEN CURVE (BELOW), THE INTEGRAPH AUTOMATICALLY DRAWS THE INTEGRAL CURVE (ABOVE)

draw the integral curve corresponding to any given curve. One integraph was invented by Charles V. Boys in 1881.

For any value of x the steepness $\frac{dz}{dx}$ of the curve drawn by the instrument is proportional to the ordinate (y) of the given curve for the same value of x. Thus the integraph solves the relation

$$\frac{dz}{dx}=y, \text{ or } z=\int y\,dx$$

The framework of Boys' instrument is a kind of T-square (which can slide along a horizontal straight edge) carrying a centre B which moves along the x axis of the given curve. A rod passing always through B carries a pointer A which is constrained to move in a vertical line ee of the T-square; A can then be made to follow any curve. The distance from B to ee is a constant k; therefore the inclination of the rod AB is such that its tangent is equal to the ordinate of the given curve divided by k. Thus AB has always the inclination of the required curve.

The integral curve is generated by a three-wheeled cart, whose front wheel C is steerable. By means of epicyclic gearing this wheel is kept parallel to AB and can move only in the direction of its own plane. As C is always in the line ee produced, the wheel draws the required curve when allowed to pass over carbon paper.

The first integraph made commercially was invented independently by Abdank Abakanowicz about the same time as that of Boys. This instrument has been made in considerable numbers, with modifications and improvements in design and construction, by Coradi of Zurich.

Harmonic Analyzers.—Jean B. J. Fourier, in his study of the transmission and diffusion of heat, first made use of the simplification which often occurs when a complicated function or curve is represented as the sum of a number of simple harmonic or sinusoidal components. The importance of such a representation has increased with the years, and the measurement of the harmonic components in empirically given data is of importance to the study of communication lines, of electrical power machinery, of mechanical vibrations and noise, of musical instruments, and even in the theory of prediction of statistical data.

While much of the analysis in these fields is carried out by numerical processes, some is done by harmonic analyzers. It is shown in the theory of harmonic analysis (*q.v.*) that under suitable restrictions on the function analyzed a periodic function $f(x)$ can be represented by the series

$$f(x) = \sum (A_n \sin nx + B_n \cos nx)$$

where the amplitudes A_n, B_n are determined by

$$A_n=\frac{1}{\pi}\int_0^{2\pi} f(x)\sin nx\,dx$$

$$B_n=\frac{1}{\pi}\int_0^{2\pi} f(x)\cos nx\,dx$$

It is the object of the harmonic analyzer to determine the coefficients A_n and B_n by a rapid and easy process. There are harmonic analyzers of at least three basically different types. The earliest is an extension of the planimeter and integrator; more recent analyzers have been constructed in which the function is represented on photographic film, and the analysis performed photoelectrically; still other analyzers have converted the given data into electric currents and applied the extensive mechanisms in existence for the analysis of such currents.

Lord Kelvin in 1876 was the first to invent an instrument for performing harmonic analysis mechanically, by an adaptation of the disk-sphere-cylinder mechanism invented by his brother, James Thomson, in 1876. The first completed instrument designed by Kelvin and used for the harmonic analysis of tidal observations, embodies 11 sets of the disk-sphere-cylinder combination, one for each harmonic to be measured. The curve to be analyzed is wound on a central cylinder, and the simple harmonic motions of the proper periods are communicated to the disks by suitable gearing. The bar to which the tracer is attached has a series of forks which embrace the spheres. In actual use, the tracer is made to follow the curve, and the readings on the different integrating cylinders give the required coefficients. An improved form of the analyzer was invented by O. Henrici and Abraham Sharp in 1894.

A different type of harmonic analyzer in which the principle of action is based on William K. Clifford's graphic method of harmonic analysis, was invented by O. Mader in 1909. Essentially Mader's instrument consists of a gear and linkage which, as a pointer traces a given curve, cause a point on the gear to describe a transformed curve; the area enclosed by the transformed curve is measured by an ordinary polar planimeter, and is proportional to the required harmonic coefficient. In using the Mader instrument, a guide ruler which forms part of the machine is placed parallel to the base line of the curve to be analyzed, and the tracer of the planimeter is placed in one of two holes in the gear. For each harmonic to be found there is an appropriate gear with two indentations in its face. To find the sine coefficient, the tracer of the planimeter is placed in one of the indentations while the analyzer traces the given curve, while to find the cosine coefficient, the tracer of the planimeter is placed in the other. The Mader instrument measures only one harmonic at a time, as contrasted with the Henrici analyzer which measures several simultaneously.

Several analyzers have been devised to use optical and photo-

electric means. One such device was designed by H. C. Montgomery in 1939. To use Montgomery's analyzer, the curve to be analyzed is drawn or photographed on a transparent film, and the area of the film on one side of the curve is blacked out to make it opaque. A set of standard films is available in which the "density" varies along the length of the film. Thus when light falls on any part of the film, the fraction of the light transmitted is proportional to the function $C + D \sin nx$, where C and D are constants and x is the distance from a reference mark to that part of the film where the light falls. If the film carrying the curve to be analyzed is superposed on the standard film, then the quantity of light transmitted through any transverse strip of the two superposed films is proportional to the width of the clear part of the one film multiplied by the transmission ratio of that strip of the standard film. Except for the appearance of the additive constants in the factors, this product is the integrand in the definition of the required harmonic coefficient, and the total light transmitted by the entire length of the films is the integral of the product. The total light is measured by photocells, and from this quantity the harmonic component can be deduced. The operation of the instrument is largely automatic, and 30 harmonics can be measured in about a minute and a half.

Differential Analyzer.—The most frequently encountered mathematical problems of engineering and physics are expressed in terms of differential equations, either ordinary or partial. The methods and theory of the solution of ordinary differential equations have received treatment at the hands of many of the masters of mathematics, but there are comparatively few of the differential equations arising in practice that have solutions expressible in terms of a finite number of the elementary functions: sines, cosines, Bessel functions and so forth. Often in the applications of differential equations to engineering, formal solutions may not be necessary or even desirable if a numerical or graphic solution is obtainable. To calculate the latter kind of solution a number of differential analyzers have been constructed in the United States, Great Britain and other countries. Besides solving numerous problems in the design of electrical machinery, in the study of the scattering of electrons by atoms and the determination of the paths of electrons in the field of magnetic dipoles, in the treatment of the performance of automatic industrial control systems and of transients in electric lines, in the determination of the energy exchanges between gases and solids, and in the study of the boundary layer motion of viscous fluids, to mention a few items, the analyzers found extensive use in World War II in the computation of thousands of ballistic trajectories.

The development of the differential analyzer is largely due to Vannevar Bush and his associates at the Massachusetts Institute of Technology in Cambridge. In 1927 Bush and others completed and described a product integraph or continuous integraph which was a forerunner to the analyzer. This device solved differential equations of the form

$$\frac{d^2y}{dx^2} = f_a\,(f_1 + f_2)$$

where the f's are functions of x ordinarily given in the form of graphs.

In 1928 Bush published a description of the first differential analyzer capable of solving a broad class of differential equations. Many minor modifications have been made in the detailed mechanisms of this machine, and more or less exact copies have been produced for use at educational institutions and industrial laboratories throughout the United States, Great Britain and Europe.

The Rockefeller differential analyzer, dedicated in Nov. 1945, represented a considerable advance over the original model partly in refinement of elements but principally in the speed and convenience of means for setting up and controlling the operation of the analyzer.

The basic elementary device in the differential analyzer is the disk and wheel integrator, which appeared first in the early planimeters. Its function is to perform the integration,

$$z = \int y\,dx$$

where, in the integrator, x is the angular displacement of the disk, y is the distance of the integrating wheel from the centre of the disk, and z is the resulting angular displacement of the integrating wheel. The addition of two quantities, x and y, each represented by the angular displacement of a shaft, is performed by a mechanical "differential" or adder, so arranged that a third shaft is rotated through an angle equal to the sum, z, of the first-mentioned displacements:

$$z = x + y$$

Multiplication by a constant is accomplished in the analyzer by appropriate gearing; thus, if k is the gear-ratio between a shaft representing a variable x and another shaft representing a variable y, then

$$y = kx$$

Arbitrary or empirical functions are introduced by means of "input tables," on which are plotted the necessary functions in graphic form.

The solutions which result from the operation of the differential analyzer appear in the form of graphs drawn by the analyzer on output tables, or in the form of numerical values printed by the machine at predetermined intervals.

The original differential analyzer is entirely mechanical in construction, all connections between the computing elements being made by means of shafts and gears which are mounted on a bedplate approximately 4 ft. wide by 18 ft. long. In using the differential analyzer, the equations to be solved are first written as a set of equations each of which may contain an integration, an addition, a multiplication by a constant, or a functional relation like $y = f(x)$. From the equations, a working diagram is made in which symbolic representations of shafts, integrators, adders and gears appear. The variables of the equations are equated to the rotations of corresponding shafts with suitable proportionality factors, and the performance of each mathematical operation in the equations is assigned to a particular one of the elementary mechanisms. The shafts, gears, integrators and other elements of the analyzer are set up in accordance with their symbolic representation on the working diagram.

In the Rockefeller analyzer, shaft rotations are converted by means of rotating electrical condensers into electrical signals which control motors in such a way that the shafts driven by the motors follow very closely the positions of the controlling shafts. Electrically operated switches steer the control signals as required from place to place, thus dispensing with the necessity of connecting shafts by mechanical means. All the information needed to set up the analyzer for a given problem is coded and punched in paper tapes which automatically arrange the electrically operated switches as required, in a few minutes.

Weiss Integrator.—When rapid approximate solution of a system of linear differential equations with constant coefficients is required, a device invented in 1944 by H. K. Weiss is applicable. By well-known analytic means, such systems of differential equations can be solved with the aid of any device which will solve the simple differential equations

$$a\frac{dy}{dx} - by = f(x)$$

$$a\frac{d^2y}{dx^2} - b\frac{dy}{dx} - cy = f(x)$$

where a, b and c are real numbers.

Weiss' integrator for the former of these equations consists of an arm at one end of which is a roller fitted with an inking pad so that it traces out the graph of y, when an adjustable pointer on the arm is made to follow a graph of $f(x)$. The integrator for the second differential equation consists of a pair of arms with a parallel linkage between them; each arm is equipped with a roller, one of which is inked and traces the graph of y. The lengths of the arms and the scale of $f(x)$ must

be chosen so that the angles of the arms with the axis of x remain small throughout the solution.

INSTRUMENTS FOR THE SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

All mathematical instruments are in a sense analogues of the physical situation for which they are intended to furnish a solution, but in the case of certain devices which are used to obtain the solution of partial differential equations the analogy is very close. A typical device of this kind is that used to solve the differential equations of the potential in electronic tubes, and to predict the paths followed by electrons moving under the influence of that potential. It is shown in the potential theory that the electric potential and the displacements of a stretched elastic membrane satisfy the same partial differential equation. Several industrial and educational laboratories concerned with the study and design of electron tubes have developed instruments consisting of rigid frames with circumferential clamps which maintain a practically uniform tension in a sheet of rubber stretched across the frame. The sheet being horizontal, its vertical displacements satisfy the potential equations, and when suitable boundary values are introduced by means of supporting blocks or clamps, the sheet supplies the solution to the potential problem with specified boundary conditions. A light marble rolled on the rubber sheet follows the path which an electron would in an electric potential field.

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MATHEMATICAL MODELS. The child's box of wooden blocks is probably his earliest acquaintance or contact with mathematical conceptions. These concrete forms of the cube, or the more complete selection of geometrical solids comprising cubes, prisms and cylinders, appeal to the latent mathematical talent of the child, just as the abacus or counting-bead frame may stir some understanding of arithmetic.

The child learns that such forms as the cube and prism have many special properties which may, when used in right proportions, make them some of the most pleasing forms of architecture. The simple doubled cube, for example, provides an exquisite form of pedestal; in fact, the inherent beauties of the rectangular prism furnish a valuable architectural theme; also, by means of models it is possible to illustrate to the practical man a conception which may be ordinarily grasped only by a gifted or trained mathematical thinker.

A knowledge of plane geometry acquired without any reference to models may be said to flatten out habits of thinking and make it difficult at a later stage of mathematical education to explore space of three dimensions.

Plane Geometry.—Some early editions of Euclid (*q.v.*) had diagrams intended to be cut and folded, and a work by Cowley of 1752, *New and Methodical Explanations of the Elements of Geometry*, included pieces of cardboard for building various models. As talented a thinker and philosopher as Herbert Spencer appreciated the advantage of a model; in a letter to his father in Jan. 1839 he mentioned his self-set task of regular, daily and systematic study of mathematics, and wrote, "I have found out the grand principle of the projection of shadows and I feel almost certain of its correctness. To make myself still more satisfied I have made a model in pasteboard and I find that the real shadow is as exactly as possible what I had made it by projection."

Intuitive Geometry.—A valuable aid in training mathematical beginners is to cut cardboard equilateral triangles of the same size. The single triangle represents the plane figure; several piled with corresponding edges coplanar and corresponding corners collinear illustrate the triangular prism; while four of them placed with pairs of edges coinciding, one of them being used as a base, give the tetrahedron, the first of the regular solids. The student may thus, by an inductive process, quickly arrive at the complete family of the five regular solids (*see* SOLIDS, GEOMETRIC).

Simple models of this nature may be used to demonstrate common practical problems involving important principles relating to regularity and maximum and minimum values; for example, that a triangle of given perimeter encloses the greatest area when it is equilateral, or that a tetrahedron of given surface area encloses the greatest volume when it is regular.

Polyhedrons.—An important application of this style of model can be made by drawing a cluster of seven equal hexagons, one surrounded by six others. Cut along the 18 boundary lines of the cluster, along the six sides of the central hexagon (which can then be discarded) and along just one of the remaining (radial) lines of the ring of six hexagons. Then cut halfway through and fold back or crease the rest of the radial lines. The paper may now be folded to illustrate some interesting figures. First slide one hexagon over another, so that the hole becomes pentagonal. Sliding two over two produces a square hole; three over three, triangular. If a number of such rings are cut out and made up permanently by gumming the folds, three of the Archimedean solids may be worked up in an effective manner. Twelve of the rings with pentagonal holes may be stuck together (with overlapping hexagons) to make a sturdy model of the truncated icosahedron, sufficiently illustrative although the pentagonal faces are lacking. Similarly, a truncated octahedron (fig. 1) may be constructed from six of the rings with square holes; in fact, two such rings will suffice if they are connected by extra flaps of adhesive strips instead of overlapping hexagons. Again, the truncated tetrahedron may be constructed from two of the rings with triangular holes, or from one such ring attached by flaps to one extra hexagon.

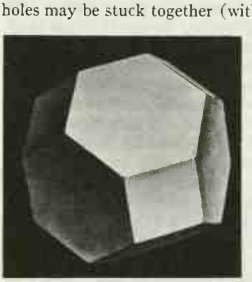

FIG. 1.—PAPER MODEL OF TRUNCATED OCTAHEDRON

A large number of identical models of the truncated octahedron or of the truncated tetrahedron may be fitted together like bricks to fill any volume of space (with small tetrahedral cavities in the latter case). The hexagons are then the faces of a regular sponge or skew polyhedron, each vertex being surrounded by four hexagons in the former case, six in the latter. (*See* the *Proceedings of the London Mathematical Society* [2], 43:33–62 [1937], or *Scripta Mathematica*, 6:240–244 [1939].)

There are altogether three such regular skew polyhedrons. The third has square faces, six at each vertex, and may be built up from repetitions of a simple ring of four squares, like a cube with two opposite faces omitted. This last model has the peculiar property of being collapsible. It may be rendered rigid by inserting diagonal struts into two or more of the rings. These sponges have equal regular faces and equal angles, just like the five Platonic solids.

Another kind of generalized regular polyhedron is obtained by stellating those three of the Platonic solids that have obtuse dihedral angles; *i.e.*, extending or producing the faces until they meet again in new vertexes, always preserving the rotational symmetry of the original solid. In this manner the octahedron leads to the *stella octangula* of Johannes Kepler (1619), which may be regarded as a compound of two interpenetrating tetrahedrons with edges that are the diagonals of the faces of a cube. A dodecahedron (fig. 2)

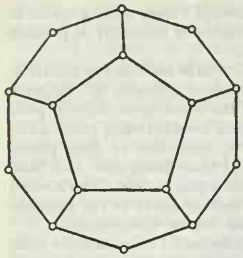

FIG. 2.—REGULAR DODECAHEDRON

leads to three of the four Kepler-Poinsot polyhedrons, as follows. The 12 faces of the small stellated dodecahedron are pentagrams or star pentagons (angle 36°) obtained by extending the sides of the ordinary pentagon until they meet again. The 12 faces of the great dodecahedron are larger pentagons having the same vertexes as these pentagrams. The 12 faces of the great stellated dodecahedron are pentagrams obtained by extending the sides of the large pentagons. In other words, the small stellated dodecahedron may be constructed by placing a pentagonal pyramid (with face angles of 36° at the apex) on each face of the ordinary dodecahedron; and the great stellated dodecahedron, by placing a triangular pyramid (again with angles of 36° at the apex) on each face of the icosahedron. The great dodecahedron may be derived from a solid icosahedron (of wood or wax, for example) by digging a shallow pyramidal pit in each face, and retaining the original edges. Finally, by stellating the icosahedron one can obtain the great icosahedron, as well as several compounds and many irregular but beautiful figures.

Material for Models.—It is not the purpose of mathematical models to prove propositions, but to aid understanding and to suggest further lines of investigation. They need not attain the standard of accuracy required for graphs or nomograms (*see* NOMOGRAPHY). But they should be constructed with reasonable care, and of suitable materials.

The nearest approach to a mathematically plane surface that occurs in nature is a face of a good crystal. In practice, thin sheet metal or cardboard suffices for many purposes although in certain cases transparent plastic or glass is to be preferred; in other cases, strings, or elastic, silk or cotton cords—which may be of different colours—arranged closely together and parallel, may be employed.

Descriptive Geometry.—For the study of such topics as descriptive geometry and perspective (*qq.v.*), a useful device is found in a pair of planes hinged together and possibly provided with a third plane of reference. Such folding planes, if perforated, are helpful in clarifying orthogonal projection. The models introduced by O. Reynolds and G. Cussons (1876) (fig. 3, left) and the later developments by A. H. Miller (fig. 3, centre) are interesting examples of this class. In the former type the problems are permanently drawn out, in the latter they may be built up before the eyes of the student (precaution being taken in the design to avoid distracting the student's attention from the mathematics to the mechanism), thus allowing the solution of the problems to be demonstrated in proper sequence step by step. In this class may be included the design (fig. 3, right) of H. G. Green described in the *Mathematical Gazette*, no. 174, as "A Model for Figures in Three Dimensions," which is particularly useful for three-dimensional and trigonometric studies. Posts may readily be fixed in the holes of the double base of the apparatus; and cords as lines of vision, serve to illustrate questions of the man-and-flagstaff type, subtended angles, and so on.

Wooden Models.—Solid models of wood may be cut in sections to clarify many problems. An impressive example is shown in fig. 4, where a cube is dissected into six equal tetrahedrons without making any new corners. Three of the tetrahedrons are directly congruent; so are the other three, but they are the reflected images of the first three. All four faces of each tetrahedron are right triangles.

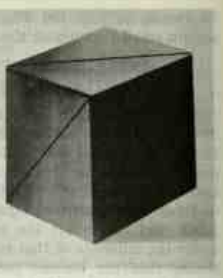

FIG. 4.—WOODEN CUBE

A further example is the well-known model of the binomial cube; *i.e.*, a cube built up of small cubes and prisms with edge lengths represented by arbitrary values of a and b, and an entirely new and larger cube $(a + b)^3$ being formable by a combination of blocks equaling $a^3 + 3a^2b + 3ab^2 + b^3$. The study of conic sections (*see* CONIC SECTION), so frequently treated analytically, is much simplified by the use of a model, such as the right circular cone, in which plane sections are made: (1) parallel to the base; (2) parallel to just one generating line of the cone; (3) inclined to the axis at an angle greater than the semivertical angle of the cone; and (4) inclined to the axis at an angle less than the semivertical angle of the cone. These give respectively the circle, parabola, ellipse and hyperbola (one branch), while a combination solid, wire and plane model allows demonstration (as in fig. 5) of the theorem that the inscribed spheres touch the plane of section at the two focuses of the ellipse.

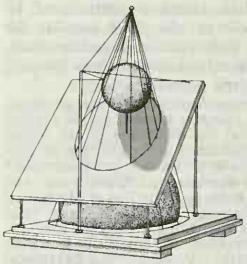

FIG. 5.—CONE WITH INSCRIBED SPHERES AND SECTION PLANE

Problems concerned with interpenetration (*e.g.*, of a torus and a cylinder) can best be illustrated in wood since the intersection is produced in the course of manufacture and its shape may be separately examined (*see* fig. 6).

FIG. 6.—TORUS AND CYLINDER

Technical Construction.—Symmetrical solids and surfaces of revolution can be turned in a lathe, a template representing a plane section through the axis being applied to the work from time to time until the whole solid of revolution is worked up. Surfaces that are not symmetrical around the axis may also be formed in a suitable lathe having a chuck that can produce eccentric motion. Such models may attain a high order of accuracy since micrometer measurements may be applied to the work in the machine. It is easy to represent many surfaces by means of fixed wires shaped and assembled to represent various sections (*see* fig. 7), but a more intriguing series of flexible models can be made up of rods or strips, pin-jointed or hinged at their extremities, since these provide a mechanism whereby ruled hyperboloids may be continuously converted into their confocal surfaces (fig. 7, bottom right).

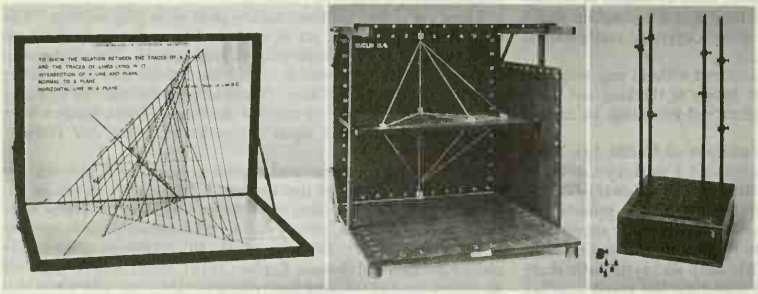

FIG. 3.—CLASSROOM MODELS

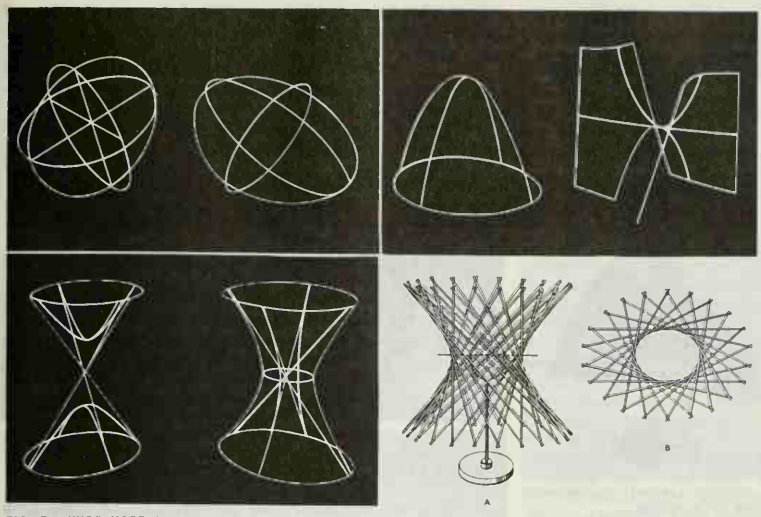

FIG. 7.—WIRE MODELS: (TOP LEFT) ELLIPSOIDS; (TOP RIGHT) ELLIPTIC AND HYPERBOLIC PARABOLOIDS; (BOTTOM LEFT) TWO-SHEET AND ONE-SHEET HYPERBOLOIDS; (BOTTOM RIGHT, A) MOVABLE ROD MODEL OF ONE-SHEET HYPERBOLOID, (B) MODEL VIEWED FROM ABOVE

Thread Models.—Ruled surfaces (*i.e.*, surfaces generated by the motion of a straight line) fall naturally into a class for easy modeling, since the generators can be represented by successive stretched threads (*see* SURFACES). Thread models can, therefore, illustrate a wide variety of combinations as in fig. 8, which shows two circular disks drilled with equidistant holes close together, supported as shown and threaded with weighted cords so that the cords may slide through the lower holes. This model is a demonstration of a cylinder, when the disks and cords hang freely; a hyperboloid of revolution, when one or the other disk is rotated slightly relative to the other; and the limiting position of a double cone.

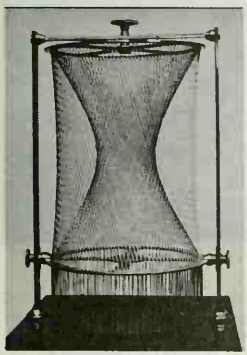

FIG. 8.—DISK AND THREAD MODEL

Threads stretched as generators across the bars of a jointed quadrilateral of which the sides are movable in pairs may be used to illustrate the changes from a plane, through all forms of hyperbolic paraboloid, to double plane. Figure 9 shows a model that comprises two bars pierced with equidistant holes, one bar being fixed, the other free to swing around an axis that can also be inclined at different angles to the fixed bar. It should be observed that the hyperbolic paraboloid cannot be made by simply twisting a plane sheet of metal. Surfaces that can be so developed from a plane (*e.g.*, cylinders and cones) are said to be developable.

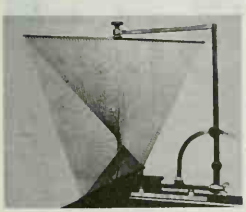

FIG. 9.—BAR AND THREAD MODEL

Space Curves.—Such twisted curves may be modeled either by threads representing their tangents, as in fig. 10 (top left), or by wires suitably bent (top right). The tangents generate a surface which is also the envelope of the osculating planes.

Any twisted cubic (*i.e.*, curve of the third order) may be constructed as the residual intersection of two quadric cones that have a common generator. Figure 10 (bottom left) shows the dual figure: the envelope of planes touching two conics that have a common tangent line.

Figure 10 (bottom right) shows a physical application of twisted curves, illustrating the equipotential lines and lines of force corresponding to two electric conductors bearing equal charges.

Helical Surfaces.—Helicoids may best be demonstrated by either shaped wires or flat pieces of tin plate hinged together, the former providing the cheaper but less flexible medium. Typical examples are seen in fig. 11 (left), where the wires form helices lying on the surface, and (right) where the model is composed of small hinged sections.

Cardboard Models.—Figure 12 (top) shows several models made of thin sheets; *e.g.*, cardboard circles of regularly varying diameters set evenly apart in parallel vertical planes, whereby it is possible to evolve the whole family of quadric surfaces (*e.g.*, ellipsoids, hyperboloids, paraboloids).

A further advantage of this type of model is that the sections may be interlocked across an axis and thereby deformed at will, a feature which appears another way in the deformable circles of fig. 12 (bottom). In this type a number of different-sized wire circles are loosely jointed together across a diameter by a special form of hinge (Wiener's limited joint).

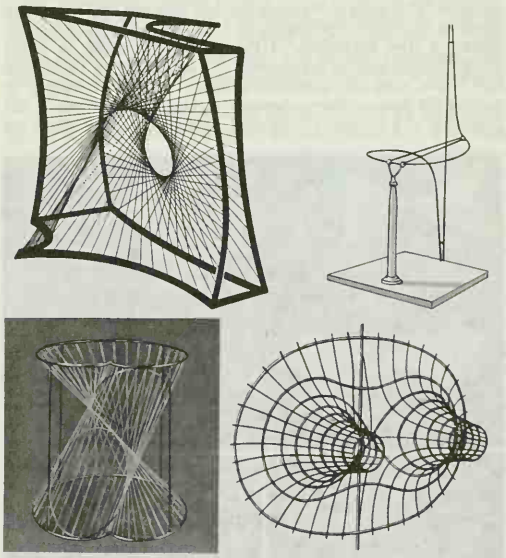

FIG. 10.—SPACE CURVES: (TOP LEFT) THE OSCULATING DEVELOPABLE OF A CUBIC ELLIPSE; (TOP RIGHT) THE HOROPTER, A SYMMETRICAL CUBIC ELLIPSE LYING ON A CIRCULAR CYLINDER; (BOTTOM LEFT) DUAL FIGURE; (BOTTOM RIGHT) EQUIPOTENTIAL LINES

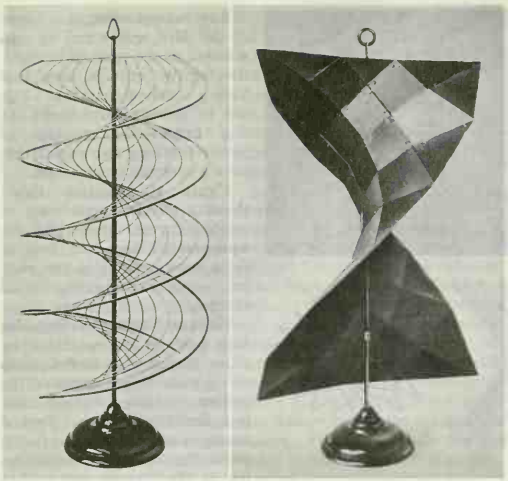

FIG. 11.—(LEFT) HELICES LYING ON A HELICOID; (RIGHT) POLYHEDRONS APPLIED TO THE THEORY OF THE BENDING OF SURFACES

The figures show the limiting positions of circle and sphere and the formation of prolate and oblate spheroids. Similar models may be readily made to illustrate the elliptic paraboloid and the hyperboloid of two sheets.

Surface Models.—The method of representing quadric surfaces by thin sheet circles arranged in parallel planes suggests the means of producing what is probably the most generally useful of all types: surface models of wood, clay or plaster, evolved by applying templates after the manner employed in shaping a model ship's hull. Such a model may represent a three-dimensional "graph," exhibiting the relations among such physical functions as the pressure, volume and temperature of a gas, as in the case of J. Thompson's model of 1871, made to illustrate the data obtained by Thomas Andrews in his classic experiments on a constant mass of carbon dioxide. A later application of the method was made by James Clerk Maxwell who, as the outcome of a suggestion by Josiah Willard Gibbs, used the quantities volume, energy and entropy in making his famous thermodynamic surface model in which the properties of a substance in its solid, liquid and gaseous states are indicated by the geometrical properties of the surface. Maxwell showed how isothermal and isopiestic lines could be drawn upon it and that there is one position of the tangent plane in which it touches the surface in three points that represent the solid, liquid and gaseous states of the substance when the temperature and pressure are such that the three states can exist together.

Plaster Models.—Plaster casts can obviously be produced at less cost than the original mold; wherever feasible the method affords a convenient means of reproducing models of surfaces of revolution or of polyhedrons.

The surface of revolution is typically represented by the model in fig. 13 (left) (the surface of rotation of the tractrix about its asymptote) upon which may easily be marked, after molding, some samples of asymptotic lines, geodesics, etc. Some surfaces of constant mean curvature are shown in fig. 13 (right).

FIG. 13.—PLASTER MODELS OF (LEFT) TRACTROID; (RIGHT, FROM LEFT TO RIGHT) UNDULOID; NODOID; RING OF NODOID ARISING BY ROTATION OF THE LOOP; AND CATENOID, A MINIMAL SURFACE

Surfaces of rotation having a constant negative Gaussian curvature are shown in fig. 14 (left), the pointed model being of the cone type and bearing geodesics and asymptotic lines, the other illustrating the hyperboloid type and being marked with geodesics and geodesic circles. Figure 14 (right) illustrates a cubic surface having four real conical nodes. A form of Kummer surface (singularity surface of a quadratic complex of lines) is shown in fig. 15. It is of the fourth order, of the fourth class, and has 16 real nodes and the same number of singular tangent planes, each touching the surface all along a conic. A further example of a surface of the fourth order is Steiner's Roman surface, shown in fig. 16. It has the equation $y^2z^2 + z^2x^2 + x^2y^2 + xyz = 0$, crosses itself along each of the co-ordinate axes and is one-sided. Its asymptotic lines are indicated on the model.

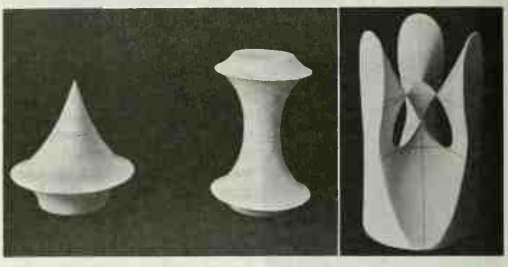

FIG. 14.—(LEFT) SURFACES OF ROTATION; (RIGHT) CUBIC SURFACE

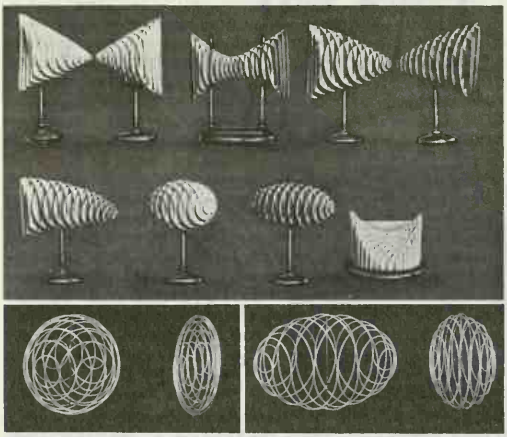

FIG. 12.—(TOP) CARDBOARD MODELS OF SECOND-ORDER SURFACES; (BOTTOM, LEFT AND RIGHT) FLEXIBLE WIRE CIRCLES

FIG. 15.—KUMMER SURFACE

An interesting example of a model illustrating a minimal surface is shown in fig. 17 (left). It contains a system of real parabolas, the planes of which make a constant angle with a fixed plane. Figure 17 (right) is a representation of winding points of the first and second order on Riemann

surfaces. They arise, for instance, when the complex functions $z^{\frac{1}{2}}$ and $z^{\frac{1}{3}}$ are considered in the neighbourhood of the origin.

Linkages and Kinematical Models.—Linkages (*q.v.*) may be described as systems of bars connected by pin joints or hinges to allow deformation without sliding motion (*see* fig. 18). The most famous plane linkage is C. N. Peaucellier's inversor with six bars that consist of a rhombus APBQ and two equal links joining the opposite vertices A and B to a fixed point O. When P is constrained to trace a given curve, Q will trace the inverse curve. In particular, if P is joined by a seventh link to a fixed point M that has a distance from O equal to the length of this new link (so that P traces a circle through O), then Q will trace a straight line.

FIG. 16.—STEINER'S ROMAN SURFACE

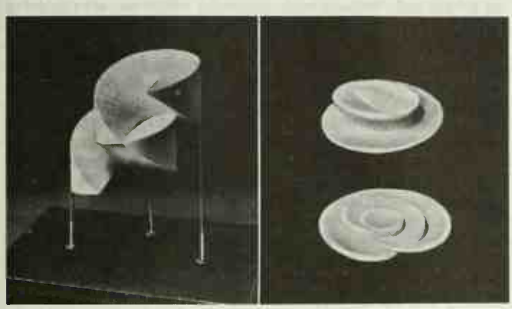

FIG. 17.—(LEFT) MINIMAL SURFACE MODEL; (RIGHT) RIEMANN SURFACES

Space linkages may be made of rigid flat plates hinged together. In the special case when the hinges are all parallel, such a space linkage is clearly equivalent to a plane linkage. Peaucellier's inversor was preceded by the remarkable space linkage of P. F. Sarrus (1853), also shown in fig. 18. This consists of six plates, p, a, b, q, d, c, having three parallel hinges at the edges pa, ab and bq and three parallel hinges at the edges pc, cd and dq. The plates p and q will remain parallel; if the former is fixed, every point of the latter will describe a straight line.

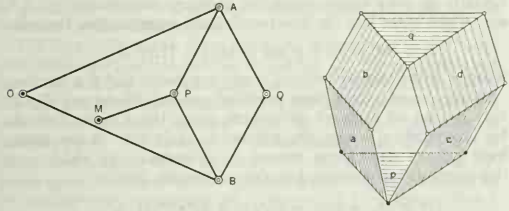

FIG. 18.—(LEFT) PEAUCELLIER'S PLANE LINKAGE; (RIGHT) SARRUS' SPACE LINKAGE

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(G. W. CU.; H. S. M. C.)

MATHEMATICAL SYMBOLS constitute a language in which quantities, operations with them, and their relations to each other are represented in abstract terms, clearly and concisely. As records, symbols eliminate much needless remembering, and the statements themselves frequently suggest procedures to be followed in mathematical thinking.

The symbols used in the earliest printed works in arithmetic and algebra (*qq.v.*) were abbreviations and initial letters such as the hand copyists of earlier days had used. These short cuts were later supplemented by signs devised for specific purposes. This was the case in the first known use of the equality sign (=) which Robert Recorde introduced in his algebra (1557) with the explanation: ". . . to auoide the tediouse repetition of these woordes: is equalle to: I will sette as I doe often in woorke vse, a paire of paralleles, or Gemowe (*i.e.*, twin) lines of one lengthe, thus: ═══, bicause noe .2. thynges, can be moare equalle."

From the 15th to the 17th centuries there was great activity in representing unknown quantities and their powers and in indicating operations with numbers. For relationships among numbers, the symbols $<$, $=$, and $>$ (meaning less than, equal to, and greater than) sufficed. Various symbols were proposed for the same idea; in the hands of several authors, a single symbol might have as many different meanings. Some symbols seem to have survived because of the importance of the people who introduced them; others apparently persisted because they were adapted to new developments in subject matter. The result is that the symbols of elementary mathematics have been aptly described by F. Cajori as "a mosaic of individual signs of rejected systems."

Among 16th–17th-century mathematicians who gave serious study to the subject of mathematical symbols were François Vieta, William Oughtred, René Descartes and Gottfried Wilhelm Leibniz (*qq.v.*). Vieta used vowels for unknown quantities and consonants for known quantities. This made possible the representation of an equation in general terms. Descartes followed this pattern but used the letters from the beginning of the alphabet as knowns and those from the end of the alphabet as the unknowns. Oughtred experimented with more than 150 symbols, of which only a few survive. Toward the close of the 17th century, Leibniz made a careful study of the symbols then in use with particular attention to their clarity and to the ease with which they could be printed. It was in the course of this work that Recorde's equality sign came to be preferred to its competitors.

The use of symbols had its detractors in this period; according to the philosopher Thomas Hobbes (*q.v.*), "Symbols are poor unhandsome though necessary scaffolds of demonstration." In reference to John Wallis' work, Hobbes wrote, "And for . . . your Conic Sections, it is so covered over with the scab of symbols, that I had not the patience to examine whether it be well or ill demonstrated."

The differing approaches to the calculus held by Sir Isaac Newton (*q.v.*) and Leibniz produced different notations. For more than a century, British mathematicians clung to Newton's symbols, mathematicians on the continent to those of Leibniz (*see* CALCULUS, DIFFERENTIAL AND INTEGRAL).

In the 18th century, Leonhard Euler (*q.v.*) contributed an unusual number of symbols that lasted in mathematics; few men have been responsible for more than one. Among Euler's symbols are $f(x)$, meaning a function of x; e, the base of the natural logarithms; Σ, indicating summation; and i, standing for $\sqrt{-1}$.

As a young man Leibniz had a dream of devising a method of representing ideas in a symbolic language. He failed to implement this and the project lay dormant until the 19th century. Then, following the publication of George Boole's *Analysis of Logic* (1847), the attention of mathematicians began to be directed toward the matter of symbolic logic. And in the first half of the 20th century, the study of the structure of mathematics became of prime importance. Each of these activities was accompanied by specific symbolism. Thus the modern symbolism for sets, groups (*q.v.*) and the other materials of the newer algebra, and the symbols for symbolic logic exhibit a variety similar to that which accompanied the development of algebra and of the calculus (*see* SET THEORY [THEORY OF AGGREGATES]).

The precision of these symbols is striking. In the matter of sets, the statement $R = \{x|x > 2\}$ means that R is the set of values x such that x is greater than 2. If A and B are two sets, then $A \cap B = \{x|x$ belongs to A and x belongs to $B\}$; *i.e.*, the intersec-

tion of A and B means the set of values of x that belong to both A and B. The symbol ϕ signifies an empty set.

[3]In logic (*q.v.*), if p and q are propositions or statements, then $p \not\equiv q$ means p or q but not both; $p \vee q$ means p or q or both; and $p|q$ means not both p and q. New symbols are extensions of the old; for example, if A and B are two points, then AB represents the line segment that joins them; $\overset{\frown}{AB}$ is the length of the arc between them if A and B lie on a circle. The symbol $\overrightarrow{AB}$ has been chosen to represent a vector (*see* VECTOR ANALYSIS). What Newton called the "Analytick Language" has become more precise and more flexible.

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MATHEMATICAL TABLES. By a mathematical table is meant any set of tabulated values the primary purpose of which is to render less laborious the work of professional computers in mathematics, engineering, astronomy, physics, chemistry, statistics and other fields of applied science. The term mathematical tables as commonly employed includes specifically the values of mathematical functions such as $\log x$, $\sin x$, etc., and lists of special quantities such as prime numbers, mathematical constants, etc. In a broad sense it is sometimes used to include certain numerical values obtained empirically in scientific laboratories. In this category, for example, are actuarial tables, lists of physical constants, astronomical tables, etc.

Classification.—The need for some system of classification of tables was early recognized, and such a system was made by Arthur Cayley (1821–95) to accompany the extensive report by James W. L. Glaisher on *Mathematical Tables* published by the British Association for the Advancement of Science in 1873. Modern development of the field revealed the inadequacy of this classification, and a system was devised in 1940 by the Committee on Mathematical Tables and Other Aids to Computation of the National Research Committee of the United States as follows:

A. Arithmetical tables; mathematical constants
B. Powers
C. Logarithms
D. Circular functions
E. Hyperbolic and exponential functions
F. Theory of numbers
G. Higher algebra
H. Numerical solution of equations
I. Finite differences
J. Summation of series
K. Statistics
L. Higher mathematical functions
M. Integrals
N. Interest and investment
O. Actuarial science
P. Engineering
Q. Astronomy
R. Geodesy
S. Physics
T. Chemistry
U. Navigation
V. Calculating machines and mechanical computation

Basic Concepts.—Most mathematical tables are designed to give the numerical values of some particular function $f(x)$ corresponding to a set of values of the independent variable x. Thus tables of square roots provide values of the function $\sqrt{x}$ over a range of values of x, let us say from 1 to 10,000. The numbers recorded in the table are called tabular entries, and the values by which the table is entered, namely the values of x, are called the arguments. Such an array of values is called a single-entry table. Although such tables are the most common type, functions of two variables $f(x,y)$ are frequently tabulated. Thus, multiplication tables record the values of the product xy in terms of the two arguments x and y. Such arrays of values are called double-entry tables.

The length and the size of tables depend upon the character of the functions tabulated, the order of the approximation desired and the uses for which the tables are designed. For example, in tabulating $\sin x$, where x is given in degrees, minutes and seconds, it is sufficient to take x by appropriate intervals from 0° to 90°, since the numerical values repeat from quadrant to quadrant. But if x is given in radian measure, then, because of the incommensurability of π, a complete table would require that x be taken from 0 to infinity. Tables have actually been constructed to 100 radians. The interval over which the values of the argument are taken is called the range of the table, and the interval between the argument entries is called the tabular interval. The number of decimal places to which the function is computed is called the place value of the table. Thus we speak of a table of logarithms computed to five decimal places as a five-place table, or a table computed to n decimal places as an n-place table. Sometimes, however, it is more important to refer to the number of significant figures rather than to the decimal places. For example, 22022.466 is an approximation to three decimal places although it contains eight significant figures. Tables which emphasize significant figures are often referred to as n-figure tables. The size of a table clearly depends upon three factors; namely, the range, the tabular interval and the place value. For much practical work, tables computed to four or five decimal places are usually sufficient and many important collections are computed to this approximation. However, other needs have required more place values for certain functions.

A table is said to be linear if the tabular interval is chosen small enough so that linear interpolation is sufficient to obtain, to the place-value approximation of the table, the values of the function at unrecorded value of the argument. For example, a five-place table of the function $\log \sin x$ is linear, except near 0°, if the tabular interval is one minute, but a seven-place table is computed at intervals of ten seconds. Aside from its convenience, a linear table has the advantage of serving also as a table of the function inverse to the one tabulated. Thus a linear table of logarithms is also a table of antilogarithms, for if one enters the tabular values with a number he may obtain, by inverse interpolation, the corresponding argument. This value is the antilogarithm of the number. Similarly a linear table of $\sin x$ will also provide the values of arc $\sin x$, and a linear table of squares may be used to compute square roots.

When values of a function are needed over a long range, it is often impossible to choose the tabular interval sufficiently small to attain linear interpolation without making the table too large. (*See* INTERPOLATION AND EXTRAPOLATION.) In this case differences of second and higher order may be provided for interpolation. Various types of differences have been given, the most usual, particularly in older tables, being the ordinary differences, Δ, Δ^2, etc., which enter into the Newton-Gregory interpolation formula:

$$f(x + ph) = f(x) + p\Delta f + \tfrac{1}{2}p(p-1)\Delta^2 f + \ldots$$

where h is the tabular interval, x any argument, and p a fraction.

Many recent tables have provided central differences, δ^2, δ^4, etc., instead of ordinary differences, since the Everett formula for interpolation is specially adapted to their use. A few tables have printed derivatives instead of differences, in which case the interpolation formula has the convenient form:

$$f(x + ph) = f(x) + phf'(x) + \tfrac{1}{2}p^2h^2f''(x) + \ldots$$

where, as above, h is the tabular interval, x any argument, and p a fraction.

Inverse interpolation in tables which require differences of second or higher order for direct interpolation is usually difficult. Hence such tables are not useful as tables of the functions inverse to those tabulated. For this reason, if the tabular interval is not chosen sufficiently small to permit linear interpolation, two tables are required to evaluate any function whose inverse is also desired. Thus one finds tables of sines and tables of inverse sines, tables of logarithms and tables of antilogarithms, tables of elliptic functions and tables of elliptic integrals, etc.

As to the value of a table the following is a quote from Glaisher:

The intrinsic value of a table may be estimated by the actual amount of time saved by consulting it; for example, a table of square roots

to ten decimals is more valuable than a table of squares, as the extraction of the root would occupy more time than the multiplication of the number by itself. The value of a table does not depend upon the difficulty of calculating it; for, once made, it is made forever and as far as the user is concerned the amount of labour devoted to its original construction is immaterial. In some tables the labour required in the construction is the same as if all the tabular results had been calculated separately; but in the majority of instances a table can be formed by expeditious methods which are inapplicable to the calculation of an individual result. This is the case with tables of a continuous quantity, which may frequently be constructed by differences. The most striking instance perhaps is afforded by a factor table or a table of primes; for, if it is required to determine whether a given number is prime or not, the only universally available method (in the absence of tables) is to divide it by every prime less than its square root or until one is found that divides it without remainder. But to form a table of prime numbers the process is theoretically simple and rapid, for we have only to range all numbers in a line and strike out every second number beginning from 2, every third beginning from 3, and so on, those that remain being primes. Even when the tabular results are constructed separately, the method of differences or other methods connecting together different tabular results may afford valuable verifications. By having recourse to tables not only does the computer save time and labour, but he also obtains the certainty of accuracy.

Notation.—In describing the range, the tabular interval and the place value of tables, a notation has recently come into general use. It may be best described by an example. Thus, let us suppose that we are describing H. Andoyer's table of sin x which has been computed to 15 decimal places over a range from 0° to 90° at intervals of 10″. All these facts are contained in the simple statement that the values of sin x are given for $x = [0°\ (10'')\ 90°;\ 15D]$. More complicated ranges may be similarly expressed. Thus, a recent table of e^x gave 15 decimal values from $x = 1$ to $x = 2.5$ at intervals of .0001 and from 2.5 to 5 at intervals of .001. We might then write that the function was tabulated for $x = [1\ (.0001)\ 2.5\ (.001)\ 5;\ 15D]$. If the approximation was to significant figures rather than to decimal places, then S is substituted for D. Thus, the table just described also gave the values of the function from $x = -100$ to $x = +100$, at intervals of 1, to 19 significant figures. These facts are included in the statement that the function was evaluated for $x = [-100\ (1) + 100;\ 19S]$.

The Computation of Tables.—The computation of tables is an art to which great mathematical ingenuity has been devoted in the 20 or more centuries during which tables have been made. A broad knowledge of the theory of functions and the calculus of finite differences is a primary requirement for anyone beginning an extensive computing program, since many hours of computing labour can be saved by the use of special properties of functions or by the appropriate adaptation of some of the formulas in the difference calculus.

The first task of the computer is to determine (1) the range over which the function is to be evaluated, (2) the approximation to be attained and (3) the tabular interval. The determination of the first two depends primarily upon the purposes for which the table is to be used; the last upon the order of interpolation contemplated. If the table is to be linear, that is to say, if linear interpolation is to be used, then the tabular interval depends upon the degree of the approximation. As an example, let us consider the function log sin x, where x is in degrees. Standard seven-place tables usually give this function for $x = 0°\ (1'')\ 6°\ (10'')\ 84°\ (1'')\ 90°$. Linear interpolation to seven places is attained throughout this table, except very close to 0°; but this would not be the case for, let us say, a tabular interval of 1′, which is the one used in five-place tables of the same function. In most cases the tabular interval may be estimated from the equation $|\triangle^2 f(x)| = h^2 |D^2 f(x)|$, where h is the tabular interval, $|\triangle^2 f(x)|$ is the absolute value of the second difference of the function at argument x, and $|D^2 f(x)|$ is the absolute value of the second derivative. In order to attain seven-place accuracy by linear interpolation, it is clear that $|\triangle^2 f(x)|$ cannot be greater than 10^{-8}. Hence the upper limit of h^2 (in radian measure) is approximately equal to $10^{-8}/|D^2 f(x)|$. Computing the second derivative of log sin x, we obtain $|D^2 f(x)| = \csc^2 x/M$, where $M = .43429$. Hence we have $h^2 = 10^{-8}\ M \sin^2 x$, or $h = \sqrt{M}\ 10^{-4} \sin x = 6.590 \times 10^{-5} \sin x$. For $x = 6°$ we find that $\sin x = .1045$, and thus we obtain the tabular interval $h = 6.887 \times 10^{-6}$ radians = 14″. From this it may be concluded that, from $x = 6°$ to the end of the table, linear interpolation is assured to seven-place accuracy if the interval is at least as small as 14″. The choice of 10″ is thus below the required value and was made for convenience of those using the table.

After the determination of the tabular interval, the computer faces the task of evaluating the function over the range of values which he has selected. In modern times the powerful tools of mathematical analysis have been at his disposal; many types of expansions exist for his use. This was not the case in earlier times. For example, Claudius Ptolemy (*c.* A.D. 150) in computing his table of chords, which is described in more detail below, required the most ingenious theorems of the ancients to attain a six-place approximation. Thus Ptolemy found it necessary, in evaluating his critical quantity: chord $1° = 2 \sin \frac{1}{2}°$, to establish with much effort the inequality: $\frac{3}{4}$ chord $1\frac{1}{2}° <$ chord $1° <$ $\frac{4}{3}$ chord $\frac{3}{4}°$. Computing by a succession of square roots the upper and lower limits of the inequality, Ptolemy obtained a value for chord 1° which was correct to six places. The computer today, however, has available the power series

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$

by which approximations to ten or more places are readily achieved.

In addition to power series, the modern table maker has available to his use asymptotic series, continued fractions, iterative processes, expansions in orthogonal functions, inverse factorial series and other types of series. He has certain devices by means of which the rapidity of the convergence of his series may be increased. Moreover, he has at his disposal the various formulas of the calculus of finite differences, which are adapted to interpolation, numerical integration, differentiation, etc.

In constructing a table of values of a function the usual method of procedure is to compute first a set of key values over some convenient set of coarsely spaced values within the range. These key quantities are computed to more places than are to be retained in the final table. The function is then computed at the intervening values of the argument by what is called subtabulation. This may be accomplished by means of ordinary interpolation, but when many values are desired, as in the case of extensive tables, the differences of the functions at the tabular interval may be computed from the differences of the key values and these in turn used to construct the tabular values.

In the computation of tables which have an extensive range it is often useful to employ certain fundamental properties of the functions tabulated. For example, from a table of values of the gamma function $\Gamma(x)$, computed between $x = 1$ and $x = 2$, an extension of the table is readily computed between $x = 2$ and $x = 3$ by making use of the well-known difference relationship: $\Gamma(x+1) = x\Gamma(x)$. Thus $\Gamma(2.5)$ is obtained from $\Gamma(1.5)$ merely by multiplying the latter value by 1.5. It is clear that the table can be extended to any value by successive applications of this process. Similarly tables of e^x are extended by observing that $e^x \times e^y = e^{x+y}$. In the absence of convenient properties of the kind given above, a function may be evaluated over an extensive range by a proper application of the series

$$f(x+h) = f(x) + hf'(x) + \tfrac{1}{2}h^2 f''(x) + \cdots$$

Thus, let us suppose that a function has been tabulated to some value of the argument x, and that by means of differences or otherwise the values of the derivatives $f'(x)$, $f''(x)$, etc., have also been computed at x. It is clear that the table can then be extended to $x + 1$ by letting h range over the values from 0 to 1. Once the function and its derivatives have been evaluated at $x + 1$, the formula is shifted to this new argument and the computation of the table continued. This device has been used effectively in the formation of tables of the Bessel functions $J_0(x)$ and $J_1(x)$ over a long range.

As an example of an iterative process we may cite what has been called Hero's formula for the extraction of square roots. If N is the number whose square root is desired, and if x_1 is

some approximation to the root, then a better approximation will be given by the formula: $x_2 = \frac{1}{2}(N/x_1 + x_1)$. Higher approximations are obtained by successive repetitions of the formula. This device is very effective in extending existing tables of square roots to additional place values, since one iteration is usually sufficient to double the order of the approximation.

Prodigies of computation have been achieved by means of some of these modern devices. For example, William Shanks (1812–1882) in 1873 published a value of π to 707 places (of which only 527 are believed to be correct), using Machin's formula:

$$\tfrac{1}{4}\pi = 4 \text{ arc tan } \tfrac{1}{5} - \text{arc tan } \tfrac{1}{239}$$

The values of the inverse tangents were found from the ordinary power-series expansion of the function. An approximation for e, the base of natural logarithms, to 707 decimal places was published in 1926 by D. H. Lehmer who used continued fractions. Such extreme values have no intrinsic merit, for one may show that if the radius of space is assumed to be of the order of 2.7×10^{10} parsecs (1 parsec = 3.258 light years) and if the diameter of an electron is assumed to be of the order of 2×10^{-13} centimetres, then a value of π to 41 decimal places is sufficient to express the circumference of space in electron-diameters.

The next task of the computer, and perhaps his most important one, is to assure the accuracy of his table. The difficulty of attaining complete accuracy may be indicated by the fact that one error was detected in the 82nd edition of a well-known standard table, which had been issued continuously for more than a century. The accuracy of a table is sometimes checked by an independent recomputation of the values, preferably by a method different from that used in the original work; but more commonly the computer differences his tabular values. A common error in some tables is the inaccuracy of the last decimal place of the approximation, since this figure is obtained by rounding off the last place in the computed values.

The difficulty in the situation is illustrated by the fact that a five-place table of logarithms cannot be formed completely from a seven-place table of logarithms. For example, in a seven-place table of log x one finds for $x = 3012$ the tabular entry 4788550. In forming a five-place table should this be reduced to 47885 or increased to 47886? The answer is obviously contained in the question whether the last two figures in the seven-place table were rounded off from a number less than 50 or greater than 50. Consulting a ten-place table we find that the corresponding logarithm is 4788549675 and thus the logarithm in a five-place table should appear as 47885. It is often a matter of considerable difficulty to answer a question of this kind.

The History of Tables.—Mathematical tables appear in the earliest records of history. Thus, certain elementary numerical values connected with the combination of the unit-numerator fractions of the Egyptians are found in the Rhind mathematical papyrus, the copy of a scribe named Ahmes, written some time before 1700 B.C. More extensive than these are the records of the Babylonians, dated perhaps as early as 2000 B.C., which contain multiplication tables and tables of reciprocal values, useful in performing elementary arithmetical operations.

The first mathematical table in the modern sense of the word is the table of chords found in the *Syntaxis Mathematica*, or as it is more commonly called, the *Almagest* of Claudius Ptolemy. This remarkable table, dating from the middle of the 2nd century A.D., gives the values of the chords of a circle at intervals of one-half degree to six-place approximation. In the computation of this table, Greek mathematical ingenuity reaches one of its highest points. It is probable that the table is derived from an earlier work by Hipparchus (*c.* 150 B.C.), which is mentioned by Theon of Alexandria. Three lines of this table as it appears in a Greek edition of the *Almagest* published in Basel in 1538, together with a translation into modern symbols, is given below:

KANONION			Translation of the CANON		
κγ	κγ νε κζ	ο α α λγ	23	23 55 27	0 1 1 33
κγs″	κδ κs ιγ	ο α α λ	23½	24 26 13	0 1 1 30
κδ	κδ νs νη	ο α α κs	24	24 56 58	0 1 1 26

For the translation into Hindu-Arabic numerals the following table of equivalent symbols is necessary:

α	β	γ	δ	ε	s	ζ	η	θ	ι	κ	λ	μ	ν	ξ	ο	π	ϙ	ρ
1	2	3	4	5	6	7	8	9	10	20	30	40	50	60	70	80	90	100

Fractions were customarily written with one accent on the numerator and two on the denominator, which was written twice. Thus we have: $\iota\gamma' \kappa\theta'' \kappa\theta'' = 13/29$. For fractions of unit numerator the denominator only was written. Thus we interpret $\mu\delta'' = 1/44$, $\gamma'' = \frac{1}{3}$, etc. Although the usual way of writing $\frac{1}{2}$ was β'' the symbol s'' was also in common use for $\frac{1}{2}$ as we observe in the table of Ptolemy.

The modern character of this table is seen from the fact that it contains first the values of the argument, then the tabular entries and finally a table of differences. To interpret the table we need to know only that Ptolemy used the sexagesimal system of numbers. He divided the radius into 60 parts, each of these units into 60 parts, and so on. Hence, in terms of the radius, we have

$$\text{chord } 24° = \frac{24}{60} + \frac{56}{60^2} + \frac{58}{60^3} = .415824$$

This value is equivalent to $\sin 12° = \frac{1}{2}$ chord $24° = .207912$, which is correct to the last place.

Although mathematical tables were prepared and used both by Hindu and Arab mathematicians, it was not until the 15th century that modern development of this art began. Great tables of the natural trigonometric functions were started under the direction of Georg Purbach (1423–61), who divided the radius into 600,000 parts; and his pupil Johann Müller, more generally called Regiomontanus (1436–76), who computed a table of sines to every minute of arc with a radius of 1,000,000. In the first book of his *De revolutionibus orbium coelestium* (1543), Nicolaus Copernicus (1473–1543) gave a five-place table of sines. The first table of tangents appeared in the *Canon foecundus* (1553) of Erasmus Reinhold and the first table of secants in the contemporary *Tabula benefica* of Franciscus Maurolycus (1494–1575).

Among the greatest labours ever undertaken in table making were those of Rheticus, Otho and Pitiscus. George Joachim, generally known as Rheticus (1514–76), a student of Copernicus, began the task of computing a table of the trigonometric functions to 15 decimal places for every 10 seconds of arc and for every second in the first and last degrees of the quadrant. He completed the tables of sines and began the construction of tables of tangents and secants, but died before they were completed. It is said that he kept several calculators in his employ for 12 years.

The great task was finished by his pupil Valentine Otho (*c.* 1550–1605), who produced the celebrated ten-place canon *Opus palatinum* in 1596. The 15-place table of sines was published in 1613 under the title of *Thesaurus mathematicus* by Bartholomäus Pitiscus (1561–1613). These works are the basis of modern tables.

With the independent publication of a table of logarithms by John Napier (1550–1617) in Scotland in 1614 and a brief table of antilogarithms by Joost Bürgi (1552–1632) in Prague in 1620, numerical computation took a fresh start. Napier's table of logarithms extended to eight places, but his base was essentially $1/e$, $e = 2.7183\ldots$. Although it is common to refer to tables of logarithms to the base e, namely of $\log_e x$, as tables of Naperian logarithms, the more proper name is natural or hyperbolic logarithms. The first table of logarithms to the base 10 was computed by Henry Briggs (1561–1631) and published under the title *Arithmetica logarithmica* in 1624. The computations were made to 14 decimal places, but included only the logarithms of numbers from 1 to 20,000 and 90,000 to 101,000. Although Briggs had intended to complete his monumental computations he was anticipated in this by E. de Decker in his *Tweede Deel der Nieuwe Telkonst* (1627) and A. Vlacq (*c.* 1600–67) in his so-called *Editio secunda* of Briggs's *Arithmetica* (1628). These men, who were essentially partners in the undertaking, gave ten-place logarithms together with differences over the integers 1 to 100,000.

The work of De Decker and Vlacq was reprinted by G. Vega in 1794 under the title *Thesaurus logarithmorum completus*. Vega also included Vlacq's table of log sines and log tangents described

below and a table of natural logarithms to 48 places computed by J. Wolfram, a lieutenant of artillery in the Netherlands. Wolfram's tables, which extended over all the numbers up to 2,200 and all the primes, together with a few numbers whose least factor is a large prime, to 10,000, was printed for the first time in the *Sammlung* by J. C. Schulze (1778).

Tables of the logarithmic trigonometric functions followed shortly the publication of the logarithmic tables of integers. The fundamental contributions were made (1) by Vlacq in his *Trigonometria artificialis* (1633), which gave ten-place values of log sines and log tangents to every 10 seconds of the quadrant with differences, and (2) by Briggs in his *Trigonometria Britannica* (1633), which gave the natural sines to 15 places, tangents and secants to 10 places, log sines to 14 places and log tangents to 10 places at intervals of 0.01° from 0° to 45°. It is interesting to observe that mathematicians have followed Vlacq's division of the degree rather than that of Briggs. A new turn to this question was given at the time of the French Revolution, when weights and measures were being reduced to the metric system.

Gaspard Riche, baron de Prony (1755–1839), was placed in charge of a project to produce the values of the trigonometric functions in terms of centesimal units, namely divisions of the quadrant into 100 parts called grades, each grade into 100 minutes, and each minute into 100 seconds. This vast undertaking, called the *Tables du Cadastre* from the fact that Prony was the director of the Bureau du Cadastre, was carried out on a scale which involved the calculation of the natural sine to 22 decimal places and log sine and log tangent to 14 decimal places. Although the original work was never published, tables based upon it have appeared.

With the now rapidly growing demands both of science on the one hand and commerce on the other, as shown by extensive manuals of navigation, the number of tables increased rapidly. The 18th century produced more tables than the 17th; and the 19th, by greatly expanding the number of functions tabulated, increased both the volume of tables and their variety. During the first half of the 19th century, for example, we find the origin of tables of the elliptic integrals, the elliptic functions, the hyperbolic functions, the gamma function, the probability functions, the Bessel functions, and many others. With the widespread use of rapid calculating devices the 20th century has already increased by severalfold the total number of tables produced in preceding centuries. Hence the history of tables is becoming rather a history of the tables of special functions.

The Bibliography of Tables.—With the rapid increase in mathematical tables it became clear more than a century ago that if the needs of science, engineering and commerce were to be served properly, some systematic account of the origin, size and accuracy of tables must be made. A number of excellent historical and bibliographical surveys were produced during the 19th century by Glaisher for the British Association for the Advancement of Science, and by Augustus de Morgan, J. B. J. Delambre and Charles Hutton.

Such surveys were supplemented by a number of others, but by 1943 the need for current information became so great that the National Research council of the United States established a special quarterly journal, *Mathematical Tables and Other Aids to Computation,* designed to provide reviews of recent tables, a record of manuscript tables, lists of errata in standard tables, miscellaneous notes on tabular material, publication of bibliographies of tables in special fields of research and of particular functions, as well as descriptions of calculating machines.

In addition to the report of Glaisher referred to above, others of value concerning tables of historical interest include the following: (1) De Morgan's article on "Table" in the *Penny Cyclopaedia* (1842) and *Supplement* (1846), which also appeared later with numerous additions in the *English Cyclopaedia,* Arts and Science section (1861); (2) Glaisher's articles on "Logarithms" and "Table, Mathematical" in the 11th ed. (1910–11) of the *Encyclopædia Britannica;* Hutton in the first six editions of his *Mathematical Tables* (1785–1820).

Reports made on tables of special functions include the following: (1) J. Henderson's *Bibliotheca Tabularum Mathematicarum,* part i; "Logarithms of Numbers" (1926); (2) D. H. Lehmer, *Guide to Tables in the Theory of Numbers* (1940); (3) Harry Bateman and R. C. Archibald, "A Guide to Tables of Bessel Functions," published as no. 7 (1944) of *Mathematical Tables and Other Aids to Computation.*

A remarkable work of A. Fletcher, J. C. P. Miller and L. Rosenhead, *An Index of Mathematical Tables,* 2nd ed. (1962), is a comprehensive guide to tables.

See also MATHEMATICAL INSTRUMENTS and the references given therein for electronic and mechanical computing methods.

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MATHEMATICS (ARTICLES ON). An introductory perspective on mathematics as a creative force is offered by the article SCIENCE. In this general survey, mathematical discoveries are seen in the contexts of the sciences to which they contributed, and the reader who is unversed in mathematics can obtain at least a glimpse of its philosophy and its objectives.

Similar insights will be found in the introductory sections of various articles in the fields of physics and chemistry. For example, numerical relationships are seen as clues to the dynamics of nature in HARMONIC ANALYSIS, and to its architecture in such articles as ATOM and PERIODIC LAW. MATHEMATICS, HISTORY OF outlines the evolution of the major branches of mathematics, and MATHEMATICS, FOUNDATIONS OF describes their basic principles and methods.

To facilitate study, it is customary to divide mathematics into somewhat arbitrary subfields, but it will be apparent upon reading various of the articles that few subjects in modern mathematics can be thought of as lying wholly in any one of these so-called classical areas.

The first of these areas includes the more elementary phases that are discussed in such articles as ARITHMETIC; MENSURATION; NUMBER; and NUMERALS AND NUMERAL SYSTEMS. The properties of whole numbers are treated in NUMBERS, THEORY OF, and those of imaginary numbers are discussed in COMPLEX NUMBERS.

ALGEBRA and ALGEBRA, HISTORY OF outline the history and basic principles of this discipline. Specialized branches of algebra are treated in ALGEBRAS (LINEAR) and TENSOR ALGEBRA. Articles on topics related to algebra include BINOMIAL THEOREM; EQUATIONS, THEORY OF; FIELDS; GROUPS; GROUPS, CONTINUOUS; GROUPS, TRANSFORMATION; GROUPS AND ALGEBRAS, REPRESENTATIONS OF; POLYNOMIAL; and VECTOR SPACES.

GEOMETRY surveys the history and general principles of the branch of mathematics dealing with the properties of space, and is supplemented by such articles as CONIC SECTION; CURVES; CURVES, SPECIAL; MANIFOLDS; SOLIDS, GEOMETRIC; and SURFACE. Articles on special geometries include ALGEBRAIC GEOMETRY; ANALYTIC GEOMETRY; DESCRIPTIVE GEOMETRY; DIFFERENTIAL GEOMETRY; GEOMETRY, NON-EUCLIDEAN; PROJECTIVE GEOMETRY; RIEMANNIAN GEOMETRY; TOPOLOGY, ALGEBRAIC; and TOPOLOGY, GENERAL.

TRIGONOMETRY outlines the history and general principles of this branch of mathematics, in which techniques of geometry, algebra and arithmetic are applied.

The branch of analysis known as calculus is treated in CALCULUS, DIFFERENTIAL AND INTEGRAL. Specialized types of calculus are discussed in CALCULUS OF DIFFERENCES and CALCULUS OF VARIATIONS. Related articles include DIFFERENTIAL EQUATIONS, ORDINARY; DIFFERENTIAL EQUATIONS, PARTIAL; INTEGRATION AND MEASURE; and OPERATORS, THEORY OF. The theory of series,

which preceded calculus but was greatly advanced by its discovery, is treated in SERIES; FOURIER SERIES; INTERPOLATION AND EXTRAPOLATION; and NUMBER SEQUENCES.

ANALYSIS defines the scope and elementary principles of this broad area of mathematical science which is associated with much of the modern progress in physics and mechanics. Of special interest to physicists and engineers are TENSOR ANALYSIS and VECTOR ANALYSIS.

The statistical techniques applied in quantum mechanics are described under that title, and in PROBABILITY; STATISTICAL MECHANICS; and UNCERTAINTY PRINCIPLE. Other statistical discussions include ERRORS, THEORY OF; PROBABILITY, MATHEMATICAL; STATISTICS, MATHEMATICAL; RANDOMIZATION; MEAN; and PERCENTAGE.

GAMES, THEORY OF, deals with techniques acquired in the analysis of simplified versions of games, and their application.

The philosophical structure of mathematical theory is discussed in LOGIC and LOGIC, HISTORY OF.

The principles on which modern electronic computers are based are outlined in COMPUTING MACHINES, ELECTRONIC. Related topics include AUTOMATION; BINARY NUMBERS; INFORMATION THEORY; and SERVOMECHANISM. Articles devoted to mathematical aids include GRAPH; LOGARITHMS; NOMOGRAPHY; MATHEMATICAL INSTRUMENTS; MATHEMATICAL TABLES; and SLIDE RULE. Visual aids are described in MATHEMATICAL MODELS.

Biographical articles contain a wealth of material on the origin of mathematical ideas and the relationship between mathematics and other fields of study. Much of the philosophy of mathematics is reflected in such articles as EINSTEIN, ALBERT; FOURIER, JEAN BAPTISTE JOSEPH; GAUSS, (JOHANN) CARL FRIEDRICH; LAPLACE, PIERRE SIMON; NAPIER (NEPER), JOHN; NEWTON, SIR ISAAC; POINCARÉ, (JULES) HENRI; RUSSELL, BERTRAND ARTHUR WILLIAM RUSSELL; and WHITEHEAD, ALFRED NORTH.

The importance of mathematical relationships as clues to the patterns of nature was sensed intuitively many centuries before it was scientifically explored. This provided the stimulus for superstitious beliefs but also for some important discoveries, as can be found in PYTHAGORAS AND PYTHAGOREANISM.

The articles cited above are merely examples of the *Encyclopædia Britannica's* treatment of various fields of mathematics. For a comprehensive list of articles and sections of articles dealing with each mathematical topic, the Index should be consulted.

MATHEMATICS, FOUNDATIONS OF. The study of the foundations of mathematics has dealt with the concepts, and the assumptions about those concepts, with which mathematics starts. Especially since 1900, foundational investigations have come to include also an inquiry into the nature of mathematical theories and the scope of mathematical methods.

THE AXIOMATIC METHOD

Geometry According to Euclid.—Euclid's *Elements* (*c.* 300 B.C.) is a treatise on the foundations of mathematics as well as on geometry, which is said to have had a greater circulation than any book in history except the Bible. Euclid employs the deductive method, which had come down from Pythagoras two centuries earlier.

First, Euclid introduces fundamental concepts such as point, line, plane, and angle. He relates these to physical space by such "definitions" as "A line is length without breadth"; but since their definitions play no further role in his system, they constitute primitive or undefined terms.

Second, Euclid asserts certain primitive propositions or postulates (*q.v.*) about these primitive terms. These are propositions which the reader is asked to accept as true immediately on the basis of the "definitions" of the primitive terms relative to the physical world.

Third, Euclid deduces further propositions, called theorems, such as the theorem of Pythagoras, "The sum of the squares constructed on the arms of a right triangle is equal to the square constructed on the hypotenuse." That is, he shows that their truth follows logically from the truth of the primitive propositions. While doing so, he also introduces defined terms, such as triangle, right triangle, and hypotenuse, which are single words that can take the place of phrases using besides ordinary language only the undefined terms.

The net result is that the reader, starting with postulates of which he is supposed to be immediately convinced, is led, by a long series of simple steps each intended to be convincing, to accept the truth of other propositions of which he would be far from convinced had they been asserted at the outset. (*See* LOGIC; LOGIC, HISTORY OF.)

Non-Euclidean Geometry.—Euclid's parallel postulate, on which depends the theorem "Through a point P not on a line L there can be drawn exactly one line parallel to L," had seemed less evident than his other postulates. Attempts to prove it as a theorem from the other postulates culminated in the discovery published by Nikolai Ivanovich Lobachevski in 1829 and Johann Bolyai in 1832 that a different parallel postulate can be substituted to give a non-Euclidean geometry in which instead "Through a point P not on a line L there can be drawn infinitely many different lines parallel to L."

Insofar as Euclidean geometry fits physical space, it is impossible to say that the geometry of Lobachevski and Bolyai does not also fit. It is only necessary that the discrepancies between the two be too small to show up in any measurements we can make. So while Euclid thought of his geometry as a true description of physical space, we are obliged to regard it as one of a number of different possible mathematical models of that space.

That a theorem of Euclidean geometry be exactly true can only be a property of the geometry as a logical structure. Now a person who accepts Euclidean geometry as a valid logical structure is equally obliged to accept the geometry of Lobachevski and Bolyai. For example, as Felix Klein observed in 1871 (and Eugenio Beltrami in somewhat different terms in 1868), the postulates of Lobachevski and Bolyai's plane geometry are true in Euclidean plane geometry, when in those postulates the plane is interpreted to be the interior of a circle, the lines to be the chords of that circle, and congruence, distance and angle are defined by a method given by Arthur Cayley in 1859. (*See* GEOMETRY.)

Formal Axiomatic Method.—Here we have varied the meaning of the undefined terms of a postulational theory while holding the deductive structure fixed, a procedure which is characteristically modern. One can deduce a theory from its postulates without saying at all what the undefined terms are to mean. Then the theory applies to any system of objects which, when taken as the meanings of the undefined terms, make the postulates true.

Indeed, in a postulational theory, one should be able to perform the deductions treating the undefined terms as meaningless. For if their meanings had to be used, whatever had to be taken from their meanings should instead be provided by additional postulates. In Euclid's *Elements* some properties of the undefined terms did in fact enter from their meanings via the figures. These hidden assumptions were brought to light and stated as postulates by Moritz Pasch (1882) and by David Hilbert (1862–1943) in his *Grundlagen der Geometrie* (1899). Thus Hilbert states as a postulate, "If a line L cuts the side AB of a triangle ABC and does not pass through A, B or C, then it must also cut AC or BC."

The postulational method when the undefined terms are treated as meaningless is called the formal postulational method, or formal axiomatic method as in this connection axiom (*q.v.*) and postulate are often used synonymously, in contrast with the material axiomatic method of Euclid. Formal axiomatics is represented par excellence by Hilbert in the work cited.

It might be thought that meaninglessness of the undefined terms would rob a theory of its interest, but the opposite can be the case. Thus for some theories many different interpretations of their undefined terms each make the postulates true (*e.g.*, Euclidean geometry without the parallel postulate, or in algebra abstract groups). The deduction of such a theory independently of any interpretation makes it a mathematical tool prepared in advance for diverse applications. If in essential respects only one such interpretation exists, the postulates are categorical (*q.v.*). If there is no such interpretation, the theory is without value, and one of the problems for foundations is to exclude such theories.

THE GENETIC METHOD

Arithmetic, Analysis.—Systems of numbers are more often introduced by the genetic method, so-called by Hilbert (1900). In this the objects are generated or constructed in a certain orderly manner, and the theorems express properties of the system of the objects assured by this mode of generation. Of course deductive reasoning is used, just as in the axiomatic method, to obtain unobvious properties from obvious or immediate ones, and the immediate properties can be listed as postulates. Thus the natural numbers 0, 1, 2, . . . , used in counting discrete objects, are describable genetically as the objects which are generated by starting with a first object 0 and by proceeding from any object n already generated to a next object $n + 1$, objects differently generated being distinct. A suitable selection of immediate properties constitutes the five postulates of Giuseppe Peano (1889), which are categorical for the arithmetic of the natural numbers. By starting from these postulates, rather than from the generation, that arithmetic can then be considered as a formal axiomatic theory. But we shall continue here with the genetic method in describing some other mathematical systems of objects.

Arithmetic (*q.v.*) has several senses; but one of them is the theory of the natural numbers, and of similar systems of numbers, such as the (rational) integers . . . , -2, -1, 0, 1, 2, . . . , or the rational numbers which are the numbers expressible as fractions p/q where p and q are integers and $q \neq 0$.

Analysis (*q.v.*) deals with such systems of objects as the real numbers, used in the measurement of continuously variable magnitudes. A theory of real numbers not resting on vague geometrical imagery was only achieved in the latter part of the 19th century, by K. T. W. Weierstrass, Julius Dedekind, Charles Méray and G. F. L. P. Cantor. The version using infinite decimals will suffice here. For example, $\frac{9}{4} = 2.25 = 2.24999\ldots$, $-\frac{9}{4} = -2.25 = -3 + .75 = -3 + .74999\ldots$, $1 = 0.99999\ldots$, $\sqrt{2} = 1.41421\ldots$, $\pi = 3.14159\ldots$. In each example, a real number x is expressed as a sum $X + .x_0x_1x_2x_3x_4\ldots$ of an integer X and a nonterminating decimal fraction $.x_0x_1x_2x_3x_4\ldots$ (*i.e.*, one without all digits 0 after some place). The real numbers are given genetically, each number uniquely, as all possible such sums.

Cardinal Number, the Theory of Sets.—Imagine a tribe of aborigines, unable to count above 20, whose chief is by custom their member with the most numerous herd. If there were two contenders for the chieftaincy, the tribe could decide the winner (or that the two contenders are tied) by passing their herds through a gate, a pair of animals one from each herd at a time.

Cantor was the first who applied this idea systematically to the comparison of infinite collections. A one-to-one correspondence between two collections or sets of objects S and T is a collection of ordered pairs in which the first member of each pair belongs to S, the second member to T; and each member of S occurs as first member, each member of T as second member, of just one pair. Two sets have the same cardinal number if there is a one-to-one correspondence between them.

The natural numbers 0, 1, 2, . . . , the positive integers 1, 2, 3, . . . , the squares of the positive integers 1, 4, 9, . . . (an example used by Galileo Galilei in 1638), and the integers 0, 1, -1, 2, -2, . . . have the same cardinal number. Infinite sets with this cardinal are countable (or countably infinite, to distinguish them from finite sets which are also countable), since they can be counted off or listed by using the natural numbers. A fifth example of a countably infinite set is the rational numbers; for each rational can be written as $(-1)^n p/q$ with the least possible natural numbers n, p, q, and then the rationals can be enumerated in the order of magnitude of the positive integers $2^n3^p5^q$.

A part or subset of a set S is a set each member of which is a member of S. As Galileo had noted, a part not the whole of an infinite set can be in one-to-one correspondence with the whole. (Dedekind in 1888 used this property to distinguish infinite sets from finite sets.) A set T is of greater cardinal number than another set S, if there is a one-to-one correspondence between S and a subset of T but not vice versa.

Cantor showed in 1874 by his diagonal method that there are sets of greater cardinal number than the natural numbers. A (single-valued) number-theoretic function f of one variable x is a correspondence by which, to each natural number x, there corresponds a unique natural number $f(x)$, called the value of f for x as argument. The set of these functions is uncountable. For consider any infinite list $f_0, f_1, f_2, \ldots$ of such functions. Then the function f defined by $f(x) = f_x(x) + 1$ (so the values of f come by altering every value in the diagonal, if the values of $f_0, f_1, f_2, \ldots$ have been written in successive rows) is not in the list; for if f were f_q, the contradictory equation $f_q(q) = f_q(q) + 1$ would be obtained upon taking the value for q as argument. The set of these functions is of greater cardinal number than the natural numbers; for on the other hand, the natural numbers n are in one-to-one correspondence with the constant functions $f(x) = n$.

In our generation of the real numbers, the nonterminating decimals can be construed as number-theoretic functions taking values ≤ 9; so the reals are uncountable, by reasoning the same as above except taking $f(x) = 8$ when $f_x(x) = 9$.

A given set of natural numbers is represented by a function which takes 0 or 1 as value according as the argument is in the set or not; so the sets of natural numbers are uncountable, by reasoning the same as above except taking $f(x) = 0$ when $f_x(x) = 1$.

It is not hard to show that these three uncountable sets have the same cardinal. The third illustrates Cantor's theorem, "The cardinal number of the set of the subsets of a set S is greater than the cardinal number of S."

Thus infinity is not simple, but indeed there are a whole host of infinite or transfinite cardinal numbers. This is only one of the results of Cantor's theory of sets, which greatly extended the mathematical horizon, besides seeming to provide the ideas for a general foundation of mathematics.

THE CRISIS IN FOUNDATIONS FOLLOWING 1900

The Paradoxes.—Already in the last decade of his scientific life Cantor became aware that his theory of sets pushed too far leads to contradictions; we describe two (*see* ANTINOMY).

Let S be the set of all sets, and T the set of the subsets of S. Since T corresponds one-to-one to itself as a subset of S, it cannot have a greater cardinal than S. Yet by Cantor's theorem it must; this is Cantor's paradox (1899).

The phrases in the English language are countable. After listing all the phrases, strike out those which do not define number-theoretic functions. Application of Cantor's diagonal method to the list remaining enables one to define in the English language a function which differs from every function definable in the English language. This paradox was found by J. A. Richard (1905).

These modern paradoxes have a counterpart in the ancient paradox of the liar, which in one form appears in a paradoxical statement attributed to Epimenides (6th century B.C.?); and in another is attributed to Eubulides (4th century B.C.) who has a person say, "What I am now saying is a lie." The quoted sentence if true must by what it says be false, and if false be true.

No one has succeeded in disposing of the paradoxes by simply pointing out a fallacy upon which all can agree.

Cantor's paradox is evidently connected with the use of too large sets. But where shall a line be drawn? And what definition of set shall replace Cantor's as "any collection of definite well-distinguished objects of our perception or our thought into a whole?"

In fact it is possible to reformulate set theory to exclude too large sets. In doing so, axioms are listed to govern just what sets shall be allowed; and set theory becomes a formal axiomatic theory instead of a genetic one. The first system of axiomatic set theory was given by Ernst Zermelo in 1908, and improved by Adolf Fraenkel and Thoralf Skolem in 1922–23. Axiomatic set theory provides probably the simplest system in which most existing mathematics, but not the paradoxes as far as is known, can be deduced. Kurt Goedel in 1938 showed that Cantor's continuum hypothesis, "The cardinal number of the real numbers is the least cardinal number greater than that of the natural numbers," which no one has succeeded in proving up to the 1960s, can be added as a new axiom to set theory without introducing contradiction.

That the paradoxes arose shows there is some defect in the

methods, which hitherto had been trusted, of constructing and reasoning about mathematical objects. Transforming the theory of sets from a genetic into a formal axiomatic theory leaves over the problem of whether there is an interpretation of the undefined terms which makes the axioms in some sense true. To ignore these issues is to adopt a mathematical nihilism. Formally axiomatized mathematics cannot be all of mathematics. To draw upon another formal axiomatic theory for such an interpretation is a regress. At some level there must be a meaningful mathematics. At the very least we must believe that the theorems of a formal axiomatic theory really do follow from the axioms. As a further example, when mathematicians say that by a certain method it can be determined in a finite number of steps whether an equation $ax + by + c = 0$ with given integral coefficients a, b, c has a solution for x,y in integers, they certainly do not mean merely that this proposition can be deduced from certain axioms.

Henri Poincaré and Bertrand Russell about 1905 concluded that the explanation of the paradoxes lies in a certain circularity of definition. When a set M and an object m are so defined that m is a member of M but is defined only by reference to M, the definition of M or of m is called impredicative. An impredicative definition can be found in each of the paradoxes. Thus the sickness of mathematics could be cured by banning impredicative definitions, if it did not inconveniently turn out that the cure would kill the patient. For, as was especially emphasized in Hermann Weyl's *Das Kontinuum* (1918), there are impredicative definitions also in analysis.

Three main schools of thought have arisen which have provided both a philosophy of mathematics and a development of mathematics based upon it.

Logicism.—The logicistic thesis is that mathematics is a branch of logic. Gottfried Wilhelm Leibniz in 1666 had conceived of logic as a universal science embracing the principles underlying all others. Dedekind (1888) and especially Gottlob Frege (1884, 1893) derived arithmetic from logic. The thesis that all of mathematics is reducible to logic alone is due to Russell.

Russell, after rediscovering results of Frege, had to make provision against the paradoxes. This provision took the form of a ramified theory of types. Roughly described, the primary objects not being subjected to logical analysis he took to be of one type, say type 0, properties of objects of type 0 to be of type 1, properties of properties of type 1 to be of type 2, etc.; and he excluded from use any properties not belonging to one of these types. Then to exclude impredicative definitions within a type, he separated the types above type 0 into orders, the properties defined using the totality of properties of a given order being placed in the next higher order. Finally to overcome the obstacle which exclusion of impredicative definitions opposes to analysis, he postulated his axiom of reducibility, which asserts that to any property belonging to an order above the lowest there is a property of order 0 possessed by exactly the same objects.

On this basis, mathematics was deduced from logic, in a symbolic language, in the monumental *Principia Mathematica* by Alfred North Whitehead and Russell (3 vol., 1910–13).

The use of the axiom of reducibility weakens the case for the logicistic thesis. For if the axiom be true, should not the reductions to order 0 be constructed instead of being merely postulated as existing? Weyl hence remarked (1946) that in *Principia Mathematica* "mathematics is no longer founded on logic, but on a sort of logician's paradise."

Leon Chwistek (1921) and F. P. Ramsey (1926) introduced a simple theory of types in which the separation into orders is suppressed. This still allows the deduction of mathematics from logic, with the paradoxes apparently excluded, but it does not improve the philosophical position.

A fundamental objection to the logicistic thesis is posed by the intuitionists (*see* below), who find an essential mathematical kernel in the idea of iteration, which already has to be used in establishing the hierarchy of types and even in listing the propositions in a proof.

Willard Van Orman Quine (1937) weakened the type restriction to one of stratification. The resulting system is a form of axiomatic set theory rather than of type theory. Indeed, though the logicistic thesis did not so develop historically, it could be based as well on a set theory as on a type theory.

Intuitionism.—In the 1880s Leopold Kronecker had objected to the methods of Weierstrass, Dedekind and Cantor in that their fundamental definitions are only words since they do not enable one in every case to decide whether a given object satisfies the definition.

In 1908, in a paper on the untrustworthiness of the principles of logic, L. E. J. Brouwer challenged the belief that the laws of the classical logic as they have come down to us essentially from Aristotle (4th century B.C.) have an absolute validity, independent of the subject matter to which they are applied.

In particular, Brouwer refuses to accept the law of the excluded middle, "Either A or not-A," as valid for all A's. Suppose A is "There exists a member of the set S having the property P." Then not-A is equivalent to "Every member of S lacks the property P." Thus the law of the excluded middle would give "Either there is a member of S with the property P, or every member of S lacks the property P," call this M. Suppose it is possible in principle to decide, for any given member of S, whether it has property P. Then if S is finite, it is possible in principle, by examining each member of S in turn, either to find a member of S with property P or to verify that every member of S lacks property P, though it might be impracticable to complete the examination for large S or even for small S if the determination for some members whether they have property P is lengthy. On the basis of this possibility, Brouwer accepts the truth of M for such P and finite S. But when S is infinite, the described examination cannot in principle be completed; if in pursuing it one has come upon a member of S with property P, the first alternative is substantiated, but if at any stage of the examination a member with property P has not yet been found, one does not know whether it is because there is none or because he has not persisted long enough. In some examples the second alternative might be substantiated by deducing a contradiction from the supposition that an arbitrary member of S has property P. This is the case when S is the set of pairs (p, q) of positive integers and P the property that $p^2 = 2q^2$, as was discovered by Pythagoras in the 6th century B.C. (*i.e.*, $\sqrt{2}$ is irrational). But take the case that S is the quadruples (x, y, z, n) of positive integers with $n > 2$, and P the property that $x^n + y^n = z^n$. About 1637 Pierre de Fermat wrote that he had a proof of the proposition that every member of this S lacks this property P, which is known as Fermat's last theorem (*q.v.*). He did not record his proof, and no one has since been able to find a proof or a counter-example, though immense effort has been expended. We know of no method which must resolve the question if pursued long enough. Brouwer says that M can only mean that one can in principle find out that one or the other alternative is true; and in the face of examples for infinite S in which we have no assurance that we can, he declines to accept M, and hence also the law of the excluded middle, as a universally valid principle of logic.

Similarly, for Brouwer a statement that an object exists having a given property means that, and is only proved when, a method is known which in principle would enable such an object to be found or constructed. Thus he does not accept indirect existence proofs, which consist in deducing a contradiction from the assumption of nonexistence.

In classical mathematics, *i.e.*, mathematics as based on the classical logic, infinite sets are treated as though they could be given completely, whereas Brouwer admits only a potential infinite. The concept of the natural number sequence 0, 1, 2, . . . has its origin, as he sees it (1907), in our capacity to distinguish one sensation as it recedes into the past and is retained by memory from another which replaces it, and to imagine an unlimited repetition of this process. The sequence 0, 1, 2, . . . is thus only "a manifold of possibilities open towards infinity" (Weyl, 1946).

For Brouwer, neither language nor logic is a presupposition for mathematics, which has its source in an intuition that makes its concepts and inferences immediately clear to us.

Most theorems of classical arithmetic can be established intuitionistically. But Brouwer's critique affects the whole

methodology of classical analysis. Thus to say that any two real numbers x and y are either unequal or equal is to say that either there exists, among the integer of x and successive digits of x, one which is different from the corresponding one of y, or that all are the same. This is an application of the law of the excluded middle of the kind which Brouwer eschews.

Brouwer developed an intuitionistic mathematics, including an analysis and set theory (1918–24). This is interesting in itself, but too different and too complicated to serve as a substitute for classical mathematics satisfactory to most mathematicians or to be practically usable in the natural sciences. But his insights have played an important role in foundational investigations.

Formalism.—Hilbert accepted that the parts of classical mathematics which employ the completed infinite go beyond intuitive evidence. But instead of rejecting those parts, he proposed, roughly, to formulate classical mathematics up to a suitable point as a formal axiomatic theory, and to prove this theory consistent, *i.e.*, free from contradiction.

Previous to this proposal of Hilbert's (1905, and more specifically from 1918 on), proofs of consistency had been given for axiomatic theories by interpreting their undefined terms in another theory so that the axioms become true, or briefly by giving a model. Thus the plane Lobachevskiian geometry was interpreted in Euclidean geometry by Beltrami. The consistency of geometries generally is reduced to that of analysis by René Descartes' analytic geometry (1637), which employs real numbers as co-ordinates of points, so that geometrical propositions become propositions in the algebra of real numbers. For proving the consistency of analysis itself, the method of models offers no hope, since no theory is available in which analysis could be interpreted which appears safer than analysis.

Hilbert's proposal called for proving consistency by a new method based directly on the meaning of consistency as freedom from contradiction. Not only should all the mathematical assumptions of a theory be listed, but also all of the principles of logic, both the primitive propositions and the rules for drawing inferences, to be used in deducing theorems from the mathematical postulates. This done, one could undertake to show that no two proofs in the theory terminate in theorems one of which is the negation of the other. Hilbert would thus make the proofs of the formal theory the object of an intuitive theory, called proof theory or metamathematics. The latter should use only intuitively convincing methods, called by him finitary methods. These methods in practice are intuitionistic methods on the level of number theory. The formal theory provides a sort of stereotyped model of the previously existing informal theory, which is called the interpretation of the formal theory. This interpretation should play no role in the metamathematics, though it motivates the choice of the particular formal theory which is the object of the metamathematics.

To guarantee that all the principles of logic used in deducing theorems have been listed as axioms and rules of inference, the meanings of all the words should be left out of account in deducing theorems, just as in a formal axiomatic theory it should be possible to leave out of account the meanings of the undefined mathematical terms. Because of the irregularities and ambiguities of the existing word languages, it is only feasible to do this by reconstructing the informal theory as a symbolic language, which can be done by combining symbolic logic with the symbolization common in modern mathematics. The resulting formal theory is called a formal system or logistic system, a statement in it a formula (or by some writers a well-formed formula, to emphasize that it must be formed from the symbols by listed formation rules), and the method the logistic method. The description of a formal system must be given from outside in an informal theory. The method was already available, but Hilbert added the proposal to make the formal system the object of mathematical investigations in this informal theory or metamathematics.

There ensued a controversy in which Brouwer questioned how a metamathematical proof of consistency of classical mathematics would meet the objection that the propositions of classical mathematics beyond a certain elementary level lack a clear intuitive meaning. The upshot was that the intuitionists would accept Hilbert's program as unobjectionable, provided the formalists refrain from construing a consistency proof as in some manner vindicating classical mathematics intuitively. Hilbert drew an analogy with the stratagem in mathematics of adjoining ideal elements to a previously constituted system to achieve some theoretical end (*e.g.*, the irrational numbers were added to the rationals so that all convergent sequences should have limits, the imaginary numbers to the reals so that all algebraic equations should have solutions; *see* NUMBER). He called the statements of classical mathematics with an intuitive meaning real, the others ideal. The statements involving the completed infinite are ideal. So he said, in classical mathematics the ideal statements are adjoined to the real to give the theory as a whole a simpler logical structure, and it is no more reasonable to require that each separate statement should be interpretable taken by itself, than that in theoretical physics each separate statement should be verifiable by experiment. The possibility appeared that classical mathematics reinforced by a proof of consistency might even serve as a tool for the intuitionistic proof of real statements via short cuts through the ideal statements.

Hilbert's program was undertaken by him, Paul Bernays, Wilhelm Ackermann, John von Neumann, and others after 1920. The start was made by investigating a formal system of classical arithmetic (with several variants), obtained by adding Peano's postulates and definitions of sum and product to the first-order functional calculus, as described in Hilbert and Bernays' *Grundlagen der Mathematik* (2 vol., 1934 and 1939). A proof by Ackermann in 1924–25 of consistency of a subsystem did not lead at once to a proof of consistency of the whole system. Then in 1931 results of Goedel appeared which clarified the situation, and which we present below from a standpoint reached after 1935. The metamathematical method proved valuable for a variety of purposes in studying formal systems generally, as well as the ones Hilbert considered. Thus a formal system of intuitionistic logic and mathematics was described by Arend Heyting in 1930.

COMPUTABILITY AND DECIDABILITY

Decision Problems, Church's Thesis.—For certain classes of questions in mathematics, a method is known which can be applied to answer by yes or no any given question of the class. For example, for any positive integers a and b, the question "Is a a multiple of b?" can be answered by dividing a by b and seeing whether the remainder is 0 or not. As a less obvious example, there is a method for deciding, for any given integers a, b, c, whether $ax + by + c = 0$ has solutions for x, y in integers. Such a method is called an algorithm or decision procedure; and the problem of finding such a method for a class of questions is called the decision problem for that class. Similarly, for a class of questions which require for their answers, not yes or no, but the exhibiting of some object, we speak of an algorithm or computation procedure, and a computation problem.

In the logistic method, the description of a formal system must enable one to decide whether any given formula is an axiom, and whether any given formula comes by a permitted inference from one or two others; so there is a decision procedure for whether a given finite list of formulas is a proof in the system. But a decision procedure is not thereby provided for whether a given formula is provable, *i.e.*, for whether there is a proof of it. The problem of finding a decision procedure for the latter is often called the decision problem for the formal system, and was recognized as a problem of logic by Ernst Schroeder (1895), Leopold Loewenheim (1915) and Hilbert (1918). Emil L. Post (1921) gave a decision procedure for the classical propositional calculus.

A decision procedure for a formal system embracing a given portion of mathematics would make automatic the solution of any problem in that portion statable as a yes or no question. It is therefore implausible that there should be a decision procedure for a formal system embracing the usual arithmetic, in view of the experience of mathematicians in trying to solve the one particular problem whether Fermat's last theorem is true; and many other similarly refractory problems are known. For there to be a de-

cision procedure would mean, so to speak, that the infinitely many arithmetical problems involve only a finite number of difficulties such that once those are overcome no further ingenuity will be required. But it might have seemed equally farfetched in 1918 to hope that mathematics could get a hold on the problem of finding a decision procedure for arithmetic, which would enable this problem to be solved by showing that there cannot be one. Exactly this latter was done in 1936 by Alonzo Church.

We begin by considering the computation problems for number-theoretic functions. What functions can be computed or effectively calculated, in the sense that, for a given argument, the value can be found by use only of preassigned rules, applicable without ingenuity on the part of the computer? Instead of a human computer, we can propose to have a machine to do the computation, according to rules built into its structure.

As this description is somewhat vague, what is needed is an exact mathematical formulation which comes to the same. Such a formulation was given briefly by Post in 1936 and independently in detail by Alan M. Turing (1936–37). What Turing did was to describe a kind of theoretical computing machine, not limited in use by a fixed maximum amount of storage of information nor liable to malfunctioning, as are actual computing machines. A Turing machine operates in the following manner. At discrete moments the machine assumes one of a finite list of states (fixed for a given machine), the first of which we call the passive state, the other k ($\geqq 1$) active. A linear tape, potentially infinite to the right, is ruled in squares, each of which is either blank or has printed upon it one of a finite number j ($\geqq 1$), of symbols (fixed for a given machine), including say the tally |; but only a finite number of squares are printed. The tape passes through the machine so that one of its squares is scanned. If at the given moment the machine is in an active state, then it can alter the condition of the scanned square (by erasing, printing, or both), and/or move the tape so that the scanned square becomes the one next right or left, and/or change to another state, between the given moment and the next; this act is determined (for a given Turing machine) by the state of the machine and the condition of the scanned square at the given moment.

Turing used his machines primarily to compute in succession the digits of decimal expansions of real numbers, but they can be adapted to compute number-theoretic functions. Let an argument x be supplied to the machine by placing a blank followed by $x + 1$ tallies on successive squares of the tape starting with the leftmost square, leaving the tape otherwise blank, and placing the tape in the machine with the rightmost tally scanned and the machine in its first active state. The machine is said to compute a value y for x as argument, if then it eventually reaches the passive state with the $x + 1$ tallies followed immediately to the right by a blank and $y + 1$ tallies, the rightmost being scanned and the tape being otherwise blank. If, for each natural number x, the machine computes the correct value $y = f(x)$ of a function f, when supplied the argument x, it computes the function f, which is then said to be Turing computable.

Turing advocated the thesis that any function which can be effectively calculated is Turing computable. His arguments include showing that various operations that a human computer can perform can be analyzed into successions of the simple operations his machines perform. Church had already in 1936 proposed the thesis that every effectively calculable function is λ-definable in a sense due to Church and Stephen C. Kleene, or equivalently general recursive in a sense due to Goedel, who built on a suggestion of Jacques Herbrand; and this thesis was subsequently proved equivalent to Turing's, so the λ-definable functions, the general recursive functions, and the Turing computable functions are the same.

Church's Theorem.—The pattern of behaviour of a Turing machine is completely described by a $k \times (j + 1)$ table showing the act to be performed for each of the k active states with each of the $j + 1$ conditions of the scanned square. A system for encoding such tables can be established which, to each table, gives a natural number t as code number so that a person who knows the system can from t find the table and thence the behaviour of a machine M_t with this table. If t is the code number of a machine M_t which computes a value for x as argument, let $f_t(x)$ be this value; and let $f_t(x)$ be undefined otherwise.

Consider the function f defined by letting $f(x) = f_x(x) + 1$ if $f_x(x)$ is defined, and $f(x) = 0$ otherwise. This function f is not computable. For if machine M_q with code number q computes a value for q as argument, that value is $f_q(q)$, not $f_q(q) + 1$ as it would have to be if M_q computes f. It follows that the property "$f_x(x)$ is defined" is undecidable. For otherwise we could compute $f(x)$, given x, thus: first decide whether $f_x(x)$ is defined; then if it is, imitate the behaviour of M_x to compute it and add 1; if it is not, write 0.

Thus from Turing's thesis we have proved that there is a class of quite elementary arithmetical questions for which there is no decision procedure. This essentially is Church's theorem (1936), which he proved from his thesis using a corresponding class of questions in terms of λ-definability. For each x, the proposition "$f_x(x)$ is defined" is expressible in any formal system S which includes the usual vocabulary of arithmetic, by a formula A_x effectively determinable given x. If the quoted proposition is true, it is demonstrable intuitively by exhibiting the sequence of the acts of machine M_x in computing $f_x(x)$. Suppose S includes ordinary arithmetical reasoning; then that demonstration can be translated into a proof in S of A_x; *i.e.*, A_x is provable in S whenever (the proposition expressed by it is) true. Finally suppose about S that A_x is provable in S only when true. Then there can be no decision procedure for provability in S; for if there were, by answering the question whether A_x is provable in S, we would have a decision procedure for "$f_x(x)$ is defined."

Moreover there is no decision procedure for the important logical system F of first-order functional (or predicate) calculus, as Church (1936) and Turing (1936–37) showed. For a proof of A_x in S can be arranged as a deduction by F of A_x from a suitable finite set of arithmetical axioms independent of x, the conjunction of which can be written as one formula C. If the symbolism has been suitably chosen, then A_x is provable in S, if and only if the implication $C \supset A_x$ is provable in F. From these beginnings, a considerable theory has grown about "unsolvable decision problems," with further contributions by Post, A. A. Markov (the younger), Turing, Alfred Tarski, Andrzej Mostowski and P. S. Novikov.

Goedel's Theorem.—A formal system like S is consistent, if for no formula B are both B and its negation $\sim$B provable in S; complete, if for each formula B without free variables (otherwise $\sim$B may not express the opposite of B) either B or $\sim$B is provable in S.

Now suppose further that $\sim A_x$ is provable in S only when true. Then it is absurd that S be complete (and that $\sim A_x$ be provable in S whenever true). For A_x is provable in S (when and) only when true. So if, for each x, either A_x or $\sim A_x$ were provable, we could decide whether $f_x(x)$ is defined or not, by searching through all the proofs in S till we find one of A_x or of $\sim A_x$. This is Goedel's theorem (1931) in a negative form.

To obtain the positive form, consider the process, for a given x, of searching through all the proofs in S for one of $\sim A_x$, and writing 0 if one is found. A Turing machine, say machine M_q with code number q, carries out this process, when supplied with x. Now by the choice of the formulas A_x, $\sim A_q$ is true if and only if $f_q(q)$ is undefined, which by the choice of M_q is the case if and only if $\sim A_q$ is unprovable in S. In brief, $\sim A_q$ expresses its own unprovability (*cf.* the paradox of the liar). So were $\sim A_q$ provable, it would be false, contradicting our supposition that $\sim A_x$ is provable only when true. So $\sim A_q$ is unprovable but true, and A_q is also unprovable (since false).

Hilbert's program called for embodying classical mathematics, including arithmetic, analysis, and set theory short of the paradoxes, in a formal system, and proving that system consistent by finitary methods. The part of Goedel's theorem that $\sim A_q$ is unprovable but true shows that not even the first step can be carried out fully. Despite the great value of the logistic method as a way of defining exactly the presuppositions of a given portion of mathematics, this very process of definition restricts that portion to include less of arithmetic than free use of intuitive reasoning would give, at least if what is already incorporated in the formal system is intuitively correct.

The part of the theorem that neither $\sim A_q$ nor A_q is provable in S shows the inadequacy of S to decide by proof or disproof, irrespective of the interpretation, all the statements expressible in it. Thus A_q is said to be formally undecidable in S.

In showing $\sim A_q$ unprovable (and true), we used (for $x = q$) the assumption that $\sim A_x$ is provable in S only when true. This can be replaced by the metamathematical assumption (not ostensibly using the interpretation) that S is consistent. For if $\sim A_q$ were provable, $f_q(q)$ would be defined, and hence as noted above A_q would be provable, which would contradict the consistency.

(The assumption that A_x is provable only when true, used in showing A_q unprovable, can be replaced by the assumption that S is *ω-consistent*, in the sense that for no formula B(x) are B(0), B(1), B(2), . . . and $\sim$(x)B(x) all provable in S, where "(x)" expresses "for all x." In verifying this, B(x) will express "at the x-th moment M_q has not yet computed $f_q(q)$." Adjoining A_q to S as a new axiom produces a formal system which is consistent but not ω-consistent, if S is consistent. Barkley Rosser in 1936 modified Goedel's formally undecidable formula so that consistency sufficed; in fact, letting M_r carry out the process of searching through all the proofs in S for one of $\sim A_x$ and writing 0 if one is found before one of A_x is found, $\sim A_r$ is unprovable but true and A_r is unprovable, if S is consistent.)

As Goedel observed in proving his theorem, the objects employed in a formal system, say S, are countable; and after correlating natural numbers (called now Goedel numbers) effectively to them, by talking about those numbers instead of the formal objects, the metamathematics of S becomes a part of arithmetic and so expressible in S. Now consider the implication "If S is consistent, then $\sim A_q$ is true," obtained above as part of Goedel's theorem. Let Consis be the formula of S which expresses "S is consistent" in S via the Goedel numbering. Then the quoted implication translated into S becomes Consis $\supset \sim A_q$. Goedel claimed that, by imitating formally in S the intuitive proof of his theorem, it should be possible to prove this formula in S. (This was done in detail by Hilbert and Bernays in 1939 in their formal system of arithmetic.) But then, if Consis were also provable, $\sim A_q$ would be, which is contrary to Goedel's (first) theorem if S is consistent. Thus Goedel obtained his second theorem: If S is consistent, then the formula Consis, which says in S via the Goedel numbering that S is consistent, is unprovable in S.

Goedel's second theorem raises an obstacle to the second part of Hilbert's program. One might have supposed that the finitary methods to be used in proving consistency would be part of the methods formalized in the system, which amounts to saying that a finitary proof of consistency of S should be formalizable as a proof in S of Consis. Only such methods appear to have been used in attempts prior to 1931. Goedel's second theorem shows that not even all the methods incorporated in S, including the nonfinitary ones, would suffice.

Some mathematicians felt that this ended once and for all Hilbert's plan to make classical mathematics more secure by a consistency proof. Others thought it possible that methods might be found for proving consistency, which, though not formalizable within S, could be construed as finitary and thus as safer than some of the methods incorporated in S. Thus Gerhard Gentzen in 1936 gave a proof of the consistency of a system S of classical arithmetic, in which the nonelementary method (not formalizable in S) is an extension of mathematical induction (*q.v.*) from the natural number sequence to a certain segment of the transfinite ordinal numbers which Cantor had introduced for extending the counting process beyond that provided by the natural numbers.

Further Perspectives.—Goedel's (first) theorem provided confirmation for the view advanced earlier by the intuitionists on philosophical grounds that the possibilities for intuitive mathematical thinking cannot be circumscribed in advance. Taking Brouwer's interpretation of a statement "a y exists such that $P(y)$" as meaning such a y can be found, and applying Church's thesis to the case the y depends on x, Kleene in 1943 proposed the further thesis that a statement "for each x, a y exists such that $P(x,y)$" is provable intuitionistically only if such a y can be given as a computable function of x. Using this thesis, there are theorems of classical arithmetic (Kleene, 1943) and of classical analysis (Ernst Specker, 1949) which are unprovable intuitionistically (not merely in some formal system, but absolutely); so classical mathematics reinforced by a consistency proof cannot serve as a tool of intuitionistic proof, except of a very restricted class of statements. Kleene (1945) and David Nelson (1946) together showed that the intuitionistic formal arithmetic based on Heyting's intuitionistic formal logic does conform to the thesis. Goedel in 1932–33 (partially anticipated by Andrei N. Kolmogorov in 1924–25) correlated to each arithmetical formula B a classically equivalent formula B′ which is provable in the intuitionistic formal arithmetic if (and of course only if) B is provable in the classical formal arithmetic. In particular, the correlation proves very simply that the classical formal arithmetic is consistent if the intuitionistic is. However, the intuitionistic arithmetic distinguishes differing degrees of indirectness among statements classically equivalent.

Using the classical law of the excluded middle, Goedel in 1930 proved a completeness theorem for the first-order functional calculus F. In one form, this says that if a formal system obtained by adjoining mathematical axioms to F is consistent, it has a model; *i.e.*, there is an interpretation which makes the axioms true. Indeed, the model can be constructed using the natural numbers as the objects. In another form, the theorem says that in such a system every formula is provable which is true under all the interpretations of the undefined terms which make the axioms true. In view of this, when S is based on first-order functional calculus, the unprovability in S of $\sim A_q$ implies that, while $\sim A_q$ is true under the intended interpretation of the undefined terms, there is some other interpretation which makes the axioms true (a nonstandard model) under which $\sim A_q$ is false. This illustrates the theorem of Skolem (1933) that no list of axioms in the symbolism of the first-order functional calculus can characterize the natural numbers categorically. If higher functional calculus is used, the deductive apparatus will be incomplete. It thus appears that the logistic method is inadequate to characterize the natural numbers categorically. Peano's axioms characterize them categorically, but only through an interpretation which cannot be rendered fully through the deductive possibilities. Also we see the Goedel formal undecidability of A_q as a phenomenon of the same kind as the undecidability of Euclid's parallel postulate from the other postulates of Euclidean geometry.

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MATHEMATICS, HISTORY OF. The study of the languages of primitive peoples, as well as related investigations of extinct languages, indicates that a process apparently as simple as counting passed through many stages before it reached a level that permitted the systematization that is essential for any mathematical procedure. Similar observations have been made in the study of early writing. Only tortuous processes led from symbols for sets of concrete objects to a general notation which can be justly called a system of numerals. Mathematics originated only in a very few areas within the framework of highly developed urban civilizations and well-organized economic conditions.

Additional material relating to the following discussion will be found under ALGEBRA, HISTORY OF; ANALYSIS; GEOMETRY; GEOMETRY, NON-EUCLIDEAN; MATHEMATICS, FOUNDATIONS OF; NUMERALS AND NUMERAL SYSTEMS; SCIENCE; and in the biographies of the various mathematicians mentioned.

Historical Outlines.—Considering four of the great civilizations of antiquity—Babylon and Egypt, Greece and Rome—two contributed little to the development of mathematics: neither Egypt nor Rome advanced beyond the level of the elementary practical arithmetic and mensuration. Priority in the development of mathematics belongs to Babylonia (and to its Sumerian heritage), where numerical, algebraic and geometrical methods

existed at least since the Hammurabi dynasty (around 1700 B.C.). Little is known about the prehistory or about the subsequent period until Persian times (6th century B.C.). Nevertheless, that the tradition had been kept alive is proved by texts of the latest period of Babylonian history, when the country had come under Greek and then Parthian domination (last three centuries B.C.). Shortly before, during the 5th or 4th century B.C., the rapid development of Babylonian astronomy began, which became the main carrier of Babylonian arithmetical methods over the world—still retained today in the 60 division of hours and degrees. (*See* BABYLONIA AND ASSYRIA: *Intellectual Achievements.*)

Greek theoretical mathematics began in the 5th and 4th century B.C.—Archytas of Tarentum and Eudoxus of Cnidus were the outstanding representatives of the earliest phase which closed with Euclid in the beginning of the Hellenistic period. The climax of this development was reached about a century later with Archimedes of Syracuse and Apollonius of Perga. The period following Alexander, with the whole Persian empire from India to Egypt under Greek domination, witnessed the assimilation of Babylonian arithmetical methods, particularly in Hellenistic astronomy. Following Apollonius and Hipparchus (about 150 B.C.), geometric methods were applied to the study of eccentric and epicyclic motion, parallel with the development of trigonometry, stereographic projection, etc. The highest peak of this process was reached with Ptolemy of Alexandria in the 2nd century A.D.

Probably around A.D. 400, Hindu astronomy began under western influence. This led to two important modifications of the Hellenistic methods: the replacement of the chord function by the sine function in trigonometry, and the substitution of the decimal for the sexagesimal place-value notation.

In the Islamic period, the meeting of all the preceding forms of mathematical activities, theoretical as well as graphical and numerical methods in astronomy and optics, took place. The "Algebra" of al-Khwarizmi (9th century, Baghdad) continued the near eastern tradition rooted in ancient Mesopotamia, while his astronomy combined Indian and Greek components. After the first great scientific activity declined with the Abbasid dynasty, the centres of Islamic science followed, more or less, the political development. By A.D. 1000 one of the greatest scholars of Islam, al-Biruni, followed Mahmud of Ghazni to India, while the Fatimid court in Egypt counted Ibn Yunis and Ibn al-Haitham among its scholars. Two centuries later, under Frederick II, Sicily came into close contact with Islamic sciences and provided an important influence on the intellectual revival of Italy. Spain under the Omayyads and their successors developed into the most important source of learning to western scholars of the late middle ages.

Greek scientific tradition survived to a certain degree in Byzantium and experienced a final renaissance under the influence of Persian and Arabic works in the period of restoration between the sacking of Constantinople by the Venetians and the crusaders (1204) and the fall of the city in 1453 under the Turkish onslaught. Islamic science flourished for the last time under Mongol rulers particularly at the court of Ulugh Beg (d. 1449), the grandson of Timur (Tamerlane). At the same time Europe took the lead, beginning with the Italian Renaissance, which rapidly transformed the inherited methods to what were to become the foundations of modern science.

Simple categories are no longer applicable to the modern development of mathematics, though the earliest phase naturally followed closely the examples of antiquity. The development of analysis (Fermat, Descartes, Newton) soon left behind the classical methods and problems, and an enormous wealth of new discoveries revealed an interaction between theoretical mathematics and all branches of physics and astronomy. This period of often somewhat uncontrolled discovery culminated in the work of Leonhard Euler (1707–1783). Soon afterward the need for increasing rigour and abstraction became the dominant motif which remained characteristic for mathematics thereafter. This tendency not only profoundly influenced each of the traditional branches of mathematics; it likewise all but obliterated the boundaries between individual fields by uncovering their common logical and operational background. By the second half of the 20th century the enormous importance of mathematical physics, accompanied by the development of high-speed computing machines, furnished a new incentive to mathematical research similar to the situation at the threshold of the 19th century.

ANCIENT AND MEDIEVAL

Mesopotamia.—The superiority of Babylonian mathematics is based on the place-value notation of its number system which was equally well adapted to the expression of numbers, however large, or of fractions. This system is not the result of some intentional invention but emerged slowly during the 3rd millennium B.C. In the highly developed economic life of this period, a notation for the recording of monetary transactions originated in which larger and smaller units of weights of silver were expressed by simple juxtaposition of numbers, denoting units of different values, similar to the notation $5.20 as distinguished from $20.5. Thus the arrangement of the numbers determined their relative value; in our example the ratio of dollars to cents is 1 to 100, in the Babylonian monetary system it happened to be 1 to 60. This notation was then extended to numbers in general, so that one ended up with a "sexagesimal place-value system." In our example 5.20 means $5+\frac{20}{100}=5+\frac{1}{5}$ (dollars) or $500+20=520$ (cents). Similarly 2,30 in the sexagesimal system means $2+\frac{30}{60}=2+\frac{1}{2}$ or $2\times 60+30=150$. All other arithmetical rules familiar to us from the decimal system have their exact counterpart in the sexagesimal place-value system. We know by heart all products of integers up to 10 times 10. The Babylonians (and later the Greek and Arabic astronomers) tabulated the corresponding products up to 60 times 60. In this fashion all arithmetical operations, additions, subtractions, squares, cubes and square roots and cube roots, multiplications and divisions, were carried out first in Babylonian mathematics from the 2nd millennium B.C. on and then—beginning around the 5th century B.C.—by the astronomers of Mesopotamia, of Greece and Alexandria, of India, of the Islamic world and the Byzantines and their western pupils to the 15th century A.D. and later.

A number system which is based on a place-value notation encounters the problem of the occurrence of empty places; *e.g.*, in the sexagesimal system, this is the case when in an addition some digits total exactly 60 which then are carried as 1 to the next higher place. In the earlier period of Babylonian mathematics one had no special symbol for such cases and had carefully to watch the relative order of the digits. In the late period, however, a special sign was written for every empty place. This "zero" symbol was in common use in all astronomical computations and reached the Hellenistic mathematicians, along with the sexagesimal place-value notation. Thus in all Greek trigonometric tables, *e.g.*, in Ptolemy's *Almagest* (about A.D. 140), a zero sign is used exactly as we would use it. The same holds for Islamic and Byzantine tables; in these late Greek manuscripts the form ō for zero is the most common one. When Hindu astronomy was developed under western influence, beginning about the 5th century A.D., the zero symbol was transferred to a decimal place-value notation. This decimal system was well known to Islamic scholars, although the astronomical practice remained sexagesimal in most cases. In western Europe, the decimal notation gained ground very slowly and it was not until the 17th century that a consistent decimal place-value notation was developed by François Vieta (1540–1603) and Simon Stevin (1548–1620).

The facility of numerical computations, as the result of a place-value notation, is everywhere visible in Babylonian mathematics. An Old Babylonian text (written about 1700 B.C.) investigates, for example, triples of "Pythagorean" numbers; *i.e.*, numbers which satisfy the relation $a^2 + b^2 = c^2$. Many problems were of the following type: find two numbers of given sum when also their difference, or their product, or their quotient is known. The first and the third problems are solvable linearly; the second can be reduced to the first by squaring the sum and subtracting four times the product. The resulting procedure is the normal form for the solution of quadratic equations in Babylonian mathematics. On the basis of this insight a numerical algebra was

developed leading to the determination of unknown quantities from a system of linear relations, or from very elaborate quadratic equations, or equations of fourth order obtained by squaring second degree expressions. Similar problems in geometric formulation were handled (division of fields, etc.) involving the concept of similarity, the basic area relations, volumes, etc. In purely numerical respects, one went on to tables of consecutive powers of certain integers and to special cases of the inverse problem, analogous to determining the logarithm of a number. Also problems of compound interest occur. This does not exclude the study of purely geometric relations. The "Pythagorean" theorem for right triangles, the fact that a triangle inscribed in a semicircle is a right triangle, relations in regular polygons, etc., were known, leading to very good approximations of $\sqrt{2}$, $\sqrt{3}$, etc. For π the crude value 3 was often used, but $3\frac{1}{8}$ also was known. (*See* also PYTHAGORAS AND PYTHAGOREANISM.)

Egypt.—The main sources of our knowledge of Egyptian mathematics are two papyri, the so-called Rhind (or Ahmes) papyrus of the British museum (written about 1650 B.C.) and the Golenishev papyrus in Moscow (from about 1900 B.C.). Several smaller fragments confirm the impressions gathered from the two larger texts. The arithmetical operations were developed on an additive basis, repeated duplication for multiplication, with corresponding rules for division and fractions, derived from successive halvings. These often long-winded procedures were used to solve very elementary practical problems; *e.g.,* distributing in given quotas bread and beer. In the same numerical fashion were determined areas of triangular or polygonal fields, volumes of solids, in particular of a truncated pyramid (probably in the special shape of a corner block of two sloping walls). The area of a circle was found by squaring $1-\frac{1}{9}$ or $\frac{8}{9}$ of the diameter (corresponding to a value of about 3.16 for π). The oft-repeated assertion attributing to the Egyptians a knowledge of the formula for the sum of a geometric progression is based on a modern misinterpretation.

Greek and Hellenistic Mathematics.—Late antiquity attempted to supplement the dim records of the past by associating the origin of mathematical knowledge with the early philosophical schools of the 7th and 6th centuries B.C. in Ionia (Thales) and southern Italy (Pythagoras). These claims are not confirmed by modern research. The basic facts of elementary geometry and arithmetic had for many centuries been known in Mesopotamia. On the other hand, Greek astronomical and cosmogonic concepts in the 5th century B.C. (*e.g.,* Philolaus) are still so primitive that only a very narrow margin is left for earlier discoveries. Indeed, it seems more plausible to assume that the independent development of Greek mathematics began essentially in the time from which we have the first reliable records; namely, the determination of certain areas bounded by circular arcs by Hippocrates of Chios (second half of the 5th century), and the investigation of curves in space in connection with the problem of the duplication of the volume of a cube by Archytas of Tarentum (first half of the 4th century). Whether this rapid development of scientific mathematical theory had anything to do with the increasing contact with the near east is unknown, but, offhand, it seems not very likely. Clear influence of the oriental tradition appears much later in the writings of Hero (1st century A.D.) and Diophantus (period uncertain) although the numerical methods of astronomy reveal Babylonian influence at least since Hipparchus (*c.* 150 B.C.).

Although Plato's lifetime (*c.* 428–*c.* 348 B.C.) belonged to the most important formative period of Greek mathematics, it seems unlikely that any active role in the development was played by him. Nevertheless, philosophy was of great importance for the origin of scientific mathematics, if only for the necessity of removing mathematical argumentation from the unsafe ground of philosophical discussion. The paradoxes about the infinite divisibility of space and time (Zeno of Elea, 5th century B.C.) and the related attempts of avoiding them through the assumption of atomistic structures (Democritus, *c.* 400 B.C.) led to the necessity of defining exactly the postulates to be made for the objects of mathematical discussion. These investigations soon resulted in the discovery that the rational numbers do not suffice for the measurement of geometrical quantities and thus require an independent foundation of geometry. Thus the mathematicians of the early 4th century B.C., foremost among whom were Theaetetus (d. 369 B.C.) and Eudoxus, developed a geometric theory of what we now call the irrational numbers. Similarly, the concept of area gave rise to a rigorous theory of integration.

The strictly geometric formulation of these problems directed Greek mathematics away from algebraic procedures, although a purely algebraic notation had been used by Aristotle (384–322 B.C.) in his investigation of formal logic, in spite of the continuation of the oriental tradition within elementary mathematics. Numerical and even graphical methods were used to a large extent within theoretical astronomy as we know from Ptolemy's *Almagest* and his minor writings, but nowhere is there visible an approach to the concept of "function," which is of such fundamental importance for the development of modern mathematics. Consequently all problems which lead to integrations are attacked as individual geometric problems since it was unknown that integration is the inverse process of finding the derivative. Similarly, the problem of finding tangents to curves, *e.g.,* conic sections, is never seen from the viewpoint of functional relationship.

As mentioned before, theoretical mathematics perhaps received its original impetus from such philosophical problems as the meaning of infinite divisibility of lines, the meaning of area and volume, or the mutual relationship between geometrical and arithmetical ratios, the latter connected with the theory of harmonies. But from a relatively early period on, two other lines of interest are also discernible; namely, curves traceable by mechanical means and conic sections. To the first group we count the problems of spherical geometry as suggested by the apparent motion of the celestial bodies. Also the second group probably has an astronomical origin; namely, the theory of sun dials. By the end of the 4th century all these areas of investigation had reached a level at which a certain codification became possible or even necessary. Eudemus, a pupil of Aristotle, wrote a history of mathematics —unfortunately it is known to us only by some short excerpts. Somewhat later appeared Euclid's *Elements* concerning the most refined part of theoretical mathematics, culminating in Book X, the classification of irrationals. A work on conic sections by Euclid is lost but some smaller writings have survived, notably a spherical astronomy which shows how far one still was from a spherical geometry. This is confirmed by a treatise of Aristarchus of Samos (first half of 3rd century B.C.), who clearly did not yet have standard trigonometrical procedures at his disposal.

The theory of conic sections, however, had in the meantime reached a high degree of perfection and its significance for the solution of algebraic problems had been understood. This was amply attested by the use of conic sections made by Archimedes and, above all, by the great work of Apollonius (*c.* 200 B.C.). In the latter we find a systematic discussion of elementary properties of axes, chords, tangents, asymptotes, focal properties, conjugate directions, etc. But many theorems are also proved, the significance of which was recognized only with the development of projective geometry. Thus we find, for example, the relationship between harmonic quadruples utilized for the proof that five points (or three points and one tangent or one point and two tangents) determine a conic section. We find theorems of duality, transformation of co-ordinates, a discussion of evolutes and theorems which are related to the projective generation of conic sections from pencils of lines.

With Archimedes and Apollonius, theoretical mathematics had reached its climax in antiquity. From then on, astronomical problems determined the direction of further progress (*see* ASTRONOMY: *History of Astronomy*). Apollonius showed that the anomalies in the motion of sun, moon and planets can be explained as either eccentric or epicyclic motion. It is easy to see that the apparent position of a body moving on an eccentric circle can be predicted by simple trigonometric relations which, in turn, are always reducible to the solution of right triangles. The new element brought to the problem by its astronomical application consists in the need for repetitiveness, in order to describe the motion of a body by its consecutive positions. This leads to

the construction of numerical tables or to graphical or mechanical devices. In the 3rd century B.C., Babylonian mathematical astronomy had reached full maturity. With Hypsicles and Hipparchus, the Babylonian numerical methods, with difference sequences as the main tool, appeared in Greek astronomy. Hipparchus is credited with the computation of a table of chords. In the same period must belong the invention of stereographic projection which transfers problems of spherical geometry to plane geometry under preservation of circles. Similarly, methods of descriptive geometry were invented, the so-called analemma, again with the purpose of treating spherical problems in the plane. This phase of the development was completed by the middle of the 1st or the end of the 2nd century B.C.

The progress of spherical trigonometry was much slower, for obvious reasons. Plane trigonometry involves no new principle beyond the Pythagorean theorem and the fact that two chords over a diameter form a right angle—both known since Old Babylonian times. Spherical trigonometry required entirely new insight, in particular the restriction to great circle arcs. The discovery of the latter fact seemed to be due to Menelaus (*c.* A.D. 100) and it was especially remarkable because astronomical experience suggests very strongly the consideration of parallel circles. The contrast between the work of Menelaus and the earlier *Spherics* of Theodosius (1st century B.C.) shows clearly the progress made. Inequalities and qualitative considerations were replaced by accurate solutions of spherical triangles, based on the Menelaus theorem. With Ptolemy (2nd century A.D.) this method became the standard procedure for spherical astronomy.

In the 4th century A.D., the sciences became an object of teaching and commentaries. Pappus, Theon of Alexandria and Hypatia paraphrased, commented on and edited the great classics. We owe much to their industry, and a work like the *Mathematical Collection* of Pappus had great influence on the revival of mathematics in the 17th century, particularly on Descartes. The philosopher Proclus (5th century) wrote an introduction to the *Almagest* and commented on Book i of Euclid's *Elements*. Eutocius (6th century) still competently discussed Archimedean treatises. But what was left of Greek mathematical literature in Byzantium had sunk to the level of elementary summaries.

The Middle Ages.—Very few details are known about the survival of ancient science during the period from the final victory of Christianity to the beginning of Islamic science in the 9th century. Persia undoubtedly played a role in this process, not only as a refuge for exiles—non-Christian as well as Christian—from orthodox persecution, but also as an intermediary with India. In the 6th century, under Sasanian rule, Jundi-Shapur (southwestern Iran, Khuzistan province) was a centre of learning, particularly in medicine, and the same city provided the Nestorian physician of the Abbasid caliph al-Mansur. Under this ruler's influence a project of systematic translating was begun, centred at the "House of Wisdom" in Baghdad and based on a widespread search for Greek scientific literature. In the same period, Indian astronomy had reached Baghdad, thus creating the first school of Islamic astronomy, the best-known representative of which is al-Khwarizmi (d. about 850). His name still lives in our "algorism" as well as in "algebra," which was derived from the title of one of his works, *Kitab al jabr wa'l muqabala*, famous although of little originality since it closely follows the tradition of elementary mathematics which we can trace from Mesopotamia through the works of Hero and others. Yet, for the revival of mathematics and astronomy, al-Khwarizmi's work was of great importance.

The most significant contribution of India to medieval mathematics was the replacement of the Greek chord function by sine function (though multiplied by constant factors; *e.g.*, 3438′ in order to obtain a circumference of 360° for the circle). The use of the decimal system, however, remained of much lesser importance though it occurred occasionally in Islamic, and then also in Byzantine, works. No influence on the west was exerted by the development in India of a theory of Diophantine equations, beginning in the 6th century A.D. (Aryabhata) and ending in the 12th (Bhaskara). The origin for these investigations in all probability lay in questions related to the periodicity of planetary phenomena. Thus methods had been known in India that were not rediscovered until Bachet de Mézirac (1624) in Europe. The Hellenistic theory of numbers culminated in Euclid's proof of the existence of an infinity of prime numbers and of the Euclidean algorism. What remained of Greek theory of numbers, for example in Iamblichus (A.D. 300) or Diophantus (date unknown but sometimes placed A.D. 200–300), did not form a connected theory and had little influence during the middle ages.

The progress due to Islamic mathematicians and astronomers probably lay mostly in the perfection of computational devices. Accurate tables for the sin- and tan-function were computed, and methods were devised to modify particularly the first-mentioned function in order to tabulate the equation of centre for planetary orbits. Spherical trigonometry was developed far beyond the level reached in antiquity. The use of the Menelaus theorem was replaced by more elegant methods; *e.g.*, the sin-theorem, known since about A.D. 1000 (Abul Wefa). At the same time the ancient tradition of descriptive geometry and graphical procedures was developed in the theory of sun dials.

Abul Wefa and his contemporary Kushyar bin Labban wrote treatises on sexagesimal computation. From them proceeds a continuous tradition to al-Kashi, the first director of Ulugh Beg's observatory in Samarkand (about 1400). Among these scholars, the so-called Ruffini-Horner (1804–1819) method was developed for the determination of the nth root by means of an iteration process. Al-Kashi wrote a treatise on the computation of π in which he gives approximations both in sexagesimal and decimal fractions to 9 and 16 places, respectively, based on the comparison of an inscribed and a circumscribed regular polygon of more than 800,000,000 sides.

It is natural to measure Islamic science by its new discoveries and independent achievements. It is clear that the five centuries from A.D. 900 to 1400 cannot compete with the most creative period of Hellenistic science from 300 B.C. to A.D. 200. One must read such masterpieces of scientific analysis as al-Biruni's work on India (1030) or Ibn Khaldun's (1332–1406) sociological studies in order to understand the depth of Islamic cultures which westerners rightly regarded with the greatest of admiration.

The process of transmission of Islamic science to Europe began in the 11th century with men like Adelard of Bath who visited Syria or Leonardo Pisano in north Africa and Italy at the time of Frederick II, whose court in Palermo became a centre of learning. Gerard of Cremona (*c.* 1114–1187), working in Toledo, was perhaps the most prolific translator of Arabic versions of Greek works (Euclid, Archimedes, Theodosius, etc.). Only a long series of names would cover the European scholars who worked in Spain during the 12th and 13th centuries, often helped by Jewish scholars, in their efforts to commit to Latin an Arabic text. Their works formed the foundation on which the science of the Renaissance was built. (O. E. N.; X.)

MODERN PERIOD

In 1545, only two years after Copernicus had published his *De revolutionibus* and Vesalius had corrected the physiology of Galen, Geronimo Cardano published the *Ars magna*, a book that opened a new era in mathematics. Linear and quadratic equations had been solved for thousands of years, but the cubic had resisted all efforts until suddenly several Italian algebraists discovered a solution. First to succeed seems to have been Scipione del Ferro (*c.* 1510); but the formula often is named for Niccolo Tartaglia, a rediscoverer, or for Cardano, who first published it in the *Ars magna*, together with Lodovico Ferrari's solution of the quartic. This unexpected success gave a fillip to the theory of equations, and enthusiasm for "the great art" (algebra) spread to other lands. Simon Stevin of Bruges gave rules for locating roots of equations and established the systematic use of decimal fractions (1585). In France, at the court of Henry IV, François Vieta gave algebra a new name (the "analytic art") and a more general form. His use of vowels for unknown quantities and consonants for known paved the way later for the important concepts of variable and parameter, as well as for the rapid rise of a truly symbolic algebra. He is remembered also for his part (1579) in continuing the efforts of

Johann Müller (Regiomontanus) (1464) to establish trigonometry as more than a stepchild of astronomy.

17th Century.—Vieta died in 1603, just over the threshold of the "century of genius." Brilliant discoveries were about to crowd close upon each other. In 1614 John Napier published his discovery of logarithms; and the following year Johannes Kepler devised infinitesimal methods which Bonaventura Cavalieri in 1635 fashioned into a geometry of indivisibles. In 1637 René Descartes published, along with his *Discours de la méthode*, his greatest discovery—analytic geometry. Co-ordinates, the analytic method, graphical representation of functions and the application of algebra to geometry were not new at that time; but Descartes (and also his contemporary, Pierre de Fermat) correlated these in the basic principle that an equation in two unknown quantities represents a curve and vice versa. The ancient synthetic geometry of static figures now had a powerful and dynamic rival in the algebraic geometry of variable magnitudes.

In fact, except for isolated instances (such as the projective geometry of Gérard Desargues and Blaise Pascal in 1639), "Cartesian geometry" completely overshadowed "pure geometry" for almost two centuries. One of the immediate results of the new geometry was a tremendous increase in the variety of curves which came to be studied. So few curves previously had been known that no need had been felt for a general definition of tangent line; a tangent had been, with certain obvious exceptions, a line which touches the curve at one and only one point. It was Fermat, primarily, who introduced the modern idea of the tangent to a curve at a given point P. In essence, he took a second point Q on the curve, found the slope of the secant line PQ, and from this, by permitting Q to tend toward coincidence with P, he calculated the slope of the tangent. This method rightly earned for him the title of inventor of the differential calculus. When one notes also his share, together with Pascal, in the founding of the theory of probability (1654), his work on the quadrature of curves, his use of mathematical induction and his achievements in the theory of numbers, one appreciates why Fermat, for whom mathematics was but an avocation, has been hailed as the greatest of amateurs. Fermat found the length of the semicubical parabola in 1658, the year in which Christiaan Huygens determined the length of the cycloid—although rectifications had been anticipated by Evangelista Torricelli, student of Galileo, who had found the length of the logarithmic spiral (*c.* 1640). Pascal and John Wallis also studied the cycloid, a curve whose beautiful properties led to so many disputes over priority that it has been dubbed the "Helen of geometry." Huygens showed that the evolute of a cycloid is an equal cycloid, a property which led to the concept of curvature and which he applied in making pendulum clocks.

Development of the Calculus—Newton and Leibniz.—Of all the mathematicians of the 17th century, none compared in power and original contributions with Sir Isaac Newton. One of his earliest discoveries was that of the binomial theorem for rational fractional exponents. The binomial formula introduced Newton to infinite series, a topic which loomed large in his invention of the calculus at about the same time (1666). Areas by integration had been found, through summations, by earlier mathematicians from Archimedes to Wallis; and differentiations had been carried out by Fermat. It remained for Newton and Gottfried Leibniz to discover the fundamental principle of the calculus—that integrations can be performed far more easily by inverting the process of differentiation. This capital discovery was made possible, in the case of Newton, by his study of the methods of his teacher, Isaac Barrow, as well as by works of Fermat and Wallis; Leibniz seems to have been led to the calculus independently (*c.* 1673–76) by reading the works of Barrow and Pascal. Neither inventor was able to establish the calculus on a sound logical basis. Newton at first adopted a crude explanation in terms of infinitely small "moments"; later he had recourse to the plausible but undefined idea of "prime and ultimate ratios" of the rates of change (fluxions) of flowing quantities (fluents). Leibniz tried (unsuccessfully) to explain his method in terms of sums and quotients of infinitely small "differentials," the notation for which was so felicitous that it has been used ever since.

Newton's first publication of the calculus was in 1687 in a short scholium in the *Philosophiae naturalis principia mathematica*, conceded to be the greatest of all scientific treatises. The *Principia* is couched in the synthetic language of the ancients, even though the discoveries in the book were made through the new analytic devices which the author helped to develop. Newton is best known for his demonstration, in the *Principia*, of one of the greatest of scientific generalizations, the law of gravitation. Newton's discovery of the composite nature of white light was published in the *Opticks* of 1704, a treatise containing also Newton's *Quadrature of Curves* and his *Enumeration of Cubic Curves*. Where Newton's aim was to understand nature, the motive of Leibniz was to find a general pathway to knowledge. The Leibnizian search for a universal characteristic, which resulted in the first steps toward symbolic logic, failed to attract a following until the publication of George Boole's *Laws of Thought* (1854); but the method of differentials, the formal algorithmic nature of which was in accord with the aims of its inventor, became the mainspring of mathematical development in the following century.

18th Century.—The mathematical contributions of the versatile Leibniz were more modest than those of Newton, but their influence on the continent was far greater. The Bernoulli family in particular, great admirers of Leibniz, were fired with enthusiasm for the differential calculus; and the greatest and most influential pupil of Jean Bernoulli was Leonhard Euler, the most prolific mathematical author of all time. The 18th century saw few spectacular discoveries; yet this prosy age generated more new mathematics than had any earlier period—and most of this centred about the work of Euler. One of his treatises, the *Introductio in analysin infinitorum* of 1748, may be called the foremost mathematical textbook of modern times, for it fashioned the function concept and infinite processes into the third member of the mathematical triumvirate comprising geometry, algebra and analysis. The *Introductio* contains the earliest algorithmic treatment of logarithms as exponents and of the trigonometric functions as numerical ratios; in it the five proper quadrics are first recognized as members of a single family; and the book systematized the use of parametric equations, polar co-ordinates and the graphical representation of elementary functions.

Euler contributed to all analytic aspects of mathematics. His treatises on the differential and integral calculus are the source from which modern authors have drawn material; he was one of the founders of the calculus of variations and of differential geometry; he was the greatest figure in the theory of numbers since Fermat; and he contributed much to mathematical physics. The vast scope of his interests accounted perhaps for a lack of soundness in logical foundations. He based the calculus on quotients of "qualitative zeros," and he had no qualms about operating with the "sums" of divergent series.

Mathematicians of the 18th century generally were connected with a university or a royal court, and Euler, no exception, found patrons at Berlin and St. Petersburg. When in 1766 Euler resigned from the Prussian academy to return to Russia, Frederick the Great chose as his successor J. L. Lagrange, reputed the greatest mathematician of the century. The interests of Lagrange (algebra, analysis, the theory of numbers and mechanics) were much like those of Euler, but his disposition was different. Lagrange published far less, but his contributions were beautifully finished products with a sound foundation. His *Théorie des fonctions analytiques* of 1797 made mathematicians more keenly aware of the need for rigour; but the book which earned him greatest fame was the *Mécanique analytique* (1788), which established mechanics as a branch of mathematical analysis. Beginning with a small number of postulates, such as the principle of "virtual work," the author built up the principles of the subject without recourse to anything beyond deductive logic. The Age of Reason, typified by the mathematician and encyclopaedist Jean le Rond d'Alembert, may be thought of as culminating in Lagrange's *Mécanique*, published just one year before the opening of the French Revolution. The greatest legacy left to mathematics by the French Revolutionary period was the establishment in 1795 of the École Polytechnique, a school which boasted among its teachers the

greatest mathematicians of France, including Lagrange, Pierre Simon Laplace and Gaspard Monge. Laplace established celestial mechanics as a branch of analysis, and it was through his work that such tools as potential theory, the "Laplace transform," the "Laplace equation" and orthogonal functions became the stock in trade of the analyst. His masterpiece, the *Mécanique céleste* (5 vol., 1799–1825), purported to prove the stability of the solar system, for the origin of which the author proposed the nebular hypothesis. The students of the École Polytechnique esteemed as their greatest teacher Gaspard Monge, who began an era in mathematics characterized by a resurgence of geometry. The *Géométrie déscriptive* (1799) of Monge, originally devised for military purposes, was the first significant contribution to synthetic geometry after 1639; but the author was not a single-minded synthesist, and the emphasis at the École Polytechnique upon analytic and differential geometry was in large measure the result of the successful textbook of Monge (1795). The key idea in his work was that each step in an analytic calculation corresponds to some geometrical construction. Lazare N. M. Carnot, the "organizer of victory" for the French revolutionary armies, likewise contributed both to analytic and synthetic geometry, his greatest treatise being the *Géométrie de position* (1803), although he is better known for his theorems on transversals.

19th and 20th Centuries.—Carnot had sought to avert the despotism of Napoleon, but Monge and J. B. J. Fourier were friends and ardent admirers of the emperor. Fourier's chief contribution to mathematics is typical of the originality (but not the rigour) of the new century. His classic *Théorie analytique de la chaleur* (1822) showed that an arbitrary function can be expanded in a "Fourier series" of sines and cosines. In the very same year, Fourier's boldness in analysis was paralleled in projective geometry by the *Traité des propriétés projectives des figures* of J. V. Poncelet, a student of Monge. Poncelet became a centre of controversy over the "principle of continuity" and the idea of duality. His reckless charges of plagiarism antagonized a young German geometer, Julius Plücker, who turned from synthetic methods to become the greatest of analytic geometers.

In his many treatises, Plücker developed the ideas of abridged notation, homogeneous co-ordinates (of points, lines and planes), enumerative geometry and the line as an element in a four-dimensional space. In Germany his work was not well received, for Jakob Steiner by 1832 had built up a strong following in synthetic geometry. Steiner hated analysis as thoroughly as Lagrange disliked geometry, arguing that calculation replaces thinking, whereas pure geometry stimulates it. His ideas were carried on (1847) by K. G. C. von Staudt, who, with still sharper logic, examined the structure of pure geometry.

Non-Euclidean Geometry.—Probably no earlier period in the history of mathematics rivaled the 19th century either in critical spirit or in originality of development, both of which are seen in the rise of non-Euclidean geometry. Attempts to prove the parallel postulate had been so numerous as to constitute a "fourth classical problem of antiquity"—until N. I. Lobachevski (1826–29) and Johann Bolyai (1831–32) showed that it is possible to build self-consistent geometries in which this postulate is denied. In 1854 G. F. B. Riemann proposed the characterization of a geometry by the quadratic differential form for arc length, an idea essential later in general relativity. C. F. Gauss, still another independent discoverer of non-Euclidean geometry, failed to publish his thoughts on the subject. The informed consensus is that Archimedes, Newton and Gauss were the greatest mathematicians of all time. When he was not yet 19, Gauss discovered (1796) that a regular polygon of 17 sides can be constructed in the Euclidean sense. Other results (non-Euclidean geometry, the graphical representation of complex numbers, the double periodicity of elliptic functions) were entered in his diary and went unpublished until rediscovered by others. His *Disquisitiones arithmeticae* (1801), containing the law of quadratic reciprocity and the algorithm of congruences, is a classic in the theory of numbers; and the *Disquisitiones generales circa superficies curvas* (1828) marked a new epoch in differential geometry through the exploitation of the parametric representation of surfaces and their "Gaussian curvature." These books show a modern tinge in the meticulous attention to proofs. Gauss was also a prolific contributor to statistics (including the method of least squares, invented independently by A. M. Legendre) and to applied mathematics (especially in astronomy, geodesy and magnetism).

Theories of Groups, Functions and Complex Variables.—Gauss proved (1799) that every polynomial equation has at least one complex root, but it remained for two younger contemporaries, N. H. Abel and Évariste Galois, independently to demonstrate that in most cases the root cannot be expressed by means of radicals. Abel's proof (1824) that the quintic cannot be "solved" led Galois to seek general criteria of solvability. Galois (who died in 1832, before his 21st birthday) observed that every algebraic equation is associated with a certain group of substitutions and that solvability is determined by the properties of this group, thus establishing the "Galois theory" or the theory of groups. In 1872 Felix Klein, in his famous *Erlanger Programm*, pointed out the unifying role of the group concept in geometry; and Sophus Lie, through the theory of continuous groups (about 1873), made it a part of analysis. Gauss and A. L. Cauchy, the foremost mathematicians of their day, are typical exponents of 19th-century mathematics in their rigour and inventiveness. The prolific Cauchy was the successor of Lagrange in the theory of functions, to which subject he added the theory of a complex variable. The graphical representation of complex numbers by J. R. Argand (1813–14) and the discovery by Abel (1824) of the imaginary period of elliptic functions had led up to this; but the complex variable really came into its own in 1825 with the "Cauchy integral theorem." This work later was continued in two directions: Karl Weierstrass emphasized the pure analytic aspect through the "analytic continuation" of functions defined by power series; Riemann made greater use of geometric intuition through a study of conformal representation and "Riemann surfaces."

Algebraic Geometry.—British mathematics had been handicapped throughout the 18th century by excessive deference to synthetic methods and the notations of Newton. In 1816, however, the Cambridge Analytical society was formed to promote the Leibnizian methods of the calculus. Moreover, the first half of the 19th century was characterized by the rise of mathematical journals (mathematical societies being chiefly a product of the latter half of the same century), and these facilitated publication and dissemination of knowledge (*see* MATHEMATICS, SOCIETIES OF). Hence it was not long before England, through the voluminous work of Arthur Cayley, became the stronghold of algebraic geometry. The geometry of n dimensions had been hinted at by Sir William Hamilton (1843) and Hermann Grassmann (1844), but Cayley is regarded as the true founder of this branch of geometry (1869), as well as of the theory of matrices and algebraic invariants. Algebra, overshadowed by analysis for two centuries, again was assuming a decisive role, with the application of determinants in algebra and analysis becoming one of the most fruitful lines of development. The critical spirit of the 19th century found clearest expression in the ever-greater arithmetization of mathematics. Bernard Bolzano already had taken a step in this direction in 1817 by giving an analytic proof of the location theorem; but development of the foundations of arithmetic dates especially from 1872 when definitions of irrational number were given by Weierstrass, Julius Dedekind and Georg Cantor. These definitions, based on the notion of infinite classes, led Cantor (in his *Mengenlehre* of 1895–97) to one of the most strikingly original contributions of all time—the theory of transfinite numbers. After showing that the class of algebraic numbers is denumerable, Cantor was led to the startling conclusion that the "number" of points in space of n dimensions is not greater than that in a single dimension, a paradox confirmed by the Peano space-filling curve.

Influence of Science on Analysis.—Perhaps the most powerful impetus on the development of analysis came from mathematical physics and astronomy (*see* ANALYSIS). The common role of extremal principles for the laws of optics as well as dynamics became clear through the work of Sir William Rowan Hamilton (1824–37) and Karl Gustav Jacobi (1837–43). The geometric interpretation of the $2n$ "canonic variables" of the dynamic dif-

ferential equations led Sophus Lie (about 1873) to the concept of contact transformations and continuous groups which, in its abstract form, gained an important place in modern topology. The deep interaction between analysis and mathematical physics is also visible in the work of the almost self-taught genius James Clerk Maxwell, which ranges from the investigation of the stability of Saturn's rings to thermodynamics and his celebrated field theory of electrodynamics (1873). The theory of statistical mechanics as developed by Maxwell, Ludwig Boltzmann and J. Willard Gibbs opened the road to the investigation of the so-called ergodic theorems (solution by George David Birkhoff, 1932). Through the theory of probability by A. Kolmogorov and A. Khintchine (1932) it had become clear that problems of statistical mechanics are essentially problems of the theory of measure, and in this form the ergodic theory has again developed into a branch of abstract mathematics. A similar development can be observed in the theory of integral equations which slowly emerged during the second half of the 19th century from problems of electrostatics and the theory of potentials. The essential turn toward a solution originated from the investigation of determinants of infinitely many rows and columns, begun by G. W. Hill (1877) in connection with the perturbation theory of the lunar motion. This new type of approach led Erik Fredholm (1900) to the discovery of the algebraic analogue of the theory of integral equations, which was crowned by the theory of eigen-values of David Hilbert (1906) and the related theory of spaces of infinitely many dimensions ("Hilbert space" and its modern generalizations).

Fundamental Questions.—Hilbert in 1900 prophetically proposed to the second International Congress of Mathematicians at Paris a series of fundamental problems which should challenge the efforts of the new century. The first problems concerned the continuum, where the question of whether or not there is a transfinite number between that of a denumerable set and that of the continuum remained unanswered. Questions inquiring about the transcendence of certain numbers were partially solved by C. L. Siegel (about 1930) and by Gelfond's theorem, although results here still were sporadic. The problems which stimulated the most spectacular development were those lying in the relatively novel field of analysis situs or topology. Certain puzzle problems of Euler were suggestive of topology, and Gauss prophesied the rise of the new subject, but the origins are more clearly apparent in results of Henri Poincaré (1899–1904). By the middle of the 20th century the infant prodigy had burgeoned into a major branch of mathematics. Originally an offshoot of geometry, topology became closely related also to algebra and analysis.

One of Hilbert's favourite questions concerned the compatibility of the axioms of arithmetic. Gottlob Frege in 1879 had given a critical definition of the word "number," and just a decade later the Peano postulates for arithmetic were proposed; but by far the most ambitious effort to establish the foundations of mathematics appeared in the *Principia Mathematica* (3 vol., 1910–13) of Bertrand Russell and A. N. Whitehead. This *Principia,* like that of Newton, set the fashion for decades to come, so that research in symbolic logic at mid-20th century constituted a major branch of mathematics. In fact, the greatly expanded role of the axiomatic approach became possibly the most conspicuous aspect of 20th-century mathematics. Such studies in the foundations of mathematics engendered lively controversy in which varying orthodoxies are distinguishable—from the formalists, who assert, as did Hilbert, that mathematics is a meaningless game played with meaningless symbols, to the intuitionists, who, with L. E. J. Brouwer, hold to a more Kantian view of the "inner meaning" of the subject. One of the factors contributing to the dilemma was the persistence of deep-rooted paradoxes. By rejecting the use of impredicative definition, Poincaré, Hermann Weyl, and Brouwer were able to eliminate the antinomies; but this drastic solution, to which Brouwer (and later Weyl) added also the rejection of the law of excluded middle, cut the ground out from under much of classical mathematics. Hilbert sought to save the mathematical fortunes by rejecting the idea of mathematics as necessarily "true," clinging only to the criterion of self-consistency; but such efforts were dealt a shattering blow by Goedel's theorem. Kurt Goedel in 1931 showed essentially that if the game of mathematics actually is consistent, the fact of this consistency cannot be proved within the rules of the game itself (*see* MATHEMATICS, FOUNDATIONS OF).

The conclusion which necessarily follows from such a devastating discovery is that the ultimate foundations of mathematics remain a deep mystery—at least to mathematicians. One should expect the result of this to be a deep pessimism. On the contrary, one found everywhere in the modern period the faith that mathematics was entering a golden age surpassing even the brightest periods of the past. Theories of integration, revolutionized by H. L. Lebesgue through his concept of measure (1902), had carried the subject far beyond Archimedes, Cauchy and Riemann into the realm of abstract spaces; and the unification of analytic methods had led to the general analyses of E. H. Moore (1906) and Maurice Fréchet (1928).

The atmosphere of 20th-century algebra, with its concern for such abstract axiomatic concepts as field, ring and ideal, was far more general than that of any previous age. Geometry—now encompassing spaces of infinitely many dimensions—undertook a critical examination of its postulational basis.

See also references under "Mathematics, History of" in the Index.

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MATHEMATICS, SOCIETIES OF. Mathematicians have always felt the need to communicate their results and problems to their colleagues. Until the 17th century these needs were met by personal contact and correspondence and by the publication of books. Thereafter there grew a multitude of societies devoted to mathematical knowledge, with an even greater number of periodical publications.

The oldest mathematical society still in existence in the 1960s is the Mathematische Gesellschaft in Hamburg, Ger., founded in 1690 as the Kunstrechnungsliebende Societät, and continued (1790–1876) as the Gesellschaft zur Verbreitung der Mathematischen Wissenschaften. Its publications were entitled *Jahresbriefe* or *Jahres-Berichte* or *Berichte* (1723–1878) and *Mitteilungen* (1873–80, mimeographed; 1881 *et seq.,* printed).

Another early organization was the Mathematical society founded as a discussion circle in Spitalfields, London, in 1717. It continued until 1845, when it was absorbed by the Royal Astronomical society.

Most national mathematical societies did not appear until the

second half of the 19th century, the scientific academies and the independent mathematical periodicals having sufficed until then. One exception is the Wiskundig Genootschap, founded at Amsterdam in 1778.

The oldest of the major national societies is the Moskovskoe Matematicheskoe Obshchestvo (Moscow Mathematical society), organized in 1864 as a circle for mathematics enthusiasts and re-established on a wider basis in 1867. It publishes the important periodical *Matematicheskiĭ sbornik* (*Recueil Mathématique;* 1866 *et seq.*) and *Trudy Moskovskogo Matematicheskogo Obshchestva* ("Transactions of the Moscow Mathematical society"; 1952 *et seq.*). There are many other mathematical societies in the U.S.S.R., that at Kharkov having been established in 1879.

The London Mathematical society, founded in 1865, began as a purely local society in London, most of the original members being at University college; its first president was Augustus De Morgan. It grew rapidly, however, and soon established itself as the national mathematical society of England. It publishes *Proceedings* (1865 *et seq.*) and a *Journal* (1926 *et seq.*), the latter containing shorter papers. The Edinburgh Mathematical society was founded in 1883 and publishes *Proceedings* (1883 *et seq.*) and *Mathematical Notes* (1909 *et seq.*).

The Société Mathématique de France was founded in 1872, its first president being Michel Chasles. It publishes a *Bulletin* (1872 *et seq.*).

The New York Mathematical society, founded in 1888, became the American Mathematical society in 1894. With more than 5,700 members, it is one of the most important mathematical societies in the world; and its meetings are held in all parts of the United States. Its periodical publications include the *Bulletin* (1891 *et seq.*), containing reports of lectures, abstracts of papers presented to the society, records of the society's activities and book reviews; *Transactions* (1900 *et seq.*) for longer papers; *Memoirs* (1950 *et seq.*) for papers of unusually great length; and *Proceedings* (1950 *et seq.*) for short papers (before 1950 the *Bulletin* was used for short papers also).

The Deutsche Mathematiker-Vereinigung, founded in 1890, is the German national society. Its *Jahresbericht* (1892 *et seq.*) contains many extremely valuable expository surveys of mathematical progress.

In Italy the Circolo Matematico di Palermo, founded in 1884, achieved international status; its *Rendiconti* (1887 *et seq.*) was for many years one of the most important mathematical periodicals in the world. The Unione Matematica Italiana was established in 1922; it publishes a *Bollettino* (1922 *et seq.*).

By the 1960s national mathematical societies had been formed in most countries; two of the most important outside Europe and the Americas were the Indian Mathematical society, which began in 1907 as a local club in Madras, and the Mathematical Society of Japan, which was formed after World War II as a partial continuation of the earlier Physico-Mathematical Society of Japan (founded 1884). Each publishes a journal. *See* also ACADEMIES.

Occasional international meetings of mathematicians took place during the 19th century, but the first of the present series of international congresses of mathematicians was held in 1897. The congress has met regularly every four years after 1900, except for interruptions caused by World Wars I and II. The *Proceedings* of each congress have been published, usually by the mathematical society of the sponsoring country. After World War I an abortive attempt was made to establish a permanent International Mathematical union; the project was revived in 1950 and a new union was formed; it was admitted to the International Council of Scientific Unions in 1952.

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(F. Ss.; J. V. W.; X.)

MATHER, COTTON (1663–1728), American Congregational minister and author, the most celebrated of all American Puritans although an extreme example, rather than typical, of the tradition for which he stood. He lived all his life in Boston, where he was born Feb. 12, 1663, the son of Increase Mather and grandson of John Cotton and Richard Mather (*qq.v.*). He took his A.B. at Harvard in 1678, his A.M. in 1681, was made a fellow in 1690 and joined his father in the ministry of the Second church in 1685.

The prominence of Mather's ancestry, combined with a profound mystical strain, led him throughout his life to believe that he was destined to accomplish great deeds in continuation and perhaps fulfillment of the work which the first colonists had begun. But his heritage worked against him also, for to many of his contemporaries he was the embodiment of an outdated ideology. He saw his political influence dwindle as the Brattle Street church, which advocated a broad basis for church membership, was founded (1698) and prospered; his father was ousted from the presidency of Harvard in 1701, which led him to resign his fellowship in 1703; and Joseph Dudley became governor in 1702. He did not relent in the zeal with which he opposed men and institutions which he believed to be derogations from the primitive purity of Massachusetts, but his tremendous energy came more and more to be channeled into his ministry and the production of nearly 450 separate printed works.

One of Mather's chief concerns was the presence of the supernatural in daily life, and he collected instances of this in his *Memorable Providences Relating to Witchcraft and Possessions* (1689). He is, therefore, generally credited with stimulating the frenzy which culminated in the witchcraft trials of 1692. Although he believed in the presence of witches and was determined to counteract witchcraft, Mather did not generalize about the trials, but weighed each case on its own merits, believing that some had been sentenced unjustly and cautioning the judges to be scrupulous in their acceptance of evidence.

Mather produced sermons and works of scriptural explanation, scientific instruction and political morality. His most famous and valuable work is his biographical and historical collection, *Magnalia Christi Americana* (1702), which contains information about almost every significant man or deed from the founding of New England to his time. He rarely allowed any successful experiment of his to remain unpublished if he felt the information would make for a better life and, therefore, he produced numerous tracts on subjects as diverse as the christianizing of Negroes and the raising of children.

Interest in science, which at one time encouraged Mather to consider a career in medicine, furnished him with a wide European correspondence on natural and supernatural phenomena in America. This resulted in his being elected to the Royal society in 1713 and is reflected in his *Curiosa Americana* (1712–24). He was an enthusiastic leader in the campaign for inoculation against smallpox in 1721, even though popular disapproval resulted on one occasion in a bomb's being thrown into his house. His impressive scholarship and tireless writing gained him an honorary degree from the University of Glasgow in 1710, an award which he especially cherished because of his differences with Harvard. These differences led him to take an interest in the new college in Connecticut, to urge Elihu Yale to contribute to it and to suggest to Gov. Gurdon Saltonstall that the college be named for Yale. Mather appears to have been offered the Yale presidency in 1721.

Mather died on Feb. 13, 1728. He was married three times and had 15 children, only two of whom survived him. He was nervously sensitive and frequently hot-tempered, both of which qualities increased his alienation from the popular trends of his day, such as the antitheocratic political movement and the establishment of heterodox Puritan and Anglican congregations in Boston. Nevertheless, he wielded a strong personal influence, and Benjamin Franklin remembered him with warmth, attributing his own penchant for practical schemes to notions derived from Mather's essays. Mather was the first American minister to organize clubs for young people, and he initiated the practice of regular calls upon aged and ailing parishioners and upon prisoners, as well as making himself available to any who summoned him.

Although his writings are saturated with archaisms and learned allusions, he was a conscious literary stylist and achieved passages of literary merit. His written work and his activities reflected his constant zeal for the betterment of his fellows and his sincere devotion to the ideal which he believed was responsible for the settlement of America and indispensable for its success.

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MATHER, INCREASE (1639–1723), American Congregational minister, author and statesman, a determining influence in the councils of New England during the crucial period when leadership passed into the hands of the first native-born generation, was born in Dorchester, Mass., on June 21, 1639, the oldest son of Richard Mather (*q.v.*). He graduated from Harvard in 1656, took his M.A. degree at Trinity college, Dublin, in 1658 and ministered to various congregations in England. He returned to Boston in 1661, married Maria, daughter of the Rev. John Cotton (*q.v.*), in 1662, and became the father of Cotton Mather (*q.v.*) in 1663. He became teacher of the Second church of Boston in 1664, licenser of the press in 1674, fellow of Harvard in 1675 and in 1685 president of the college. The last office he lost in 1701, in great part as a consequence of political opposition to his stand on the Massachusetts charter. When, in 1683, Charles II demanded that Massachusetts surrender the original charter by which the citizens elected their own governor, Mather took the lead in opposing the order. He perpetuated the theocratic ideal of the founders by pronouncing compliance with the royal demand to be a sin. After the charter was vacated by the court of chancery in 1686, Mather remained in the forefront of the opposition, hindering the measures of the royal governor, Sir Edmund Andros.

In 1688 Mather was sent to London as the emissary of some of the Massachusetts churches to try to regain the old colonial charter, and in 1690 he was made one of the colony's official agents in England. He stayed in London until 1692, interviewing James II, William III, Queen Mary and many others influential in politics. He enlisted in his cause the good offices not only of his Puritan brethren but also of the Quaker William Penn and of the Anglican bishops Burnet and Tillotson. When prospects of full restoration of the old charter appeared hopeless, Mather turned his energies to procuring measures favourable to the colonists in the new charter of 1691, and so succeeded as to be allowed to nominate the royal governor and other officers for the first year under that charter. Sir William Phips, the governor of his choice, proved unpopular, as did the charter itself, so that those who longed for the liberties of the old charter refused to concede that its restoration had been an impossibility and held Mather responsible for the new restrictions.

After leaving the presidency of Harvard, Mather was less active in public affairs, but he wrote much and remained a dominating figure in Congregational councils. He published more than 150 books, most of them theological, but a few dealing with history, biography or, in part, with science. Among the more interesting are his life of Richard Mather (1670), his political tracts written in 1688–93, his *Essay for the Recording of Illustrious Providences* (1684), a collection of narratives of strange happenings in New England with discussion of a few scientific topics, his *Brief History of the Warr With the Indians* (1676) and his account of the Indian wars in New England, *A Relation of the Troubles . . .* (1677). His *Cases of Conscience* (1693) displays his attitude toward the witchcraft trials. Mather died on Aug. 23, 1723.

Harvard developed during Mather's term of office; his agency in England had important historical results; and to the fame given him by these things was added that derived from his reputation as a preacher and scholar. He manifested his interest in science by forming a scientific society in Boston in 1683. His large library reflected the wide range of his reading in politics, science, the classics and history, as well as in theology. His hot temper, his stout championing of his own doctrine—though he was more moderate in debate than most of his adversaries—and his reputed ambition made enemies, who, however, were always outnumbered at home and abroad by those who revered him as a leader. He combined leadership in both church and state with greater effect than had any other Massachusetts minister since the settlement of the colony, and is regarded as the greatest of the native American Puritans.

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MATHER, RICHARD (1596–1669), American Congregational minister, was born in Lowton, Lancashire, Eng. At 15 he began to teach at a grammar school at Toxteth Park, near Liverpool. In 1618 he attended Brasenose college, Oxford, for a few months, but in November became minister of the Toxteth chapel. His Puritan tendencies led the ecclesiastical authorities to silence him in 1634, and on Aug. 17 of the next year he arrived at Boston, Mass. A year later he became teacher of the church at Dorchester, Mass., and held that office until his death on April 22, 1669.

Mather was locally celebrated as a preacher, and his books on the principles of New England Congregationalism together with his activity in colonial church councils made him one of the most famous New England Puritans of his day. He was one of the translators of *The Whole Booke of Psalmes* (1640), the "Bay Psalm Book" designed for use in colonial churches. His greatest achievement was a statement of the creed and polity of Massachusetts Congregationalism which, with but few alterations, was printed as *A Platform of Church Discipline* (1649). This, the "Cambridge Platform," was for years the basic document of his sect in Massachusetts. He was an active advocate of the "Half-Way Covenant," a plan which provided a modified form of church membership for those who were unable to meet the tests prescribed by the original Congregational polity.

By his first wife, Katharine Holt of Bury, whom he married in 1624, he had six sons, four of whom became ministers; the eldest was Increase Mather, father of Cotton Mather (*qq.v.*). His second wife was Sarah Cotton, widow of the Rev. John Cotton of Boston.

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MATHEWS, CHARLES (1776–1835), English actor with a wonderful gift of mimicry, was born in London on June 28, 1776. His father was "a serious bookseller" who also officiated as minister in one of Lady Huntingdon's chapels. Mathews was educated at Merchant Taylors' school. He first appeared on the stage in Dublin in 1794, and his London debut took place in 1803 at the Haymarket theatre in the roles of Jabal in *The Jew* and of Lingo in *The Agreeable Surprise*. From this time his professional career was an uninterrupted triumph. Mathews visited the United States in 1822 and 1834; his last appearance in New York city was made on Feb. 11, 1835, when he played Samuel Coddle in *Married Life* and Andrew Steward in *The Lone House*. In 1797 Mathews had married Eliza Kirkham Strong (d. 1802) and in 1803 Anne Jackson, an actress, author of the popular and diverting *Memoirs, by Mrs. Mathews* (4 vol., 1838–39). He died at Plymouth on June 28, 1835.

His son Charles James Mathews (1803–1878) was born in Liverpool on Dec. 26, 1803, educated at Merchant Taylors' school and then articled to an architect. He went on the stage, appearing at the Olympic theatre, London, in 1835 as George Rattleton in his own play *The Humpbacked Lover*. In 1838 he married

Madame Vestris (*q.v.*), then lessee of the Olympic. Their joint management of this and other theatres, including Covent Garden and the Lyceum, failed. Mathews visited the United States in 1838. As an actor, he held in England an unrivaled place in his own peculiar vein of light, eccentric comedy. His wife died in 1856, and Mathews visited the United States again in 1858 and married Mrs. A. H. Davenport. He was one of the few English actors who played in French successfully and was acclaimed in Paris in 1863. At the age of 65 he made a world tour, appearing again in the United States. Returning to England in 1872, he continued to act until his death on June 24, 1878. His last appearance in New York was at Wallack's theatre on June 7, 1872, and in London at the Opéra Comique on June 2, 1877. His last stage appearance was at Stalybridge, Cheshire, in 1878.

See Charles Dickens (ed.), *Life of Charles James Mathews,* 2 vol. (1879); H. G. Paine, *Actors and Actresses of Great Britain and the United States* (1886). (W. J. M.-P.)

MATHEWS, SHAILER (1863–1941), U.S. educator and theologian, one of the leaders in the Social Gospel movement of the late 19th and early 20th centuries, was born in Portland, Me., on May 26, 1863, and educated at Colby college, Waterville, Me., Newton Theological institution, Newton, Mass., and the University of Berlin. From 1884 to 1894 he taught at Colby. He occupied various professorial posts in the divinity school of The University of Chicago until his retirement in 1933, when he became dean emeritus. During his tenure as dean of the divinity school (1908–33) he was constantly engaged in academic research, public lecturing, editorial responsibilities and a host of ecclesiastical, political and social activities. He held a number of high ecclesiastical and professional offices and contributed significantly to the reorganization of theological education in the United States. Mathews published more than a score of books and hundreds of articles. His major publications include *The Messianic Hope in the New Testament* (1905); *The Spiritual Interpretation of History* (1916); *The Faith of Modernism* (1924); and *Creative Christianity* (1935). His autobiography, *New Faith for Old* (1936), is a significant document for the history of the Social Gospel movement in the United States. He died in Chicago on Oct. 23, 1941.
(W. Ha.)

MATHEWSON, CHRISTY (Christopher) (1880–1925), famous U.S. baseball player also known as "Matty" and "Big Six." A National league pitcher, his most outstanding achievement came in the world series of 1905 when he shut out the Philadelphia Athletics in three games. Born on Aug. 12, 1880, at Factoryville, Pa., he was one of the first of five baseball immortals voted into the National Baseball Hall of Fame at Cooperstown, N.Y., in 1936. He was one of the first college men to enter the major leagues, having been a baseball and football player at Bucknell university, Lewisburg, Pa. A right-handed thrower and batter, he pitched for the New York Giants from 1900 to 1916 and the Cincinnati Reds in 1916; he also was used in the outfield and at first base for New York. He won 372 games in his career and was the master of the fadeaway pitch, later known as the screwball (*see* Baseball: *Pitching*). Noted as a control pitcher, Mathewson established an all-time league record of 2,499 strike-outs, and a season mark of 267 strike-outs, in 1903. He won 30 or more games in four separate seasons and 20 or more games in nine other years. He pitched a no-hit, no-run game (*v.* St. Louis) on July 15, 1901. He was manager of the Cincinnati club from 1916 to 1918 and served as president of the Boston Braves from 1923 to 1925. He died of tuberculosis at Saranac Lake, N.Y., on Oct. 7, 1925.
(D. Sr.)

MATHURA (formerly Muttra), a city and district located in the Agra division of Uttar Pradesh, India. The city, headquarters of the district, lies about 80 mi. S.S.E. of Delhi, on the right bank of the Jumna (Yamuna) river. Pop. (1961) 125,258 (comprising the municipal area 116,959 and the cantonment 8,299). In the 6th century B.C. it was the capital of the Saurasenas. Fa-hsien (*c.* A.D. 400), the Chinese traveler, refers to it as a Buddhist centre, but Hsüan Tsang (*c.* 650) recorded a Brahmanical revival. Mahmud of Ghazni sacked it in 1017–18. Sultan Sikandar Lodi (about 1500), Shah Jahan (1636) and Aurangzeb (1669–70) caused the destruction of the Hindu shrines and temples. It was again plundered by Ahmad Shah in 1757. The city is still a great centre of Hindu devotion. Temples and ghats (bathing stairs), mostly modern, line the river bank. Two degree-granting colleges and a state college of veterinary science and animal husbandry are affiliated to Agra university; Curzon archaeological museum is in Dampier park. Printed cotton cloth and pilgrims' charms are the chief manufactures. The town is a rail and road junction.

Mathura District (area 1,467 sq.mi.; pop. [1961] 1,071,279) lies on both sides of the Jumna which divides it into two parts. The smaller eastern part consists of a rich upland plain irrigated by the branches of the Ganges (Ganga) canal. The western portion, less fertile, is watered by the Agra canal. The principal crops are wheat, sugar cane, pulses, millets, barley and cotton.

The central part is revered in Hindu mythology. Braj-Mandal, as the area within a sacred circuit of 170 mi. round Gokul and Vrindaban (Brindaban) was called, is rich in legends of Krishna (*q.v.*) as relics in towns of Mathura, Gobardhan, Gokul, Mahaban, Vrindaban, Baldeo, Barsana and Radha Khund attest. After the invasion of Mahmud of Ghazni, the area fell into insignificance till the reign of Akbar; thenceforward its history merges with that of the Jats of Bharatpur, until it again acquired separate identity under Suraj Mal in the mid-18th century. It passed under British rule in 1804. (S. S. Bh.)

MATILDA (sometimes called the Empress Maud) (1102–1167), consort of the Holy Roman emperor Henry V and afterward claimant to the English throne in the reign of King Stephen, was the only daughter of Henry I by Queen Matilda. She was born in London in 1102, sister of William the Aetheling. Both her marriages were in furtherance of Henry I's policy of strengthening Normandy against France. In 1114 she was married to Henry V; he died in 1125, leaving her childless, and three years later she was married to Geoffrey Plantagenet, effectively count of Anjou. Her brother's death on the "White Ship" in 1120 made her Henry I's sole legitimate heir, and in 1127 he compelled the Anglo-Norman baronage to accept her as his successor, though a woman ruler was equally unprecedented for kingdom and for duchy. The Angevin marriage was unpopular and flouted the barons' stipulation that she should not be married out of England without their consent. The birth of her eldest son, Henry, in 1133 gave hope of silencing this opposition, but he was only two when Henry I died (1135) and a rapid coup brought to the English throne Stephen (*q.v.*) of Blois, son of William the Conqueror's daughter Adela. Though the church and the majority of the baronage supported Stephen, Matilda's claims were powerfully upheld in England by her half brother Robert of Gloucester (*q.v.*) and her uncle King David I of Scotland. Matilda and Robert landed at Arundel in Sept. 1139, and she was for a short while besieged in the castle. But Stephen soon allowed her to join her brother who had gone to the west country, where she had much support; after a stay at Bristol she settled at Gloucester.

She came nearest to success in the summer of 1141, after Stephen had been captured at Lincoln in February. Elected "lady of the English" by a clerical council at Winchester in April, she entered London in June, but her arrogance and tactless demands for money provoked the citizens to chase her away to Oxford before she could be crowned. Her forces were routed at Winchester in Sept. 1141, and thereafter she maintained a steadily weakening resistance in the west country. Her well-known escape from Oxford castle over the frozen river took place in Dec. 1142. Normandy had been in her husband's possession since 1144, and she retired there in 1148, remaining near Rouen to watch over the interests of her eldest son, who became duke of Normandy in 1150 and king of England in 1154. In 1155 she dissuaded him from attempting the conquest of Ireland. She spent the remainder of her life in Normandy exercising a steadying influence over Henry II's continental dominions. She died on Sept. 10, 1167. As a young woman she had not been unpopular in Germany, and it is possible that the chroniclers are unfairly critical of her conduct in England in the 1140s, where her cause inspired the outstanding loyalty of Robert of Gloucester, Miles, earl of Hereford, and Brian Fitz-Count.

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Geoffrey de Mandeville (1892); A. L. Poole, *From Domesday Book to Magna Carta*, 2nd ed. (1955). (G. W. S. B.)

MATILDA (*c.* 1046–1115), countess or margravine of Tuscany, remembered for her role in the conflict between the papacy and the German kings or Holy Roman emperors, was a member of the house of Canossa (*q.v.*). Her great-grandfather Atto Adalbert (d. 988) had acquired the counties of Modena, Reggio and Mantua; her grandfather Tedald had added those of Brescia and Ferrara. In 1027 her father, Boniface, was invested by the German king Conrad II with the march of Tuscany, with which he combined his extensive possessions north of the Apennines. The house of Canossa had been traditionally loyal to the German kings; but after his marriage (soon after 1036) to Beatrice, daughter of Duke Frederick II of Upper Lorraine, Boniface began to oppose Conrad's son, Henry III. He was assassinated in 1052; and on the death, soon afterward, of his elder daughter Beatrice and of his son Frederick, Matilda remained his only surviving child and became, on her mother's death in 1076, the sole heiress of his dominions. In 1054, meanwhile, her mother had married Godfrey the Bearded, who because of his opposition to Henry III had been deprived of the duchy of Upper Lorraine. Since Godfrey was suspect to him, Henry in 1055 took Beatrice and Matilda in custody to Germany; but after Henry's death in 1056, they returned to Tuscany together with Godfrey, whose power was now uncontested and whose brother Frederick became pope in 1057 (Stephen X or IX; d. 1058). Godfrey the Bearded, who became duke of Lower Lorraine in 1065, died in 1069. In the same year his stepdaughter Matilda was married to his son Godfrey the Hunchback (d. 1076).

Matilda's character and religious development were deeply influenced by her confessor and counselor, Bishop Anselm II of Lucca, and by her friend Pope Gregory VII. Throughout the Investiture conflict (*see* GERMANY: *History;* INVESTITURE CONTROVERSY) she supported Gregory with undaunted determination, first together with her mother and then alone, though Godfrey the Hunchback had taken Henry IV's side. Matilda's castle of Canossa was the scene of Henry IV's penance before Gregory VII (Jan. 1077). During the renewed struggle after Henry's second excommunication in 1080, Henry deposed Matilda and deprived her of her possessions (1081). Lucca, Siena and other Tuscan towns, as well as many Tuscan counts and bishops, deserted her. Yet she continued to maintain the papal cause after Gregory VII's death (1085); and in 1089, doubtless for political reasons, she married the 17-year-old Welf V (Welf II as duke of Bavaria from 1101), from whom she was separated a few years later. In 1093 she urged Henry IV's son Conrad to rebel against his father and to assume the Italian crown. In 1110 she finally concluded peace with Henry V; and in the following year she made him the heir of her allodial possessions, though she had already made a donation of them to the papacy—probably in 1080—and had renewed this donation in 1102. This was to give rise to endless controversies between papacy and empire. She died at Bondeno near Mantua on July 24, 1115, and was buried in the abbey of St. Benedict at Polirone. Pope Urban VIII had her remains taken to Rome and reinterred in St. Peter's (1634).

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MATINS (MATTINS), the breviary office for the night, originally intended to be said at midnight but sometimes said at dawn. In the modern Roman Catholic Church, outside monastic services, the office is usually said on the preceding afternoon or evening. In the Church of England the term matins is used for the service of morning prayer. *See* BREVIARY; HOURS, CANONICAL.

MATISSE, HENRI ÉMILE BENOÎT (1869–1954), considered by many to be the most important French painter of the 20th century, was born at Le Cateau, Nord, on Dec. 31, 1869. He started studying law, but at the age of 20 took up painting while recovering from an illness. He studied first under the popular Adolphe Bouguereau but, finding him too academic, soon moved to the greater freedom of Gustave Moreau's studio. There he remained for five years, studying and copying the old masters in the Louvre. Matisse could have followed this profitable path but when he discovered the great Impressionist painters, especially Camille Pissarro, his whole outlook radically changed, and in 1897 he exhibited his first successful original picture, the large "Dinner Table" (Niarchos collection). Matisse then threw himself into the stream of the most advanced art and, although forced to live on a pittance, joined the *avant-garde* painters, André Derain, Georges Rouault and Maurice de Vlaminck. In 1901 he exhibited at the Salon des Indépendants, and Berthe Weill showed several of his canvases in her small gallery. In 1904 the most influential dealer in Paris, Ambroise Vollard, gave him a one-man show and also bought the "Dinner Table." Matisse was then launched, but it was not until the next year that he became a public sensation when he exhibited an astounding and brilliant portrait of his wife, "Woman With the Hat" (Hass collection, San Francisco, Calif.), at the famous 1905 Salon des Indépendants. Matisse and his friends had unleashed colour so riotously that they were dubbed the *Fauves* or "wild beasts," and visitors to the "central cage," the gallery where their pictures were hung, howled and jeered. It was an American, Leo Stein, brother of Gertrude Stein, who had the courage to buy the "Woman With the Hat."

In 1906 Matisse painted the first of a long series of masterpieces, "Joy of Life" (Barnes foundation, Merion, Pa.). A visit to Morocco gave him a new insight into colour; a trip to Italy, where he saw Giotto and the Sienese, a new vision of line; while an exhibition of Islamic art in Munich introduced him to the vivid and intricate designs of the east. Matisse then executed three of the most important paintings of his career, for the famous Russian collector Sergei Shchukin: "Harmony in Red" (1908) and the two decorative panels for the staircase of his Moscow palace, "Dance" and "Music" (1910). Shchukin's large collection of Matisses was acquired by the Hermitage museum, Leningrad.

For the next seven years Matisse produced at least one masterpiece a year: "The Red Studio" (1911; Museum of Modern Art, New York city), "Moorish Cafe" (1912–13; Hermitage), "Mme. Matisse" (1913; Hermitage), "Mlle. Landsberg" (1914; Philadelphia), "The Moroccans" (1916; Museum of Modern Art) and in 1917, perhaps Matisse's greatest year, "Piano Lesson" (Museum of Modern Art), "Music Lesson" (Barnes foundation) and the triptych "Three Sisters" (Barnes foundation). The first Matisses in the U.S. were shown by Alfred Stieglitz in 1908 at his "291" gallery, New York city. In the Armory show (1913) Matisse had 13 paintings.

After such an amazing output of important canvases with their invention and daring distortion, Matisse went to live in Nice,

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"THE MOROCCANS," HENRI MATISSE, 1916. OIL ON CANVAS. IN THE MUSEUM OF MODERN ART, NEW YORK

France, where the Mediterranean atmosphere proved a relaxation, reflected especially in his brilliant paintings of Moorish odalisques. During this period between World Wars I and II his pictures ceased to astonish the *avant-garde*, but their daring colour delighted an ever-increasing group of purchasers. After a short trip to Tahiti he executed an important mural (1932–33) for the Barnes foundation. During World War II Matisse had a new burst of creative energy, and even in his 80th year produced paintings such as "Egyptian Curtain" (Phillips gallery, Washington, D.C.) and "Large Interior in Red" (Musée Nationale d'Art Moderne, Paris), both reminiscent of his finest period.

Throughout his life Matisse produced considerable sculpture, many lithographs and etchings, and illustrated numerous books, notably *Poésies de Stéphane Mallarmé* (1932). He also designed the settings for two important ballets: *The Nightingale* (1920) for Diaghilev, and *Rouge et Noir* (1939).

In 1943 Matisse retired to Vence, a small village in the hills behind Nice. There he designed the entire decoration of the Chapel of the Rosary for the Dominican nuns (1948–51). His work included the brilliant stained-glass windows, furniture, vestments and mural paintings on white tiles with strikingly original stations of the cross. This chapel, visited by thousands of tourists yearly, was described by Matisse himself as his masterpiece. He died in Nice on Nov. 3, 1954.

See PAINTING: *Fauvism;* POSTIMPRESSIONISM; *see* also references under "Matisse, Henri Émile Benoît" in the Index.

See Alfred H. Barr, Jr., *Matisse: His Art and His Public,* with a complete bibliography (1951). (H. CD.)

MATLOCK, an urban district and vacation resort of Derbyshire, Eng., is 18 mi. N. of Derby by road. Pop. (1961) 18,505. The district, of beautiful valleys and rugged hills on the southeastern side of the Peak National park, comprises a group of towns and villages extending about nine miles along the river Derwent. Between Cromford (where Sir Richard Arkwright used his first water-powered mill in 1771) and Matlock Bridge (16th century) the river runs through a narrow gorge dominated by the High Tor on one side and the wooded slopes of Masson hill on the other.

Chatsworth house, the home of the duke of Devonshire, and Haddon hall, a residence of the duke of Rutland, lie just outside the district boundary. The hydropathic treatment for which Matlock was once famed is no longer available. The largest hydro, Smedley's, is now the county offices, and the Matlock Training college occupies Rockside and Chatsworth hydros. At Matlock Bath the thermal water (20° C. or 68° F.) is no longer used for medicinal purposes but serves an open-air swimming pool, the fishponds and "petrifying" wells. There are a number of limestone caves. The Roman "Nestor" lead mine is part of the Rutland cavern in the wooded Heights of Abraham. Industries include agriculture, horticulture, quarrying and mining (limestone, gritstone, lead and fluorspar), textiles and grain milling. (J. O. HU.)

MATO GROSSO, a state in the west-central region of Brazil, bounded north by Amazonas and Pará, east by Goiás and Minas Gerais, southwest by São Paulo and Paraná, northwest by Rondônia and Bolivia and southwest by Paraguay. Area 475,501 sq.mi. Pop. (1960) 910,262. Most of Mato Grosso lies on the Brazilian plateau and marks the watershed which separates the Amazon basin from the basin of the Plata river system. The western section of the state, chiefly a flood plain (*pantanal*), is among Brazil's best grazing lands. In the southeast is the valley of the Paraná, along the east the valley of the Araguaia, and to the north the tableland descends to the basin of the Amazon. Elevations range from 300 to 400 ft. in the lowlands to 3,000 ft. on the plateau. Natural vegetation consists mainly of patches of scrub growth and light forest. The annual average rainfall is 50–60 in. with a distinct dry season from May to September.

Livestock raising and agriculture represent the principal economic activities of Mato Grosso, which is one of the great frontier regions of the world. The state supports more than 6,000,000 head of cattle, many being driven to market in São Paulo each year. The state is known to have important deposits of gold, diamonds, iron, manganese and platinum. The inadequacy of transportation facilities is a major barrier to further development. Mato Grosso's 4,000 mi. of roads are largely trails, many of which are impassable during the rainy season. Paved roads are seldom found outside the limits of the principal cities of Cuiabá (pop. [1960] 43,112), the state capital, Corumbá (36,744) and Campo Grande (64,477).

Cuiabá (*q.v.*) has not attained the economic importance of Corumbá (*q.v.*) or Campo Grande in modern times because of its isolation. Campo Grande and Corumbá are served by the Brazilian Northwest railroad, which provides access to Santos and Rio de Janeiro. Coast-to-coast travel is possible via the Corumbá-Santa Cruz (Bolivia) railroad.

Campo Grande is the main agricultural centre in southern Mato Grosso, a position enhanced by the railroad communication with São Paulo, the movement of the coffee frontier toward the west and northwest of São Paulo state, and the concomitant shift of population. The existence of *terra roxa* and other fertile soils in the Campo Grande region and south into Dourados allows a wide diversity of crops to be grown. Coffee, rice, cotton, sugar cane and corn, the main commercial crops, are produced in that order. Colonization projects have been instituted by the federal and state governments in the Dourados region, with emphasis upon coffee cultivation.

Mato Grosso ("great woods") was settled first by pioneering Paulistas after they had been forced to retreat from Minas Gerais by the so-called war of the *emboabas* in 1709, over mining rights in the gold fields. The state was initially a district of the captaincy of São Paulo with the founding of Cuiabá in 1719, and in 1748 it became an independent captaincy. Mato Grosso became a province of the empire in 1822 and a state of the federal union in 1889. While sections of the state remained unexplored in the 1960s, the expedition of Marshal Candido Mariano Rondon in the early part of the 20th century furnished the first complete, accurate data about Mato Grosso. (J. L. TR.)

MATRIARCHY, a theoretical human social system in which final authority would reside in women. Tales are still told of villages where only women lived, maintained by the annual admission of one male who was killed when his procreative task was done. However, the consensus among modern anthropologists and sociologists is that no reliable evidence (either contemporary or historical) supports the theory. *See* MATRILINY; BACHOFEN, JOHANN JAKOB.

MATRILINY means matrilineal descent; *i.e.,* descent group membership gained through the mother. Patriliny indicates that descent group membership is gained through the father. If either form operates exclusively in a given society the system is known as unilineal descent. When matrilineal and patrilineal descent groups operate simultaneously in the same society, the rule of descent is called double unilineal.

Matriliny is not matriarchy; in matriarchy women hold ultimate authority over the family, household, community or state. Matrilineal descent, matrilocal residence and a complex of other related customs were supposed to be associated with a system in which women hold the reins. Whether such a state of affairs preceded or followed patriarchy (its logical counterpart) in social evolution was hotly debated in the 1900s; but the debate has stilled. No peoples on earth are known to be organized matriarchically, nor are there reliable historical records of such societies. If there ever were matriarchates in the very earliest times, there is no trustworthy evidence for their existence. In the light of established data, there exists no single, indivisible complex that can be called a matriarchy; particularly, the empirical absence of the crucial element of matriarchy (ultimate authority in the hands of women) strips the term of its relevance. (*See* BACHOFEN, JOHANN JAKOB.)

It is important to distinguish the descent rule from such social rules as those governing inheritance, succession, residence and the locus of formal authority over descent group activities. Whether the group is matrilineal or patrilineal, formal authority over descent group activities is found (if at all) in the hands of men. Although in some cases queens may rule with almost absolute power, the society as a whole has never been found in which women in general have authority over men in general. Formal authority in a patrilineal group resides in the husband, father, father's brother

and father's father. The authority in a matrilineal lineage is in the hands of men who are brothers, mother's brothers, mother's mother's brothers and so forth.

Inheritance and succession refer to the transmission of property and office (such as chieftainship) after the death of the holder. These may follow the matrilineal line, as in the nepotic rule under which a man inherits from or succeeds his mother's brother. Among Trobriand Islanders a man may inherit his mother's brother's magic (*see* MAGIC, PRIMITIVE) or he may succeed to his mother's brother's chiefly office. On the other hand, patrilineal inheritance and succession may occur, or chiefly office may be elective or appointive without regard to descent even though matrilineal descent groups are present in the society.

Similarly, the rules of residence for the newly wedded couple may be matrilocal, in which case the couple lives with the matrilineal kinsmen of the bride; avunculocal, when the couple live with the matrilineal kinsmen of the groom (*see* AVUNCULATE); and patrilocal, where they live with the patrilineal kinsmen of the groom. The Hopi (*q.v.*) Indians of Arizona have matrilineal clans and follow the rule of matrilocal residence. In the Trobriand Islands, the rule of avunculocal residence is followed, as it is on Losap, an atoll of the east Caroline group in Micronesia. On Yap, in the West Caroline Islands, where matrilineal clans occur alongside patrilineal lineages, residence is patrilocal.

There is no necessary and inevitable correlation between matriliny and any particular rule of inheritance, succession, residence or authority; nevertheless certain rules tend to occur together in logically and functionally consistent clusters. Thus, of all the rules of residence the matrilocal and avunculocal rules are (in a sense) the most consistent with the rule of matrilineal descent. According to D. F. Aberle (1961) about half of all matrilineal societies are also matrilocal, while about one quarter of them have avunculocal residence; the rest follow other rules.

Descent groups differ in terms of the particular combination of social rules under which they are organized. Matrilineal and patrilineal descent groups might be thought of as precise mirror images of each other in the essential features of their structure. However, empirically they have important structural differences, largely since specific males (as husbands, fathers and father's fathers) hold formal authority over the patrilineal group, while under matriliny other males (as brothers, mother's brothers and mother's mother's brothers) have such authority. This means that no known descent group, matrilineal or patrilineal, is matripotestal; *i.e.*, there are no matriarchates.

Patrilineal and matrilineal descent groups are similar in that males hold authority in both. But, since the line of affiliation (the descent line) runs through women only in matrilineal groups, there is a crucial structural difference. It means that patrilineal descent groups depend on females neither for continuity of the descent line nor for authority functions, while matrilineal groups depend on males for authority and on females for continuity. Under matriliny there is an interdependence of the sexes which is not replicated under patriliny; this fundamental difference gives rise to others. For example, there are few (if any) matrilineal groups in which marriage is as stable as it is among some patrilineal groups. Under matriliny there is a structured conflict between a woman's husband and her brothers over control of the woman and her children; this is not replicated in patrilineal groups. Further, the processes of group fission, segmentation, growth and expansion are different.

Although matrilineal descent is widespread, patriliny is about twice as frequent. Matrilineal systems are quite rare in the east Eurasian and Mediterranean areas, but are well-represented in Africa, the Americas and in Oceania. Matrilineal descent is not often found among peoples who make their living by herding large animals, nor among those who depend heavily on hunting and food gathering. Matrilineal descent is not often found where food is grown by plowing; it is found primarily among peoples who live by agriculture but who do not use the plow.

Although early theorists tended to confuse matriliny with matripotestality, and to consider that both were somehow inextricably combined with other traits to form a unity called matriarchy, such rules are observed to vary from society to society. These theories were often based on the idea that human society had a single, inevitable line of evolutionary development, a position that most modern theorists have abandoned. Further, each argument relied on the doctrine of survivals (telltale traces of former states of organization from which the past history of the group could be reconstructed). Naïve application of the doctrine, and a tendency to see survivals whenever convenient led to the decline of most of these theories. Recent efforts have been directed toward the specification of conditions under which rules of descent may change; no attempt is made to guess at earliest origins or to trace development in a single line to the present. *See* KINSHIP; KINSHIP TERMINOLOGY; MARRIAGE, PRIMITIVE; *see* also references under "Matriliny" in the Index.

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(D. M. SR.)

MATRIX. The term matrix in mathematics is due to James Joseph Sylvester (1850), who applied it to a rectangular array of numbers "out of which determinants can be formed." The modern concept of a matrix as a hypercomplex number is due to William Rowan Hamilton (1853) and Arthur Cayley (1858). Matrix theory has found application in many branches of mathematics, including algebraic and differential equations, astronomy, mechanics, electric circuit theory, quantum mechanics, relativity, nuclear physics and aerodynamics. David Hilbert (1904) introduced matrices of infinite order in connection with a theory of integral equations. The theory of infinite matrices has grown into an important branch of mathematics.

A system of linear equations such as

$$\begin{aligned} 2x + y - 2z &= -2 \\ x - 3y + 5z &= 10 \\ 3x - y + 4z &= 13 \end{aligned}$$

determines two matrices, namely

$$\begin{bmatrix} 2 & 1 & -2 \\ 1 & -3 & 5 \\ 3 & -1 & 4 \end{bmatrix} \qquad \begin{bmatrix} 2 & 1 & -2 & -2 \\ 1 & -3 & 5 & 10 \\ 3 & -1 & 4 & 13 \end{bmatrix}$$

The first is called the coefficient matrix, the second the augmented matrix. The system of equations is, in fact, essentially determined by the latter.

The commonly accepted definition of matrix is that of Sylvester, namely a rectangular array of numbers. Most authorities, however, feel that the definition is incomplete until the operations to which a matrix is subject have been defined and, therefore, prefer to define a matrix as a number of a total matric algebra. A modern point of view consists in first defining linear transformations, or endomorphisms of a vector space, and investigating their properties. Then, since a matrix is a representation of a linear transformation, its properties may be defined from those of the linear transformation.

A total matric algebra of order n^2 is the set of all n by n arrays, or matrices,

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

whose elements a_{rs} are numbers of a given field or ring R, subject to the operations to be defined. If B is another such matrix, the sum $A+B$ is obtained by adding corresponding elements. The product $A \times B$ is the matrix whose element in row r and column s is the inner product of the rth row of A by the sth column of B, namely

$$a_{r1}b_{1s} + a_{r2}b_{2s} + \ldots + a_{rn}b_{ns}$$

A number of the field or ring R is called a scalar. The scalar

product kA of the matrix A by the scalar k is obtained by multiplying every element of A by k. Addition of matrices is associative and commutative, and multiplication is associative and distributive, but is not usually commutative.

The matrix O, each of whose elements is 0, is the identity of addition, since $O + A = A + O$ for every matrix A. The matrix

$$I = \begin{bmatrix} 1 & 0 \cdots & 0 \\ 0 & 1 \cdots & 0 \\ \cdot & \cdot \ \cdot & \cdot \\ 0 & 0 \cdots & 1 \end{bmatrix}$$

having 1's in the main diagonal and 0's elsewhere is the identity of multiplication, and is called the identity matrix. A matrix having 0's in every position outside the main diagonal is called a diagonal matrix.

Determinant theory (*see* DETERMINANT) is properly a branch of the theory of matrices. Every square matrix has associated with it a scalar, called its determinant, which serves as a norm or absolute value. Thus the determinant of the product of two matrices is equal to the product of the determinants of the factors. A matrix whose determinant is not equal to zero is said to be nonsingular, and possesses an inverse A^{-1} such that $A^{-1}A = AA^{-1} = I$. A singular matrix has no inverse, but for every singular matrix A there is a nonzero matrix B such that $AB = BA = O$.

If x is an indeterminate, the matrix $A - xI$ is called the characteristic matrix of A, and its determinant $d(A - xI) = f(x)$ is called the characteristic function. The Hamilton-Cayley theorem states that $f(A) = O$; *i.e.*, that every matrix satisfies its characteristic equation. Hence every n by n matrix satisfies an equation $m(x) = 0$ with scalar coefficients of minimum degree $\mu \leqq n$. If $\mu < n$, the matrix is called derogatory. A square matrix may be considered as an operator transforming one vector into another. (*See* VECTOR ANALYSIS.) Thus

$$\begin{bmatrix} 2 & 1 & -2 \\ 1 & -3 & 5 \\ 3 & -1 & 4 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} = \begin{bmatrix} -2 \\ 10 \\ 13 \end{bmatrix}$$

or $A\zeta = \eta$. Thus the solution of a system of linear equations is the process of finding the vector ζ when the vector η and the matrix A are given. If A is nonsingular, $\zeta = A^{-1}\eta$.

The rows of a matrix may be considered as a set of vectors, and the columns constitute another set of vectors. The number of linearly independent row vectors is equal to the number of linearly independent column vectors, and this number is called the rank of the matrix. The rank is also equal to the order of a nonsingular minor matrix of maximum order. The rank is not changed when a matrix is multiplied on either side by a nonsingular matrix. A system of linear equations in n unknowns has no solution unless the rank of the augmented matrix is equal to the rank of the coefficient matrix. If these ranks are both equal to r, there are $n - r$ linearly independent solutions, and every solution is a linear combination of these.

Calculations with matrices are much simplified by the use of elementary transformations (Hermann Grassmann, 1862, and Leopold Kronecker, 1866). Elementary transformations on the rows of a matrix are of three types: (1) the interchange of two rows; (2) the multiplication of the elements of a row by a unit of R; (3) the addition to the elements of a row of k times the corresponding elements of any other row, k being in R. An elementary matrix is obtained by applying an elementary transformation to the identity matrix I. Every elementary transformation on the rows of a matrix A can be accomplished by multiplying A on the left by the corresponding elementary matrix. Analogous results hold for columns and right multipliers. Every unimodular matrix (*i.e.*, a matrix whose determinant is a unit of R) is a product of a finite number of elementary matrices.

If P and Q are unimodular, the matrices A and $B = PAQ$ are called equivalent. Let the elements of A be either integers or polynomials in x. The quotients $h_i = d_i/d_{i-1}$, where d_i is the greatest common divisor of the i-rowed minor determinants of A, are called the invariant factors of A, and are invariant under the relation of equivalence. Two matrices are equivalent if and only if they have the same invariant factors.

A linear homogeneous transformation $x'_i = \sum a_{ij}x_j$ can be written $\zeta' = A\zeta$ where ζ is the column vector whose components are $x_1, x_2, \ldots, x_n$. The matrix A is called the matrix of the transformation. If new variables are introduced by means of the substitution $\zeta = P\eta$, $\zeta' = P\eta'$, then $\eta' = P^{-1}AP\eta$, which is a transformation of matrix $P^{-1}AP$. Such a substitution corresponds to a change of frame of reference in projective geometry.

If P is unimodular, the matrices A and $B = P^{-1}AP$ are called similar. Two matrices A and B with element in a field are similar if and only if their characteristic matrices $A - xI$ and $B - xI$ have the same invariant factors.

A homogeneous polynomial such as

$$\sum a_{ij}x_ix_j \qquad (i, j = 1, 2, \cdots, n)$$

is called a quadratic form. Such forms arise as the elements of length in differential geometry and the theory of relativity. There is no loss of generality in assuming that $A = (a_{rs})$ is a symmetric matrix—that is, $A = A^{\mathsf{T}}$ where A^{T} (the transpose of A) is obtained from A by changing rows to columns. The quadratic form may be written $\zeta^{\mathsf{T}}A\zeta$ where ζ^{T} is the row vector $(x_1, x_2, \ldots, x_n)$ and ζ is the column vector composed of the same letters. If new variables are introduced by means of the linear substitution $\zeta = P\eta$, the new quadratic form $\eta^{\mathsf{T}}P^{\mathsf{T}}AP\eta$ has the (symmetric) matrix $P^{\mathsf{T}}AP$.

Two symmetric matrices A and B are called congruent if a nonsingular matrix P exists such that $B = P^{\mathsf{T}}AP$. If R is the real field, a matrix P can be found so that B has 0's everywhere except in the main diagonal, and with diagonal elements which are either 0 or 1 or -1. The number of nonzero elements in the diagonal is the rank, and the number of 1's diminished by the number of -1's is called the signature. These are invariants, and determine the matrix up to a congruence transformation.

In Euclidean geometry, an orthogonal transformation has a matrix P such that $P^{\mathsf{T}} = P^{-1}$. Rotations are transformations of this type. An important problem is to reduce a quadratic form to diagonal form by means of an orthogonal transformation. Since $B = P^{\mathsf{T}}AP = P^{-1}AP$, this is both a similarity transformation and a congruent transformation. If R is the real field, it is possible to find an orthogonal matrix P such that B is diagonal, its diagonal elements being the (real) roots of the characteristic equation of A.

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MATSUDAIRA TSUNEO (1877–1949), Japanese diplomat and statesman, was born in Tokyo on April 17, 1877. In 1902, upon graduating from Tokyo Imperial university, he entered the diplomatic service. After assignments in China, England and France, he represented Japan in post-World War I discussions with the Soviet Union and also attended the Washington conference (1921–22). He then served as ambassador to Washington (1924–28), when U.S.-Japanese relations were strained by the Oriental Exclusion act passed by the United States congress. He was also ambassador to Great Britain (1929–36).

At the London Naval conference in 1930 Matsudaira helped secure an increase in Japan's allotted naval strength, which, however, failed to satisfy the rabid militarists at home. From 1936 to June 1945, as imperial household minister, he was a moderate adviser of the emperor.

In 1947, being elected to the diet, he became president of the

house of councilors (upper house). He died in Tokyo on Nov. 11, 1949. (Hn. Kn.)

MATSUE, ancient castle town of Japan on southwestern Honshu Island and capital of Shimane prefecture at 35° 28′ N., 133° 04′ E., is on a spit which cuts an arm of the Sea of Japan nearly in two. The city is a centre of land and sea communications and an important commercial centre. Political amalgamation with small adjacent villages from 1940 increased the area of the city from 3.8 sq.mi. to 57.5 sq.mi.; its population increased from 55,500 to 106,476 by the 1960 census. (C. A. Mr.)

MATSUKATA MASAYOSHI, Prince (1835–1924), Japanese statesman, was born in Kagoshima of a Satsuma samurai family on Aug. 17, 1835. As a young man he was a close friend of Okubo Toshimichi (*q.v.*), and it was in large part through the influence of Okubo that Matsukata became active in the movement to overthrow the shogunate.

In the new government Matsukata held the positions of governor of Tosa province (from 1868), assistant minister of finance (from 1874), home office (1880), and minister of finance (1881). But it was not until after Okubo's death in 1878 that Matsukata came into his own. After serving as the nation's representative at the Paris exposition of 1878, he returned to Japan to become the major advocate and executor of financial reform. The government had met the financial strain of modernization, which required great outlays, and of the suppression of the Satsuma rebellion (*q.v.*; 1877–78), by printing paper money. By the 1880s, currency was badly depreciated, specie was being hoarded, and government revenues, because of the fixed tax on land, were declining in value. Matsukata won the government over to a policy of stringent retrenchment. Government expenses were cut, factories owned by the government were sold to private buyers and paper money was redeemed. The Bank of Japan was founded with the right to issue convertible notes. In a period of three years the currency had been stabilized and government finances restored to health. Matsukata, who was created a prince in 1922, died at Tokyo on July 2, 1924. (T. C. Sh.)

MATSUMOTO, an industrial city in a mountain basin of central Japan, on Honshu Island, at 36° 14′ N., 137° 58′ E., is noted for its important silk industry. Silk production dates from feudal times when it was encouraged by the feudal lord or *daimyo,* because the price silk commanded would compensate for the cost of transportation over the mountain passes. Mulberry and fruit are grown on terraces encircling the floor of the basin. Hot springs and skiing resorts in the surrounding mountains made the city a tourist centre. The city increased in area from 7.3 sq.mi. in 1940 to 83 sq.mi.; the population increased from 72,800 to 148,710 between 1940 and the 1960 census. (C. A. Mr.)

MATSUO BASHŌ (pseudonym of Matsuo Munefusa) (1644–1694), the greatest of the Japanese *haiku* poets, came from a minor samurai family of Ueno, Iga province, and was in the service of Sengin (the pen name of Yoshitada Tōdō), the son of the local lord, when he became interested in *haiku* (*see* Japanese Literature). In 1666, after Sengin's death, Bashō gave up his life as a samurai to devote himself to this form of verse. In 1673 he moved to Edo (modern Tokyo), where he gradually acquired a reputation as a poet and critic. He attracted wide attention with the verse:

> On a withered branch
> A crow has alighted:
> Nightfall in autumn.

In 1684 Bashō made the first of the journeys that figure so importantly in his work. His accounts of his travels are prized not only for the *haiku* that record various sights along the way but also for the equally beautiful prose passages that furnish the backgrounds. *Oku no Hosomichi* ("The Narrow Road of Oku," 1694), describing his visit in 1688 to northern Japan, is one of the loveliest works of Japanese literature.

The *haiku* previous to Bashō's emergence as a master had been subject to two evils: staleness, the result of the imposition of strangulating codes of rules intended to make this popular form of verse "respectable"; and ephemerality, the result of cramming with allusions to current gossip, supposedly so as to keep it lively and up-to-date. Bashō, deploring both, insisted that the *haiku* must be at once unhackneyed and eternal; he advised his pupils, "Do not seek to follow in the footsteps of the men of old; seek what they sought."

On his travels Bashō also met local poets and engaged with them in the composition of linked verse (*renga*), an art in which he so excelled that some critics believe his linked verse was his finest work. When Bashō began writing in this medium the connection (or link) between successive verses had generally involved a pun or play on words, but he insisted that poets must go beyond mere verbal dexterity and link their verses by "perfume," "echo," "harmony" and other delicately conceived criteria.

One term frequently used to describe Bashō's poetry is *sabi,* which means the love of the old, the faded and the unobtrusive, a quality found in the verse:

> Scent of chrysanthemums . . .
> And in Nara
> All the ancient Buddhas.

Here the musty smell of the chrysanthemums blends with the visual image of the dusty, flaking statues in the old capital. In still other verses a combination of the momentary and eternal suggests the Zen philosophy that underlies much of Bashō's work.

Bashō led a life of austerity that contrasted with the general flamboyance of his time. On occasion he withdrew from society altogether. Later men, honouring both the man and his poetry, revered him as the "saint of the *haiku*," and, indeed, no writer in Japan has been more loved or respected.

See Kenkichi Yamamoto, *Bashō* (1957); "The Narrow Road of Oku and Other Writings," Eng. trans. by Donald Keene (ed.) in *Anthology of Japanese Literature* (1955). (Dd. K.)

MATSUYAMA, seaport on the northwest coast of Shikoku Island, Japan, a tourist, industrial and communication centre and capital of Ehime prefecture, is located at 33° 50′ N., 132° 46′ E., in the rich agricultural Dogo plain. Since 1940 the city area has increased from 6.9 sq.mi. to 77.8 sq.mi.; the population rose from 117,500 to 238,604 between 1940 and the census of 1960. Cotton and synthetic textiles are the leading industries; lesser industries are chemicals, paper and machinery. The surrounding area produces citrus fruit, persimmons and loquats. Originally a castle town, Matsuyama still possesses an important castle museum and park. After World War II, the city was one of the first to use modern city planning in rebuilding. (C. A. Mr.)

MATTANCHERRI, a town in Ernakulam district of Kerala, India, and the commercial centre of the former Cochin state, lies on a backwater opposite to and 2 mi. S. of the port of Cochin (*q.v.*). Pop. (1961) 83,896. It is still a centre of import and export trade in which the Kutchi memons and banyas of Bombay have a large share. It has a spacious old palace of quaint Portuguese design (1555), where the rajas of Cochin resided. The palace contains mural paintings of exquisite design and rare execution. To the south lies the Jewish quarter, perhaps the only place in India that has synagogues. (G. Kn.)

MATTEOTTI, GIACOMO (1885–1924), Italian Socialist leader murdered for his opposition to the Fascist regime, was born at Fratta Polesine (Rovigo) on May 22, 1885. After graduating at Bologna he became a barrister and joined the Italian Socialist party. He was elected to the chamber of deputies in Nov. 1919, re-elected in May 1921 and finally re-elected again in April 1924, just after he had become secretary-general of his party. On May 30 he resolutely impugned the Fascist party before parliament. (The speech was published in London in 1924 as *The Fascisti Exposed.*)

On June 10, 1924, six *squadristi,* Amerigo Dumini, Augusto Malacria, Filippo Panzeri, Amleto Poveromo, Giuseppe Viola and Albino Volpi (allegedly hired by four leading Fascists, Cesare Rossi, Francesco Giunta, Giovanni Marinelli and Filippo Filippelli), seized Matteotti in Rome, took him by car to the thicket of Quartarella, near Riano Flaminio, murdered him and placed his body in a hastily dug hole. His disappearance was already causing a great sensation when, on Aug. 16, his body was accidentally discovered. The murder shook the regime and Mussolini ordered a judicial inquiry that lasted one and one-half years. On

March 24, 1926, at Chieti, the court of assizes found Dumini, Poveromo and Volpi guilty of "unintentional homicide" and sentenced them to 5 years, 11 months and 20 days of penal servitude. The other three were found not guilty. Two months later the Rome court of appeal remitted the three sentences.

After World War II the Italian government ordered a retrial, but by that time some of the accused men were either dead or fugitive. In 1947, in Rome, a special court of assizes sentenced Dumini, Poveromo and Viola to 30 years of penal servitude. Rossi and Giunta were acquitted for lack of evidence.

See M. del Giudice, *Cronistoria del processo Matteotti* (1954).

MATTER: *see* KINETIC THEORY OF MATTER; ATOM; NUCLEUS.

MATTERHORN (French MONT CERVIN; Ital. MONTE CERVINO), one of the best-known mountains (14,688 ft.) in the Alps, is on the frontier between Switzerland and Italy southwest of the village of Zermatt. Though on the Swiss side it appears to be an isolated horn-shaped peak, it is really the butt end of a ridge, and the Swiss slope is not nearly so steep or difficult as the grand terraced walls of the Italian slope. The Matterhorn was first conquered from the Swiss arête, after a number of attempts chiefly on the Italian side, on July 14, 1865, by Edward Whymper (*q.v.*), but four of his party fell to their death on the descent. Three days later it was scaled from the Italian side by a party of men from Val Tournanche led by J. A. Carrel. It is now frequently ascended in summer, especially from Zermatt.

MATTHAY, TOBIAS (1858–1945), English pianist, teacher and composer, was born in London on Feb. 19, 1858. He studied at the Royal Academy of Music and afterward taught there from 1876 to 1925, when he left to devote his attention to a piano school he had founded in 1900. In 1903 he published *The Act of Touch,* the first and most important of a number of books in which he made a detailed examination of the problems of piano technique, the interpretation of music and the psychology of teaching. Later publications included *The First Principles of Pianoforte Playing* (1905), *Relaxation Studies* (1908), *Musical Interpretation* (1913) and *On Method in Teaching* (1921). These books, together with his own teaching, brought him international fame and many pupils of distinction, the foremost of whom was Myra Hess. Matthay also composed music for the piano. He died at High Marley, near Haslemere, Surrey, on Dec. 15, 1945.

See Jessie Henderson Matthay, *The Life and Works of Tobias Matthay* (1945). (H. RU.)

MATTHES, FRANÇOIS EMILE (1874–1948), U.S. geologist and topographer of some of the most rugged and scenic features of western United States, was born in Amsterdam, Neth., on March 16, 1874. His education, begun in Holland, Switzerland and Germany, was continued at Massachusetts Institute of Technology and Harvard university. He became a U.S. citizen in 1896 and as topographer with the U.S. geological survey (1896–1913) he mapped the Bighorn mountains, Glacier and Grand Canyon National parks, Yosemite valley, Mount Rainier and other western areas. His beautiful sketching on these maps has probably never been equaled. Later (1913–48) Matthes concentrated on geologic problems, attaining distinction as geomorphologist and glacialist. Investigations widely carried on in the Sierra Nevada, California, culminated in his classic *Geologic History of the Yosemite Valley* (1930). He organized the program of systematic glacier observations in North America, part of a world-wide study of climatic fluctuations as indicated by changes in existing glaciers. Matthes was an unusual linguist, highly artistic, and a writer of rare excellence. He died in Berkeley, Calif., on June 21, 1948. (F. M. FL.)

MATTHESON, JOHANN (1681–1764), German composer and writer on musical theory and practice, was born Sept. 28, 1681, at Hamburg. From 1690 to 1705 he was a singer at the Hamburg opera and from 1699 he also worked there as composer and conductor. In 1704 he was appointed tutor to Cyrill, son of Sir John Wich, the English resident in Hamburg, and in 1706 he became secretary to Sir John and later to his successors. He held this position until 1755. While performing his secretarial work he also was organist at the Hamburg cathedral from 1715 to 1728. His musical activities were hampered by ear trouble that started in 1705 and later led to total deafness. In 1709 he married an English woman, Catharine Jennings. He died in Hamburg on April 17, 1764.

Mattheson's compositions—operas, church music, serenades and chamber music—are of average quality, but as a writer on music his influence was great. He advocated the merging of Italian, French and German styles in music; revitalizing church music; the use of equal temperament; the inclusion of women in church choirs; good musical education for musicians and adequate payment for their services. He fought against the use of solmization and against corruption and simony in musical life. His books are an inexhaustible source of information on German music of the 18th century.

Mattheson's numerous theoretical works include *Der vollkommene Capellmeister* (1739), an encyclopaedia of his musical ideas; *Grosse General-Bass-Schule* (1731) and *Kleine General-Bass-Schule* (1735) on the figured bass. He also wrote *Grundlage einer Ehrenpforte* (1740), which contains biographies of 148 composers and includes details of his own life. He translated English pamphlets, periodicals and books into German; *e.g.,* Defoe's *Moll Flanders* (1723) and J. Mainwaring's *Memoirs of the Life of . . . Handel* (1761) with additional notes.

See B. C. Cannon, *Johann Mattheson* (1947). (W. G. BE.)

MATTHEW, SAINT, one of the Apostles of Christ. In Mark's list of the Twelve appointed by Christ (iii, 13–19), the name of Matthew is seventh, and is followed by that of Thomas. Apparently the evangelist made some attempt to arrange the names in the order of their eminence in the early church. His list may possibly indicate also that Matthew and Thomas were accustomed to work together; it was usual for Christian missionaries to work in pairs, and Mark records that Christ sent out the Twelve on a mission "two by two" (vi, 7). In the corresponding list in the third Gospel (Luke vi, 13–16) Matthew's name occurs in the same position. The first evangelist, who groups the names in pairs, gives "Thomas and Matthew" as the fourth (Matt. x, 3). A slightly different grouping is given in Luke's list of members of the primitive community in Jerusalem (Acts i, 13), "Philip and Thomas, Bartholomew and Matthew."

The first evangelist, however, when he records from Saint Mark the story of the call of Levi the tax collector, substitutes the name "Matthew" for that of "Levi the son of Alphaeus" (Matt. ix, 9; Mark ii, 14); he also adds "the tax collector" to Matthew's name in his list of the Twelve. According to tradition indeed it was Matthew himself who was the author of the first Gospel, but the tradition is undoubtedly a mistaken one. (*See* MATTHEW, GOSPEL ACCORDING TO SAINT.)

On the assumption that the identification of Matthew with Levi is correct, "Matthew" (probably meaning "Jehovah's gift") would appear to be the Christian name of Levi, who had been employed as a tax collector in the service of Herod Antipas, and whose call to be one of the immediate followers of Jesus Christ came to him as he sat at the tax office by the Sea of Galilee. It should be noted that Mark's story of his call resembles that of the call of Peter and Andrew and the sons of Zebedee, and one would expect to find Levi somewhere in his list of the Twelve. As a tax collector Levi would share in the distrust and contempt which these officials had earned for themselves everywhere.

According to Luke (v, 29) Levi after his call made a great feast for Jesus in his house. But the evangelist is here rewriting Mark, whose statement that "he was sitting at meat in his house" does not necessarily bear the meaning put upon it by Luke; Mark may mean that Jesus was entertaining friends at his own table, inserting the incident here as another illustration of the attitude of Jesus toward "tax collectors and sinners."

It will be seen that the New Testament affords only scanty and uncertain information in regard to Saint Matthew. Outside the New Testament the only statement of any importance in regard to the Apostle is the passage from Papias preserved by Eusebius: "So then Matthew composed the Oracles in the Hebrew language, and each one interpreted them as he could."

Legend differs as to the scene of the Apostle's missionary labours, and as to whether he died a natural or a martyr's death.

His feast day in the east is Nov. 16, in the west Sept. 21. *See* also APOSTLE. (B. T. D. S.; X.)

MATTHEW, WILLIAM DILLER (1871–1930), North American vertebrate paleontologist known for his studies of fossil mammals, was born in Canada, at Saint John, New Brunswick, Feb. 19, 1871. After completing his studies at the University of New Brunswick and at Columbia university, New York city, he was associated with the American Museum of Natural History for 32 years. In 1927 he became professor of paleontology at the University of California. Matthew's initial work brought him in contact with thousands of specimens of fossil mammals in the collections of E. D. Cope. These and the work of Cope directed his life toward extensive studies of fossil mammals. Throughout his scientific research runs a progressive conservatism: Matthew valued facts above theories and materials above speculations.

His most widely known work is *Climate and Evolution* (1915), in which he gave strong support to the concept of holarctic radiation centres of mammals and preservation of primitive "relics" in the periphery of areas of radiation. Evolution and the importance of geological succession are ubiquitous themes in his studies. His other works include "Evolution of the Horse" (*Quart. Biol. Rev.*, 1915); "The Evolution of Mammals in the Eocene" (*Proc. Zool. Soc. Lond.*, 1927); "Faunas of the San Juan Basin" (*Mem. Amer. Philos. Soc.*, 1937, posthumous, ed. by Granger, Gregory, Colbert). (E. C. O.)

MATTHEW, GOSPEL ACCORDING TO SAINT, in canonical order the first of the four Gospels, and thus the first book of the New Testament. Though the preferred "Gospel of the Church" since the 2nd century A.D., it was not chronologically the first Gospel. As one of the three Synoptic Gospels, Matthew used the Gospel of Mark as the primary source for most of its narrative material, while most of the sayings of Jesus in Matthew were drawn from Q, the Synoptic saying-source, which was also used by Luke (*see* GOSPELS).

Composition.—The framework of Matthew is taken from Mark with little modification, but Matthew frequently tries to establish a closer connection between isolated units, especially by filling in gaps in the Marcan composition (*cf.* Matt. iv, 12 with Mark i, 14, for example). Matthew often introduces chronological sequence or connects stories by a participial construction (*e.g.*, "Jesus seeing/hearing this . . . ," v, 1, etc.). The artificiality of such secondary combinations is most obvious in xiv, 13 where Matthew has forgotten that the death of John the Baptist was told in "parentheses" (xiv, 1–12) as having already occurred some time ago. Also, the dating of the material within the limits of certain days is quite unlikely if we begin to take this dating seriously; a single day would cover the material from v, 1 (Sermon on the Mount) through viii, 17 (including three healings), and the next day would include two crossings of the lake, five healing narratives and several discussions (viii, 18–ix, 34).

Although he usually takes his scenery and geography from Mark, the author of Matthew also independently adds the lake (ix, 1), the synagogue (ix, 35) and the mountain (v, 1; xv, 29); furthermore, he gives Jesus' activity a wider locale. It is no longer a private house (as in Mark) where Jesus teaches and instructs the disciples (xv, 15; xvii, 19; xix, 9), because Matthew is not interested in the theory of the Messiah secret (*see* MARK, GOSPEL ACCORDING TO SAINT), but rather in stressing the *public* appeal of Jesus' ministry. "Great multitudes" are mentioned even more often than in Mark. The presence of the disciples is noticed more frequently, and their number, 12, is now taken for granted. Among the opponents, the Pharisees are particularly prominent and their hostility is emphasized more than in Mark (*e.g.*, Matt. xxii, 34, 41 compared with Mark xii, 28, 35; Matt. xv, 12; *see* also xxiii, 1 ff.).

Although Matthew did not basically change Mark's outline of Jesus' life, even a superficial examination of the former leaves the reader with an impression quite different from that derived from Mark. This is primarily because of the following factors: (1) Matthew adds further legendary materials, especially the birth narratives, and some new sections in the Passion account; (2) the author weaves the sayings taken from his second source, Q, into the Marcan framework; and (3) he arranges related materials in larger homogeneous sections—*e.g.*, the Sermon on the Mount (v–vii) and the collection of miracle stories in viii–ix.

Outline.—The outline of Matthew must therefore follow the themes of the collected material rather than the geographical sequence, which remains basically the same as in Mark. (Matt. iii–xvi, 12, in and around Galilee; xvi, 13–xx, toward Jerusalem; xxi–xxvii, last days in Jerusalem and Passion.)

i, 1–iv, 11: Messianic origins
- i, 1–25: genealogy and birth
- ii, 1–23: visit of the Magi, flight into Egypt
- iii, 1–iv, 11: John the Baptist, baptism, temptation

iv, 12–ix, 34: the Messiah of word and work
- iv, 12–25: call of the disciples, summary of preaching and healings
- v, 1–vii, 29: the Messiah of the word (Sermon on the Mount) *discourse*
  - v, 1–48: the entrance into the Kingdom: Beatitudes, salt and light, New Righteousness (antitheses)
  - vi–vii, 12: the new conduct of life; alms, prayer, fasting, treasures, cares, judging, golden rule
  - vii, 12–27: eschatological warnings; narrow gate, false prophets, self-deception, hearers and doers
- viii, 1–ix, 33 (34): the Messiah of the work
  - viii, 1–17: three healings (leper, the centurion's servant, Peter's mother-in-law)
  - viii, 18–22: two followers
  - viii, 23–ix, 8: three miracles (tempest, Gadarene [Gerasenes] demoniacs, man sick of palsy [paralytic])
  - ix, 9–17: call of Levi, question on fasting
  - ix, 18–33 (34): three healings (Jairus' daughter, two blind men, dumb demoniac)

ix, 35–xvi, 12: the Messiah in the world
- ix, 35–xi, 1: sending out of the Twelve and *discourse* for the missionaries
- xi, 2–30: about John the Baptist and Jesus' own mission
- xii, 1–50: controversies (sabbath, Beelzebul, seeking for signs, real brethren)
- xiii, 1–52: the parables of the Kingdom *discourse*.

(for xiii, 53–xxviii, 10 *see* also outline of MARK, GOSPEL ACCORDING TO SAINT)
- xiii, 53–xiv, 12: critical events (rejection in Nazareth, death of John the Baptist)
- xiv, 13–xv, 31: feeding of 5,000, discussion about clean and unclean
- xv, 32–xvi, 12: feeding of 4,000, on signs and leaven

xvi, 13–xx, 28: the Messiah of the church
- xvi, 13–xvii, 23: the foundation and conditions of the church (Peter's confession, transfiguration, suffering of the Messiah and the church)
- xviii, 1–35: *discourse* on the church's life
- xix, 1–xx, 16: further instruction of the disciples (marriage and divorce, little children, rich young man, labourers in the vineyard)
- xx, 17–28: the church facing the Passion (third prediction, sons of Zebedee)

xx, 29–xxv, 46: the Messiah of the "Last Days"
- xx, 29–xxi, 17: Jesus comes to Jerusalem (the two blind men of Jericho, entry into Jerusalem, cleansing of the Temple)
- xxi, 18–xxii, 14: Israel in its eschatological decision (cursing of the fig tree and question about authority; parables of the two sons, the wicked husbandman and the marriage feast)
- xxii, 15–xxiii, 36: Jesus overcoming the Pharisees in controversy (tribute to Caesar, resurrection, great commandment, David's son, woes against the Pharisees)
- xxiii, 37–xxv, 46: the great eschatological *discourse* (the future of Jerusalem, "Synoptic Apocalypse," watchfulness of the disciples, the great eschatological parables)

xxvi, 1–xxviii, 20: the Victory of the Messiah
- xxvi, 1–46: preparation for the Passion (anointing, betrayal, Last Supper, Gethsemane)
- xxvi, 47–xxvii, 31: trial of Jesus (and death of Judas)
- xxvii, 32–66: crucifixion and death, burial and guard at the tomb
- xxviii, 1–20: the Resurrection (the empty tomb, bribing of the soldiers, appearance in Galilee and command to baptize)

Themes.—In Matthew, the adopted Marcan outline of the Gospel has been united with a thematic classification of the material. Sayings, collected into large discourses, have become the backbone of Matthew's composition. This indicates a fundamental

change in the way in which Jesus is viewed in the Gospel. According to Matthew the content of the Gospel is not Jesus' life and person, but the message and teachings in which Jesus interprets the Law and proclaims the New Righteousness. These teachings are presented by Matthew in the form of ecclesiastical instructions, with Jesus himself as teacher. It is legitimate, therefore, to call Matthew's Gospel a "manual of discipline" for the church, similar in many respects to the "manual of discipline" of the Essene community of Qumran, which also had its "Righteous Teacher" (*see* DEAD SEA SCROLLS). But the fundamental difference from the Essene community must not be overlooked; no messianic attribute is given to the Qumranic Righteous Teacher, whereas in Matthew the authoritative interpretation of the Law is precisely the ministry of Jesus *as the Messiah*. Consequently, there are two main aspects in the Gospel: (1) to feature Jesus as the divine Messiah, the eschatological Lord and Judge, and (2) to unfold Jesus' interpretation of the Law and His teachings as the guide and rule of the eschatological community as it confronts the coming Kingdom of God.

Matthew emphasizes Jesus' divinity in several ways. It is already explicit in the birth narratives. Significantly, the messianic fulfillment of Old Testament prophecy is underlined throughout the Gospel by the "formula quotations": "This happened in order to fulfill what was said . . ." (i, 22; ii, 15, 17, 23, etc.). The miracle stories are significantly altered by Matthew to show Jesus not as the powerful Messiah but rather as the merciful King (compare, *e.g.*, Matt. ix, 18–26 with Mark v, 21–43) who fulfills the words of the prophets by saving His people from sickness (*see* viii, 16–17, ix, 35–36; xi, 2–6). The Christological titles given to Jesus are presented as testimonies that Old Testament expectations are accomplished in his person (Messiah, Son of David, Lord, King of Israel, Son of Man, Son of God). They go far beyond the titles given to a "teacher," and Jesus' disciples (except Judas; *see* xxvi, 25) never use this form of address, but always the title of divine majesty, "Lord" (compare Matt. viii, 25 with Mark iv, 38). Matthew, more consistently than Mark, identifies Jesus with the future Messiah and Judge (compare Matt. x, 33 with Mark ix, 37).

According to Matthew, the centre of Jesus' messianic ministry of fulfillment is His teaching. To fulfill and to re-establish the Law is the chief task of the Messiah. It is not a new law that Jesus proclaims, but the old and only Law of God as it was given through Moses and the Prophets, and which is reinforced in its entire validity including every "iota and dot" (v, 18–19). What is "new" is the righteousness Jesus requires—an obedience that recognizes God's radical demand upon man's existence as it is made clear in Jesus' interpretation of the Law (v, 21–48). This New Righteousness, which must "exceed that of the Scribes and Pharisees," is the condition for the entrance into the Kingdom (v, 20). The five great discourses in Matthew unfold this "Law" as the demand for a New Righteousness in its full eschatological dimension.

All these discourses (v–vii; x; xiii; xviii; xxiii–xxv) follow the same pattern of eschatological church instruction: (1) the announcement of the essentials of the re-established law; (2) detailed regulations for the life of each individual and the church as a whole; and (3) an eschatological appeal and warning. This pattern goes back to the Old Testament covenant formula, and in the early church is used especially in "catechisms" like the Teaching of the Twelve Apostles (*see* APOSTOLIC FATHERS). Even the sequence of Matthew's various discourses follows this general pattern.

The Matthean understanding of the nature of the church also is revealed through this arrangement of the materials. For the first time, Jesus is depicted as the founder of the church in Matt. xvi, 17–19 (here and in xviii, 17 are found the only use of the word "church" in the Gospels). This debated passage (which is often used as a proof-text for the Petrine-Roman "power of keys") stresses that the church as the eschatological community possesses the promise that the doors of hell shall not be able to overcome it in its eschatological trouble. Thus the concept of the church is rooted in the eschatological perspective. The stilling of the tempest (Matt. viii, 23–27) becomes a paradigm for the church in the apocalyptic earthquakes. The relation between Jesus and His disciples prefigures the relation between the risen Lord and His church in the terrors and torments that will precede the Second Coming (xxiv, 3–8). The church is always pictured in a situation of persecution and exposed to dangers from within and without—a feature emphasized at the end of every discourse.

It is in this eschatological setting that uncompromising obedience, the New Righteousness, becomes relevant. To do good works (vii, 16–23), to love one's enemies (v, 43–47), to refrain from retaliation (v, 38–42), to forgive continually (xviii, 21–22)—in short, the commandment of love as the fulfillment of the Law (xxii, 36–40)—is the demand upon the true disciple who aspires to achieve the eschatological quality of "perfection" (v, 48; xix, 21). Every compromise excludes from the Kingdom, but "blessed are those who are persecuted for righteousness' sake" (v, 10; this beatitude is added by Matthew to the traditional beatitudes of Jesus). This, however, does not mean blind subordination or fatalistic endurance. Matthew often stresses the necessity of real insight and understanding (compare Matt. xiii, 19–23 with Mark iv, 15–20), and eschatological watchfulness is synonymous with ethical preparedness (xxii, 11–13, etc.). Christology, ecclesiology and eschatology thus are bound together by the concept of Law and New Righteousness. Christian life is mature responsibility in view of the final judgment of each man's works. Jesus as the Messiah is the teacher of the Law, the Lord of the obedient church and the Judge of the Last Day. Consequently the Gospel is not presented in Matthew as the eternal doctrine about some superhuman being, but as the message of that Jesus who Himself has suffered and died as the archetype of the true disciple.

Literary History.—With its strong emphasis upon the Law and its constant dispute with the leaders of Judaism, Matthew certainly was written for a Jewish-Christian church in a strongly Jewish environment. But, although the uniquely Matthean tradition presupposes the scholarly work of teachers acquainted with the Hebrew language, the Gospel itself belongs to Greek-speaking Christianity. Its main sources are Greek writings (Mark and Q), and the author often substitutes more fluent Greek idioms for the clumsy sentences of his sources. Thus, the Gospel must have been written somewhere outside Palestine in a strong Greek-speaking Jewish community. Since Matthew probably was used first by Ignatius of Antioch (A.D. 110), the coastal district of Syria is still the best suggestion of a possible place of origin, although the city of Antioch itself is unlikely because it also was influenced by Pauline teachings, which are lacking in Matthew.

All these evidences also belie the statement of Papias that the Gospel was written first in Hebrew by the disciple Matthew (*see* GOSPELS). Since the fall of Jerusalem in A.D. 70 is clearly presupposed in xxii, 6–7 (*cf.* xxiii, 37–39), and since the name of Levi the tax collector in Mark ii, 14 is changed to Matthew in Matt. ix, 9 it seems clear that the author was a later writer who claimed Matthew's authority for his Gospel, rather than the disciple himself. The dependence on written sources, school traditions and developed Christological, doctrinal and liturgical formulations point to a man of third-generation Christianity who composed the Gospel between A.D. 75 and 100. *See* also BIBLE and references under "Matthew, Gospel According to Saint" in the Index.

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MATTHEW PARIS: *see* PARIS, MATTHEW.

MATTHEWS, (JAMES) BRANDER (1852–1929), U.S. essayist and dramatic critic, chief U.S. advocate of the "well-made" play of the Jones-Pinero school, was born in New Orleans, La., Feb. 21, 1852, and educated at Columbia university (A.B., 1871; LL.B., 1873; A.M., 1874). Though admitted to the bar he never practised but turned instead to writing and the study of literature. He was professor of literature at Columbia, 1892–1900, and of dramatic literature, 1900–24. A prominent figure in New York literary groups, Matthews was the author of many short stories and critical essays, was a regular critic for the *New York Times* for a long period, and published more than 40 books (as author or editor). His scholarship, revealed in such works as *Molière, His Life and His Works* (1910), *Shakespeare as a Playwright* (1913) and *French Dramatists of the 19th Century* (1881), is sound, although in his lighter essays there is much repetition. He died in New York city on March 31, 1929.

MATTHIAS, SAINT, the disciple chosen to fill the place vacated by Judas Iscariot (Acts i, 21–26). The primitive method of choice (by lot), the Aramaic form of the name (a shortened form of Mattathias and not Grecized like the better-known Matthew), and the fact that Paul received a tradition which referred to "the twelve" as distinguished from "all the apostles" (I Cor. xv, 5–7) lead to the inference that the story is based upon actual fact. The choice of twelve disciples by Jesus points to a consciousness of a nation-wide mission, which was contained in the community after the crucifixion. Matthias is not mentioned again in the New Testament. Clement of Alexandria refers to the "Traditions" of Matthias; some, he says, identified him with Zacchaeus the publican. *The Acts of Andrew and Matthias* is a romance preserved in Greek and Syriac and, in part, in Latin. In it Matthias goes to the anthropophagi, where he has remarkable adventures. St. Matthias' feast day is Feb. 24 (Feb. 25 in leap year) in the Western Church and Aug. 9 in the Greek Church.

(W. K. L. C.)

MATTHIAS (1557–1619), Holy Roman emperor from 1612, also king of Hungary from 1608 to 1618 and of Bohemia from 1611 to 1617, was born in Vienna on Feb. 24, 1557, the third son of the future emperor Maximilian II and Maria, daughter of the emperor Charles V. He was educated in Spain by the learned diplomat Augier Ghislain de Busbecq. His father, who died in 1576, left no territories to him. On the invitation of the Catholic nobility of the Netherlands, Matthias went to Brussels in Oct. 1577 to take the place of his uncle Philip II's governor general there, Don John of Austria, and to mediate in the quarrel between the Netherlands and Spain; in Jan. 1578 the states-general appointed him governor general. He found himself, however, unable to do anything without William of Orange, to counteract whose influence he had been invited; and in Oct. 1581 he finally left the Netherlands for Germany.

Matthias now sought to obtain a governorship in the Habsburg lands, but not until 1593 did his eldest brother, the emperor Rudolf II, appoint him governor of Austria. There he furthered the work of the Counter Reformation against the Protestants (although tolerating Protestants in his household), suppressed risings of the Protestant peasants between 1594 and 1597 and fought against the Turks. He was only partly successful in all these activities. From *c.* 1598 onward Matthias relied increasingly on the advice of the ecclesiastical statesman Melchior Klesl (*q.v.*).

Meanwhile, the discontent of members of the house of Habsburg at Rudolf's political inactivity grew until, in 1605, they forced him to empower Matthias to conduct affairs in Hungary, which had revolted under István Bocskay. In April 1606 the Habsburg archdukes, temporarily united, recognized Matthias (whose second elder brother Ernest had died in 1595) as their head and as Rudolf's successor. Matthias made peace with the Hungarians at Vienna on June 23, 1606, granting to the estates religious freedom both for Lutherans and for Calvinists and some political independence. The armistice that he concluded with the sultan Ahmed I at Zsitvatörök (Nov. 11, 1606) was broken in 1611 but was reaffirmed in 1615, inaugurating a period of peace between the Habsburgs and the Turks that lasted till 1663.

Rudolf, henceforward full of suspicion toward Matthias, disliked the peace policy and prepared to renew the Turkish war but Matthias, in alliance with the estates of Hungary, Austria and Moravia, forced Rudolf to cede these lands to him in June 1608 and to promise him the succession in Bohemia as well as in Rudolf's other lands. Matthias, who was crowned king of Hungary in Nov. 1608, was compelled by the estates of Hungary, Austria and Moravia to grant them further religious concessions. The formal reconciliation of 1610 between Matthias and Rudolf was broken in 1611, when the Bohemian estates asked Matthias for assistance against Rudolf's mutinous troops, which were ravaging Bohemia under the archduke Leopold (1586–1632) with Rudolf's connivance. The estates forced Rudolf to abdicate, and Matthias was crowned king of Bohemia on May 23, 1611. Rudolf prevented Matthias' preliminary election as king of the Romans, or successor designate to the empire, but died on Jan. 20, 1612. Then Matthias was elected on June 13 and crowned emperor on June 24, 1612. He also succeeded to Rudolf's remaining lands.

In Dec. 1611 Matthias had married his cousin Anna of Tirol (1585–1618), daughter of his uncle the archduke Ferdinand (1529–95). Devoting himself to his household and to patronage of the arts, Matthias neglected public affairs, the conduct of which was mostly left to Klesl. Matthias and Klesl failed in their attempts to reconcile the contending religious parties of Germany and to revive the imperial institutions, which had ceased to function. Imperial instructions were ignored in the continuing dispute over the succession to Jülich and Cleves. Matthias' only success was to prevent a confederation of the estates of all the Habsburg lands in 1615. The unyielding Catholic princes of Germany received support in their opposition to Klesl's peaceful policy from the younger Habsburgs, led by the emperor's brother, the archduke Maximilian (1558–1618), and by his cousin, the archduke Ferdinand of Styria, afterward the emperor Ferdinand II. The archdukes decided that Ferdinand should succeed Matthias, who was old, ill and childless, as emperor. Ferdinand was accepted as king of Bohemia in 1617 and crowned king of Hungary in 1618, but met with Protestant resistance in Bohemia. Matthias and Klesl advised concessions to the rebels, but Ferdinand and Maximilian defeated this policy by imprisoning Klesl. Matthias died at Vienna on March 20, 1619, just when the Bohemian struggles were leading into the Thirty Years' War.

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(H. J. Co.)

MATTHIAS I CORVINUS (MÁTYÁS HUNYADI) (1440–1490), king of Hungary from 1458 and of Bohemia from 1469 to 1478, was born probably on Feb. 23, 1440, at Kolozsvár (Cluj) in Transylvania, the second son of János Hunyadi (*q.v.*) and Elizabeth Szilágyi. He shared in his father's campaigns when only 12 years of age. He was created count of Beszterce (Bistrita) in 1453 and knighted at the siege of Belgrade in 1454. At 15 he was married to Elizabeth of Cilli (Celje), but the young Elizabeth died before the marriage was consummated. On his father's death (1456) he was inveigled to Buda by his enemies and condemned to death on the pretext of an imaginary conspiracy, but was spared on account of his youth. On King László V's death (1457), he was detained for a time by George of Podebrady, governor of Bohemia, who treated him hospitably and affianced him to his daughter Catherine. On Jan. 24, 1458, Matthias was elected king of Hungary by acclamation, though a section of the magnates, headed by the palatine László Garai and by the governor of Transylvania, Miklós Ujlaki, was opposed to him; and on Feb. 14 he entered Buda in state.

The situation of Hungary was precarious, and to the king's numerous foreign enemies were added the magnates, headed by his own uncle and guardian, Mihály Szilágyi. Despite their opposition, Matthias, on Feb. 9, 1458, married Catherine of Podebrady, whose father was crowned king of Bohemia soon afterward. Matthias was now able to fight against the Turks, to invade Serbia and to reassert his suzerainty over Bosnia. After malcontents had actually crowned the Holy Roman emperor

Frederick III as king of Hungary at Wiener Neustadt (March 4, 1459). Matthias drove him out. In April 1462 the emperor was forced to recognize Matthias as king of Hungary and to give up the crown of that country. He was allowed, however, to retain certain Hungarian counties with the title of king. After a campaign against the Turks, during which he invaded Bosnia successfully, Matthias was crowned king of Hungary on March 29, 1464. Having joined the Catholic league against his father-in-law, George of Podebrady, in 1468, he was elected king of Bohemia by the Czech Catholics on May 3, 1469. George of Podebrady, however, allied himself with the Poles; and after years of fighting and maneuvering against the counterclaimant Wladyslaw (son of Casimir IV of Poland) and against the emperor Frederick, Matthias was forced at last, under the peace of Olomouc in 1478, to recognize the Pole as king of Bohemia (Vladislav II), while he himself secured Moravia, Silesia and Lusatia until they should be redeemed for 400,000 florins.

The emperor promised to pay Matthias 100,000 florins as war indemnity and recognized him as the legitimate king of Hungary on the understanding that he (the emperor) should succeed him in the then unlikely event of his dying without legitimate issue (a widower since 1464, Matthias had married his third wife, Beatrice of Aragon, daughter of Ferdinand I of Naples, on Dec. 15, 1476). In his third war against Frederick, which began in 1481, Matthias was rapidly successful. He entered Vienna (which he made his capital thenceforward) on June 1, 1485, and proceeded to conquer Styria, Carinthia and Carniola. He consolidated his position by alliances with the dukes of Saxony and of Bavaria, with the Swiss confederation and with the archbishop of Salzburg and furthermore extended his influence southward into Italy. Henceforth he was the greatest potentate in central Europe.

Though his policy was so predominantly directed toward the west that he soon abandoned his youthful idea of driving the Turks out of Europe, Matthias at least succeeded in making them respect Hungarian territory and in pushing his frontier southward in Bosnia. He had no children by Beatrice, and his last days were occupied in trying to secure the succession for János (John) Corvinus, his illegitimate son by a Breslau burgher's daughter. Beatrice, however, opposed this project fiercely, and the matter was still unsettled when Matthias died suddenly in Vienna on April 6, 1490.

Matthias Hunyadi was the greatest prince of his day. He was illustrious as a soldier, a statesman, an orator, a legislator and an administrator. Although naturally passionate and repeatedly provoked, he was never cruel or vindictive. It was said that often half his nights were spent in reading, after the labour of his most strenuous days. His camp was a school of chivalry, and humanist culture had its heyday in Hungary during his reign. His library, the Corvina, was famous the world over, and he had a fine collection of illuminated codices. In his luxurious residences of Buda and Visegrád, he surrounded himself with humanists, poets and artists. He established the first printing press in Buda and founded the University of Pozsony (Bratislava) and a college in Buda.

See also references under "Matthias I Corvinus" in the Index. (GE. GR.)

MATTHISSON, FRIEDRICH VON (1761–1831), German poet whose verse was praised by Schiller for its melancholy sweetness and its fine description of scenery, was born near Magdeburg on Jan. 23, 1761. In 1812 he was appointed intendant of the court theatre and chief librarian of the royal library at Stuttgart. In 1828 he retired and settled at Wörlitz near Dessau, where he died on March 12, 1831. Matthisson's poems, *Gedichte,* were published in 1787. His poem "Adelaide" remains famous in a setting by Beethoven.

BIBLIOGRAPHY.—Matthisson's *Schriften* appeared in 8 vol. (1825–29): vol. 1 collects his poems; vol. 2–8 his reminiscences. A supplementary volume (1833) contains a biography by H. Döring. There is a 2-vol. ed. by G. Bolsing (1812–13). A selection from his correspondence, ed. by F. R. Schoch, appeared in 4 vol. (1832). *See* also W. Krebs, *Friedrich von Matthisson* (1912); A. Heers, *Das leben Friedrich von Matthisson* (1913).

MATTING, a general term for woven or plaited mats of vegetable fibres and similar articles of other materials, used as floor coverings, carpet cushioning or underpads, table mats, hangings, wrappings, etc. Materials used in vegetable fibre matting include straw, bulrushes, fibres and leaves of several palms and the screw pine, munj or munja grass and mat grasses. Various natural and man-made fibres, usually in a blend, are used in non-woven matting (*see* FELT). Floor mats for automobiles and other means of transportation are frequently made of rubber; some door mats are made of woven wire. The term matting also includes some types of foam rubber, used in industry.

A coarse floor covering ideal for summer use is made from coir (*q.v.*), a fibre of the coconut palm, and from other bast fibres such as cane, manila hemp, abaca, henequen and various grasses and rushes. The fibres are made into yarn which is then woven into a coarse fabric on heavy, wide looms. Simple weaves are used and patterns may be plain, striped, checked, twilled, etc. The fabric may be woven to size or cut to size; if it is cut, the pieces are bound around the edges by a rope or strand of the material but the selvage edges are usually left unbound.

Another type is made from strands or rope formations by arranging alternate layers in sinuous and straight paths and then stitching the parts together. This matting finds use as the outer covering for the fenders of ships. (G. E. L.)

MATVEEV, ARTAMON SERGEEVICH (1625–1682), Russian diplomat and statesman, the friend and the influential adviser of the tsar Alexis, was the son of an obscure government clerk. By 1654 Matveev had risen to the rank of chief of the Moscow *streltsy* (household troops) and in that year negotiated with the Poles the surrender of Smolensk to Russia. He replaced A. L. Ordyn-Nashchokin at the head of the department for Ukrainian affairs in 1669 and at the head of the foreign department in 1671. Unlike his predecessor, he favoured a policy leading to the incorporation of the whole Ukraine in Muscovy, but was hindered in its execution by the re-emergence of the Turkish threat to Europe. His policy toward the west foreshadowed that of V. V. Golitsyn. In 1672 he took a prominent part in the conclusion of an agreement with Poland about concerted action against Turkey. When, later in 1672, Kamenets fell to the Turks, Matveev dispatched envoys to Austria, Brandenburg, France, Spain, Venice, the Holy See, Sweden and Holland to enlist support against Turkey. A manual of diplomatic correspondence was compiled by the clerks of the foreign department during Matveev's term of office. His influence on the tsar Alexis, already great, increased with the tsar's marriage (1671) to Matveev's ward, Natalia Kirillovna Naryshkina; but only in 1674 was Matveev, whose low birth handicapped him, made a privy councilor. On the accession of the tsar Fedor Alekseevich in 1676, Matveev was accused of black magic and fraud, deprived of his rank and possessions and exiled. In Jan. 1682 he was pardoned and allowed to reside at Lukh, whence Peter I, on succeeding Fedor in April, was induced to recall him to Moscow. On May 25 (new style; 15, old style), 1682, four days after his return, he was killed by the rebellious *streltsy.*

Matveev's intellectual horizon was uncommonly wide for a Muscovite of his day. In 1672 he arranged the first theatrical performance to be given at the Russian court. His way of life bore witness to his westernizing inclinations; his wife appeared in male society and his house was furnished after the western fashion. (L. R. LR.)

MAU: *see* IRENG.

MAUBIN, a district in the Irrawaddy delta of the Union of Burma, lying to the west of Rangoon. Area 1,651 sq.mi. Pop. (1962 est.) 576,546. In the rainy season (June–September) when the rice fields are flooded, only the huts, strung out along the banks of the delta creeks, appear to rise above the floods; in the dry season the paddy fields are brown and dry but numerous freshwater marshes remain. Communication is by water; Maubin town is on the west bank of the main Irrawaddy distributary and is linked directly with Rangoon by the Twante canal. Opposite Maubin is a very large unreclaimed freshwater swamp. (L. D. S.)

MAUCH CHUNK: *see* JIM THORPE.

MAUCHLINE, a village and civil parish of Ayrshire, Scot., 9 mi. S.E. of Kilmarnock and 11 mi. E.N.E. of Ayr by road. Pop. (1961) 4,454. It is situated on a gentle slope about 1 mi. from the river Ayr. On the village green a monument marks the spot where five Covenanters were killed in 1685. Mauchline is the site of the Burns National memorial and has many links with the poet, who lived with his brother Gilbert on the farm of Mossgiel, about a mile to the north, from 1784 to 1788. In Castle street is the house (now a museum) where Robert Burns and Jean Armour stayed before going to Ellisland. Mauchline kirkyard was the scene of the "Holy Fair"; the "Jolly Beggars" met at "Poosie Nansie's"—still, though much altered, a popular inn; "auld Nanse Tinnock's" house nearly faces the entrance to the churchyard; the Rev. William Auld was minister of Mauchline, and "Holy Willie," whom the poet scourged in the celebrated "Prayer," was one of "Daddy Auld's" elders. Behind the kirkyard stands the house of Gavin Hamilton, the lawyer and firm friend of Burns, in which the poet was married. The braes of Ballochmyle, where he met the heroine of his song, "The Lass o' Ballochmyle," lie about a mile to the southeast.

Mauchline's industries are coal mining and the making of curling stones, optical instruments, powdered milk and agricultural implements.

MAUGHAM, WILLIAM SOMERSET (1874–), English novelist, playwright and short-story writer, whose work is characterized by a clear unadorned style, cosmopolitan settings and a shrewd understanding of human nature, was born in Paris on Jan. 25, 1874. Orphaned at the age of ten, he was brought up by an uncle and educated at King's school, Canterbury. After a year at Heidelberg, he entered St. Thomas' medical school and qualified as a doctor in 1897. He drew on his experiences as an obstetrician in his first novel, *Liza of Lambeth* (1897), and its success, though small, encouraged him to abandon medicine. He traveled in Spain and Italy and in 1908 achieved a theatrical triumph, with four plays running at once, which brought him financial security. During World War I he worked as a secret agent, visiting the United States, the South seas and Russia. After the war he continued to travel widely, and in 1928 bought a villa on Cape Ferrat in the south of France which became his permanent home.

His reputation as a novelist rests primarily on four books: *Of Human Bondage* (1915), a semiautobiographical account of a young medical student's painful progress toward maturity; *The Moon and Sixpence* (1919), an account of an unconventional artist suggested by the life of Paul Gauguin; *Cakes and Ale* (1930), the story of a famous novelist, which was thought to contain caricatures of Thomas Hardy and Hugh Walpole; and *The Razor's Edge* (1944), a young American war veteran's quest for a satisfying way of life. Maugham's plays, mainly Edwardian social comedies, soon dated, but his short stories (complete edition, 3 volumes, 1951) have steadily increased in popularity. They often portray the conflict of Europeans in alien surroundings which provoke strong emotions, and Maugham's skill in handling plot, in the manner of Guy de Maupassant, is distinguished by economy and suspense. In *The Summing Up* (1938) and *A Writer's Notebook* (1949) Maugham explains his philosophy of life: a resigned atheism and a certain skepticism about the extent of man's innate goodness and intelligence; it is this which gives his work its astringent cynicism.

See R. A. Cordell, *Somerset Maugham* (1961).

MAUKHARI, a north Indian ruling family or clan, prominent in the 6th century A.D. The earliest reference to the Maukharis is on a seal of the Mauryan period, found at Gaya in south Bihar. They appear again in sacrificial inscriptions at Kotah in Rajasthan, dated A.D. 239. A further Maukhari family ruled in the 5th century in the Gaya district.

The most important branch of the Maukhari family, however, is not known to have been directly connected with those mentioned above, and seems to have had its main centre to the north of the Ganges. Originally feudatory chiefs of the Gupta empire, the Maukharis asserted their independence on its decline, and by 554 their king Isanavarman had thrown off all allegiance and had taken imperial titles. The second half of the century saw continuous conflict between the Maukharis and the kings of the later Gupta line. The Maukharis seem to have ruled much of modern Uttar Pradesh, their power sometimes extending into parts of Magadha (south Bihar); there is also some evidence of Maukhari raids in the Deccan. Their capital was Kanyakubja (Kannauj), and they were mainly responsible for developing this city.

The last significant Maukhari king, Grahavarman, was defeated and killed by the Guptas soon after his accession, and his capital was occupied. His brother-in-law Harsha (*q.v.*), however, expelled the Guptas *c.* 606 and thus gained control of the Maukhari kingdom. After this the Maukhari family is hardly heard of again.

See E. Pires, *The Maukharis* (1934); R. S. Tripathi, *History of Kanauj* (1937). (A. L. BA.)

MAULE, a coastal range province of central Chile. It was created in 1826. In 1927 Linares province (*q.v.*) was annexed, the capital moved to Linares and Itata department transferred to Ñuble province (*q.v.*). In 1936 Maule and Linares provinces were separated and Maule's capital was re-established at Cauquenes (pop. [1960] 17,836). Area 2,200 sq.mi. Pop. (1960) 79,800. Maule is the least densely populated province between the Bío-Bío and Aconcagua valleys. Its rolling hill terrain is brush covered in the east but becomes forested in the centre and west. The accessible hardwood forests have been cut over and in some areas replaced by pine and eucalyptus plantations. Sheep and cattle range everywhere. Agriculture is concentrated in the valleys, chief among them the Cauquenes. Most valuable crop is the vine, but wheat, various legumes and maize are important. The products of field, range and forest may be shipped on the Cauquenes-Parral or Constitución-Talca branches of the state railway. The latter line parallels the Maule river, one of central Chile's larger streams. Small ships enter the lower river and barges carry logs, pulp and firewood to Constitución or across the river to the railroad.

Constitución (pop. [1960] 9,536) remains a minor port although considerable effort has been made to scour the river mouth and build an artificial harbour nearby. Wooden ships and barges are constructed, and a summer vacation trade is attracted by the picturesque town, wooded hills, cliff coast and beaches. Constitución, Chanco (pop. [1960 mun.] 11,741) and Cauquenes are departmental seats. The Maule river is said to have represented the southern limit of the Inca empire. (J. T.)

MAUNDY THURSDAY, the Thursday before Easter, is so called from the first word of an anthem sung on this day in Roman Catholic churches: *Mandatum novum do vobis* ("a new commandment I give to you"; John xiii, 34). From earliest times the day has been observed in commemoration of Christ's institution of the Eucharist with a general communion of clergy and people. At a special Mass the bishop consecrated the holy oils in preparation for the anointing of the neophytes at the baptism on Easter night. Since 1956 Maundy Thursday has been celebrated in Roman Catholic churches with a morning Mass for the consecration of the holy oils (in cathedrals) for the coming year and an evening Mass in commemoration of the institution of the Lord's Supper with general communion; during this Mass occurs the ceremony of the washing of feet (*pedilavium*, known more generally as the Mandatum) when the celebrant ceremonially washes the feet of 12 men in memory of Christ's washing the feet of his disciples. At this Mass the hosts are consecrated for the communion on Good Friday (when there is no Mass). Orthodox churches also have a ceremony of foot-washing and a blessing of oil on this day.

The Maundy ceremony, usually held at Westminster abbey, London, when alms are distributed on behalf of the British sovereign, is a relic of the former practice whereby sovereigns used to wash the feet of the poor on this day. In most European countries Maundy Thursday is known as "Holy Thursday"; other names are "Green Thursday" (common in Germany, *Gründonnerstag*), from the early practice of giving penitents a green branch in token that their Lenten penance was completed, and "Sheer Thursday" (that is, "clean Thursday"), a reference to the ceremonial washing of altars on this day. *See* also HOLY WEEK; LENT.

See W. J. O'Shea, *The Worship of the Church* (1957); H. Thurston, *Holy Week and Easter* (1904). (L. C. S.)

MAUPASSANT, (HENRY RENÉ ALBERT) GUY DE (1850–1893). French writer of short stories and novels whose work is distinguished from that of other naturalists both by its universality and by the purity of its style and who is remembered also for the tragic circumstances of his life, was born in the château of Miromesnil, near Dieppe (Seine-Inférieure), on Aug. 5, 1850. His father, Gustave de Maupassant, who had a partnership in a Paris firm of stockbrokers, had in 1846 married Laure Le Poittevin, sister of Gustave Flaubert's friend Alfred Le Poittevin, who himself in the same year had married Gustave de Maupassant's sister Louise. This double link explains why Flaubert took so affectionate an interest in his friend's nephew after Alfred's death in 1848. Because of disagreements with her husband Mme de Maupassant went to live on her estate Les Verguies, at Étretat, after the birth of her younger son Hervé (1856). There, in wild surroundings, Guy grew up in the company of sailors' and peasants' children. Having learned Latin from the vicar, he was sent at the age of 13 to a Catholic school at Yvetot, but was expelled after less than two years, without regret on his part, and passed to the Rouen *lycée*. His poem "Le Dieu créateur," which won a prize in the philosophy class there, shows the influence of Alfred de Vigny's pessimism, of Victor Hugo's pantheism and also of the conversations that he heard between Flaubert and Louis Bouilhet, with whom he spent his Sundays in termtime. In 1867 he matriculated at Caen university. For his holidays he used to go back to Étretat. There, in the summer of 1868, he met the English poet Swinburne and his friend George Powell. The house and the dinner to which these two invited the young Maupassant made a vivid impression on him, which was reflected in one of his first stories ("La Main d'écorché," published under the pseudonym Joseph Prunier in 1875) and reproduced in his preface to Gabriel Mourey's translation of Swinburne's *Poems and Ballads* (1891).

Enlistment in the army on the outbreak of the Franco-German War in 1870 interrupted Maupassant's work as a law student, and after his discharge (autumn 1871) he secured a post as a clerk in the ministry of marine in Feb. 1873. This gave him some insight into the office workers' way of life, which he was later to exploit in stories such as "Les Dimanches d'un bourgeois de Paris" (1882) and "L'Héritage" (1884). Meanwhile Maupassant divided his spare time between rowing on the Seine and writing. Everything that he wrote he submitted to Flaubert, who called him his disciple and proved himself an exacting critic, forbidding Maupassant to publish anything before he had formed his style and matured his personality. Flaubert moreover encouraged him to write verse, so as to make his prose style more supple. Thus it was that Maupassant's first book was a collection of poems, *Des Vers* (1880). One of these poems, which had first appeared under the title "Au bord de l'eau" in a periodical in 1876, had been threatened with prosecution on the grounds of indecency when it was reprinted as "Une fille" in another periodical in 1879, but the case was dropped thanks to Flaubert's intervention. Flaubert furthermore persuaded his friend Agénor Bardoux, who was then minister of education, to give Maupassant a secretarial appointment in his office instead of his post at the ministry of marine. He had also introduced him to other writers, Zola, Daudet, Edmond de Goncourt and Turgenev.

Together with other young writers of his own age—Paul Alexis, Henry Céard, Léon Hennique and J. K. Huysmans—Maupassant used to pass his Sundays at Zola's house at Médan. Thus when Zola and his circle published *Les Soirées de Médan* (April 1880), a collective volume of stories on the Franco-German War, Maupassant was a contributor to it. This book, an outspoken demonstration of naturalism in literature, provoked heated controversy. Maupassant's contribution was "Boule de suif." In this, a prostitute traveling by coach is companionably treated by her fellow passengers anxious to share her provisions of food until a German officer stops the coach and refuses to let it proceed until he has possessed her; the others then induce her to satisfy him, but ostracize her for the rest of the journey. Unanimously regarded as the best story in the book, it was described by some critics as a masterpiece. This result was the last satisfaction that Flaubert was to have before his death (May 8, 1880).

The really triumphant success of "Boule de suif" was in Maupassant's mind when he later said that his passage through the world of letters was like that of a meteor. Unfortunately, however, he was thinking not only of his brilliant arrival in that world but also the painful end that he felt to be fast approaching him. In the period between "Boule de suif" and his collapse in 1891 he wrote enough to fill 30 books. *La Maison Tellier* (1881), a book of short stories on a variety of subjects, can be regarded as typical of his achievement as a whole, but in his novels as well as in his stories he was to show himself both versatile in his choice of themes and constant in his determination to present men and women just as he saw them in the manifold aspects of life. His concern was with *l'humble vérité*—words which he chose as the subtitle to his novel *Une Vie* (1883). This novel does in fact record what he had observed as a child, the little dramas of family relationships and the day-to-day preoccupations of real people, all drawn from life. A loyal disciple of Flaubert and of Zola, he presents his characters with strict objectivity, forgoing any expression of a personal judgment on them but noting always the word, the gesture or even the reticence that betrays the essential personality of each one and enhancing the effect by his description of the background against which they move. Conciseness, strength and the most rigorous economy are the characteristics of his art.

Collections of short stories and novels followed one another in quick succession until illness struck Maupassant down. Two years saw six new books of short stories: *Mademoiselle Fifi* (1883), *Contes de la bécasse* (1883), *Clair de lune*, *Les Soeurs Rondoli*, *Yvette* and *Miss Harriet* (all four 1884). Yet he knew that his family had a long history of neurosis and was himself subject to eye troubles and agonizing headaches. To distract himself from his anxiety he worked like a man possessed, took overviolent exercise and indulged in sensual pleasures that wore him out. Convinced that there was no escape for him, he sought both to enjoy all that he desired and to express all his potentialities, all that he had in him for posterity. He took stimulants and narcotics in excess.

As well as shorter pieces, Maupassant wrote full-length novels. *Bel-Ami* (1885), drawn from his observation of the Parisian world of sharp businessmen and cynical journalists, is a scathing satire on a society whose members let nothing stand in the way of their ambition to "get rich quick." Bel-Ami, the hero of the novel, is now a standard literary example of that attitude. When the sale of his books enabled him to buy a yacht, Maupassant named it "Bel Ami." *Sur l'eau* (1888) and *La Vie errante* (1890) are based on the cruises that he made in it in the Mediterranean.

Maupassant's later books of short stories include *Toine* (1886), *Le Horla* (1887), *Le Rosier de Madame Husson* (1888) and *L'Inutile Beauté* (1890). In "Le Horla" he made use of the theories that J. M. Charcot was putting forward in his lectures on hysteria and psychological disorders at the Salpêtrière hospital. These theories were at that moment receiving worldwide publicity, but Maupassant's use of them in "Le Horla" was mistakenly interpreted, after his subsequent confinement in a mental home, as reflecting the onset of his own madness. Four more novels also appeared: *Mont-Oriol* (1887), on the financing of a fashionable watering place; *Pierre et Jean* (1888), on a man's tragic jealousy of his half brother, the child of his mother's adultery; *Fort comme la mort* (1889); and *Notre coeur* (1890).

Maupassant's work is all thoroughly realistic. Nevertheless it reflects at many points his deep love for the Norman countryside and the sea. Some of his stories have such tragic power that Taine compared them to the plays of Aeschylus (for instance "Le Port" and "Le Champ d'oliviers"). He does in fact present his characters, poor people or rich bourgeois, as if they were the heroes of a Greek tragedy, their lives dominated by *ananke* or ironic necessity, crushed by the fate that they have dared to defy yet still struggling against it hopelessly. Such indeed was his own life, with his obstinate self-dedication to his work. Not until his pain had become unbearable did he give way to despair. Then, on Jan. 2, 1892, at Cannes, he tried unsuccessfully to cut his throat. Sent to A. E. Blanche's nursing home in Paris, he died

there on July 6, 1893, at the age of 42.

Because so many of his stories deal with madness, it has been alleged that Maupassant himself was already mad when he wrote them. Yet these stories are perfectly well balanced, and in them Maupassant treats madness as a doctor, not as a patient. Down to the last work that he wrote, all his work is characterized by a clarity of style that betrays no sign of mental disorder. The lucid purity of his French and the precision of his imagery are in fact the two features of his work which account for its success, especially outside France. In the discussion of novel writing which serves as a preface to *Pierre et Jean* he described the French language as a clear pool that affectation of style could never cloud. This is an unconscious definition of his own stylistic principles, a rejection of the "artistic" or "precious" style practised by Edmond de Goncourt (who never forgave him).

Maupassant's work is easily distinguished from that of other naturalist writers. He gives a true picture of the society of his time, in which every detail of background and behaviour is recognizable. Yet there is a universality in his view of mankind, and this explains how Benjamin Britten and the librettist Eric Crozier could turn "Le Rosier de Madame Husson," which Maupassant had set in the Vexin Normand, into *Albert Herring*, set in East Suffolk, by means of a few modifications of minor details (e.g., in the matter of local customs), without any change in the presentation of the characters. Likewise film after film has been made from Maupassant's novels and stories, each one topical and contemporary however much the world has changed since his time.

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For biography see B. Maynial, *La Vie et l'œuvre de Guy de Maupassant* (1906); R. Dumesnil, *Guy de Maupassant* (1947); F. Steegmuller, *Maupassant* (1949). For personal reminiscences see A. Lumbroso, *Souvenirs sur Maupassant* (1905); E. Tassart, *Souvenirs sur Guy de Maupassant* (1911).

For criticism see Jules Lemaître, *Les Contemporains*, 8th series, 2nd ed. (1892); E. Faguet, *Propos littéraires*, 3rd series (1905); Abel Hermant, *Essais de critique* (1913); Joseph Conrad, *Notes on Life and Letters* (1921); Paul Bourget, *Nouvelles pages de critique et de doctrine* (1922); A. Thibaudet, *Réflexions sur le roman* (1938); A. Artman, *Maupassant Criticism in France* (1941); B. D. Sullivan, *Maupassant the Novelist* (1954). (R. Du.)

MAUPEOU, RENÉ NICOLAS CHARLES AUGUSTIN DE (1714–1792), the chancellor of France whose reform of the judicial system deprived the *parlements* of their political powers, was born in Paris on Feb. 25, 1714, the eldest son of René Charles de Maupeou. His father, who was premier président of the *parlement* of Paris from 1745 to 1757, was appointed Keeper of the seals in 1763 and became chancellor on Sept. 15, 1765, but resigned within 24 hours. Then René Nicolas, who had himself been made premier président in 1763, took office in his turn as chancellor.

At this time the French *parlements* seemed to have reached the height of their power, exercising a close supervision and control over the royal finances, influencing the course of the government's religious policy and presuming to interfere even in the administration of the separate provinces. After imposing the recall of the duc d'Aiguillon from the military governorship of Brittany in view of the affair of La Chalotais, however, the *parlement* of Paris overplayed its hand by attempting to procure his prosecution at law. The disgrace of the duc de Choiseul, who had protected the *parlements*, in 1770 and the return to favour of the duc d'Aiguillon as foreign minister in 1771 led to the formation of a strongly authoritarian government determined to reassert the royal authority.

After further conflicts during which the magistrates of the *parlement* of Paris had defied a *lit de justice* and had called a judicial strike, Maupeou resorted to force. On the night of Jan. 19, 1771, musketeers delivered to each judge of the Paris *parlement* a *lettre de cachet*, ordering him to declare whether or not he would resume his judicial duties. When nearly all refused, 130 of them were exiled to remote places in the provinces and deprived, without compensation, of their offices. On Feb. 23, 1771, Maupeou established by decree six *conseils supérieurs* to exercise in their respective areas the judicial authority formerly possessed by the *parlements*. Part of the latter, the *grand conseil* (later known as the *parlement Maupeou*), was however preserved in fact as a capital tribunal for crown cases and to exercise the right of legitimate remonstrance, i.e., against the form but not the substance of royal legislation. Soon afterward both the *cour des aides* (dealing with fiscal cases) and the *châtelet*, a central criminal court, were abolished. Louis XV prevented Maupeou from suppressing the provincial *parlements*.

In proposing these reforms, Maupeou argued that they amounted only to administrative changes designed to restrict the overgrown jurisdiction of the *parlements* of Paris, to abolish the sale of judicial offices by the establishment of magistrates appointed by the crown and to remove the abuse of judicial bribes (*épices*) by the payment of fixed salaries to the judges. The significance of the reforms, however, was thereby political, for they challenged the pretensions of the *parlements* of Paris to act as the substitute for the États-Généraux, withdrew the power of refusing royal legislation and rebutted the claim of the provincial *parlements* to the character of a united corporation within the state. Designed to uphold the sovereign authority of the monarchy against quasi-judicial criticism, the reforms were in fact carried out by a *coup d'état*—but one which would have paved the way for an enlightened despotism in France unrestrained by the reactionary opposition of hereditary magistrates.

Public opinion reacted strongly both against the manner of the coup and against the alleged despotism of Maupeou. Jansenists and Gallicans detected in the reforms the influence of the Jesuits; the provincial nobility feared the loss of its privileges and local liberties; and, with the exception of Voltaire and Condorcet, the *philosophes* were also critical, for they feared that the masses would accept the leadership of the exiled magistrates. Yet by the end of Louis XV's reign the new system was operating successfully. With the accession of Louis XVI in 1774 a series of ministerial changes occurred. Maupeou fell from power (though he remained chancellor in theory), and the *parlements* of Paris was restored to its former powers and privileges. Maupeou died in retirement at Thuit (Eure) on July 29, 1792.

See also PARLEMENT.

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MAUPERTUIS, PIERRE LOUIS MOREAU DE (1698–1759), French astronomer and mathematician, best known for his principle of least action, was born at St. Malo on Sept. 28, 1698, and died at Basel, Switz., on July 27, 1759. He became a member of the Académie des Sciences at Paris in 1723, and the following year he introduced into France the Newtonian doctrine of gravitation. In 1736 Maupertuis led an expedition to Lapland to measure the length of a degree along the meridian, thereby verifying the Newtonian view of the earth as an oblate spheroid—a sphere flattened at the poles. Called to Berlin, he became a member of the Academy of Sciences there in 1741 and served as president from 1745 to 1753.

Maupertuis contributed mathematical papers to the *Mémoires* of the Académie des Sciences of Paris and published more than half a dozen books on geography, astronomy and cosmology. In 1744, enunciating the principle of least action, he claimed that the operations of nature conform to a rule of economy in which action, defined by $\int mv\,ds$, is a minimum. The chevalier d'Arcy, however, pointed to cases in which action is a maximum rather than a minimum, and Samuel Koenig accused Maupertuis of plagiarism from Leibniz. In the ensuing polemic Euler came to the support of Maupertuis, but Voltaire, once his protective, satirized the "earth flattener" so mercilessly that Maupertuis, a favourite of Frederick the Great, left Berlin for Paris in 1753.

The *Oeuvres* appeared at Dresden in 1752, at Berlin in 1753, and

in new four-volume editions at Lyons in 1756 and 1768.

For bio-bibliographical details *see* Pierre Brunet, *Maupertuis, l'oeuvre et sa place dans la pensée scientifique et philosophique du XVIIIe siècle* (1929). (C. B. Br.)

MAURA Y MONTANER, ANTONIO (1853–1925), Spanish statesman, five times prime minister, was born at Palma de Mallorca on May 2, 1853. Graduating in law from the University of Madrid, he became a successful advocate: a native Catalan-speaker, he made himself a master of oratory in Castilian Spanish. Deputy for Palma in the *Cortes* of 1881, he attached himself to P. M. Sagasta's Liberal party. Appointed minister for the colonies in Dec. 1892, he resigned when his proposals to grant autonomy to Cuba came to nothing (1894), but resumed office as minister of justice for a few weeks early in 1895. Progressively estranged from Sagasta, he became the leader of a distinct group, which he merged with the Conservative party in 1902. From Dec. 1902 to Oct. 1903 he was minister of the interior.

Maura's first period as prime minister (Dec. 1903–Dec. 1904) was troubled by opposition to his financial and ecclesiastical policy. Appointed prime minister again in Jan. 1907, he embarked on that program of reform or "revolution from above" (*desde arriba*) or "from the government" (*desde el gobierno*) for which he had called during the Spanish-American War of 1898. He sought to transform local administration by breaking the power of the *caciques* (bosses) and introduced laws to make education compulsory, to set up industrial tribunals and to strengthen the economy. He had also worked to uphold Spanish interests in Morocco, but the conscription of troops to defend Melilla against the Riff tribesmen provoked disorders in Barcelona in July 1909; and the savage repression of these disorders, followed by military reverses in Morocco, led to Maura's fall from power (Oct. 1909). He resigned the leadership of the Conservatives in 1913, but headed three more short-lived governments in times of crisis (March–Nov. 1918; April–July 1919; Aug. 1921–March 1922). A steadfast adherent of constitutional practice, he deprecated Miguel Primo de Rivera's seizure of power by a military coup in 1923. Maura died at Torrelodones, near Madrid, on Dec. 13, 1925. *See* also Spain.

MAUREPAS, JEAN FRÉDÉRIC PHÉLYPEAUX, Comte de (1701–1781), French statesman, was born at Versailles on July 9, 1701, the eldest son of Jérôme de Pontchartrain, one of the secretaries of state. In 1715 Pontchartrain's incapacity prompted the duc de Saint-Simon to suggest that the title and emoluments of his office should be transferred to his 14-year-old son and its functions performed by his relative the marquis de La Vrillière, who was himself also a secretary of state (d. 1725). In 1718, on marrying La Vrillière's daughter, Maurepas was given nominal control of his father-in-law's department, the royal household; and in 1723 he was assigned the marine, his father's old department. As an administrator Maurepas proved himself intelligent, disinterested and active, remaining in office until 1749, when he was disgraced by Louis XV as a result of a personal quarrel with Mme de Pompadour. He was recalled from exile by Louis XVI on his accession in 1774, in the capacity of chief confidential adviser without portfolio. It was very largely Maurepas who was responsible for the restoration to the *parlements* of their former political powers, of which they had been deprived in 1771. This act, which was to compromise the prospects of effective fiscal and administrative reform during the remainder of the *ancien régime*, may be attributed to Maurepas' prejudices in favour of the judicial authority imbibed from his grandfather, who had been chancellor under Louis XIV, to his spiteful desire to destroy the chief political innovation of Louis XV's reign and to his shortsighted bid for popularity.

Able, shrewd and experienced, Maurepas was cynical in his use of political power and greatly accelerated the decline in the monarchy's fortunes by his abandonment of Turgot in 1776 and of Necker in 1781, when those reforming ministers threatened to challenge his ascendancy over the king. He died at Versailles on Nov. 21, 1781. (A. Gn.)

MAURER, GEORG LUDWIG, Ritter von (1790–1872), German legal historian and statesman, one of the 19th-century German scholars inspired by the rising tide of nationalism both to investigate his country's past and to take an active part in its politics. Maurer was born at Erpolzheim near Dürkheim on Nov. 2, 1790, but spent his youth near Heidelberg and attended the university there.

The romantic movement which inspired such scholars as Jacob Grimm and Friedrich von Savigny drove him to inquire into early German institutions. In 1824 he published his *Geschichte des altgermanischen . . . öffentlich-mündlich Gerichtsverfahrens*, a standard though superseded work. In 1826 he became professor of German civil law and legal history at Munich. His most considerable work consists of 12 monographs on German local government (*Geschichte der deutschen Gemeindeverfassung*, 1854–71). Though defective in detail it is rich in material and ideas.

Maurer's political life continued meanwhile. After holding a number of official legal posts he was appointed a member of the Bavarian *Staatsrat* in 1829. When Prince Otto of Bavaria became king of Greece in 1832, Maurer was made one of his council of regency and until his recall in 1834 he worked at the task of giving Greece a revised penal code and civil procedure. He published a book on Greece in 1835. After the fall of Karl von Abel in 1847 he was for a few months Bavarian chief minister. He died at Munich on May 9, 1872.

See K. T. von Heigel, *Denkwürdigkeiten des . . . G. L. von Maurer* (1903).

MAURETANIA, the Roman name of part of Africa north of the Atlas mountains and the Sahara, comprising parts of modern Morocco and Algeria. Its early inhabitants of Berber stock were divided into numerous tribes collectively referred to by the Romans as *Mauri*, and were mostly seminomadic pastoralists. The Mulucha (Moulouya) river was the boundary between the Mauri in a restricted sense and another tribal group to the east, the Massaesyli. From the 6th century B.C. Phoenicians and Carthaginians settled at many points on the Mediterranean and Atlantic coasts, though their civilization spread only slowly into the interior. Mauretanian history really begins with the Punic Wars. The Massaesyli became part of Masinissa's Numidian kingdom in 203 B.C. after the defeat of its ruler Syphax, an ally of Carthage against Rome. Between 108 and 105 B.C. Bocchus, who ruled west of the Mulucha, hesitated between an alliance with Jugurtha (*q.v.*) or the Romans, finally siding with the latter, to be rewarded with an extension of territory eastward. It was Roman policy to dominate such a vast, difficult and ill-defined area through loyal client kings (*see* Bocchus; Juba). The last ruler of all Mauretania was Ptolemy, who was executed by Caligula in A.D. 39 or 40 for reasons unknown. After the suppression of a subsequent revolt of the Mauri, Mauretania was provincialized; it was soon divided into two provinces, Mauretania Tingitana, with its capital at Tingis (Tangier) west of the Mulucha, and Mauretania Caesariensis, with its capital at Caesarea (Cherchel) between the Mulucha and Ampsaga (Wadi el Kebir). Both were governed by officials of equestrian rank and only auxiliary units were stationed in them. Wars and revolts are recorded on a number of occasions throughout the imperial period and though almost all were of a minor and local character, it is clear that in the extensive mountain ranges and in the desert areas, where the nomads paid little attention to frontiers, Roman rule was never fully accepted. Mauretanians were good military material and were used by the Romans in both Africa and other parts of the empire, being particularly effective as light cavalry. They had little bent for city life, and the tribal units were not broken up by the Romans, who continued to recognize the chiefs, generally supervising them by officials called *praefecti*. A few native Mauretanians achieved prominence in the empire, for example Lusius Quietus, a tribal chief who became one of Trajan's best generals. There were seven *coloniae civium Romanorum* in Tingitana and eleven in Caesariensis and a number of *municipia*, but the influence of Roman civilization was restricted to points on the coast, river valleys like that of the Chinalaph (Chéliff) and the plains round Sitifis (Sétif).

Serious revolts beginning in 297 required the presence of the emperor Maximian and parts of both provinces were permanently given up. In Diocletian's reorganization a new province, Maure-

tania Sitifensis, was formed out of the eastern part of Caesariensis. When the Vandals arrived in Africa in 429 much of Mauretania became virtually independent and Mauretanians participated as allies in Vandal campaigns against Rome and Italy. The Byzantine reconquest of Africa after 533 extended to only a small part of Mauretania where little now remained of Roman influence except Christianity, which had spread rapidly in the 4th and 5th centuries but which was extinguished when the Arabs finally overcame determined Mauretanian resistance.

See P. Romanelli, *Storia delle province Romane dell'Africa* (1959); J. Carcopino, *Le Maroc antique* (1943). (B. H. WA.)

MAURIAC, FRANÇOIS CHARLES (1885–), French novelist and winner of the Nobel prize for literature in 1952, was born in Bordeaux on Oct. 11, 1885. His family had its roots deep in this region, which was to provide the framework and essential atmosphere for most of his stories. The circumstances of his childhood—strongly marked by Catholic influences which proved lasting—are admirably described in *Commencements d'une vie* (1932). He studied at the University of Bordeaux and in 1906 entered the Paris École des Chartes for a short period. His literary career began in 1909 with a volume of poems entitled *Les Mains jointes*, which brought him to the notice of Maurice Barrès. (See *La Rencontre avec Barrès*, 1945.)

Mauriac's first novels were *L'Enfant chargé de chaînes* (1913) and *La Robe prétexte* (1914), followed by *La Chair et le sang* (1920) and *Préséances* (1921). These stories, especially the first two, showed his technique as still uncertain, but they gave indications, particularly *La Chair et le sang*, of his insight into some of those troubled human relationships which he later depicted so forcibly. They deal with themes which constantly recur in his writings: the strains of adolescence, religious and emotional conflicts, the narrow materialism of commercial and middle-class life in his own part of provincial France. *Le Baiser au lépreux* (1922), describing a tragic incompatibility between husband and wife, established Mauriac as a major novelist. He showed increasing mastery in *Génitrix* (1923), a grim story of obsessive maternal affection, *Le Désert de l'amour* (1925; *grand prix du roman* of the Académie Française) and *Thérèse Desqueyroux* (1927). The heroine of this novel, a woman driven to attempt the murder of her husband for motives she does not fully comprehend, reappears in *La Fin de la nuit* (1935) and in two of the short stories contained in *Plongées* (1938). *Le Noeud de vipères* (1932) is often considered Mauriac's masterpiece. It depicts an old man's rancorous enmity toward his family and his eventual change of heart.

In 1933 Mauriac became a member of the Académie Française. His subsequent novels included *Le Mystère Frontenac* (1933), a much less sombre story than most of his works, *Les Anges noirs* (1936), *Les Chemins de la mer* (1939) and *La Pharisienne* (1941), a scathing analysis of religious hypocrisy and the desire for domination. Some shorter stories, published after World War II, met with unequal success: *Le Sagouin* (1951); *Galigaï* (1952); *L'Agneau* (1954).

In 1938 Mauriac had begun what seemed likely to be a notable career as a dramatist with *Asmodée*, a further study of religious hypocrisy. This was followed by *Les Mal Aimés* (1945) but *Le Passage du Malin* (1947) was less successful.

Mauriac was highly sensitive to criticism and anxious to justify himself as a novelist. *Le Roman* (1928), *Le Romancier et ses personnages* (1933) and the five volumes of his *Journal* (1934–53) say much about his intentions and methods. The *Journal* is a work of outstanding interest, which also records his reactions to moral and contemporary problems and his reflections on literature and music. (*See* also *Mémoires intérieurs*, 1959.)

From about 1923 to 1930 Mauriac went through a period of religious disquiet. He was faced with two problems: as an individual he had to work out his faith anew; as an artist he had to reconcile his duty as a novelist with his obligations as a Catholic—namely how to portray the evil in human nature without putting temptation into the minds of his readers. These conflicts and the convictions that emerged are recorded in *Dieu et Mammon* (1929) and *Souffrances et bonheur du chrétien* (1931). His preoccupation with religious themes found constant expression, for instance in his *Vie de Jésus* (1936), his biographies of St. Margaret of Cortona, Racine and Pascal and the essays on literary topics contained in *Mes Grands Hommes* (1949). As a creative writer he was first and foremost an observer of mankind in the light of eternity. The doctrines of grace and redemption underlie his delineation of human passions, frustrations and weaknesses, particularly sensuality, avarice, jealousy and pride. His characters lead narrowly circumscribed lives, preoccupied with their own problems and little affected by the outside world; their relations with each other, their indwelling upon themselves and the predestined patterns of their lives are all recorded with singular intensity and concentration.

Mauriac was also prominent as a polemical writer. He intervened vigorously in the ideological conflicts of the 1930s, condemning totalitarianism in all its forms and denouncing fascist excesses in Ethiopia and Spain. In World War II, during the occupation of France, he worked with the writers of the Resistance. *Le Cahier noir*, published in the clandestine *Éditions de minuit* in 1943 under the pen name of Forez, was a declaration of faith in fundamental human values. After the war he became increasingly engaged in political discussion, first as an editorial writer for the *Figaro* and then as a contributor to *L'Express*.

In 1946, with *A Woman of the Pharisees* (*La Pharisienne*), Gerard Hopkins began a complete translation into English of Mauriac's novels.

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MAURICE (MAURITIUS), **SAINT** (d. *c.* 286), an early Christian martyr. The oldest form of his story is found in the *Passio Martyrum Acaunensium*, ascribed to Eucherius, bishop of Lyons, *c.* 450, who relates how the Theban legion (from the Thebaid in Egypt) commanded by Mauritius was sent to north Italy to reinforce the army of Maximian. Maximian wished to use them in persecuting the Christians, but as they themselves were of this faith, they refused, and for this, after having been twice decimated, the legion was exterminated at Octodurum (modern Martigny, in Valais canton, Switz.).

Critical study of the legend was stimulated by excavations carried out at St. Maurice (Celtic Agaunum, in Valais canton near Martigny) from 1944 to 1949. In 1956 appeared D. van Berchem's thorough analysis of Eucherius' *Passio*, mentioned above. Since this 5th-century bishop gives as his ultimate source the oral account of Theodore, 4th-century bishop of Octodurum (who signed the decrees of the Council of Aquileia in 381 and to whom reference again is made in 389 or 390), it is with this Theodore that Berchem is especially concerned. He believes him to have been an oriental who brought from his native east to the west the legend of St. Maurice of Apamea, a military saint, who suffered martyrdom together with the 70 soldiers under his command. Theodore may have brought relics of these martyrs with him to the west or, in an age when discovery of the relics of martyrs was not uncommon, he may have transferred the legend to the remains of several bodies which he had found and over which he dedicated a basilica. The explanation is ingenious, and though it remains pure hypothesis, all future work must begin with Berchem's keen criticism of the legend. As a specialist in the history of the Roman army, he showed that if soldiers were martyred at Octodurum they were not Thebans and certainly not a legion, for two of their officers—Mauritius, a *primicerius*, and Candidus, a *senator militum*—have the titles of cavalry officers, whereas a legion was a formation of infantrymen.

The cult of St. Maurice and the Theban legion is found in Switzerland (where two places bear the name in Valais, besides St. Moritz in Grisons), along the Rhine and in north Italy. The foundation of the abbey of St. Maurice in Valais is usually ascribed to Sigismund of Burgundy (515). Relics of the saint are preserved there and at Brieg and Turin. The feast of St. Maurice and his companions is celebrated on Sept. 22.

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(AM. S.)

MAURICE (MAURICIUS FLAVIUS TIBERIUS) (*c.* 539–602), Byzantine emperor from 582 to 602, was a Cappadocian. A soldier of distinction, as *comes excubitorum* he directed the Persian war in the last years of Tiberius II's reign (578–582). On Aug. 5, 582, the dying Tiberius made him Caesar, and on Aug. 13, 582, crowned him emperor and betrothed him to his daughter Constantia. Maurice succeeded to an empty exchequer and made himself unpopular by his policy of retrenchment. In the east the Persian war continued with varying success until a revolution in Persia enabled Maurice to restore the exiled Khosrau (Chosroes) II (591) on condition that he ceded Persarmenia and East Mesopotamia with Daras and Martyropolis.

From 592 onward campaigns in the Balkans and beyond the Danube frontier were directed against the Avars, and also the Slavs who were ravaging the Balkans and Greece and settling in these provinces. Though fully occupied in the north and east, Maurice did not abandon the west. He created the exarchates of Ravenna and Carthage in which the governor (exarch) was a military commander also having civil authority, thus foreshadowing the 7th-century system of themes. His will drawn up in 597 bequeathed Rome, Italy and the western islands to his second son, showing that he regarded the west as an integral part of the empire. Maurice's severe military discipline and his strict economy caused a revolt amongst the troops on the Danube which spread to the factions in the capital. Maurice fled to Asia Minor and the army's spokesman Phocas was proclaimed emperor (602). Shortly afterward Maurice and his sons were executed.

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MAURICE (1567–1625), prince of Orange and military leader of the United Provinces of the Netherlands in their war of independence against Spain, was born at Dillenburg on Nov. 13, 1567, the son of William I the Silent, prince of Orange, by his second wife, Anna, only daughter of Maurice of Saxony. After studies at Heidelberg he went to the Netherlands in 1577 and stayed with his father at Breda and at Antwerp. At the instance and partly at the expense of the estates of Holland he was sent to Leiden (1583) to read mathematics and classics. After the assassination of his father (July 1584) he was appointed president of the council of state of the United Provinces and in Nov. 1585 succeeded his father as stadholder of Holland and Zeeland. He was allowed by the estates of Holland in 1586 to call himself "born prince of Orange" but he did not rightly succeed to the princely title till his elder half brother Philip William, who was in Spain from 1566 to 1596, died childless in 1618.

Maurice began to play a role of importance when the earl of Leicester left the Netherlands at the end of 1587. He became also stadholder of Utrecht and Overijssel in 1590 and of Gelderland in 1591 and was moreover admiral general and captain general of the forces paid by the provinces of which he was stadholder. He reorganized the army in a scientific way, making use of Roman military principles as well as of his mathematical knowledge (he was himself a specialist in siege warfare); and he enjoined his engineers and officers to study at his old university of Leiden. His revival of the art of war made the Dutch army the most modern in Europe and attracted much attention. In the years 1590–98 he and his cousin, William Louis, stadholder of Friesland, who was his close collaborator, drove the Spanish army out of their strongholds in the northern and eastern provinces (for details *see* NETHERLANDS, THE: *History*). After 1598, however, Maurice was less successful; he was not much interested in conquering the southern Netherlands, and in this respect (as in many others) his attitude differed fundamentally from his father's. When the advocate of Holland, Johan van Oldenbarnevelt (*q.v.*) organized the attempt to carry the war southward, Maurice did not really approve of it; and his military triumph at the battle of Nieuwpoort in West Flanders, where he beat the Spaniards under the archduke Albert in the open field (July 2, 1600), remained a fruitless victory.

Tension between Maurice and Oldenbarnevelt grew up when Oldenbarnevelt, after England had made peace with Spain (1604), saw that the war had lost its purpose and began negotiations with the southern Netherlands. The 12 years' truce which was finally agreed upon in 1609 was bitterly opposed by Maurice, who was afraid that the army would be weakened and the interests of the house of Orange neglected. When the quarrel between Arminians and Gomarists within the Reformed Church seemed about to turn into civil war, Maurice, although ignorant about doctrinal questions, in 1617 took the Gomarist or extreme Calvinist side against Oldenbarnevelt, who supported the Arminians. He finally had Oldenbarnevelt arrested (1618) and executed (1619).

Maurice, who became stadholder of Groningen in 1620, made little use of his victory over Oldenbarnevelt's party. His most important decision after 1619 was his refusal to extend the 12 years' truce in 1621, but the war that he thus resumed was unsuccessful for him. He fell a victim to a liver ailment and died, a disappointed man, in The Hague on April 23, 1625. Unmarried, he had had seven illegitimate children.

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(E. H. K.)

MAURICE (1521–1553), elector of Saxony from 1547, a dynamic, versatile and cynical prince who turned the troubles of the Reformation in Germany to his own great advantage, was born on March 21, 1521, at Freiberg in ducal Saxony (Meissen), the son of the future duke Henry, of the Albertine branch of the Wettin dynasty. Henry's elder brother George, a stern Catholic who ruled the duchy from Dresden, tried to exclude Henry from the succession unless he would renounce Lutheranism; but on George's death in 1539 Henry promptly sponsored the Reformation in the Albertine lands and soon won the approval of the territorial estates. As well as these conflicting examples, Maurice grew up to know both the classical Lutheranism of Wittenberg and the universalistic outlook of the Holy Roman emperor Charles V's court; and his marriage, early in 1541, to Agnes of Hesse linked him also with the Protestant activism of her father the landgrave Philip (*q.v.*).

Maurice became duke of Saxony on Henry's death in 1541. At this time Philip of Hesse for personal reasons was coming to terms with Charles V by departing from the extreme position that he had originally taken in the Protestant princes' League of Schmalkalden; and this consideration, together with the advice of Georg von Carlowitz, a Catholic exponent of compromise who had served George and Henry alike, was one of the reasons why Maurice for the next four years pursued a noncommittal policy between the emperor and the league (*see* GERMANY: *History*). Another consideration, however, was that, apart from Philip, the dominant prince in the league was the elector of Saxony, John Frederick I (*q.v.*), head of the Ernestine Wettins, who was now beginning to interfere aggressively in ecclesiastical matters affecting Albertine spheres of influence. Accordingly Maurice assisted Charles V against the Turks in 1542, against Cleves in 1543, and against France in 1544, but supported the League of Schmalkalden against Henry II of Brunswick-Wolfenbüttel in 1545. In June 1546, however, at Regensburg, Charles V won Maurice's good will for his projected war against the league; and when Charles in October had formally agreed to transfer the Saxon electoral dignity to him, Maurice invaded John Frederick's lands. A counterattack drove Maurice from most of his own Albertine territory early in 1547,

but Charles then marched to his help. John Frederick was captured at the battle of Mühlberg (April 24) and ceded the electoral dignity and much territory to Maurice by the capitulation of Wittenberg (May).

Since Maurice was reluctant to accept the Augsburg Interim of 1548 for the temporary settlement of the religious question, the so-called Leipzig Interim, a mitigated version, was negotiated for Saxony. Maurice, however, soon began to nurse grievances against the emperor. Personally he resented the imprisonment of Philip of Hesse, who had surrendered at the end of the Schmalkaldic War only on the strength of Maurice's undertaking that he (Philip) should not be imprisoned; and generally he objected to Charles V's "Spanish" attempt to "enslave" the German princes. He therefore sought to plot a revolt. Commissioned to enforce the ban of the empire against Lutheran Magdeburg, which was still standing out against the Interim, he seized the pretext for raising an army; and after the reduction of Magdeburg (Nov. 1550), which he treated very leniently but kept under his control, some embittered Protestant princes, who had hitherto regarded him as a Judas, fell in with his plans. In Jan. 1552 the treaty of Chambord was concluded between the conspiring German princes and France.

Hostilities began in March 1552. The rebels overran southern Germany, Maurice took the Ehrenberg pass in May, the emperor fled from Innsbruck to Villach in Carinthia, and the Council of Trent dispersed itself. Though Charles V refused a definitive settlement of the religious issue before the next meeting of the *Reichstag*, Maurice through negotiation with the emperor's brother Ferdinand I obtained the armistice of Passau (Aug. 1552), which provisionally guaranteed the Lutheran position, granted the political claims of the princes and secured the liberty of Philip.

While the emperor marched against the French invaders of Lorraine, Maurice went to fight for Ferdinand against the Turks in Hungary. Returning to Germany, he took up arms against his former ally Albert Alcibiades of Brandenburg-Kulmbach, who had rejected the armistice of Passau. At Sievershausen, on July 9, 1553, Albert Alcibiades was defeated, but Maurice himself was killed.

MAURICE, (JOHN) FREDERICK DENISON (1805–1872), one of the most outstanding theologians and liberal thinkers of the Church of England in the 19th century, was born at Normanston, Suffolk, on Aug. 29, 1805, the son of a Unitarian minister. The family became sharply divided on matters of religious belief, and this early experience of disunity was one of the causes of Maurice's lifelong concern for unity and reconciliation among men. In 1823 he entered Trinity college, Cambridge, transferring later to Trinity hall, and in 1827 obtained a first class in civil law. At this time he was greatly influenced by the writings of the poet Coleridge.

After several years in London working as a writer and journalist, Maurice decided to seek ordination in the Church of England. In 1830 he went to Exeter college, Oxford, where he was baptized in 1831. He was ordained in 1834 and, after a brief curacy, became chaplain to Guy's hospital in London. In 1840 he was appointed professor of English history and literature at the recently founded King's college, London, and in 1846 he became professor of divinity there. These chairs he held until 1853, when he was deprived of them for supposedly unorthodox views on eternal punishment. He remained in London as chaplain of Lincoln's Inn and from 1860 to 1869 was incumbent of St. Peter's, Vere street. Throughout the period he exercised an important influence in the political and literary world of London, by preaching and writing and, above all, by the nobility of his character. In 1866 Maurice was appointed professor of moral philosophy at Cambridge university and from 1870 to 1872 was also incumbent of St. Edward's in Cambridge. He died in Cambridge on April 1, 1872.

Maurice was impatient of all the party "orthodoxies" of his day, which seemed to him too narrow to match the breadth and inclusiveness of the Christian revelation. In a more profound sense his own theology was deeply orthodox and biblical, but marked by a great liberality of outlook which brought him into conflict with many of the received opinions of Victorian religion, as, for example, in his controversy with both evangelicals and high churchmen about the doctrine of atonement. In his great work *The Kingdom of Christ* (1837) he sought to show the possibility of drawing out the positive elements in all the different Christian traditions and of bringing them together into one catholic whole. For him, theology was to be a source of unity, not division, and its scope was the whole of man's personal and social nature. Hence, both in his writing and in his action he frequently went beyond the narrowly ecclesiastical sphere.

Maurice was closely connected with the beginnings of Christian socialism (*q.v.*) and with the foundation of Queen's college, London, for the education of women (1848). He planned and became the first principal of the Working Men's college in London (1854).

Maurice was a voluminous writer, but his style lacks clarity and conciseness and in his own day he had the reputation of being a cloudy thinker. Besides *The Kingdom of Christ* his most notable works are *Moral and Metaphysical Philosophy* (1848), *Theological Essays* (1853) and *The Doctrine of Sacrifice* (1854). Later study of his work has revealed a writer of genuinely prophetic insight and remarkable creative power.

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MAURIENNE, a high Alpine valley, about 80 mi. long, in southeastern France, drained by the Arc river, tributary of the Isère. Lying behind the central crystalline mountains of the Savoie Alps, it was for long extremely isolated, but modern communications approaching the Col du Mont Cenis (*q.v.*) crossing from France to Italy have opened it to the outside world. Since 1869 it has been followed by the railway as far as Modane (3,200 ft.), whence the line turns south toward the tunnel. The road continues higher up the valley to Lanslebourg (4,330 ft.) at the foot of the Mont Cenis pass and a valley road continues past Bonneval, as part of the Route des Alpes, to the Col de l'Iseran, which leads into the head of the Isère valley. Lower down the Maurienne, the Route des Alpes leaves the valley line at St. Michel to climb south toward the Col du Galibier via Valloire.

The Arc river crosses transversely the grain of varied, narrow outcrops of heavily folded and overthrust rocks that constitute the internal zone of the Alpine system; the Maurienne is a succession of narrow, wild gorges cut through rock bars, and more open basins. In such a basin, at 1,896 ft., lies the chief market centre, St. Jean de Maurienne, with a medieval cathedral. Sheltered by the surrounding wet, snowy mountains, the Maurienne is itself relatively dry with sunny summers, but winters are severe with a long period of snow cover. Altitude limits of vegetation, crops and settlement are remarkably high. The vine has been grown up to 3,500 ft. and hardy crops to 7,000 ft. The highest hamlet, Averole, lies near that height. There are rich forests on the high mountain slopes and fine Alpine pastures toward the snow line. The shady north-facing slopes are often deserted and clothed with continuous forest, but the notches of side valleys provide shoulders for chalets at a variety of altitudes, and a pastoral economy prevails, with cultivation of fodder crops on gently sloping land at lower levels and seasonal grazing of the alps. The elaborate up-and-down seasonal movements of cattle and herdsmen are much less practised than formerly, and more specialized dairying has become general. There are a few workings of anthracite, but the chief industrial resource is water power. The torrents that gash the valley sides have been harnessed in many places to drive turbines and, although most of the hydroelectric power is exported, some electrometallurgical and electrochemical industries have been established along the route, for example at Modane and Pontamafrey. (AR. E. S.)

MAURISTS (CONGREGATION OF ST. MAUR), a congregation of French Benedictine monks (*see* BENEDICTINES), founded in 1618, whose patron, St. Maurus, according to legend introduced the Benedictine rule to France. The name is commonly restricted to those devoted to learned work. Their peculiar characteristics were due to Dom Gregory Tarrisse (1575–1648), the first president, who desired to make literary work a distinguishing feature; he organized schools of training and set up their headquarters,

which soon became a rendezvous for all the scholars of the *grand siècle*, at St. Germain-des-Prés (Paris). As the monks professed for the congregation, not the individual house, promising students could be selected and work apportioned by the superiors. Tarrisse found in Luc d'Achery (1609–85) an excellent organizer of his designs. D'Achery built up a great library and outlined a program, which he himself began to execute. He also recognized the genius of Jean Mabillon (*q.v.*), the greatest of the Maurists. The golden age lay between the arrival of Mabillon (1664) and the death (1741) of Bernard de Montfaucon (*q.v.*). Mabillon, prince of monastic historians, the creator of the modern discipline of paleography and diplomatic with his magisterial *De re diplomatica* (1681), who was in himself a man of admirable integrity and exemplary piety, is also remembered for his edition of St. Bernard, his publication of the *Lives* of Benedictine saints and his *Annals* of monastic history from Benedict to Bernard. Montfaucon, a genial, indefatigable worker of a less spiritual mold, who did for Greek paleography what Mabillon had done for Latin, produced editions of Athanasius and Chrysostom and in his last years two works which had an immense vogue and remained as models: an encyclopaedic history of the ancient world and an illustrated "social" history of medieval France. Meanwhile Mabillon and his disciples Thierry Ruinart (d. 1709) and Edmond Martène (d. 1739) had done pioneer work on ancient liturgy and ritual and had commented upon the rule of St. Benedict; other companions had produced a complete edition of St. Augustine. In the 18th century great projects of every kind were begun: a history of the crusades; a literary history of France, the *Gallia Christiana;* a basic work of chronology, *L'Art de vérifier les dates*—to say nothing of numberless regional and civic histories.

The Maurists as a group were, and have remained, without a parallel in the annals of scholarship both for the bulk of work achieved and the uniform level of excellence attained. Both as editors and historians they excelled, and many of their texts remain the best available; they were pioneers in critical medieval history and their work has attached the adjective "learned" to the Benedictines. The congregation was suppressed during the French Revolution in 1789.

See J. Baudot, in A. Vacant (ed.), *Dictionnaire de théologie catholique*, vol. x (1928); M. D. Knowles, "The Maurists," *Transactions of the Royal Historical Society*, 5th series, vol. 9 (1959). (M. D. K.)

MAURITANIA, ISLAMIC REPUBLIC OF (RÉPUBLIQUE ISLAMIQUE DE MAURITANIE), an independent republic on the west coast of Africa, is bounded by the Atlantic ocean and Spanish Sahara on the west, Algeria on the northeast, Mali on the east and south and Senegal on the south. A former territory of French West Africa, it gained its full independence in 1960. Area 419,229 sq.mi. Pop. (1961 est.) 792,019. The capital is Nouakchott (*q.v.*).

Physical Features.—Mauritania represents the westérn part of the Sahara, which is desert, but desert mitigated by the proximity of the cool ocean waters. The crystalline bed is partially concealed by dunes, some formed by the trade winds and shifting, others, in the Trarza and Brakna region toward Senegal, more or less stable. This base disappears beneath plateaus of primary sandstone near Spanish Sahara and particularly in the southeast. The steep edges of these plateaus form the principal relief. Harmattan winds persist in the interior, and even the trade winds, felt along the coast, bring little rain. The moistest part of the country is the extreme southeast. Sélibaby averages about 26 in. of rainfall annually. Temperatures and humidity vary widely, both seasonally and daily. The coast is broken by promontories oriented in a southwesterly direction (*e.g.*, Cape Blanc, which forms the bay of Port Étienne) and is sandy in the south. Port Étienne, however, is the only port. (J. D.)

People.—The valley of the Senegal river in the south, which forms the boundary between Mauritania and Senegal, is inhabited by Negro agricultural tribes, such as the Tukulor (Toucouleur) and the Sarakole (or Soninke), with Fulani (Peul) cattle breeders. The rest of the country is peopled by Moors, pastoral nomads of Berber and Arab stock, who are mainly fair-skinned though mixed with Negro blood in the more depressed classes (freed slaves, servants, and Haratin or cultivators). They are Muslims and mostly Arabic-speaking. The southern tribes (of the Trarza, Brakna and Kunta regions) practise short-distance nomadism, to the river and back, with cattle, sheep and goats. The northern tribes (Regeibat) raise mainly camels and practise long-distance nomadism. The inhabitants of the oases are Negroes.

History.—Numerous discoveries of Acheulian and Neolithic remains have been made in the north.

Mauritania was first peopled by Negroes and by the Sanhadja Berbers. It was the cradle of the Berber Almoravid movement, which in the 11th century laid waste the Ghana empire before conquering Morocco (*see* ALMORAVIDS). The Almoravids imposed Islam upon all the neighbouring peoples. A caravan route at that time linked Mauritania with Morocco. Arab tribes infiltrated by this route, and in the 15th century submerged the Berbers. The nomadic tribes formed several powerful confederations: Trarza and Brakna, who dominated the Senegal river; Kunta in the east; and Regeibat in the north.

In 1442 Portuguese vessels rounded Cape Blanc, and in 1448 the Portuguese founded the fort of Arguin, from whence they derived gold, gum arabic and slaves. Later the French and English frequented Portendick, and then the French settled at St. Louis at the mouth of the Senegal river. In 1858 Col. L. L. C. Faidherbe ended Moorish domination over lower Senegal. After 1898 an Islamic specialist, Xavier Coppolani, succeeded, without a struggle, in rallying all the Moors of the south to France. He was assassinated in 1905 and his work completed by Col. H. J. É. Gouraud, who occupied Tagant in 1907 and Adrar in 1909. The Regeibat were not finally pacified until after World War I.

Mauritania was constituted a territory of French West Africa in 1920 and later became a colony; it was at first governed from St. Louis in Senegal. In 1946 Mauritania became an overseas territory and in 1957, after repulsing an attack by Moroccan irregulars on the north, elected a government under Mokhtar ould Daddah, who established the new capital at Nouakchott. In 1958 Mauritania voted to become a member state of the French Community, and on Nov. 28, 1960, its full independence was declared. It became a member of the United Nations in Oct. 1961.

By far the largest political party is the Mauritanian Regroupment party (P.R.M.), formed in 1958 by an amalgamation of the two largest parties. Certain elements, especially in the north, support the persistent claim of Morocco to sovereignty over Mauritania. Relations with Morocco have constituted the country's most serious problem in foreign relations. Moroccan raids were repulsed in 1956 and 1957, and in 1961 Moroccan claims were reasserted by King Hassan II. (HU. DE.)

Population, Administration and Social Conditions, and Economy.—Mauritania is administered by a council of ministers nominated by the premier. The legislative body (*assemblée nationale*) consists of members elected for five-year terms by universal suffrage; it elects the premier. The over-all policy of the country, however, is decided and conducted by the president, who is the head of state.

The country is divided into 11 *cercles:* Baie du Lévrier (chief town Port Étienne), Inchiri (Akjoujt), Trarza (Rosso), Brakna (Aleg), Gorgol (Kaédi), Guidimaka (Sélibaby), Assaba (Kiffa), Tagant (Tidjikdja), Hodh west (Aioun el Atrouss), Hodh east (Néma) and Adrar (Atar). The largest town is Kaédi (pop. [1962 est.] 9,123); the second, Atar (pop. [1962 est.] 7,220).

Though Islam is the state religion, the constitution guarantees religious freedom. Mauritania, especially the ancient city of Chinguetti, was for centuries a centre of Islamic culture and learning, famous throughout the Muslim world.

Educational development has been slow mainly because of limited public funds and the problem of nomad children. By the early 1960s, however, there were more than 150 primary schools, 50 secondary schools and about 90 schools for nomad children.

Cattle—Zebu (Brahman) of the Maure type—have long been the greatest resource of the people of Mauritania. Sheep and goats are raised along the coast, and camels are the beasts of burden all over the country. Agriculture is of minor importance. The trade in gum arabic, traditionally of great importance as an export

product, declined in the 20th century. A few of the Moors are fishermen, but Port Étienne has become a fishing centre for men from the Canary Islands and a crayfish-catching centre for Bretons. Canning factories have been built, and fish and preserved food represent half the total exports in weight and value.

Mauritania is also rich in mineral resources: iron from the region of Fort Gouraud, where the deposits are conservatively estimated at 100,000,000 tons of high-grade ore, and from Gleitat el Kader; and copper from Akjoujit. Two companies, of which the one concerned with iron is an international consortium, have supplied equipment to mine the deposits. The iron will be taken by a projected railway to Port Étienne. In this way the country is becoming provided with lines of communication, supplementing the trans-Sahara road from Rosso, in southwest Mauritania, to Morocco, by way of Nouakchott, Akjoujit, Atar, Fort Gouraud and Fort Trinquet. The country has no class A airports but several of class B. The government-controlled Radio Mauritanie in Nouakchott broadcasts in French and Arabic. Mauritania became a member of the West African Monetary union (established May 1962) and thus remained in the franc area.

See also FRENCH WEST AFRICA; SAHARA; SENEGAL, REPUBLIC OF; WEST AFRICA. (J. D.)

See Molchtar ould Hamidoun, *Précis sur la Mauritanie* (1952); Pierre Munier, *L'Assaba* (1952). Current history and statistics are summarized annually in *Britannica Book of the Year.*

MAURITIUS, an island and British crown colony in the Indian ocean, lies about 500 mi. E. of Madagascar, between longitude 57° 17′ and 57° 46′ E., and latitude 19° 58′ and 20° 32′ S. The island is pear shaped, about 38 mi. long and 29 mi. broad, with an area of 720 sq.mi. Administered as dependencies of Mauritius are a number of small island groups scattered throughout the Indian ocean more than 1,000 mi. to the northeast. These are Rodrigues (*q.v.*), the Chagos archipelago (of which the principal island, covering 11 sq.mi., is Diego Garcia), Agalega (27 sq.mi.) and Cargados Carajos shoals. The dependencies cover 87½ sq.mi.

Physical Geography.—Mauritius is wholly volcanic, built up during three periods of volcanism. In the Cretaceous or Early Tertiary a vast volcanic dome was formed, but the centre of this either foundered or was blown out in a paroxysmal eruption, so that only a series of jagged, toothlike stumps survive around the edges to form the grotesque bordering mountains of the island. In the Late Tertiary there was a second outpouring of lava, followed by a third in the Pleistocene, in which flow after flow of basalt poured out from a series of low craters aligned across the centre of the island from north-northeast to south-southwest. These later lavas formed a vast, gently sloping dome from which protrude the stumps of the older series.

The highest summit, the Piton de la Rivière Noire, in a block of high country in the southwest of the island, reaches only 2,711 ft., but in other parts of the mountain ring there are peaks almost as high. In the jagged chain behind Port Louis are the Pieter Both (2,690 ft.) and Le Pouce (2,661 ft.). The abruptness of the Mauritian mountains, rising above the smooth slopes of the newer lavas, makes them more impressive than their small elevations would suggest.

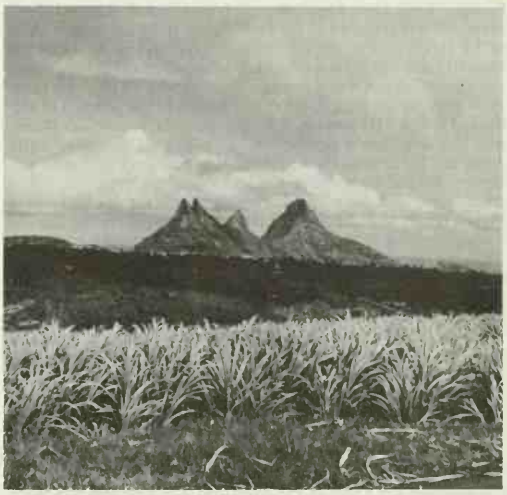
The surface of the newer lavas is very slightly trenched by erosion; only the Grand River South East, which with a length of 10 mi. is the principal stream, has cut down to form a sizable gorge. Some of the volcanic craters still contain lakes, and the small streams falling over the western escarpment, on the older lavas, have impressive falls. There are some underground streams in lava tunnels. The whole coastline is girt by a coral reef, and there is also raised coral at several points on the coast, up to 40 ft. above sea level. These formations are ascribed to high sea levels in the Pleistocene and are taken to indicate that volcanism ceased about 100,000 years ago.

Climate.—Mauritius is swept by the southeast trade winds from April to October, and during these months the climate is mild, even chilly on the high ground. From November to March the weather is oppressively hot and humid except at high altitudes, and during this part of the year the island is sometimes visited by cyclones. Rainfall is heaviest on the southeast-facing slope, rising steadily from about 60 in. annually on the coast to more than 200 in. on the high ground. The west coast is relatively dry, with less than 40 in. in Port Louis. Rain is heaviest in summer but there is no dry season except on the northwestern and western lowlands.

Vegetation.—The vegetation of Mauritius consists predominantly of species introduced since the colonization of the island. Prior to the 17th century the vegetation seems to have been characterized by a wide extent of dense rain forest containing many valuable hardwood timbers; these were extensively exploited in the first two centuries of settlement. Heath and a mossy forest mantled the highest parts, and on the drier lowlands the vegetation was probably a palm savanna. By the middle of the 20th century little was left of these associated groups: about two-fifths of the surface is covered by sugar cane and the rest is occupied largely by heath on the uplands, *Ravenala* thicket (chiefly the traveler's tree) or pine plantations in the other superhumid areas, and grassland with acacias or aloes (*Furcraea*) in the subhumid areas. The ebony forests and the palm savanna are extinct, but endemic species of screwpine (*Pandanus*) are still numerous, and their leaves are used for a variety of purposes, such as making bags.

The Royal Botanical gardens at Pamplemousses, in the north of the island, were established in 1770 to facilitate the introduction of a wide variety of tropical crops, mainly from Asia. They played an important part in the history not only of Mauritius but also of other lands, notably by providing Zanzibar with cloves in the early 19th century.

Animal Life.—Mauritius has always been an oceanic island, never linked to any land mass. The indigenous fauna was therefore limited and also highly endemic. Two species of bats were the only mammals, and reptiles were limited to two kinds of snakes, confined to an off-lying islet. Birds were more numerous and were distinguished by a large, flightless species, of which the most famous is the dodo (*Raphus cucullatus*). Man and the introduced wild pig had hunted down the last dodo by 1681, and ten other endemic forms are extinct. Rats, like the pigs, were introduced early, and sambur deer were brought by the Dutch. Mongooses were introduced in the 19th century to combat rats, but themselves became a pest. Other mammals include a small hare, a shrew-mouse and the tenrec from Madagascar. The most significant insect introductions were the common fly and several mosquito species, including the African mosquitoes *Anopheles funestus* and *Anopheles gambiae*. *Anopheles funestus,* which spread malaria



MILES FROM BLACK STAR

JAGGED VOLCANIC MOUNTAINS ON THE PLAINS OF MAURITIUS. SUGAR CANE IS GROWING IN THE FOREGROUND

after its introduction about 1865, was finally eradicated by spraying in the 1950s. (Ha. C. Bd.)

The People.—The people of Mauritius are all immigrants or descendants of immigrants. About two-thirds are of Indian origin deriving from either northern or southern India, the majority having come from areas around Bihar; about one-quarter are Creoles of mixed African and European, or Indian and European, descent; about 3% are Chinese born in or deriving from southern China; and 2% are Europeans, mostly of French descent. Creole, a French patois, is the lingua franca of the island, although five Indian languages, two Chinese dialects, French and English are also spoken. The Indians practise several forms of Hinduism. Ceremonies such as firewalking and the sacrifice of animals are performed. Caste has largely disappeared except in marriage, where caste endogamy still is practised. About one-quarter of the Indians are orthodox Sunni Muslims. The Creoles and Europeans are overwhelmingly Roman Catholic. Very few traces of African culture remain among Creoles. About half the Chinese are Roman Catholic, the rest practise traditional forms of Chinese religion. (Bu. B.)

Population.—The population of Mauritius in 1962 numbered 681,619 (not including about 20,000 inhabitants of the dependencies). It was increasing rapidly at that time, following the virtual elimination of malaria in the late 1940s, and by 1959 the inhabitants numbered more than 600,000. The rate of increase, about 3.7% a year, was causing alarm in view of the size of the island. Population density was more than 900 to the square mile (one of the highest in the world), and in some rural areas of the northeastern plain densities had risen to more than 1,500 to the square mile. The chief towns (pop. 1962) are Port Louis (89,096), Curepipe (35,275), Beau Bassin-Rose Hill (37,797) and Quatre Bornes (28,388). (Ha. C. Bd.)

History.—Mauritius was probably visited by both Arab sailors and Malays during the middle ages, and on maps of about 1500 it is shown with an Arabic name. The first European to discover it is believed to have been Domingo Fernandez, and on many 16th-century maps the island appears with the Portuguese name of Cerné. The Portuguese made no settlement on the island, and in 1598 the Dutch took possession and called it "Mauritius" after their stadholder, Maurice of Nassau. The Dutch settlers never numbered more than a few hundred, and the island was abandoned in 1710. The Dutch exploited the island's ebony forests and introduced sugar cane, cotton, domestic animals and deer.

The French claimed the island in 1715 and called it the Île de France. Until 1767, when the French government assumed direct control, it was governed by the French East India company. Mahé de La Bourdonnais (*see* La Bourdonnais, Bertrand François Mahé, Comte de) did more than any other governor to change what was a small outpost into a prosperous and strong colony. He made sugar planting the main industry and promoted the planting of cotton and indigo. He also put down the maroons, or runaway slaves, who had long been a problem on the island. The regime introduced in 1767 divided the administration between a governor, primarily charged with military matters, and an intendant. The colony continued to rise in value during the time it was held by the French crown, and to one of the intendants, Pierre Poivre, was due the introduction of the clove, nutmeg and other spices.

During the long war between France and England, at the beginning of the 19th century, Mauritius was a continual source of harm to English Indiamen and other merchant vessels; and at length the British government determined upon an expedition for its capture. This was effected in 1810, and upon the restoration of peace in 1814 the possession of the island was confirmed to Britain by the treaty of Paris. By the eighth article of capitulation the inhabitants retain their own laws, customs and religion; and thus the island is still partly French in language, habits and predilections; but its name was changed to that given by the Dutch.

A council of government was first constituted in 1825, consisting of the governor and four officials, but a year later the constitution was amended and a council including unofficial members was introduced. At the emancipation of the slaves (1833), Indian labourers were brought in to work in the fields, and the planters received £2,000,000 compensation for the loss of their slave labour. In spite of many calamities the island continued to prosper as an important sugar-producing country. Cholera caused the death of 17,000 persons in 1854, and 30,000 died of malaria in 1866–67. In 1892 a cyclone of terrific violence caused 1,200 deaths and immense destruction of property. In 1893 a great part of Port Louis was destroyed by fire. The epidemic of surra in 1902 killed all the draft oxen and necessitated the introduction of mechanical transport. In 1911 the *Phytalus smithi* beetle was found to be attacking the sugar cane.

Prosperity resulting from the high price of sugar in World War I made possible many improvement plans, but the price fell once more, and at the end of 1930 the condition of the sugar industry was extremely serious. A cyclone in 1931 and a severe drought in 1934 accentuated the difficulties of the planters, but with substantial sugar crops the position subsequently improved. Because imports were restricted during World War II, tens of thousands of acres formerly under sugar cane were planted with maize (corn), manioc and sweet potatoes, and for a time Mauritius became entirely independent of imports of rice, the staple food of the people. In 1945 an intense cyclone wreaked enormous damage. After the war the island's prosperity increased, and in 1957 a five-year development program was inaugurated, with the purpose of raising agricultural and industrial productivity, extending the scope of the social services and overcoming the employment problems created by the rapid increase of population. Early in 1960 Mauritius was struck by severe cyclones causing many casualties and destroying a large part of the sugar crop, but the economic consequences were mitigated by grants and loans from the British government.

In 1947 the colony was granted a broader political franchise, the number of registered electors rising from 12,000 to 71,723, and a ministerial form of government was introduced in 1957. In 1961, following a constitutional conference in London, the leader of the majority Mauritius Labour party became chief minister. The British government acknowledged that progress toward internal self-government was inevitable, but stated that its extent and timing must take account of the need to safeguard the individual liberties and community interests of a very mixed population. (W. H. Is.; X.)

Administration and Social Conditions.—Mauritius made rapid constitutional progress after World War II, and by the early 1960s the colony had achieved a considerable measure of self-government. A majority of the legislative council is elected by universal adult franchise. In practice there is also a majority of elected members on the executive council, which provides a ministerial form of government. The governor retains only limited powers, principally the right to nominate members to represent minority interests on both councils. The chief minister and most of the other ministers belong to the majority party, the multiracial Labour party, but the chief secretary, attorney general and financial secretary are officials.

Port Louis (*q.v.*), the capital, is administered by a municipal corporation; the first mayor was appointed in 1854. The other principal towns have town councils. The island is divided into nine districts, which have endured since the 18th century, although their boundaries were finally defined only in 1871. Except as registration and judicial areas, they no longer have any administrative function.

Living Conditions.—Most Mauritians are poor, and about 250,000 are directly dependent on the sugar industry. Some of these still live on estate camps, but most live in villages built of Indian-type mud-and-thatch houses. In the urban areas, especially in Port Louis, overcrowding is intense, and there is an average of three persons to a room over the whole island. Parts of Port Louis have about 1,000 persons to the acre. The normal wage for a sugar labourer is between R. 20 and R. 30 (30*s.* and 40*s*; $4.20 and $5.60) a week. Many of the artisans, who are largely Creole, are paid less. In the early 1960s there was comparatively little unemployment, but there was considerable underemployment, and the rapid increase in population was not being balanced by an increase in employment opportunities.

Welfare Services.—A social welfare department, created after

World War II, established village welfare centres in all parts of the island, and these provide some basic medical services. Besides several general hospitals there are a number of sugar-estate hospitals. Health is generally poor: with the elimination of malaria the main causes of sickness are enteric diseases and hookworm, which affects at least nine-tenths of the population. Nutrition is widely inadequate. However, great improvements were made after the war, especially in infant mortality. The death rate fell from 36 to 9.9 per 1,000 between 1945 and 1961. Piped water has been extended to all parts of the island. There is a noncontributory old-age pension scheme.

Justice.—Mauritius has largely retained the old French laws, as stipulated in the terms of surrender in 1810, except insofar as these have been modified by colonial ordinances. A supreme court of civil and criminal justice was established in 1831; it is also a court of admiralty, and it decides appeals from the supreme court of the Seychelles. A court of criminal appeal was set up in 1955 to hear appeals from the supreme court.

Education.—In the early 1960s about 550 primary schools, of which one-fifth were government institutions, were attended by about three-quarters of the children of primary-school age, education not being compulsory. There were about 70 secondary schools, but almost all of these were private institutions, often of doubtful standing. An agricultural college is the only post-secondary institution, although some higher as well as secondary education is provided at the Royal college at Curepipe, the principal boys' institution. However, Mauritians receiving training at universities overseas, mainly in the United Kingdom, number several hundreds.

Defense.—The Royal Pioneer corps (Mauritius) is recruited locally, and a small Mauritius Naval Volunteer force was created in 1949. In 1960 the British garrison was withdrawn from the island after an occupation that had lasted 150 years.

The Economy.—Mauritius is almost entirely dependent on the cultivation of sugar cane, the crop occupying two-fifths of the whole island and more than four-fifths of the arable land. There is no crop rotation, and milk, coconut oil and vegetables are almost the only foodstuffs produced locally. Fishing is practised, and the entire annual catch of about 2,000 tons is consumed locally. A beginning has been made in the farming of fresh-water fish.

The sugar industry comprises about 30 large estates, of which most have factories, together with about 13,000 small planters, who cultivate areas ranging from more than 100 ac. to as little as a single row of canes, and about 3,000 *métayers,* frequently part-time estate labourers who cultivate some of the land of the larger estates on a sharecropping basis. There are great variations in yield, the large estates being much the most efficient producers. Cane is grown in all parts of the island except the mountains, the superhumid uplands and some subhumid areas in the west, although the development of new cane varieties led to considerable extension of the area after World War II. Production exceeds 500,000 tons of sugar in good years. This is larger than the quotas in the world and Commonwealth sugar agreements, but underproduction elsewhere makes it possible to market the surplus. Almost the whole output goes to the United Kingdom.

The only other important primary industry is the production of tea on a small area of the superhumid central uplands. By 1960 the tea acreage had been increased to about 4,000 ac. It is estimated that from 15,000 to 30,000 ac. are suitable for the crop. By the early 1960s production exceeded local consumption, although the home market remained more remunerative than export. A small aloe-fibre industry, concentrated in the subhumid west, is in decline, and tobacco of a relatively low grade is produced for the local market. Market gardening and the rearing of mainly stall-fed cattle complete the list of primary industries. Copra is exported from the dependencies.

The sugar and tea factories, together with a government sack factory, a cigarette factory and a match factory, are the only significant secondary industries. Power for the sugar mills is supplied by burning the crushed residue of sugar cane, and for other industries by electricity generated from hydroelectric plants in the southwest and a diesel plant in Port Louis.

Trade and Finance.—Both imports and exports approached Rs. 300,000,000 annually in the early 1960s. Almost the whole value of exports is accounted for by sugar, molasses and rum. Most foodstuffs and manufactures are imported: rice, the staple food, comes from Burma under a long-term agreement signed in 1954.

Banking facilities are provided by the Mauritius Commercial bank, the Mercantile Bank of India and Barclays' bank (Dominion, Colonial and Overseas). The Mauritius Agricultural bank was founded in 1936, the capital being provided by the government. The local currency is the Mauritius rupee, equivalent to 1*s.* 6*d.* sterling, divided into 100 cents. A new note issue was established in 1954. Revenue is almost wholly locally derived; income tax was introduced in 1950.

Communications.—Mauritius has about 800 mi. of public roads, of which more than half are bitumen. Bus routes serve every town and village in the island. The standard-gauge railway system, covering less than 100 mi., catered only to freight traffic in the early 1960s and was eventually scrapped. Port Louis is the only seaport, handling more than 1,000,000 tons of shipping a year; most of the merchandise is handled by lighters. Regular cargo services are maintained with the United Kingdom, France, the Republic of South Africa and Japan, and regular passenger services with South Africa, but passenger services direct to the United Kingdom are infrequent. The airport at Plaisance is an important stop on the South Africa–Australia routes of certain airlines, and there is a weekly service to London and a twice-weekly service to France via Madagascar. The government runs the Mauritius Broadcasting service.

See also references under "Mauritius" in the Index.

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MAUROIS, ANDRÉ, the name, originally a pseudonym, adopted by ÉMILE HERZOG (1885–), French man of letters, novelist, essayist and (pre-eminently) biographer, who was born at Elbeuf, Normandy, on July 26, 1885, the son of a textile manufacturer originally of Alsace. He was educated at Rouen, where he came under the formative influence of the philosopher Alain (*q.v.*), of whom in later life he published a biography (*Alain,* 1949). A liaison officer with the British army in World War I, it was as an affectionate interpreter of the English to the French—and to themselves—in *Les Silences du Colonel Bramble* (1918) and *Les Discours du Docteur O'Grady* (1922) that Maurois won his first popularity. This was consolidated by a series of short, romanticized biographies of English figures: Shelley, Disraeli, Byron, Cecil Rhodes, Edward VII and others. After World War II, which he spent in the United States and with the Allied forces in north Africa, appeared his most solid biographical studies: the lives of George Sand (*Lélia,* 1952), Hugo (*Olympio,* 1954) and *Les Trois Dumas* (1957). His extensive production includes popular histories of England, the United States and France, and critical studies of which the most important is his profound *À la recherche de Marcel Proust* (1949). In 1938 he was elected to the Académie Française and was made a knight of the British empire.

See M. Droit, *André Maurois* (1953). (H. G. WH.)

MAUROPUS, JOHN (fl. 11th century A.D.), archbishop of Euchaita in Asia Minor, Byzantine scholar and ecclesiastic, left a number of works, mainly sermons, poems in classical metre, letters, a saint's life, and a large collection of canons or church hymns (many unpublished). The chronology of Mauropus' life is uncertain. It is however clear that he was a private tutor in Constantinople in the first quarter of the 11th century, and then came to court in Constantine IX's reign (1042–55) at the instance of his friend and pupil Michael Psellus (*q.v.*), and lectured in the re-

organized university. At some time he became a monk and archbishop of Euchaita.

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MAURRAS, CHARLES (1868–1952), French writer and political theorist, one of the major intellectual influences in Europe during the first half of the 20th century, was born at Martigues, Provence, on April 20, 1868, of a royalist and Catholic family. During his studies in the Collège de Sacré-Coeur at Aix-en-Provence an illness, in 1881, made him permanently stone-deaf, and he took refuge in books. Having lost the faith of his parents, he built up for himself a lucid conception of the world, aided by the great poets, from Homer to Mistral, as well as the Greek and Roman philosophers. In 1891, soon after his arrival in Paris, he founded, with Jean Moréas, a group of young poets in opposition to the Symbolists later known as the *école romane*. During the same years, he elaborated a complete system of political philosophy, based on the notions of Greek harmony, Roman order and modern positivism. After the Dreyfus affair, in June 1899, he was one of the founders of *L'Action française*, a review devoted to "integral nationalism," which was to become, in 1908, with help of Léon Daudet, a daily paper, the organ of the royalist party. It exercised a considerable influence, because of its incessant propaganda as well as the credit Maurras had acquired as the author of *Le Chemin de paradis* (1895), *Anthinéa* (1901) and *Les Amants de Venise* (1902), and of *L'Enquête sur la monarchie* (1900) and *L'Avenir de l'intelligence* (1905). After World War I, he was still admired in literary quarters as the poet of *La Musique intérieure* (1925), the critic of *Barbarie et poésie* (1925) and the memorialist of *Au signe de Flore* (1931). But he lost some of his political influence when on Dec. 29, 1926, the Holy See placed some of his books and *L'Action française* on the Index, thus depriving him of many sympathizers among the French clergy.

Maurras was received into the Académie Française in 1939. When World War II broke out he had long been a friend of the Italian fascists who, in fact, owed much to his doctrines. During the German occupation he became a strong supporter of the Pétain government. Arrested in Sept. 1944, he was, in Jan. 1945, sentenced to life imprisonment and excluded from the Académie. In 1952 he was released on grounds of health from the prison at Clairvaux and entered the St. Symphorien clinic in Tours. Reconciled with the Church, he produced the poems of *La Balance intérieure* (1952) and a book on *Le Bienheureux Pie X, sauveur de la France* (1953) before he died in St. Symphorien on Nov. 16, 1952.

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MAURY, JEAN SIFFREIN (1746–1817), French cardinal who, as the abbé Maury, was an outspoken opponent of the Revolution but later transferred his allegiance to Napoleon, was born at Valréas in the Comtat-Venaissin on June 26, 1746, the son of a cobbler. Educated at the seminary in Avignon, he took holy orders and began to make his reputation, from 1771, with *éloges* or panegyrics of saints and churchmen. He thus won appointments to preach before Louis XVI of France, who remarked on one of his sermons: "If the abbé had only said a few words on religion, he would have touched on every possible subject." Maury's essay on pulpit eloquence ("Essai sur l'éloquence de la chaire," first published with other discourses in 1777) remains a classic; and his efforts were rewarded with the priory of Lihons-en-Santerre in 1781 and with election to the Académie Française in 1785.

Deputy for the clergy of the *bailliage* of Péronne in the estates-general of 1789, Maury presented a list of grievances demanding considerable reforms; but when the Revolution took shape he emerged as a defender of the *ancien régime*. When many of his friends took refuge abroad, he remained in the Constituent Assembly to resist the alienation of church property and the subordination of the royal power to the idea of popular sovereignty. His witty sayings did much to deflect violent hostility from his person, but he was satirized in scathing pamphlets. After the dissolution of the Constituent Assembly he emigrated.

Called to Rome by Pope Pius VI, Maury was made titular bishop of Nicaea in May 1792 and then was sent as nuncio to the diet of the Holy Roman empire at Frankfurt (June–July). He was created cardinal in Feb. 1794 and made bishop of Montefiascone, but had to seek refuge in Venice with other cardinals after the French occupation of Rome (1798). On his return to Rome in 1800, he was ambassador to the Holy See for the titular Louis XVIII.

When Napoleon had been proclaimed emperor, Maury wrote to congratulate him (Aug. 1804) and at last returned to France (May 1806). In Oct. 1810, however, Napoleon, whom Pius VII had excommunicated in 1809, nominated Maury to the archbishopric of Paris, which Joseph Fesch (*q.v.*) would not accept. Maury undertook the administration of the diocese of Paris and ignored the captive pope's brief (Nov. 5) ordering him to give it up. On the first Restoration (1814) he left France for Rome and was suspended from his episcopal functions in Montefiascone. Arrested in May 1815 (during the Hundred Days), he was imprisoned for more than three months in the Castel Sant' Angelo. He then resigned Montefiascone and made his peace with the pope. Maury died in Rome on May 11, 1817. A selection of his writings, in five volumes, appeared in 1827 and an edition by A. Ricard of his diplomatic correspondence, with some unpublished writings, in two volumes, in 1891.

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MAURY, MATTHEW FONTAINE (1806–1873), U.S. naval officer and hydrographer whose oceanographical research received wide recognition, was born in Spotsylvania county, Va. In 1825 he entered the navy as midshipman, circumnavigating the globe in the "Vincennes" during a cruise of four years (1826–30). In 1839 an accident resulted in permanent lameness and unfitted him for active service, and in 1841 he was placed in charge of the depot of charts and instruments, out of which grew the U.S. naval observatory and the hydrographic office. He laboured to obtain observations as to the winds and currents by distributing to captains of vessels specially prepared logbooks. One result was to show the necessity for combined action on the part of maritime nations in regard to ocean meteorology. This led to an international conference at Brussels in 1853, which produced great benefit to navigation as well as indirect benefit to meteorology.

In 1855 he was given the rank of commander. On the outbreak of the Civil War in 1861, Maury threw in his lot with the South, and became head of coast, harbour and river defenses. He invented an electric torpedo for harbour defense, and in 1862 was ordered to England to purchase torpedo material, etc. After the war he went to Mexico, and as the imperial commissioner of immigration of the emperor Maximilian, attempted to found a Virginian colony there. While there he introduced the cultivation of cinchona. The scheme of colonization was abandoned by the emperor (1866), and Maury settled for a while in England, where he was presented with a testimonial raised by public subscriptions. In 1868 he accepted the professorship of meteorology in the Virginia Military institute, and settled at Lexington, Va., where he died on Feb. 1, 1873.

Among works published by Maury are the papers contributed by him to the *Astronomical Observations* of the U.S. observatory; *Letters on the American and Atlantic Slopes of South America* (1853); *Physical Geography of the Sea* (1855); *Letter Concerning Lanes for Steamers Crossing the Atlantic* (1855); *Physical Geography* (1864); *Manual of Geography* (1871).

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MAUSOLEUM: *see* Monuments and Memorials.

MAUSOLUS (Maus[s]ol[l]os), satrap and practically ruler of Caria (377/376–353/352 B.C.). The part he took in the revolt against Artaxerxes II of Persia, his conquest of a great part of Lycia, Ionia and of several of the Greek islands, his co-operation with the Rhodians and their allies in the war against Athens (357–355), and the removal of his capital from Mylasa, the ancient seat of the Carian dynasts, to Halicarnassus are the leading facts of his history. Mausolus is best known from the tomb (the Mausoleum) erected for him by his sister and widow Artemisia. The architects Satyrus and Pythius and the sculptors Scopas, Leochares, Bryaxis and Timotheus finished the work after her death in 351/350. *See* Halicarnassus.

MAUSS, MARCEL (1872–1950), French sociologist and social anthropologist, was one of the advocates of modern anthropological thought. Born at Épinal, on May 10, 1872, of a Jewish family, Mauss was the nephew of Émile Durkheim, who contributed much to his intellectual formation. Mauss succeeded Durkheim as editor of *L'Année Sociologique* and took an important part in the preparation of his uncle's works, especially *Le Suicide*. In 1902 he became professor of primitive religion at the École Pratique des Hautes Études in Paris and in 1931 was appointed to the Collège de France. By the side of Jean Jaurès, he had been active in his youth in the French socialist movement. He was one of the founders of the Institut d'Ethnologie of the University of Paris in 1925. He died in Paris in Feb. 1950.

Although he never did field work, Mauss turned the attention of a generation of French sociologists, philosophers and psychologists toward ethnographical studies. He published very little, but had an amazing knowledge of anthropological literature and a flair for new and promising trends. Rather than explaining native customs after preconceived ideas, Mauss took pains to distinguish native points of view and to preserve their freshness and specificity. He thus became one of the early advocates of a close relationship between psychology and anthropology. Mauss was the exponent of the principle of reciprocity; *i.e.,* the conception of social life as a network of obligations expressed in the exchange of goods. His outstanding work was *Essai sur le Don* (1898; Eng. trans., *The Gift: Forms and Functions of Exchange in Archaic Societies,* 1954). This and other articles are collected in book form: *Sociologie et Anthropologie* (1950). (C. Le.-S.)

MAUVE, ANTON (1838–1888), Dutch painter, who, like his friends Jozef Israëls and the three Maris brothers, was profoundly influenced by J. B. C. Corot, J. F. Millet and the Barbizon painters, and whose work consists largely of landscapes and scenes of rural life. He was born at Zaandam, near Amsterdam, on Sept. 18, 1838, and settled at The Hague in 1870, painting in the neighbouring fishing village of Scheveningen. In 1885 he went to live in the country at Laren, near Hilversum, and died at Arnhem on Feb. 5, 1888. Mauve's pictures are subdued in colour, and close to Corot in their harmonies of grays and blues. He was an accomplished water-colourist. His wife, Jet Cabentus, was a cousin of Vincent van Gogh, whom Mauve was able to help with advice about oil painting in 1881 and 1882. (A. Bs.)

MAVROKORDATOS (Mavrogordato), the name of a family of Phanariot Greeks, of whom the best known are the following:

Alexandros Mavrokordatos the Exaporite (1641–1709), born in Constantinople, Nov. 7, 1641, the son of a merchant of Chios, studied at Rome, Padua and Bologna and became physician and then dragoman (1673) to the sultan. Appointed minister plenipotentiary, he negotiated the treaty of Karlowitz (1699). His influence at the Porte was considerable and he ameliorated the conditions of the sultan's Christian subjects. He died in Constantinople, Dec. 23, 1709.

Nikolaos Mavrokordatos (1680–1730), son of Alexandros, was born in Constantinople on May 3, 1680, a scholar and linguist who succeeded his father as first dragoman in 1698. In the years 1709–10 and 1711–16 he was hospodar (prince) of Moldavia. Appointed hospodar of Walachia (1716) he was taken prisoner by the Austrians but set free and restored in 1719. The first Greek ruler in the Danubian principalities, he introduced there Greek manners, language and costume, a splendid court and administration by Greek officials who were detested by the Rumanians. He encouraged learning and founded libraries.

Prince Alexandros Mavrokordatos (1791–1865), Greek statesman and great-great grandson of his namesake, was born in Constantinople on Feb. 11, 1791. In 1812 he went to the court of his uncle, Ioannis Karadja, hospodar of Walachia with whom he passed into exile in Russia and Italy (1817). In Aug. 1821, shortly after the outbreak of the Greek War of Independence, he joined a Greek camp near Tripolitsa in the Morea. Disgusted with the aims of the leading Moreots and finding that his political wisdom was not wanted, he moved in September to Missolonghi in western Greece, where he set up an administration. In Jan. 1822 he presided over the first Greek national assembly at Epidaurus and took a leading part in drawing up a constitution. He had no illusions however about the central institutions it established and, though elected president of the executive, he soon returned to his command at Missolonghi. He failed to thrust into Epirus and join the Souliots; his troops (he was not present) were defeated at Peta on July 16, but he held out at Missolonghi. In 1823 he returned to the central government and along with Georgios Kounduriotis, the new president of the executive, faced the opposition of Theodoros Kolokotronis (*q.v.*) and others. When in 1825 Ibrahim Pasha threatened the Morea, he led forces against the Egyptians and barely escaped capture when the island of Sfaktiria was taken. Upon his return to the seat of government, he was much concerned with foreign policy. Although often regarded as pro-English, he had no desire to rely exclusively on Great Britain, but wished to enlist the support of all the powers, Austria included, and to stimulate rivalry between them. He therefore did not approve, though he was powerless to avert, the Greek demand for British protection (June–July 1825). Under the regime of Count I. A. Kapodistrias, who ignored him, he joined the so-called constitutional opposition. Under King Otho he became minister of finance and in 1833 prime minister. From 1834 onward he was Greek envoy in Munich, Berlin, London and—after a short period as prime minister in 1841—in Constantinople. After the revolution of 1843 he was again prime minister in 1844 and in 1854–55. He died on the island of Aegina on Aug. 18, 1865.

See A. A. C. Stourdza, *L'Europe orientale et le rôle historique des Maurocordato 1660–1830* (1913). (D. Dn.)

MAWER, SIR ALLEN (1879–1942), English philologist and student of place names, was born in Bow, London, on May 8, 1879.

A graduate of Cambridge university, Mawer taught at several provincial universities before coming to London, where he was provost of University college from 1930 until his death. His first interest was in early English and Scandinavian history and literature (*The Vikings,* 1913), but from 1920 all his work was in the field of English toponymy. He was one of the founders of the English Place-Name society (1924), director of its Survey of English Place Names until his death, and joint author of 14 of the 17 county surveys published by 1942, as well as of several studies concerned with English place-name research. He was knighted in 1937. Mawer died on July 22, 1942, at Broxbourne, Hertfordshire. (M. S. Bg.)

MAWLAIK, the administrative centre of the Upper Chindwin district of the Union of Burma. Pop. (1953) 3,042. The town was a creation of the British period and is pleasantly situated on low cliffs on the western bank of the Chindwin. An earlier centre, Kindat, a few miles farther up the river on the east bank, was abandoned as it was found to be unhealthful; indeed much of the Upper Chindwin district had a bad reputation for fever. The district consists of forested hills, the few settlements being mainly along the river. Homalin, 100 mi. N.N.E. of Mawlaik, is the normal high-water limit of navigation by steamers and launches; Pantha (about 12 mi. E. of which is the small oilfield of Indaw) is the limit of low-water navigation. The port of Kalewa to the south, where the Myittha enters the Chindwin from the west, became famous during World War II as the point where the Chindwin was crossed by the main Allied army, having made the extremely difficult mountain crossing from India, to drive out the Japanese forces. (L. D. S.)

MAX, ADOLPHE (1869–1939), Belgian Liberal political

leader who as burgomaster of Brussels achieved world-wide fame in World War I for his defiance of the Germans, was born in Brussels on Dec. 30, 1869. He studied at Brussels university, obtaining his law degrees in 1889. From 1896 he was successively provincial councilor of Brabant, councilor of the commune and alderman of Brussels and finally burgomaster (Nov. 1909). In Aug. 1914, when the German troops entered Brussels, he refused to perform his duties under the authority of the German governor and demanded complete freedom of action. He strove with indomitable energy for the rights of the Belgian people and for the reduction of the heavy taxes and requisitions imposed on the town. He also founded a national committee to deal with supplies. The Germans soon took exception to his resistance, and arrested him on Sept. 26, 1914. Imprisoned in the fortress of Namur, he was later sent into Germany. On Nov. 13, 1918, he returned to Belgium where he was welcomed with enthusiasm. Appointed minister of state on Nov. 21, 1918, he was elected to the chamber of representatives on Nov. 16, 1919. On Feb. 6, 1919, he had been elected to the Belgian academy. Max remained burgomaster till his death in Brussels on Nov. 6, 1939.

See A. Vierset, *Adolphe Max* (1923); O. E. Millard, *Burgomaster Max* (1936).

MAXENTIUS, MARCUS AURELIUS VALERIUS (d. 312), Roman emperor from A.D. 306 to 312, was the son of Maximian (*q.v.*). On his father's abdication on May 1, 305, he was passed over in favour of Severus, who was made the new *Caesar*, and on Constantius' death in 306 *Augustus*. Severus' moves to disband the praetorian guards and impose the poll tax on the citizens of Rome provoked discontent: Maxentius was proclaimed *Augustus* at Rome on Oct. 28, 306, and recalled his father to the throne. Severus was defeated and killed, and Galerius when he invaded Italy was forced to withdraw. Shortly afterward Maxentius quarreled with his father, who sought refuge with Constantine. Maxentius at first controlled Italy, Spain and Africa, but in 308 the vicar of Africa, L. Domitius Alexander, revolted and proclaimed himself *Augustus*, and in 310 Constantine annexed Spain. Maxentius recovered Africa in 311, but in 312 Constantine invaded Italy and Maxentius was defeated and killed at the battle of the Milvian bridge. Maxentius is represented as a brutal tyrant in our sources, which reflect the propaganda of Constantine, despite the fact that he dropped the persecution of the Christians. He built a huge basilica, which Constantine renamed after himself, and a temple to his son, Romulus, who died before him, in the Roman forum. (A. H. M. J.)

MAXIM, HUDSON (1853–1927), U.S. inventor who developed explosives that were used extensively in World War I, was born at Orneville, Me., on Feb. 3, 1853. He completed his academic studies at Kent's Hill, Me. Though he had little education, his interest in chemistry led him to wide reading and experimentation in the subject. In 1875 he formulated a hypothesis (published in *Scientific American Supplement*, 1889) of the compound nature of atoms not unlike the atomic theory that was later to be generally accepted by scientists.

In 1888 he began to experiment with explosives and in 1890 built a dynamite and powder factory at Maxim, N.J. There, together with R. C. Schupphaus, he developed the Maxim-Schupphaus smokeless powder, the first made in the United States and the first to be adopted by the U.S. government. He next invented a smokeless cannon powder, the cylindrical grains so perforated that it burned with a more rapid combustion, which was used in enormous quantities during World War I. In 1897 he sold his factory and powder inventions to E. I. du Pont de Nemours and company, but remained with the company as a consulting engineer.

He invented "maximite," a high explosive bursting powder which, when placed in torpedoes, resisted the shock of firing and the still greater shock of piercing armour plate without bursting. This powder was then set off by a delayed-action detonating fuse, which was also Maxim's invention. Later he perfected a new smokeless powder, called "stabillite" because of its high stability. "Motorite," a self-combustive substance used to propel torpedoes, was also his invention.

During World War I, Maxim served as chairman of the committee on ordnance and explosives of the naval consulting board. Several of his own inventions at this time were donated to the government. He died on May 6, 1927.

SIR HIRAM STEVENS MAXIM (1840–1916), his brother, was the inventor of the Maxim automatic gun.

MAXIMA AND MINIMA: *see* CRITICAL POINTS.

MAXIMIAN (MARCUS AURELIUS VALERIUS MAXIMIANUS) (d. 310), Roman emperor from A.D. 286 to 305, was born of humble parentage near Sirmium in Pannonia. He served in the army and was in 285 made *Caesar* by his friend Diocletian, and in the following year (April 1, 286) raised to the rank of *Augustus*. He thus became in theory the junior colleague of Diocletian, but his role was always subordinate. While Diocletian took the surname of *Jovius*, as vicegerent of Jupiter, Maximian was given that of *Herculius*, as his faithful assistant. He was assigned the government of the west, where he subdued the Bagaudae, the rebel peasants of Gaul, but failed to suppress the revolt of Carausius in Britain. On March 1, 293, Constantius Chlorus was appointed his *Caesar* and took over Gaul and recovered Britain. Maximian continued to govern Italy, Spain and Africa, where he subdued the rebel Moorish tribes. On May 1, 305, on the same day that Diocletian abdicated at Nicomedia, he abdicated at Milan, but evidently much against the grain, and retired to a villa in Lucania. When his son Maxentius rebelled in Rome on Oct. 28, 306, he gladly on his invitation resumed the throne, and it was through his prestige with the troops that Severus and Galerius were defeated. Soon afterward he attempted to depose his son, but failed and fled to Constantine, who had recently married his daughter Fausta. In 308 he was invited by Galerius to the conference of Carnuntum and was persuaded by Diocletian to abdicate once more. He returned to Constantine's court, and in 310, taking advantage of his absence on a campaign against the Franks, raised a rebellion at Arles. Constantine promptly marched back and captured him at Marseilles, but spared his life. Shortly afterward he died: he was alleged to have committed suicide in remorse for his rebellion, or, according to a more lurid version, on having been detected by his daughter in an attempt to assassinate Constantine. Maximian is a great persecutor in the Christian tradition, but seems to have done no more than obediently execute in his part of the empire the first edict of Diocletian, which ordered the burning of the Scriptures and the closing of the churches. (A. H. M. J.)

MAXIMILIAN I (1459–1519), Holy Roman emperor from 1493, was born at Wiener Neustadt on March 22, 1459, as an archduke of Austria, being the eldest son of the emperor Frederick III, of the house of Habsburg, by his consort Eleonore (Leonor) of Portugal. After Charles the Bold, duke of Burgundy, had been killed in battle (Jan. 1477), Maximilian was married, by proxy in April and in person in August, to Charles's daughter Mary (*q.v.*), whose inheritance, both in Burgundy and in the Netherlands, was being invaded by Louis XI of France. Maximilian at once undertook the defense of his wife's dominions; and he defeated the French at Guinegate (Enguinegatte) in Artois on Aug. 7, 1479. He was regarded with suspicion, however, by the estates of Mary's territories in the Netherlands. He suppressed a rising in Gelderland; but his position was weakened by his wife's early death (March 27, 1482). Maximilian claimed to be regent for his son Philip, Mary's heir, but some of the estates refused to recognize his regency. The city of Ghent, having obtained custody of Philip, refused to give him up, and disorder became general. In 1483 Maximilian had to agree to the terms of the treaty of Arras (1482), negotiated by the estates of the Netherlands with Louis XI of France: by this treaty Maximilian's daughter Margaret was betrothed to the dauphin (the future Charles VIII of France) and brought Artois and Franche-Comté to him as her dowry, while the French king's seizure of the duchy of Burgundy and of places in Picardy that Charles the Bold had held was tacitly accepted. Even so, Maximilian continued his struggle in the Netherlands, crushed a rebellion in Utrecht (Sept. 1483) and forced Ghent to deliver Philip into his hands again (July 1485).

Returning to Germany, Maximilian was elected king of the Romans (prospective successor to the emperor) at Frankfurt on

Feb. 16, 1486, and crowned at Aachen on April 9. He then went back to the Netherlands. Allying himself with Francis II of Brittany, he resumed warfare against France. The war, however, was very unpopular with the commercial cities of Flanders; and Maximilian, having entered Bruges in Jan. 1488, was held prisoner there by the citizens from February to May, being released only when his father was approaching with a large force. After a punitive expedition against the Flemings, Maximilian withdrew to Germany late in 1488 and concluded the peace of Frankfurt with the French in July 1489. His deputy in the Netherlands, Albert duke of Saxony, gradually compelled the estates to accept Maximilian as regent. In March 1490 Tirol was added to his possessions when his father's first cousin Sigismund abdicated in his favour. Tirol soon became Maximilian's favourite place of residence.

Francis II of Brittany had died in Sept. 1488, leaving the duchy of Brittany to his heiress, Anne (*q.v.*); and in Dec. 1490 Maximilian was married to Anne by proxy. He was in alliance with England and with Spain for the defense of the duchy, but was himself engaged in fighting for the crown of Hungary, whose king, Matthias Corvinus, had died in April. He drove the Hungarians out of Austria and regained Vienna, where Matthias had ruled since 1485. He could not afford an invasion of Hungary, however, and by the treaty of Pressburg (Bratislava) of Nov. 7, 1491, he recognized Vladislav of Bohemia as king of Hungary, though it was agreed that the succession to both Bohemia and Hungary should pass to the Habsburgs if Vladislav left no male heir. Brittany meanwhile had been overrun by the French, and in Dec. 1491, despite Maximilian's claim, Charles VIII of France married Anne, though Maximilian's daughter Margaret of Austria was kept in France. Maximilian could do nothing against this until, having driven the Turks from Carinthia in 1492, he turned westward to defeat the French at Salins in Franche-Comté (Jan. 1493). Neither the Netherlands nor the German *Reichstag* would support him, however, and in May 1493 he agreed to the peace of Senlis, regaining Artois, Franche-Comté and his daughter Margaret.

On the death of the emperor Frederick III (Aug. 19, 1493) Maximilian became sole ruler over the German kingdom and head of the house of Habsburg; and on March 16, 1494, at Innsbruck, he married Bianca Maria Sforza (d. 1510), sister of the duke of Milan, Gian Galeazzo Sforza. In the Netherlands again later in 1494, he led an expedition against the rebels of Gelderland; made an ineffectual appeal to the Christian sovereigns to help him drive the Turks from Europe; recognized the pretender Perkin Warbeck as the rightful king of England; and formally handed over the government of the Low Countries to his son Philip.

Maximilian's attention was next turned to Italy, where Charles VIII of France was advancing victoriously southward to make himself king of Naples. In March 1495 Maximilian therefore joined Spain, Pope Alexander VI, Milan and Venice in the League of Venice against the French; and at the same time he called the *Reichstag* to Worms, asked it for help in the projected campaign and urged the need to eject the French from Italy. But counter-proposals for the better government of Germany were brought forward, and military help did not materialize. Some reforms were adopted; the public peace was declared permanent (the *Ewige Landfriede*, outlawing private warfare between members of the *Reich*); the imperial chamber (*q.v.*) or *Reichskammergericht* was instituted as a permanent court of justice for the empire, with its seat at Frankfurt; and a tax was voted. These reforms were rendered abortive by the nonpayment of the tax and Maximilian's consequent refusal to work the constitution. Instead, he operated through judicial and financial commissions of his own. He fought another French war and made an ineffectual expedition to Italy, financed by Milan (1496). On the other hand, on Oct. 21, 1496, his son Philip was married to the Spanish infanta Joan, a union destined to produce the vast empire of their son Charles V.

In 1499 the refusal of the Swiss to submit to imperial legal decisions produced a war. Maximilian was forced reluctantly to prepare a punitive expedition. Before he himself could intervene the Swiss had defeated his Swabian and Austrian troops; and the treaty of Basel (Sept. 22, 1499) recognized the Swiss as virtually independent. Maximilian, much chastened by failure, attended the *Reichstag* of 1500 at Augsburg; asked the assembly to finance the ejection of Louis XII—who had succeeded Charles VIII as king of France in 1498 and had promptly married his widow Anne of Brittany—from the imperial fief of Milan; and accepted the formation of a *Reichsregiment* (supreme council) of 21 electors, princes and others. This would have made him formal president of an oligarchic republic. But the *Regiment* did not work, and it ceased to function after 1502. Maximilian won the support of many younger princes and established his own supreme court. He negotiated with Louis XII and concluded the treaty of Blois (Sept. 22, 1504): his baby grandson Charles was betrothed to Louis XII's baby daughter Claude; Louis kept Milan, doing homage and paying 200,000 ducats; and if Louis had no son, Charles and Claude should succeed to Milan, Blois and Brittany.

A succession dispute over the Wittelsbach duchy of Bavaria-Landshut in 1504 enabled Maximilian to judge the case and propose partition (*see* BAVARIA). Rupert of the Palatinate, a disappointed litigant, attempted violence. Maximilian raised an imperial force and quickly defeated the rebel. At the *Reichstag* of Cologne (1505) he awarded most of the inheritance to Bavaria-Munich and a lesser share to Rupert's sons, and confiscated several towns and lordships for the house of Habsburg. It was his moment of triumph. The *Reichstag* was tired of constitutional experiments. Committees of princes could not govern. Maximilian could occasionally exercise authority. The Venetian envoys reported home that he was "a true emperor and ruler of Germany."

But foreign affairs went badly. Louis XII denounced the treaty of Blois; Maximilian's son Philip, king of Castile since his mother-in-law Isabella's death in 1504, died in 1506; and the infant Charles's hope of succession was dubious. However, Maximilian established his daughter Margaret as regent in the Netherlands. If the *Reichstag* of Constance (1507) restored the *Reichskammergericht* in its permanent, if not very effective, form, it also voted a moderate force to accompany Maximilian to Rome for his coronation as emperor. Maximilian started for Rome, but was faced with Venetian resistance; and no imperial troops appeared. At Trent on Feb. 4, 1508, he assumed, with Pope Julius II's consent, the title of "emperor elect." Then, to recover long-lost imperial territory, he began a war against Venice which lasted intermittently for eight years and ultimately ruined him, since the *Reichstag* would vote nothing for a struggle so disastrous for German trade. Negotiations at Cambrai led to a treaty with France against Venice (Dec. 10, 1508); and in 1509 Spain and the pope also joined Maximilian's side (the League of Cambrai); but he had little success.

When Julius made a separate peace with Venice and set himself to drive the French out of Italy (1510), Maximilian joined Louis XII in summoning a general council for church reform at Pisa. Being again a widower, he even considered getting himself elected pope. But eventually he joined the pope's Holy League against France. Having no troops, he attached himself as an adviser to Henry VIII's English army in Artois and was largely responsible for its victory in the battle of the Spurs (Aug. 16, 1513).

Eastern affairs, the danger that Poland, Bohemia and Hungary might unite under the Polish Jagiello dynasty, then preoccupied the emperor. His efforts culminated in an agreement at Vienna (1515) whereby Louis, the young son of Vladislav of Bohemia-Hungary, was betrothed to Maximilian's granddaughter Mary, and her brother Ferdinand was betrothed to Vladislav's daughter Anne. The treaty bore fruit when Louis died in the great Turkish victory at Mohács (1526) and Ferdinand succeeded him.

Meanwhile the new French king Francis I had again conquered Milan, which Louis XII had lost. Maximilian borrowed money, raised a force and actually entered Milan (March 1516). But his money ran out; and his troops mutinied. He hurried home penniless, leaving Milan to Francis I and Verona to Venice. At the *Reichstag* of Augsburg (1518) he failed to secure the election of his grandson Charles, now ruler of Spain, Naples and the Netherlands, as king of the Romans. His strength was failing. He made for his birthplace but died at Wels on Jan. 12, 1519. He was buried at Wiener Neustadt, though his famous tomb is at Innsbruck.

Simple in his habits, conciliatory in his manner and catholic in his tastes, Maximilian enjoyed great popularity and rarely made a personal enemy. He was a skilled knight and a daring huntsman; a military expert, especially on artillery and the organization of the *Landsknechte* (infantry); a man of letters and a patron of learning and the arts. But he left Germany in even worse anarchy than he found it. As German king he is a controversial figure. His critics accuse him of absorption in Habsburg dynastic aggrandizement and indifference to the good government of Germany. It can be replied that in England, France and Spain in Maximilian's time, strong states were being created by kings, not by medieval oligarchies of nobles; that Maximilian constantly exhorted the *Reichstag* and gatherings of princes or towns to unite under their king and to provide the resources for government and defense, especially against France and Islam; and that Germany's hope of unity lay in a Habsburg monarchy free to impose taxation and to keep a standing army and in the increase of the Austrian lands. What is undoubted is that Maximilian could not be patient and realistic, but plunged into adventures for which he could not pay. Yet as ruler of Austria he laid the foundations of unified government over his various provinces, while his matrimonial arrangements produced the vast empire of Charles V and the long-lived unity of Austria-Bohemia-Hungary.

Maximilian was also an author, and his writings show his inordinate vanity. His *Geheimes Jagdbuch* is a treatise instructing his grandsons in the art of hunting. He inspired the production of *The Dangers and Adventures of the Famous Knight Teuerdank*, an allegorical poem describing his adventures on his journey to marry Mary of Burgundy (first printed by Melchior Pfintzing at Nürnberg, with woodcuts by Hans Leonhard Schäufelein, 1517). The *Weisskunig*, an unfinished autobiography of "the young white king," was long considered the work of Maximilian's secretary, Marx Treitzsaurwein, but is now believed to be mostly by Maximilian himself (first published at Vienna in 1775). He also wrote *Freydal* (an allegorical account of his tournaments during his wooing of Mary); *Ehrenpforten, Triumphwagen* and *Der weisen Könige Stammbaum* (these three on his own history and on that of the house of Habsburg); and works on miscellaneous subjects such as metallurgy, architecture and gardening. These works were all profusely illustrated, some of them by Albrecht Dürer.

There are editions of Maximilian's correspondence with his daughter Margaret for the years 1507–19 by A. G. Le Glay (1839); of some previously unpublished letters of his on the affairs of the Netherlands by L. P. Gachard (1851–52); and of his correspondence with Sigmund Prüschenk by V. von Kraus (1875).

See also references under "Maximilian I," in the Index.

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MAXIMILIAN II (1527–1576), Holy Roman emperor from 1564, was born in Vienna on July 31, 1527, the eldest son of the Austrian archduke and future emperor Ferdinand I and Anna, daughter of Vladislav II, king of Bohemia (Ulászló II of Hungary). He gained experience in warfare and government under his uncle the emperor Charles V, to whose daughter Maria he was married in Sept. 1548 (they were to have nine sons and six daughters; *see* HABSBURG: *Table II*). The Habsburg family became divided over Charles V's plan for his son, the future Philip II of Spain, to succeed as emperor, either after Ferdinand I, who had already been designated Charles's successor, or possibly, as was rumoured, instead of Ferdinand. By a compromise in 1551, Philip was placed in line of succession after Ferdinand, and Maximilian after Philip. In 1553, Philip was excluded from the succession, but Maximilian remained hostile toward the Spanish Habsburgs.

From 1547 onward Maximilian had developed inclinations toward Lutheranism. The nature of his beliefs has long been disputed; they were ambiguous and uncertain, but he was probably a humanist Christian without loyalties to the dogmas of any confession. He expressed sympathy for Lutheranism until 1562, but thereafter conformed outwardly to Catholicism by declaring his obedience to that faith and by attending Mass. Nevertheless, in his last years and on his deathbed he refused to confess to a Catholic priest or to receive sacraments from one. While hostile to Calvinists, Maximilian believed that Lutherans and Catholics, if they could not be reconciled, should at least tolerate one another. He was to grant freedom of worship to the Protestant nobility of Austria, Bohemia and Hungary because he needed their financial assistance in the Turkish war. Political necessity partly explained his friendliness toward the German Protestant princes. His conformity to Catholicism probably had similar political reasons, arising from his position as emperor and possible heir of the Spanish kingdoms. His father threatened to disinherit him if he abandoned Catholicism. Therefore, though Maximilian had promised the Protestant electors to adopt the Lutheran Augsburg confession if elected, he assured the Catholic electors of his orthodoxy before his election and coronation as king of the Romans, or successor designate to the empire, at Frankfurt on Nov. 24 and 30, 1562. Having already been proclaimed as the future ruler of Bohemia in 1549 and crowned at Prague on Sept. 20, 1562, he was crowned king of Hungary at Pressburg (Bratislava) on Sept. 8, 1563. On July 25, 1564, he succeeded Ferdinand in the empire and in the two duchies of Austria (which he had been governing from 1552), while his brothers inherited the remaining Habsburg duchies.

Maximilian disappointed the Protestant princes at the imperial diet of Augsburg in 1566 by not fulfilling his earlier promise to invest Protestant administrators of bishoprics with their imperial fiefs. He accepted the reforming decrees of the Council of Trent, but his hopes of measures against the Calvinist elector Palatine, Frederick III, were balked by opposition from Lutheran princes. Nevertheless, the diet granted financial aid for the recently renewed war against the Turks in Hungary. Maximilian's large army engaged in one ineffective campaign before peace was concluded in 1568; the emperor continued to pay tribute to the sultan for Hungary. In Austria, he allowed religious liberty to the Lutheran nobles in 1568 and 1571; he commissioned theologians to draft Lutheran ordinances, but also promoted reform of the Catholic Church. Meanwhile he had become reconciled with Philip II of Spain, who married Maximilian's daughter Anna in 1570. However, the emperor's intercession on behalf of the rebellious Protestant Netherlands failed to moderate Philip's harsh measures against them. In 1570, Maximilian proposed to the diet of Speyer a reform of the imperial military organization, based on a memorandum of Lazarus von Schwendi: the emperor and not the princes, as hitherto, would control the army, and his consent would be necessary before foreign powers could recruit soldiers in the empire. These measures were rejected because the estates would not strengthen the emperor's authority and the Protestant princes suspected an attempt to prevent them from assisting coreligionists in France and the Netherlands. Whereas Protestantism had become the faith of the majority in Austria by the end of his reign, Maximilian prevented the proclamation in Bohemia of the confession of faith agreed on by all the reforming movements in 1575, but promised to respect religious liberty.

From 1573 Maximilian sought election as king of Poland for himself or for his son Ernest. Himself elected king of Poland by a minority party in Dec. 1575, he received no assistance from the imperial diet at Regensburg. He died at Regensburg on Oct. 12, 1576, leaving his lands and his imperial title to his eldest surviving son, Rudolf. Maximilian was a collector of books and a patron of artists, architects and scholars, and of the University of Vienna. He preserved the right to worship according to his own beliefs, but succeeded in few of his political aims. There is an edition of his *Familienkorrespondenz* by V. Bibl, two volumes (1916–21).

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MAXIMILIAN (Ferdinand Maximilian Joseph) (1832–1867), archduke of Austria and emperor of Mexico, younger brother of Emperor Francis Joseph I, was born in Vienna on July 6, 1832. Of scholarly bent, he received a superior education. After serving as a rear admiral in the Austrian navy, he was appointed at the age of 25 as governor general of the Lombardo-Venetian kingdom. On Oct. 3, 1863, a committee of Mexican conservatives, exiled by Pres. Benito Juárez, came to Maximilian's palace on the Adriatic sea and invited him to become emperor of Mexico. The invitation had been maneuvered by the French emperor Napoleon III, who wanted to collect a debt from Mexico and further his imperialistic ambitions. After deep deliberation, deluded by a false report that the Mexicans had "voted" him a throne, Maximilian accepted the offer, backed by a pledge that the French army, which had conquered much of Mexico, would remain to support him. With his young wife, Carlota, daughter of Belgium's Leopold I, Maximilian sailed for Mexico in May 1864. He went in good faith as a benevolent ruler; he had dabbled in liberalism and had even discussed socialism with the famed Utopian reformer Robert Owen. On June 10, 1864, the royal pair were crowned in the Cathedral of Mexico. At remodeled Chapultepec palace, high above the city, Maximilian established his court. He created a magnificent park and planned a boulevard from the palace hill to Cathedral square.

Maximilian's tall stature and blond hair caused some Indians to believe that he was an incarnation of their fair-skinned, bearded god Quetzalcoatl, a role that Cortés had played to his advantage. Maximilian, in return, soon regarded himself as the Indians' protector. He upheld Juárez' sweeping reform laws: to the indignation of the landed proprietors, he determined to abolish peonage, and he antagonized the Roman Catholic archbishop of Mexico by refusing to restore vast church holdings confiscated by Juárez. He devised schemes for the education of the masses and started a national art gallery. But the Mexican treasury was so bare that he had to use his own inherited income for daily expenses.

By April 1, 1865, the French army had successfully supported Maximilian by driving his enemy Juárez almost into Texas. At this time, however, the Civil War in the United States ended, and the U.S. was able to turn its attention to Mexico. Regarding the presence of the French troops there as a violation of the Monroe Doctrine, U.S. Secretary of State William H. Seward issued an ultimatum demanding their withdrawal. In July 1866 Carlota rushed to Europe to plead with Napoleon not to abandon her husband. Then she sought help from the pope. Realizing that no aid would be forthcoming, she underwent so great a strain that she lost her sanity.

When the French withdrew in March 1867, Juárez and his troops moved back south. Napoleon expected Maximilian to leave Mexico with the French, but the young emperor felt he could not honourably desert "his people." The Mexican conservative leaders made him supreme commander of the imperialistic army. At Querétaro, Maximilian's small force was surrounded, starved and finally betrayed into capitulation on May 15, 1867. When deliberately given an opportunity to escape, Maximilian refused to save himself. He bore his hardships with fortitude. Wasted by fever and dysentery, he was confined in a dank crypt by Juárez and given a criminal's diet of bread and water. Though Garibaldi, Victor Hugo and half the crowned heads of Europe pleaded for his life, Maximilian was court-martialed, tried and condemned to death. His execution took place on the Hill of Bells outside Querétaro on June 19, 1867.

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MAXIMILIAN AND CARLOTA

Maximilian was a luckless, idealistic, politically naïve hero of an impossible dream, whose courage at his death turned a tragicomedy into a tragedy. As a ruler he vacillated and committed political blunders, but as a man, according to his Mexican private secretary, he "possessed the most noble, loyal and great heart." Maximilian's various writings in German were collected and published. His empress Carlota never fully recovered her sanity. She survived her husband for six decades, dying in a chateau near Brussels in Jan. 1927.

See Egon Caesar, Count Corti, *Maximilian and Charlotte of Mexico* (1928), with an extensive bibliography; Hudson Strode, *Timeless Mexico* (1944). (Hu. St.)

MAXIMILIAN I Joseph (1756–1825), the first Wittelsbach king of Bavaria (from 1806), was born at Mannheim on May 27, 1756, the second son of Prince Frederick Michael of Palatinate-Zweibrücken. From 1775 to the outbreak of the French Revolution he served with the French regiment of Alsace. When he succeeded his brother Charles II Augustus as duke of Zweibrücken (April 1, 1795), the duchy was already occupied by the French, who retained it under the Franco-Austrian peace of Campo Formio in 1797 (*see* French Revolutionary Wars); but on the death of the elector Charles Theodore of the Palatinate and Bavaria (Feb. 16, 1799) he inherited all the other Wittelsbach lands, becoming elector of Bavaria as Maximilian IV Joseph. These lands, however, were ill-administered, were scattered over southern and western Germany and were occupied by the Austrians. Maximilian Joseph and his minister Maximilian von Montgelas (*q.v.*) were to make Bavaria a consolidated modern state.

Though he had hoped, with Prussia's help, to stay neutral, the elector had to take Austria's side against France when war broke out again in 1799. After the peace of Lunéville, however, he made a treaty of his own with France (Aug. 24, 1801): formally renouncing the long-lost lands west of the Rhine, he won assurances of compensation. Under the *Reichsdeputationshauptschluss* of 1803 (*see* Germany: *History*), he obtained the formerly episcopal lands of Würzburg, Bamberg, Freising, Augsburg and part of Passau, with 15 imperial cities. Meanwhile, with the help of B. E. Deroy and Karl Philipp Wrede, he was building an army, which in 1805 he brought to France's side against Austria. The Austrians had to cede Tirol, Vorarlberg and other territories to Maximilian, who, however, gave Würzburg up. He also received Ansbach for renouncing distant Berg to France. On Jan. 1, 1806, the elector assumed the title of Maximilian I, king of Bavaria.

Obliged to join the Confederation of the Rhine (July 12, 1806), Bavaria took France's side against Prussia in 1806–07 and against Austria again in 1809. So in 1810 Maximilian, for ceding southern Tirol to Napoleonic Italy, received Salzburg, the Innviertel and Regensburg. Though he disliked Napoleon's Austrian marriage (1810), he sent 30,000 men to accompany the disastrous invasion of Russia (1812). On Oct. 7, 1813, however, he accepted the terms procured by Wrede from Austria: for his turning against Napoleon, the integrity of his kingdom was guaranteed (treaty of Ried, Oct. 8). He then exchanged Tirol and Vorarlberg with Austria for Würzburg and Aschaffenburg (1814). Finally he received a collection of Palatinate and other lands west of the Rhine—without, however, any territorial link with Bavaria—for retroceding the Innviertel and most of Salzburg (1816).

Having dismissed Montgelas, the architect of his kingdom, in 1817, Maximilian on May 26, 1818, granted Bavaria a constitution with a bicameral parliament; but the parliament's first session was so stormy that he thought of revoking the constitution (1819). Yet he won his subjects' affection, so that his dynasty could hold together the rather disparate lands that he had united. He died at Nymphenburg on Oct. 13, 1825.

Married in 1785 to Wilhelmine of Hesse-Darmstadt (d. 1796) and in 1796 to Caroline of Baden (1776–1841), Maximilian was survived by 10 of his 13 children, including his successor Louis I (*q.v.*) and daughters married in his lifetime to Eugène de Beauharnais (1806), to Francis I of Austria (1816), to John of Saxony (1822), to Frederick William IV of Prussia (1823) and to the Austrian archduke Francis Charles (1824).

See Prince Adalbert of Bavaria, *Max I. Joseph von Bayern* (1957). (K. O. v. A.)

MAXIMILIAN II (1811–1864), king of Bavaria from 1848, was born in Munich on Nov. 28, 1811, the eldest son of King Louis I and his consort Therese of Saxe-Hildburghausen. He

studied history and political science at Göttingen (1829) and at Berlin (1831) and then traveled extensively through Germany, Greece and Italy. As crown prince he surrounded himself with academics and artists, among whom the historian Leopold von Ranke took pride of place. By his marriage (1842) to Princess Marie of Prussia he had two sons, the future kings Louis II and Otto. He succeeded to the throne at his father's abdication on March 21, 1848.

Maximilian wished to make Bavaria the third German force in a triad (*Trias*) with Austria and Prussia, but this brought him into conflict with the German parliament at Frankfurt (*see* GERMANY: *History*). He had to call on Prussian troops to help him suppress a revolt in the Palatinate (1849), but he refused a closer alliance with Prussia. Ludwig von der Pfordten, who became Bavarian chief minister in April 1849, was in fact inclined rather to take a pro-Austrian attitude. The idea of a "third force" in German affairs was never realized, though Pfordten succeeded in obtaining great influence in the diet of the German confederation by working together with other German states.

Maximilian was more successful in his efforts to make Munich a centre of Germany's intellectual and artistic life. Large-scale research projects were furthered by the establishment of departments of the sciences, technology and history at the Bavarian Academy of Sciences. The king appointed well-known scholars to academic posts in Bavaria and remained in personal contact with them. At times these scholars and artists also meddled in politics, though it is hard to prove the extent of their influence: the historian Wilhelm von Dönniges especially gave advice to the king on political questions as well as on cultural matters.

The chances of success for Maximilian's policy diminished after Karl von Schrenck had taken Pfordten's place as minister (1859). Bavaria's support of the hereditary prince Frederick of Augustenburg as pretender to the duchies of Schleswig and Holstein (*see* SCHLESWIG-HOLSTEIN QUESTION) met with the opposition of all the other powers; but before the Austro-Prussian invasion of Denmark, Maximilian had died, in Munich, on March 10, 1864.

(K. O. v. A.)

MAXIMILIAN I (1573–1651), duke of Bavaria from 1597 and elector from 1623, was born in Munich on April 17, 1573, the son of the Wittelsbach duke William V and his wife Renée of Lorraine. Educated by the Jesuits at Ingolstadt, he succeeded to the ducal throne on his father's abdication in 1597. In Bavaria itself he broke the power of the (mostly Protestant) estates, which were not convened after 1612; and by strictly adhering to Catholicism he obtained Rome's assent to his control over the Bavarian church. With the whole apparatus of government in his own hands, he could create an efficient administration under a privy council, a well-trained army and a comprehensive law code. He was also a discriminating patron of the arts.

Maximilian's foreign policy was largely determined by rivalry both with the Calvinist Wittelsbachs of the Palatinate and with the Catholic Habsburgs of Austria. He also felt a vaguely patriotic dislike of foreign (mainly Spanish and Swedish) interference in Germany. These dispositions led him to a fairly consistent understanding with France, the chief opponent of the Habsburgs and the professed champion of the "German liberties."

When the Lutheran city of Donauwörth was outlawed by the imperial diet for failing to protect its Catholic minority, Maximilian undertook to execute the ban and then, for his insignificant exertions, drew up an account which the emperor Rudolf II could not pay. Maximilian therefore kept the town and re-Catholicized it, thus winning a foothold in Swabia. When the Protestant princes thereupon formed the union of Ahausen (May 14, 1608), Maximilian countered with the Catholic league (July 10, 1609). Next, on the death (1612) of his uncle Ernest, archbishop elector of Cologne and bishop of Hildesheim, of Liège and of Münster, he obtained these sees for his brother Ferdinand (who moreover became bishop of Paderborn in 1618); and in the War of the Cleves-Jülich Succession, the Catholic league's army under his general Tilly secured Jülich, Berg and Ravenstein in 1614 for Wolfgang William of Palatinate-Neuburg, husband of Maximilian's sister Magdalena.

When the Habsburgs tried to dominate the Catholic league, Maximilian seceded from it and in 1617 formed a new league without the Habsburgs. The emperor Ferdinand II had expressly to renounce all claims to the leadership of the league before Maximilian would come to his aid against the Bohemians (1619; *see* THIRTY YEARS' WAR). With French help Maximilian effected the neutrality of the Protestant union, and the league's army defeated the Bohemians (1620) and conquered the Upper and the Rhenish Palatinates (1622–23). Maximilian obtained the hereditary lands of the dispossessed Frederick V, together with the electoral dignity (1623), and kept Upper Austria in pawn (1620–28) for his real or alleged military expenses. He also took part in the Danish War, which was largely decided by Tilly's victory at Lutter (Aug. 27, 1626). But Maximilian's leading position was now threatened by the creation of an independent imperial army under Wallenstein. In concert with the other electors, he enforced Wallenstein's dismissal and the virtual disbandment of the imperial army (1630). The result was disastrous: the Swedes under Gustavus Adolphus promptly invaded Germany; the league's army, after the barren conquest of Magdeburg, was wiped out at Breitenfeld; Tilly himself was killed trying to defend Bavaria; and the Swedes entered Munich (1632). As Wallenstein, now generalissimo, did nothing to alleviate Maximilian's plight, Maximilian was instrumental in procuring his downfall (1634). The victory of Nördlingen liberated Bavaria from the Swedes (1634).

In return for his consent to the peace of Prague (1635), Maximilian forced the emperor to concede all that he wanted. He therefore took little part in further military actions and, on March 14, 1647, concluded an armistice with France and Sweden. Swedish reverses and an imperial attack on Bavaria soon made him abandon this new attitude, with the result that Bavaria was ravaged by the Swedes and French, who defeated the Bavarians at Zusmarshausen (May 17, 1648). The peace of Westphalia (Oct. 24, 1648) left Maximilian, thanks to his renewed co-operation with France, the electoral dignity and the Upper Palatinate, though he had to restore the Rhenish Palatinate to Frederick V's heir. Maximilian died at Ingolstadt on Sept. 27, 1651.

See F. Stieve, *Kurfürst Maximilian I. von Bayern* (1882); W. Goetz (ed.), *Die Politik Maximilians I. und seiner Verbündeten 1618–51*, 4 vol. (1907–48). (S. H. S.)

MAXIMILIAN II EMANUEL (1662–1726), elector of Bavaria from 1679, a prince of the house of Wittelsbach whose quest for dynastic aggrandizement obscured his reputation as a military hero, was born in Munich on July 11, 1662, the son of the elector Ferdinand Maria. He came of age to rule in 1680 and allied himself with the Holy Roman emperor Leopold I in 1683 for the war against the Turks, in which he made his name by capturing Belgrade in 1688. In the War of the Grand Alliance (1689–97) he took Leopold's side against France; and in 1692 Leopold induced Charles II of Spain to appoint him governor of the Spanish Netherlands. The elector set himself up in great splendour in Brussels, but his co-operation with William III of England achieved little success against the French.

Meanwhile, in 1685, the elector had married Maria Antonia of Austria, Leopold's daughter by Margaret of Spain and so a potential claimant to the succession of her uncle Charles II (*see* HABSBURG, *Tables* II and III). The electress, to whom her husband was flagrantly unfaithful, died in Vienna in Nov. 1692, having given birth to a son, Joseph Ferdinand. The elector could then expect that on Charles II's death this son would inherit the greater part of the Spanish dominions. When Joseph Ferdinand died (Feb. 6, 1699), the elector schemed to transform his governorship of the Spanish Netherlands into perpetual sovereignty.

For the War of the Spanish Succession the elector took France's side against his former allies. He now thought that the Wittelsbachs might supplant the Habsburgs in Germany. This prospect was shattered by the defeat of his army in the battle of Blenheim (1704). Dispossessed of Bavaria and, after the battle of Ramillies, driven also from the Netherlands (1706), he became a refugee at the French court. Bavaria, however, was restored to him under the peace (1714).

By Teresa Kunegunda Sobieska (1676–1730), whom he had

married in 1695, the elector had a daughter and eight sons, four of whom survived him. The eldest, Charles Albert (*see* CHARLES VII, Holy Roman emperor), was married in 1722 to Maria Amalia of Austria. The elector's last effort was to organize the Wittelsbach house-union of 1724, whereby Bavaria, the Palatinate and the Wittelsbach ecclesiastical princes concerted their action in Germany. Maximilian Emanuel died in Munich on Feb. 26, 1726.

MAXIMILIAN (MAX) OF BADEN, PRINCE (1867–1929), the last chancellor of imperial Germany, was born on July 10, 1867, the son of the grand duke Frederick I's brother Prince William of Baden (1829–97) and his wife Princess Maria Maximilianovna Romanovska. He married Marie Louise of Brunswick-Lüneburg (a titular princess of Great Britain) in 1900. From 1907 he was heir presumptive to the grand duchy of Baden, as his cousin the grand duke Frederick II (d. 1928) had no children. In the first years of World War I he devoted himself to the Red Cross and to work for the welfare of prisoners of war (on both sides). On Oct. 3, 1918, when Germany was on the verge of collapse, he was appointed chancellor of the empire and prime minister of Prussia in succession to Georg Hertling. He hastily superintended the constitutional changes whereby a genuine parliamentary system was at last brought into being in Germany, began negotiations for an armistice and secured the dismissal of Erich Ludendorff—but too late to save the monarchy. When the emperor William II would give no definite answer to Max's demands that he should abdicate in the face of the danger of Communist revolution, Max finally himself announced the abdication of the emperor on Nov. 9, 1918. He then resigned the chancellery to the leader of the Majority Social Democratic party, Friedrich Ebert.

Max continued to live in Baden till his death at Schloss Salem on Lake Constance, on Nov. 6, 1929. He had published *Völkerbund und Rechtsfriede* (1919), *Die moralische Offensive* (1921) and *Erinnerungen und Dokumente* (1927; Eng. trans. *Memoirs*, 1928).

END OF VOLUME FOURTEEN

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